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Best Undergraduate Student Paper Presentation

Best Doctoral - Student Paper Presentation

Best Paper Award

Table of Contents

Papers: Analytics, Big Data Applications, Business Intelligence, Data Mining, Statistics and Expert Systems

Papers: Data Analytics and Statistics Instruction

Papers: Healthcare, Public Sector and Not for Profit Management

Papers: IS, IT, Blockchain Technology and Social Media

Papers: Information Privacy, Security and System Resilience, Business Ethics, Business Law

Papers: Innovative Education, Assessment, Engaged Learning Curriculum, Teaching and Pedagogy

Papers: Management, Marketing, Accounting, Economics and Finance, Strategy, Organizational Behavior Organizational Theory, Human Resource Management, Consumer Behavior, International Business

Papers: Sustainability, SCM, Quality Management, Logistics, Hospitality, Recreation and Sports

Papers: Student Papers (Undergraduate, Master and Ph.D Students)

Papers: Scholarly Journal Editors Panel

Papers: College / School Deans Panel

Papers: Department Heads Panel

Papers: Post COVID-19 Academia: Special Topics on Instructions and Research (Online, Hybrid, and/or Face-to-Face)

Abstracts: Analytics, Big Data Applications, Business Intelligence, Data Mining, Statistics and Expert Systems

Abstracts: IS, IT, Blockchain Technology and Social Media

Abstracts: Information Privacy, Security and System Resilience, Business Ethics, Business Law

Abstracts: Innovative Education, Assessment, Engaged Learning Curriculum, Teaching and Pedagogy

Abstracts: Management, Marketing, Accounting, Economics and Finance, Strategy, Organizational Behavior Organizational Theory, Human Resource Management, Consumer Behavior, International Business

Abstracts: Production and Service Operations Management

Abstracts: Sustainability, SCM, Quality Management, Logistics, Hospitality, Recreation and Sports

Abstracts: Student Papers (Undergraduate, Master and Ph.D Students)

Abstracts: Scholarly Journal Editors Panel

Abstracts: College / School Deans Panel

Abstracts: Department Heads Panel

Abstracts: Post COVID-19 Academia: Special Topics on Instructions and Research (On-line, Hybrid, and/or Face-to-Face)

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Papers: Analytics, Big Data Applications, Business Intelligence, Data Mining, Statistics and Expert Systems

A NEW METHOD OF RANKING DECISION-MAKING UNITS UNDER EVALUATION WITHIN THE FRAME OF CONTEXT-DEPENDENT DEA

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ABSTRACT

The conventional data envelopment analysis (C-DEA) method effectively identified the frontier decision-making units (DMUs). But C-DEA shows several intrinsic weaknesses due to its self-evaluation property. Several methods of extending the C-DEA model are proposed to overcome these weaknesses. The cross-evaluation DEA (CE-DEA) and super-efficiency DEA (SE-DEA) are considered excellent alternatives to the C-DEA. But they also reveal their shortcomings. This paper presents a new procedure for applying the context-dependent DEA (CD-DEA)-based approach (CDBA) to complement the weaknesses of C-, CE-, and SE-DEA. We demonstrate that the CDBA significantly improves the rating and ranking DMUs beyond the original methods.

Keywords: Data envelopment analysis, Decision-making unit, Cross evaluation, Super-efficiency, Context-dependent

INTRODUCTION

Conventional data envelopment analysis (C-DEA) is widely used to rate a set of peer organizations. In the context of DEA, these organizations are called decision-making units (DMUs), which use inputs to produce outputs. The DEA method has been widely accepted as an effective technique since the DEA models need not follow the exact behavior function of those DMUs regarding transforming inputs to outputs. C-DEA was proposed by Charnes et al. [2] to demonstrate using linear programming (LP) to change a fractional linear measure of efficiency. The non-parametric approach solves an LP formulation for each DMU, and the weights assigned to each linear aggregation result from the corresponding LP. The DMUs under evaluation should be relatively homogeneous for the DEA to measure relative efficiency. Meza & Jeong [14] and Ramanathan [16] insist that a considerably large set of DMUs is necessary for the assessment to be meaningful, as the whole technique is based on a comparison of each DMU with all the remaining ones. The DEA models classify DMUs into two groups, efficient and inefficient DMUs. The DEA method can quantify what levels of improved performance should be attainable for inefficient DMUs. Also, the analysis indicates where an inefficient DMU might look for benchmarking help as it searches for ways to improve. As Zhu [21] points out, the various DEA-based methods have been developed and widely applied in many different areas to evaluate the relative performance of DMUs, resulting in more than 5,000 publications in the Web of Science database.

A single, comprehensive performance measure is produced for each DMU by DEA. The greatest ratio among all the DMUs would identify the most efficient DMU, and every other DMU would be rated by comparing its ratio to the best one. However, a weakness of the C-DEA-based assessment is that a considerable number of DMUs out of the total DMUs to be evaluated are classified as efficient, so that it may suffer immensely from a lack of discrimination. C-DEA allows each DMU to be evaluated without its most unfavorable weights due to the nature of the self-evaluation. Thus, the C-DEA model may ignore adverse inputs/outputs to maximize self-efficiency. To remedy this deficiency, the cross-evaluation DEA (CE-DEA) method is suggested by Sexton et al. [17] to rank DMUs with the idea of using DEA to do the peer evaluation rather than DEA's pure self-evaluation. Sexton et al. [17] construct a CE matrix consisting of two evaluation results, the self-evaluation and the peer evaluation. The CE-DEA can usually provide a full ranking for the DMUs to be rated and eliminate unrealistic weight schemes without requiring weight restrictions from application area experts (see Anderson et al. [1]). Due to its enhanced discriminatory power, the CE evaluation has found a significant number of applications in the DEA literature.

There have been critical issues facing the CE method application. Wang and Chin [18] insist that, from the literature review, existing CE methods are almost all computed either aggressively or benevolently, emphasizing no guarantee that the two different formulations, aggressive and benevolent, can end with the same efficiency ranking or decision conclusion. They [18] point out that there have been no attempts so far to test whether the two different formulations give the same rankings. To avoid the difficulty in choosing between the two different formulations, they propose a neutral CE-DEA model that determines one set of output and input weights for each DMU without being benevolent or aggressive to the other DMUs. Thus, the resulting CESs would be more neutral. There have not been many works of literature that consider, compare, and apply these CE models to evaluate the units. Hong and Jeong [7] show that CE-DEA does not yield consistent rankings, mainly when CE-DEA is applied to efficient DMUs only. They [7] observe that the top-ranked DMU rated by CE-DEA with all DMUs evaluated is frequently replaced by the lower-ranked DMUs when only efficient DMUs are evaluated. They also claim that the CE-DEA might not be appropriate for decision-makers to select the best DMU among the efficient DMUs.

The idea of super-efficiency (SE), mainly developed by Anderson and Peterson [1], is that a DMU under evaluation is excluded from the reference set of the T-DEA models and then its inclusion. Notably, the SE-DEA model has significance for discriminating among efficient DMUs, as Anderson and Peterson [1] demonstrate. Charnes et al. [3] use the SE-DEA model to study the sensitivity of the efficiency classification. See Deng et al. [4] and Nayebi and Lotfi [15] for further applications of SE-DEA. But the severe issue with using the model is that the adjacent DMUs decide the SE score (SES) of an efficient DMU, so it would be unreasonable for DMUs to be ranked by the SESs.

The ranking for a DMU would imply significant meanings since decision-makers can be aware of the current level of a DMU's performance and establish incentive schemes, support policies, and develop strategies to sustain the future business or core competence. Thus, the ranking of DMUs can be used to identify competitors with similar performance levels and

determine the future direction of efficiency improvement for sustainable development. No literature has explicitly and seriously discussed this critical weakness of the DEA-based models regarding unstable rankings generated by DEA-based models. These weaknesses would be unavoidable due to how DEA-based models treat unfavorable inputs/outputs.

Researchers of the consumer choice theory point out that the context often influences consumer choice. A simple example is that a circle appears large when surrounded by small circles. Performance evaluation or measurement frequently depends upon the context too. The possible question is, "what is the relative attractiveness of a particular DMU when compared to others?" The C-DEA shows that deleting or adding inefficient DMUs should not change the efficiencies of the DMUs consisting of the best-practice frontier. But, removing all of the efficient DMUs allows for another set of best-practice DMUs. Using this property, Seiford and Zhu [17] propose the context-dependent DEA (CD-DEA) method to classify all DMUs into several levels. Level 1 consists of all efficient DMUs found by the classical DEA method. Then, the efficient DMUs, after removing the DMUs in level 1, belong to level 2, and so on. CD-DEA method would measure the attractiveness score (AS) of DMUs of a higher level when DMUs of a lower level are chosen as the evaluation background/context. Thus, the AS generated by the CD-DEA method would eliminate the weakness of self-evaluation of the C-DEA. Still, ASs may not always be consistent in terms of rankings as the evaluation context changes. Suppose the AS of DMU_k in level 1 against DMUs in level 2 is the highest among DMUs in level 1. But if the AS of DMU_k against DMUs in level 3 may not be the highest. This study proposes two parameters for evaluating DMUs by using the AS. Then, we show how to rank DMUs more consistently using these two parameters.

This study aims to present and demonstrate how to apply the CD-DEA method and CE- and SE-DEA to rank DMUs based on the levels generated by the CD-DEA. Thus, the decision-makers take advantage of the strengths of each model/method by eliminating some weaknesses. Therefore, the proposed method could help practitioners and researchers produce a more refined efficiency evaluation and robust rankings than the conventional DEA-based methods. Besides, the proposed procedure would quickly provide a benchmarking framework for DMUs to improve efficiency. In addition, this study could provide a valuable tool that would help the decision-makers evaluate and rank DMUs more accurately, efficiently, and effectively.

This paper is organized as follows. The following sections provide a brief background for C-, CE-, S-DEA, and CD-DEA. Then, the proposed procedure for combining these three DEA methods is discussed. Next, we demonstrate our proposed approach using numerical examples, followed by conclusions.

DATA ENVELOPMENT ANALYSIS-BASED METHODS

Conventional DEA (C-DEA)

The mathematical model of C-DEA, which is called a multiplier DEA (*m*-DEA) model, may be stated as (see Zhu [20])

Objective Function: Maximize the efficiency rating θ for DMU_k

$$max\ \theta = \frac{\sum_{r=1}^{s} u_r y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}} \quad (1)$$

The above objective function is subject to the constraint that when the same set of u and v coefficients (or weights) is applied to all other DMUs being compared, no DMU will be more than 100% efficient as follows:

$$DMU_j \ \ \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, \forall j = 1, 2, \dots\ N \quad (2)$$

$$u_1, \dots, u_s > 0\ and\ v_1, \dots, v_m \geq 0,$$

where

θ = efficiency rating of the DMU_k being evaluated by DEA
y_{rj} = amount of output r generated by DMU_j
x_{ij} = amount of input i used by DMU_j
i = index of inputs used by the DMUs, $i = 1, 2, \dots, m$
r = index of outputs generated by the DMUs, $r = 1, 2, \dots, s$
u_r = weight or coefficient assigned by DEA to output r
v_i = weight or coefficient assigned by DEA to input i
N = number of DMUs under evaluation in the DEA analysis

The above model can be transformed into the following linear programming (LP) problem, which is called a CRS (Constant Returns to Scale) m-DEA model:

$$max\ ES_k = \sum_{r=1}^{s} u_r y_{rk}, \quad (3)$$

subject to

$$\sum_{i=1}^{m} v_i x_{ik} = 1, \quad (4)$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0, j = 1, \dots, N, \quad (5)$$

$$u_r, v_i\ \geq 0, r = 1 \dots, s; i = 1 \dots, m$$

ES_k^* in (3) denotes the optimal value of the objective function corresponding to the optimal solution (u^*, v^*), and DMU_k is defined to be efficient if $ES_k^* = 1$. Depending on the DEA's

rationale, DEA models can be either output-oriented or input-oriented. The model given by (3)-(5) is called an input-oriented CCR model, and ES_k^* is called CRS efficient score (ES).

Cross-Efficiency DEA (CE-DEA)

The most popular DEA-based ranking method is cross-efficiency (CE) DEA. The CE-DEA method, which consists of two phases, was proposed to rank DMUs with the central idea of using DEA to do peer evaluation rather than pure self-evaluation (see Sexton et al., 1986). The weights or multipliers arising from the first phase are applied to all DMUs to get the cross-efficiency score (CES) for each DMU in the second phase. In the first phase, let E_{jj} denote the efficiency score for DMU_j, which is obtained by solving the following LP model:

$$max \quad E_{jj} = \sum_{r=1}^{s} u_{rj} y_{rj}, \tag{6}$$

subject to

$$\sum_{i=1}^{m} v_{ij} x_{ij} = 1, \tag{7}$$

$$\sum_{r=1}^{s} u_{rw} y_{rw} - \sum_{i=1}^{m} v_{ij} x_{iw} \leq 0, w = 1, \dots, n, \tag{8}$$

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

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

$$E_{jw} = \frac{\sum_{r=1}^{s} u_{rj}^* y_{rw}}{\sum_{i=1}^{m} v_{ij}^* x_{iw}}, \qquad j \; and \; w = 1, \dots, n. \tag{9}$$

Note that E_{jj}, the DEA score for the self-evaluation of Phase I, can be obtained using the model by (3)-(5). Then, the CE score for DMU_w is defined as follows:

$$CE_w = \frac{1}{n} \sum_{j=1}^{n} E_{jw} \tag{10}$$

Super-Efficiency DEA (SE-DEA)

The super-efficiency score (SES) is obtained from the C-DEA model after a DMU under evaluation is excluded from the reference set of the C-DEA models. The resulting model is

called a SE-DEA model, with significance for discriminating among efficient DMUs. The SES for DMU_k is expressed as

$$max\, SES_k = \sum_{r=1}^{s} u_r y_{rk}, \tag{11}$$

subject to

$$\sum_{i=1}^{m} v_i x_{ik} = 1, \tag{12}$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0, j \neq k, \tag{13}$$

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

In the above SE model, efficient DMUs are not compared to the same standard since the frontier constructed from the remaining DMUs changes for each efficient DMU to be rated. Consequently, the SESs of efficient DMUs are allowed to have higher values than 1.

Context-Dependent DEA (CD-DEA)

Now, for CD-DEA, the input-oriented envelopment DEA model (e-DEA), is given by

$$min\, \theta - \varepsilon \left\{ \sum_{i=1}^{p} \xi_i^- + \sum_{r=1}^{s} \xi_r^+ \right\} \tag{14}$$

subject to

$$\sum_{j=1}^{n} \lambda_j x_{ij} - \theta x_{io} + \xi_i^- = 0, \qquad i = 1, \dots, m, \tag{15}$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - y_{ro} - \xi_r^+ = 0, \qquad r = 1, \dots, s, \tag{16}$$

$$\xi_i^-, \xi_r^+, \lambda_j \geq 0, j = 1, \dots n.$$

In the above model given by (14)-(16), θ is the efficient score (ES), and DMU_o is said to be efficient if $\theta^* = 1$, λ_j is called the dual variable, used to indicate benchmark information, and ε a non-Archimedean. ξ_r^+ and ξ_i^-, which are slack variables used to calculate the target input and output variables for an inefficient DMU. As stated earlier, Seiford and Zhu [14] propose

the context-dependent DEA method to measure the attractiveness score and progress of DMUs regarding a given evaluation context. They [14] stratify DMUs into different efficiency levels. Let $J^1 = \{DMU_j, j = 1, 2, \dots, n\}$ be the whole set of 'n' DMUs and iteratively define $J^{\ell+1} = J^{\ell} - E^{\ell}$, until $J^{\ell+1}$ becomes null. As a result, all the efficient DMUs on the ℓ^{th} level are the elements of E^{ℓ}, that is, $E^{\ell} = \{DMU_k \in J^{\ell} | \theta^*(\ell, k) = 1\}$, and $\theta^*(\ell, k)$ is the optimal value for the following CRS model for DMU_k.

$$\theta^*(\ell, k) = \min_{\lambda_j, \theta(\ell,k)} \theta(\ell, k) \tag{17}$$

subject to

$$\sum_{j \in F(J^{\ell})}^{K} \lambda_j x_{ij} - \theta(\ell, k) x_{ik} \leq 0, \qquad i = 1, \dots, p, \tag{18}$$

$$\sum_{j \in F(J^{\ell})}^{K} \lambda_j y_{rj} - y_{rk} \geq 0, \qquad r = 1, \dots, s, \tag{19}$$

$$\lambda_j \geq 0, j = 1, \dots n,$$

where $j \in F(J^{\ell})$ implies $DMU_j \epsilon J^{\ell}$, i.e., $F(\cdot)$ represents the correspondence from a DMU set to the corresponding subscript index set. Thus, all DMUs in E^{ℓ} are equivalent from the traditional DEA perspective. The CD-DEA model given by (17)-(19) partitions the set of DMUs into different frontier levels characterized by E^{ℓ}. As the evaluation context, we compute the attractiveness score (AS) for each DMU in the ℓ^{th} level (E^{ℓ}) against DMUs in the $(\ell + 1)^{th}$ and lower levels (see Zhu [16]). For instance, to find an attractiveness score for $DMU_q = (I_q, O_q)$ from a specific level, $E^{\ell_o}, \ell_o \in \{1, 2, \dots L - 1\}$, we solve the following model:

$$H_q^*(d) = Min\, H_q(d), \qquad d = 1, \dots L - \ell_o \tag{20}$$

subject to

$$\sum_{j \in F(E^{\ell_o + d})}^{K} \lambda_j x_j - H_q(d) x_q \leq 0 \tag{21}$$

$$\sum_{j \in F(E^{\ell_o + d})}^{K} \lambda_j y_j - y_q \geq 0, \tag{22}$$

$$\lambda_j \geq 0, j \in F(E^{\ell_o + d}).$$

$H_q^*(d)$is called the d-degree attractiveness of DMU_q from a specific level E^{ℓ_o}. In this way, the context-dependent DEA can have more discriminating power on each stratification level. First, DMUs are stratified into efficiency levels, such as $E^1, E^2, E^3, \dots, E^L$, using (17)–(19). Then we compute the attractiveness score (AS), which is greater than 1, for each DMU in the level E^ℓ against the DMUs in each lower level, such as $E^{\ell+1}, E^{\ell+2}, \dots, E^L$, using (20)–(21). Similarly, we compute ASs, less than 1 for each in the level E^ℓ against the DMUs in each upper level, such as $E^1, E^2, \dots, E^{\ell-1}$, using the following model given in (23)-(25):

To find an attractiveness score for $DMU_q = (x_q, y_q)$ from a specific level, $E^{\ell_o}, \ell_o \in \{2, \dots L\}$, we solve the following model:

$$G_q^*(d) = Min\, G_q(d), \qquad d = 1, \dots \ell_o - 1 \tag{23}$$

subject to

$$\sum_{j \in F(E^{\ell_o - d})}^{K} \lambda_j x_j - G_q(d) x_q \leq 0 \tag{24}$$

$$\sum_{j \in F(E^{\ell_o - d})}^{K} \lambda_j y_j - y_q \geq 0, \tag{25}$$

$$\lambda_j \geq 0, j \in F(E^{\ell_o - d}).$$

Then, we propose two ways of ranking each DMU_q in the level E^ℓ based on the value of $H_q^*(d)$ and $G_q^*(d)$. Let $R_{q,\ell}^d$ denote the rank of DMU_q in the level E^ℓbased on the value of $H_q^*(d)$ and $G_q^*(d)$. Let $\bar{R}_{q,\ell}$be the average of ranks, which is expressed as

$$\bar{R}_{q,\ell} = \frac{\sum_{d=1}^{L} R_{q,\ell}^d}{L-1}, \ell = 1, 2, \dots L \tag{26}$$

The other way to rank is to compute the average attractiveness score (AAS) for DMU_q in the level E^ℓ, which is defined as

$$AAS_{q,\ell} = \frac{\sum_{d=1}^{L-1} (H_q^*(d) + G_q^*(d))}{L-1}. \tag{27}$$

Let $R_{q,\ell}^{[1]}$ and $R_{q,\ell}^{[2]}$ be the rank based on $\bar{R}_{q,\ell}$ in (26) and $AAS_{q,\ell}$ in (27), respectively. We rank all DMUs under evaluation based on the value of $\bar{R}_{q,\ell}$ in (26) and in (27). If those two ranks are inconsistent, the weighted rankings using these two parameters are applied. Now, we define the weighted rankings, $\bar{R}_{q,\ell}^W$, as follows:

$$\bar{R}^{W}_{q,\ell} = Rank\left\{ \alpha R^{[1]}_{q,\ell} + (1 - \alpha) R^{[2]}_{q,\ell} \right\}, \tag{28}$$

where the weight α is a value between 0 and 1, this procedure is called the CD-DEA-based approach (**CDBA**) in this study.

NUMERICAL EXAMPLES

To see the performance of the CDBA method, we consider the numerical example Zhu [20] illustrated, where the data are presented in Table 1. Table 1 shows that there are fifteen (15) companies from the Top Fortune Global 500 list in 1995, with three inputs: (i) assets ($ millions), (ii) equity ($ millions), and (iii) the number of employees, and two outputs: (i) revenue ($ millions) and (ii) profit ($ millions). ES, CES, and SCES, along with the corresponding ranks, are reported in Table 2.

Seven (7) efficient companies have a perfect ES of 1. Regarding high-ranking DMUs, CE-DEA and SE-DEA models rank completely different DMUs as #1 and #2. CE-DEA ranks 'Sumitomo' and 'Exxon' as the #1 and #2 efficient companies. In contrast, the SE-DEA method ranks 'Nippon Life' #1 and 'Walmart' #2. As stated before, Table 2 shows CE-DEA's critical weakness since it ranks two efficient DMUs, 'General Motors' and 'Nippon Life,' lower than some of the inefficient DMUs. In contrast, the SE-DEA method ranks no efficient DMU lower than inefficient DMUs. We report the absolute rank difference (ARD) between the ranks generated by CE-DEA and SE-DEA in Table 2. The total ARD, the maximum ARD, and the average ARD for 15 DMUs turn out to be 38, 10, and 2.5, showing the significant differences between these two rankings.

Table 1. Fifteen (15) companies from the Fortune Global 500 list of 1995

DMU	Company	Input			Output	
		Assets	Equity	Employees	Revenue	Profit
1	Mitsubishi	91,920.6	10,950.0	36,000	184,365.2	346.2
2	Mitsui	68,770.9	5,553.9	80,000	181,518.7	314.8
3	Itochu	65,708.9	4,271.1	7,182	169,164.6	121.2
4	General Motors	217,123.4	23,345.5	709,000	168,828.6	6,880.7
5	Sumitomo	50,268.9	6,681.0	6,193	167,530.7	210.5
6	Marubeni	71,439.3	5,239.1	6,702	161,057.4	156.6
7	Ford Motor	243,283.0	24,547.0	346,990	137,137.0	4,139
8	Toyota Motor	106,004.2	49,691.6	146,855	111,052.0	2,662.4
9	Exxon	91,296.0	40,436.0	82,000	110,009.0	6,470.0
10	Royal Dutch/Shell	118,011.6	58,986.4	104,000	109,833.7	6,904.6
11	Wal-Mart	37,871.0	14,762.0	675,000	93,627.0	2,740.0
12	Hitachi	91,620.9	29,907.2	331,852	84,167.1	1,468.8
13	Nippon Life	364,762.5	2,241.9	89,690	83,206.7	2,426.6
14	Nippon T & T	127,077.3	42,240.1	231,400	81,937.2	2,209.1
15	AT&T	88,884.0	17,274.0	299,300	79,609.0	139.0

Applying the CD-DEA method stratifies 15 DMUs into four (4) levels, as shown in Table 3. As expected, the set of the first level, E^1, consists of the seven efficient DMUs by C-DEA. E^2 consists of DMU_6, DMU_7, and DMU_{10}, E^3 consists of DMU_1 and DMU_8, and E^4 consists of DMU_{12}, DMU_{14}, and DMU_{15}. DMUs are rated and ranked level by level to remove the weakness of CE- and SE-DEA methods, which implies the rankings of DMUs in the higher level can't be lower than those of DMUs in the lower levels.

Table 3 shows CDBA ranks 'Nippon Life' and 'Sumitomo' as the #1 DMUs. Setting $\alpha = 0.5$, we compute $\bar{R}^W_{q,\ell}$ in (28), based on the two rankings generated by CDBA, and 'Sumitomo' becomes the top-ranked DMU by $\bar{R}^W_{q,\ell}$. CE-DEA ranks 'Sumitomo' as the #1 before CD-DEA applies but finds 'Exxon' as a new #1 DMU, as SE-DEA ranks a top-ranked DMU.

For evaluating DMUs in levels 2, 3, and 4, the ranks generated by CDBA are very consistent. In contrast, it is evident that the ranks generated by CE- and SE-DEA are neither consistent nor robust. Table 4 reports various ARDs to investigate the ranking's robustness further. Based on the summarized ARDs for each model, we observe that CDBA performs better than the other two methods, CE- and SE-DEA.

Table 2. Comparison of efficiency scores and rankings for fifteen (15) companies without stratification

DMU	Company	C-DEA	CE-DEA	SE-DEA	ARD[1]
		ES (R_1)	CES (R_2)	SCES (R_3)	
1	Mitsubishi	0.662 (11)	0.572 (9)	0.662 (11)	2
2	Mitsui	1.000* (1)	0.785 (4)	1.009 (7)	3
3	Itochu	1.000* (1)	0.879 (3)	1.285 (6)	3
4	General Motors	1.000* (1)	0.680 (8)	1.370 (3)	5
5	Sumitomo	1.000* (1)	0.933 (1)	1.318 (5)	4
6	Marubeni	0.972 (8)	0.772 (5)	0.972 (8)	3
7	Ford Motor	0.737 (10)	0.465 (10)	0.737 (10)	0
8	Toyota Motor	0.524 (12)	0.378 (12)	0.524 (12)	0
9	Exxon	1.000* (1)	0.897 (2)	1.341 (4)	2
10	Royal Dutch/Shell	0.841 (9)	0.691 (7)	0.841 (9)	2
11	Wal-Mart	1.000* (1)	0.751 (6)	1.379 (2)	4
12	Hitachi	0.386 (13)	0.295 (13)	0.386 (13)	0
13	Nippon Life	1.000* (1)	0.435 (11)	3.917 (1)	10
14	Nippon T & T	0.348 (14)	0.286 (14)	0.348 (14)	0
15	AT&T	0.270 (15)	0.182 (15)	0.270 (15)	0

$ARD^1 = |R_2 - R_3|$

Table 3. Comparison of diverse efficiency scores and rankings for fifteen (15) companies with stratification

DMU	Company	CDBA					CE-DEA			SE-DEA		
		$L\ (\ell)$	$\bar{R}_{q,\ell}\ (R_{q,\ell}^{[1]})$	$AAS_{q,\ell}\ (R_{q,\ell}^{[2]})$	$\bar{R}_{q,\ell}^{W}$	ARD[1]	CES (R_3)	R_{WO}	ARD[2]	SES (R_4)	R_{WO}	ARD[3]
2	Mitsui	1	6 (7)	3.814 (6)	7	0	0.665 (6)	4	2	1.009 (7)	7	0
3	Itochu	1	4 (4)	24.136 (2)	3	1	0.806 (3)	3	0	1.553 (3)	6	3
4	General Motors	1	3.6 (3)	4.309 (5)	4	1	0.732 (4)	6	2	1.370 (5)	3	2
5	Sumitomo	1	2.6 (2)	27.722 (1)	1	0	0.841 (2)	1	1	1.325 (6)	5	1
9	Exxon	1	5 (5)	4.658 (4)	5	0	0.982 (1)	2	1	5.878 (1)	4	3
11	Wal-Mart	1	5(5)	3.145 (7)	6	1	0.700 (5)	5	0	1.379 (4)	2	2
13	Nippon Life	1	1.6 (1)	15.784 (3)	2	1	0.599 (7)	7	0	3.917 (2)	1	1
6	Marubeni	2	8 (8)	24.510 (8)	8	0	1.000 (8)	8	0	22.754 (8)	8	0
7	Ford Motor	2	10 (10)	2.369 (10)	10	0	1.000 (8)	10	2	1.511 (10)	10	0
10	Royal Dutch/Shell	2	9 (9)	3.819 (9)	9	0	1.000 (8)	9	1	5.342 (9)	9	0
1	Mitsubishi	3	11 (11)	5.344 (11)	11	0	1.000(11)	11	0	7.533 (11)	11	0
8	Toyota Motor	3	12 (12)	1.123 (12)	12	0	1.000(11)	12	0	6.668 (12)	12	0
12	Hitachi	4	13.3 (13)	0.628 (13)	13	0	0.870 (13)	13	0	1.274 (15)	13	2
14	Nippon T & T	4	13.6 (14)	0.598 (14)	14	0	0.707 (15)	14	1	2.156 (13)	14	1
15	AT&T	4	15 (15)	0.374 (15)	15	0	0.797(14)	15	1	1.637 (14)	15	1

L (ℓ): Level; R_{wo}: Rank without stratification; $ARD^1 = \text{Min}\{|R_{q,\ell}^{[1]} - \bar{R}_{q,\ell}^{W}|, |R_{q,\ell}^{[2]} - \bar{R}_{q,\ell}^{W}|\}$; $ARD^2 = |R_3 - R_{wo}|$; $ARD^3 = |R_4 - R_{wo}|$;

Table 4. Summary of rank differences

	CDBA	CE-DEA	SE-DEA
	ARD^1	ARD^2	ARD^3
Total ARD	4	11	16
Mean ARD	0.2	0.73	1.06
Maximum ARD	1	2	3

SUMMARY AND CONCLUSIONS

Several problems have appeared as DEA has been applied to various evaluation areas. The DEA-based approaches' severe weakness is their biased preference for specific inputs/outputs. All DMUs under evaluation can only use favorable inputs/ outputs to boost their efficiency score, dropping the unfavorable inputs/outputs. The conventional DEA (C-DEA) evaluates DMUs in self-evaluation, allowing each DMU to rate its efficiency score with the most favorable weights. Consequently, problems related to weak discriminating power have arisen as C-DEA applications advance since multiple DMUs frequently turn out to be efficient. In addition, ranking DMUs based on the ESs generated by the C-DEA method shows a significant drawback due to the basic principles of self-evaluation. 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. To remedy this weakness and increase the discrimination power, the cross-efficiency DEA (CE-DEA) and the super-efficiency DEA (SE-DEA) models have emerged. But these two methods also show some weaknesses. The most critical weakness of CE-DEA and SE-DEA methods is the inconsistency of rankings generated by these methods.

This paper proposes a procedure for ranking DMUs by applying the context-dependent DEA (CD-DEA), which allows the decision-makers to stratify DMUs under evaluation into different efficiency levels. The attractiveness scores (ASs) for the DMUs in each level against the DMUs in other levels are obtained. The first criterion is the average rank of the rank based on each AS, while the second criterion is the rankings based on the average AS (AAS). Moreover, CE- and SE-DEA, which usually generate inconsistent rankings, are applied to rank the DMUs level by level to prevent these methods from ranking more efficient DMUs lower than less efficient DMUs.

We also apply the proposed method to a well-known numerical example to compare these DEA-based methods. The numerical examples show that the rankings generated by the CE- and SE-DEA methods show significant weakness, especially for the efficient DMUs. The results and observations through the numerical example show that the proposed approach works well and would be used as an essential tool, along with various DEA-based methods, for decision-makers to evaluate and rank DMUs to be rated. Future research would be interesting and necessary to apply the proposed method extensively in real-world DEA applications.

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References are available upon request.

Abstract

Data and analytics capabilities have leaped forward in recent years and have changed how businesses make decisions. The explosion in the field is partly due to the growing availability of vast amounts of data, improved computational power, and the development of sophisticated algorithms. More than ever, colleges and universities need a curriculum emphasizing business analytics, and companies need data-savvy professionals who can turn data into insights and action.

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CYBERSECURITY CERTIFICATE SELECTION PROCESS: A DATA ENVELOPMENT ANALYSIS APPROACH

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ABSTRACT

Organizations that face the threat of cyberattacks protect against those threats, in part, by hiring cybersecurity professionals who have both relevant experience and information security/cybersecurity certifications. Cybersecurity certificates vary in many aspects, involve costs, and offer associated potential financial returns. Given the large number of cybersecurity certificates available, the decision of which one(s) to pursue may not necessarily be straightforward. In this paper, we illustrate the use of Data Envelopment Analysis (DEA) for cybersecurity certificate selection. Our analysis identifies six of 18 certifications considered that demonstrate a maximal relative efficiency, and we analyze why the other certifications are relatively inefficient.
Keywords: data envelopment analysis, cybersecurity

BACKGROUND

Organizations increasingly face the threat of cyberattacks, both in frequency and severity. The threats range from independent programmers creating viruses to cause mischief, to organized criminals developing ransomware to extort corporations, to governments creating and funding departments to wage cyber warfare against enemies. Recent examples of successful cyberattacks demonstrate that their consequences can be extremely severe. Examples from news headlines include DDoS attacks by Killnet against major US airport websites and an orchestrated breach of Cisco's local network by the UNC2447 cybercrime gang, Lapsus threat actor group, and Yanluowang ransomware operators [10].

The cyberworld is constantly evolving, with new hardware and software being introduced to the market, each with their own set of new vulnerabilities. Consequently, cybersecurity threats are

dynamic, as attackers are constantly learning, developing, testing, and executing new techniques to exploit known and new weaknesses, and to bypass safeguards to reach their targets.

Consequent with this increasing threat, the demand for, and value of, cybersecurity professionals is increasing. According to the U.S. Bureau of Labor Statistics [11], the expected job growth for Information Security Analysts during the period 2012-2031 is 35%, which is much faster than average. While a bachelor's degree in a computer related field is usually required, often employers value additional professional certifications which are more focused on specific capabilities. There are numerous professional certifications available, which creates a decision problem for individuals in the cybersecurity profession in deciding which certification to pursue.

Deciding on which cybersecurity certification(s) to pursue is clearly challenging for a few reasons. First, there are multiple certifications from which to choose, each bringing specific skills to bear against certain aspects of various cybersecurity threats. For example, a CISM certification includes information security governance, program development and management skills useful against enterprise threats [3], while a CCSP certification ensures cloud related skills to combat attacks against cloud platforms and infrastructure security, and to mitigate cloud application threats [4]. In regards to skills, each individual has different strengths, weaknesses, and areas that they feel successful at solving problems. Similarly, with regards to threats, individuals may find differing levels of interest, challenge, and satisfaction in tackling and combating those threats. The individual's assessment of their skills and interests is essential for them to make a quality decision, and pursue the certification that best aligns with their personal objectives.

Second, with the uncertainty present in such a dynamic field, a highly useful certification today may be eclipsed in value by future threats and consequent certifications tomorrow. For example, 10 years ago the most highly sought-after certifications were vendor certifications (e.g., Cisco and Microsoft), while today with the introduction of the global APT threats, the more offensive and technical certifications are the "hot tickets" [7] for cybersecurity professionals. Evaluating and incorporating uncertainty into any decision is highly dependent on the individual and their personal preferences with regards to risk.

Thirdly, each certification includes costs and benefits, creating trade-offs between the certifications. Trade-offs are, loosely speaking, increasing the achievement of one objective by sacrificing the achievement of some other objective. For example, pursuing a certificate that generates a higher

expected salary may require a higher fee to sit for the exam for that certificate. While this example is of a single trade-off that is relatively clear, assessing the trade-offs across multitude factors for many options can become challenging. In this paper we illustrate the use of the Data Envelopment Analysis (DEA) optimization technique to assist individuals in evaluating the trade-offs between the different certifications.

DATA ENVELOPMENT ANALYSIS (DEA) EFFICIENCY MODEL

Data Envelopment Analysis (DEA) is an optimization technique developed by Charnes, et al. [1] that produces a single measure of relative efficiency between multiple "decision-making units (DMU)." The literature includes a plethora of articles on the use of DEA, with comprehensive reviews and surveys of modeling techniques ([2] and [6]) and applications specific to industries ([5] for insurance and [9] for banking), for example.

However, the literature appears to be in its infancy regarding applications of DEA in the cyber arena. Nguyen, et al. [8] use DEA to evaluate the production efficiency of cybersecurity firms. Voronenko, et al. [12] use DEA to analyze various European countries' efficiencies in the context of cybersecurity, and then use that analysis to identify main vulnerabilities in the specific country of Ukraine.

In this paper, the DMUs are various cybersecurity certifications, all of which are characterized by a common set of quantitative attributes for inputs and outputs. The DEA efficiency model produces a single measure reflective of the relative efficiency by which each DMU transforms these inputs into outputs. This relative efficiency is one measure of the various trade-offs, allowing a rank-ordering of the certifications. This ordering then may assist individuals in selecting which certifications to pursue.

In addition to the rank-ordered list of DMUs, the DEA model provides information useful for assessing why certain certifications are rated as inefficient compared to those rated as efficient. Specifically, the sensitivity analysis output of the DEA optimization model indicates for each inefficient DMU a reference set of efficient DMUs. The inefficient DMU inputs and outputs are compared to those of the subset of efficient DMUs to understand why they are ranked differently. We present an example of this analysis in the results section of this paper.

Developing a common set of input and output attributes is not trivial. As these are the basis for the relative efficiency measure, each DMU must be fairly characterized by each attribute. For example, including an output (or input) such as geographical demand which is provided by only a subset of DMUs would unfairly penalize the efficiency of DMUs not providing that output. Also, there must be data available for all input and output attributes, for all DMUs. This can be challenging if attributes are chosen which are proprietary to issuing organizations, such as their costs to administer and award certifications.

For this analysis, we selected as inputs three requirements for each certification, and as outputs two benefits of each certification. The inputs included 1) the candidates' required or recommended years of experience for the certification, 2) the estimated exam preparation time in months, and 3) the fee required to sit for the exam in U.S. dollars. The outputs included 1) the average salary of jobs requiring the certification in U.S. dollars from payscale.com, and 2) the demand for individuals with each certification in number of job postings on indeed.com. The table below shows these input and output values for the 18 certifications we evaluated with DEA.

Unit	Certification	Inputs			Outputs	
		Preparation Time (Months)	Experience Required or Recommended (Years)	Exam Fee ($)	Demand (Job Postings)	Salary ($k)
1	CCNA Security	3	1	400	10,009	89
2	Network+	3	1	358	7,817	71
3	Security+	3	2	392	11,981	79
4	CCNP Security	6	3	400	1,814	113
5	CEH	6	2	1,050	3,072	83
6	CISSP	9	5	749	11,981	121
7	SSCP	9	1	249	2,323	78
8	CISM	6	5	760	4,818	131
9	CISA	4	5	760	8,718	108
10	CCSP	4	5	599	2,635	76
11	GSEC	4	4	949	3,393	102
12	GPEN	3	3	949	750	104
13	ECSA	6	2	514	222	83
14	CRISC	6	3	760	1,593	132
15	GCIH	3	2	2,499	2,458	100
16	OSCP	6	2	850	1,583	96
17	CASP	6	5	494	1,289	95
18	CySA	3	4	392	2,059	70

Table 1: Input and Output Attributes for Cybersecurity Certifications.

DEA MODEL FORMULATION

Given a set of DMUs, the DEA model is a linear program which calculates an efficiency for a single DMU, relative to the other DMUs. The linear program maximizes the weighted sum of that specific DMU's outputs by varying the weights applied to the inputs and outputs of all the DMUs in the set. Solving this same linear program for each DMU in the set enables a rank-ordering of the DMUs by efficiency. The mathematical formulation of the DEA model follows.

Indices

- j = decision making unit $\in \{1..n\}$
- i = input $\in (1..m)$
- r = output $\in (1..s)$

Parameters

- y_{rj} = value of output r on unit j
- x_{ij} = value of input i on unit j

Decision Variables

- u_r = weight given to the r^{th} output
- v_i = weight given to the i^{th} input

Objective Function:

$$\text{Max} \quad e_j = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \tag{1}$$

Constraints:

$$\sum_{i=1}^{m} v_i x_{ij} = 1 \tag{2}$$

$$\sum_{r=1}^{s} u_r y_{rj} \leq \sum_{i=1}^{m} v_i x_{ij} \qquad \forall j \tag{3}$$

$$u_r, v_i \geq 0 \qquad \forall r, i \tag{4}$$

The objective function (1) allows the unit being solved for the chance to select those best weights to maximize its efficiency. The denominator of (1) is constrained by (2) to equal one, thereby preventing non-linearities or unbounded solutions. Constraints (3) prohibit any DMU from having an efficiency greater than 100%. Constraints (4) ensure the decision variables remain non-negative.

RESULTS

In general, the DEA model solution includes a slack variable (shadow price) for each of the difference constraints (3) associated with a single DMU. The solution for any inefficient DMU, say unit A, will have a set of non-zero slack variables, for say units B and C, which we refer to as unit A's reference set. The technical interpretation of the reference set is that it contains the coefficients for a linear combination of those units, again B and C, with which to construct a hypothetical unit capable of efficiently transforming unit A's inputs into outputs.

In our specific application we cannot construct a hypothetical certification. However, examining the units included within the reference set provides insights as to why the inefficient certification was not evaluated as relatively efficient compared to the other certifications. Table 2 includes the DEA relative efficiency for all of the 18 certifications, and the reference set for those certifications evaluated as relatively inefficient.

Unit	Certification	DEA Efficiency	Reference Set
1	CCNA Security	1.0000	
2	Network+	0.8831	1, 3, 7
3	Security+	1.0000	
4	CCNP Security	1.0000	
5	CEH	0.4663	1
6	CISSP	0.6894	1, 3, 7
7	SSCP	1.0000	
8	CISM	0.7638	1, 4
9	CISA	0.8705	1, 12
10	CCSP	0.6309	1, 12
11	GSEC	0.7845	1, 12
12	GPEN	1.0000	
13	ECSA	0.6593	1, 4, 7
14	CRISC	0.7697	1, 4
15	GCIH	1.0000	
16	OSCP	0.5393	1
17	CASP	0.7406	1, 4
18	CySA	0.7982	1, 4

Table 2: Relative Efficiencies and Reference Sets for Cybersecurity Certifications.

Consider the case of the relatively inefficient certification CEH, which has a single efficient certification, CCNA Security, in its reference set. Table 3 displays an extract from Table 1, including input and output data only for these two certifications. Each of the inputs for the CEH certification is at least twice the amount as those inputs for the CCNA Security certification, while both of the outputs for CEH are below those for CCNA Security, with demand being less than one third. Here the CCNA Security certification dominates the CEH certification, where based on these factors, the preferred alternative is unambiguous. However, note that most of the reference sets of inefficient certifications include more than one efficient certification.

		Inputs			Outputs	
Unit	Certification	Preparation Time (Months)	Experience Required or Recommended (Years)	Exam Fee ($)	Demand (Job Postings)	Salary ($k)
5	CEH	6	2	1,050	3,072	83
1	CCNA Security	3	1	400	10,009	89

Table 3: Input and Output Attributes for the Inefficient CEH Certification and the CCNA Security Certification in its Reference Set.

Consider the case of the relatively inefficient CISSP certification and its reference set of three efficient certifications; CCNA Security, Security+, and SSCP. Table 4 displays an extract from Table 1, including input and output data for these certifications. Given its high outputs, CISSP is not clearly dominated by any single certification in its reference set. Instead, it is the combination of input and output values, i.e., what inputs does it take to achieve those outputs, that makes CISSP relatively inefficient compared to the others. In relation to the CCNA Security certification, the CISSP requires 3x as much exam preparation, 5x the experience, and roughly 2x the exam entrance fee. In relation to the Security+ certification, the CISSP requires 3x the exam preparation, 2.5x the experience, and 2x the exam entrance fee. Finally, in relation to the SSCP certification, the CISSP requires 5x the experience and 3x the exam entrance fee.

		Inputs			Outputs	
Unit	Certification	Preparation Time (Months)	Experience Required or Recommended (Years)	Exam Fee ($)	Demand (Job Postings)	Salary ($k)
6	CISSP	9	5	749	11,981	121
1	CCNA Security	3	1	400	10,009	89
3	Security+	3	2	392	11,981	79
7	SSCP	9	1	249	2,323	78

Table 4: Input and Output Attributes for the Inefficient CISSP Certification and Those Certifications in its Reference Set.

This example reflects the more common case which lacks domination, but instead includes multiple and mixed trade-offs between alternatives. While the inputs are definitely higher for the CISSP certification than for those in its reference set, the CISSP outputs include the highest demand and third highest salary of all certifications in our data set. If a cybersecurity professional's primary objective is salary and job opportunities, then CISSP would be highly attractive. However if that same individual has limited experience or time to prepare, other certifications may be more appropriate.

CONCLUSIONS

Making good quality decisions requires an understanding of the trade-offs, often between multiple factors and many alternatives. We have illustrated in this paper the usefulness of the Data Envelopment Analysis model in supporting the decision about which cybersecurity certification to pursue. The DEA approach identifies which certifications are relatively efficient in their transformation of inputs to outputs. For those certifications identified as inefficient, the DEA solution identifies those specific efficient certifications to examine to better understand the trade-offs which make them inefficient.

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TEXT MINING: HOW POPULAR IS ANALYTICS? WHERE TO PUBLISH?

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ABSTRACT

One of the hardest things about getting published for academics is finding the right outlet for a particular research project. Of particular difficulty for business faculty is ensuring it is in a journal that meets their college's criteria. Many institutions provide sources for approved journals such as they must not be predatory or they must come from a reputable list. A common list is the Australian Business Deans' Council Journal Quality List. The list provides the name, publisher, field of research, journal rating, and ISSN. From this, a researcher can filter the list and find several potential journals. But knowing which journals have published on specific keywords could significantly help in focusing the search for a research outlet.

This research project began with collecting all titles, abstracts, and keywords from all A*, A, and B journals in the ABDC Journal Quality List for 2021. The process to bring these into a text format was the first hurdle. Not only were there over 1,500 journals in this list but many of them were published many times during the year. To add to the complexity, some abstracts were only available in a picture format. Another hurdle was that some were published in languages other than English. We then mined these for keywords (e.g. analytics) and will be reporting on which journals are publishing on which keywords. Next up for this research is collecting for 2022 and then 2020. We hope to develop a longitudinal study and report on publishing trends.

Keywords: ABDC, Python, publishing outlet

THE RELATION BETWEEN PSYCHOLOGICAL DISTRESS AND CHRONIC ILLNESS

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ABSTRACT

The purpose of this paper is to offer readers a look at the relationship between psychological distress and chronic illnesses. The dataset that will be used to aid the analysis includes participants in Japan who worked between February 2021 and June 2021 during COVID-19. The introduction and literature review consist of a preface and a review of empirical and theoretical works that support or undermine the claims made about psychological distress and chronic illness. The research methodology will illustrate the use of logistic regression. The Discussion section will consider biases and other perspectives made about the relationship between psychological distress and chronic illness and how future studies can address the level of importance of this topic in hopes of developing better psychological testing or medicines.

KEYWORDS: chronic illness, pandemic, psychological distress, logistic regression

INTRODUCTION AND LITERATURE

Introduction

Concern for mental health conditions while working post-COVID-19 is now the focus of many studies. The relationship between psychological distress and chronic illness has captured the interest of governments and appointed health professionals since the rise of the COVID-19 pandemic. Psychological distress in this case is defined as a range of emotions such as lack of vigor, anger-irritability, fatigue, anxiety, and depression, that may lead to chronic illness such as cardiovascular diseases, cancers, forms of arthritis, diabetes in conjunction with an increasing interest in defining mental health problems, such as depression as a chronic illness [1]. In this composition, the correlation between psychological effects and chronic illness is investigated to understand if psychological distresses (as the independent variable) significantly impacts chronic illnesses (as a dependent variable). Moreover, Logistic regression is used to help manage a large dataset and is designed to investigate or conduct data analysis of confounding variables such as psychological distress and chronic illness. In addition, the following literature reviews attempt to focus on the rationale behind the research.

Literature Review

The global spread of COVID-19 and its consequences were extremely rapid and lethal. At a point in time, no COVID vaccine existed to combat the virus, then suddenly it became the most pervasive and necessary vaccine type. Not only that, but political authorities made a

unanimous decision to issue a lockdown, i.e., stay-at-home order, in its earlier stages which aimed to reduce the viral spread and mitigate its lethality as new strands surfaced [2]. Although the lockdown had its benefits, something especially interesting happened, a concern for mental health post-COVID-19 was raised.

Since the world "opened" back up to give citizens a sense of normalcy, and mitigate the economic decline, unfortunately, the new norm has become subjected to COVID-19 mandates (i.e., mandatory masks in public areas, on-site COVID testing, vaccination certificates, etc.), and has contributed to workplace anxiety and depression [3].

Moreover, it has become evident that since COVID-19 mandates have been put in place to "open" the world back up after economic shocks, the workplace dynamic had changed in terms of remote and hybrid options impacting professionals. There are employers allowing employees to work in person under COVID-19 policy contingencies such as social distancing, mandatory masks, frequent testing using COVID-19 onsite testing kits, and so forth. With so many economic and personal challenges, many businesses had to adopt a "new normal" way of managing operations [4]. Because of that, the knowledge gaps concerning workers and their mental health needs to be a part of professional and academic discourse. Moreover, healthcare professionals were required to work to care for others while simultaneously increasing their chances of being impacted by COVID-19 due to the type of their job [3]. This "two-fold burden" as the authors suggested has increased the psychological strain on the affected workers [3].

As of recent, Vivek Murthy, the U.S. Surgeon General, publicly released a report that psychological distress motivated by toxic work environments is linked to chronic illnesses such as cancer and heart disease [5]. The report was publicized as the importance of maintaining a healthy work-life-balance became the focal point after being heavily affected by the pandemic [5]. With scientific backing, it is unequivocally clear that COVID-19 has impacted people on a global scale both physically and mentally. To view the full report conducted by Vivek Murthy, please visit [6]. Further study of the importance of post-COVID-19 work conditions affecting mental and physical health, "an appropriate public health response to mitigate and manage mental health sequelae is likely to require substantial diversion of resources. Such decisions must be underpinned by reliable information: policymakers, commissioners, and services need to know both the scale of need and who are most vulnerable" [7]. Focusing on these factors will push for a deeper understanding of how a pandemic shifted the workplace and the working class. The authors also suggest that continuity of understanding and treating mental health starts with researchers collecting high-quality data, and government funding so that "data can represent the true need arising from the pandemic" [7]; hence further justifying why this issue is important.

Lastly, the latter part of this paper considers biases and other perspectives made about the relationship between chronic illnesses and mental health and how future studies can address the level of importance of this topic in hopes of developing better psychological testing or medicines. The next sections provide a research methodology, results, a discussion, and a conclusion.

RESEARCH METHODOLOGY

The research design of this composition is non-experimental, and no sampling is done. Instead, observations of preexisting content are reviewed via the google scholar website and the dataset is acquired using scholarly databases such as google dataset search. The primary data contains psychological distresses and chronic illnesses. According to authors at the University of Tokyo in Japan, the sample observed in their study originally consisted of 1,448 participants, however, 948 participants are available in the provided dataset [8]. Everyone in the sample was employed between February 2021 and June 2021, during the Covid19 pandemic. The 948 of the individuals do not have any missing covariates and hence are used for the study [8]. Figure 1 shows that majority of individuals are not having any chronic illness while less than 200 reported some chronic illnesses.

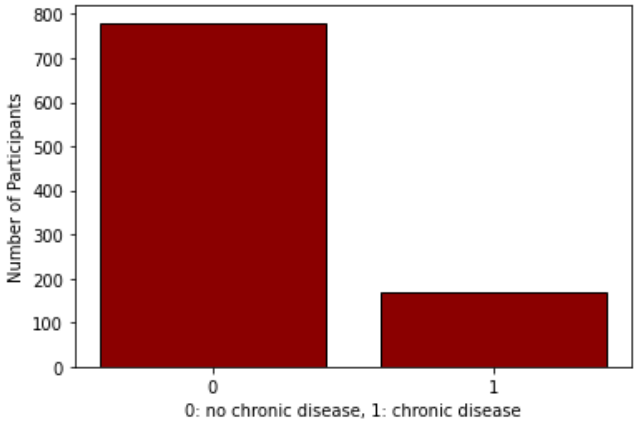

Figure 1 Histogram of individuals with a chronic illness

Chronic illness is the dependent variable in this context and is regarded as a binary variable that takes either 0 or 1-- the only two possible values that represent either no chronic disease (0) or having chronic disease (1). The independent variables are sex, age, marital status, education level, type of industry, size of the company, occupation, vaccination status, psychological distress, lack of vigor, irritability, fatigue, anxiety, and depression. The binary nature of independent variable (chronic illness) justifies the use of logistic regression. Logistic regression procedure is similar to linear regression [9]. However, Logistic regression mathematically describes the relationship between independent and dependent variables and determine if independent variable is discreet. The aim is to show if the independent variables can affect the dependent variable. To use the Logistic regression method, the Sklearn package of python is utilized to perform Logistic regression. All codes are implemented in Spyder 4 IDE of Python. To further learn about Python, readers are invited to read this [10].

RESULTS

The observations in the dataset are first randomized to prevent any bias in classification. Then, the data was broken down in order to train data and test data, which were plugged into Python for Logistic regression. How it works is that train data (2/3 of data) and test data (1/3 of data)

are imputed and run. Since the observations' order is randomized, the Logistic regression is run 100 times and the average of the results is recorded. The results show an accuracy equal to 82%. This may look promising at the first sight, but further analysis shows that the Logistic regression categorized almost all the testing data as not having a chronic illness. Only 2.6% of times the Logistic regression accurately predicted having a chronic illness while the individual indeed had such an illness. It means the independent variables, namely sex, age, marital status, education level, type of industry, size of the company, occupation, vaccination status, psychological distress, lack of vigor, irritability, fatigue, anxiety, and depression, do not predict the categorical variable (chronic illness). In other words, the independent variables cannot predict whether the individual has a chronic illness or not based on the observations of the independent variables.

As Figure 1 shows, most participants have no chronic illness. Particularly, 168 have some sort of chronic disease, while the majority of 780 have no chronic illness. To perform a more accurate analysis, one may perform Logistic regression on a subset of data where we have an equal number of observations with respect to having or not having a chronic illness. Figures 2, 3, 4, and 5 show the histogram distribution of these subsets of data.

The analyses of these subsets of data show that the accuracy of all subsets is below 60%. In addition, the accuracy of predicting a chronic illness, when the individual has it, is around 60%, which is slightly better than a coin toss. In other words, the proportion of correct predictions over the total number of predictions in this case is modest. Particularly, Figure 2 shows the histogram of the first subset of data, and logistic regression accuracy is on average 57% after 100 runs in Python. Categorizing chronic illness, when a person indeed has it, is 58% on average. For the second subset of data, the accuracy is 58% with the same prediction accuracy for categorizing the chronic illness correctly. For the third subset, the numbers are 59% and 61% respectively. For the last subset, the numbers are 66% and 68% respectively. All these predictions are not significant, and it cannot be concluded that the independent variables can explain the dependent variable (chronic illnesses).

DISCUSSION

The results of this study show that the independent variables cannot predict having a chronic illness. One may need to consider more independent variables, more observations, or another method to predict the categorizing variable, chronic illness.

Particularly, having more independent variables may improve both the accuracy of research and the percentage of correctly predicting chronic illnesses when individuals are having a chronic illness(s). Moreover, the dataset in this study has four times more individuals without any chronic illness. As the result, correctly predicting having a chronic illness is around 2.6%, which is very low. Using the subset of data with a more balanced number of individuals with and without chronic illnesses increased this percentage by around 55-57%. Although it is slightly better than a coin toss, it still shows that a more balanced dataset can benefit the researchers to determine the determining factors influencing chronic illnesses. Finally, it is possible that the Logistic regression is not suitable to categorize the having or not having

chronic illnesses given the independent variables. For this reason, it is recommended the utilization of other analytical methods for this purpose.

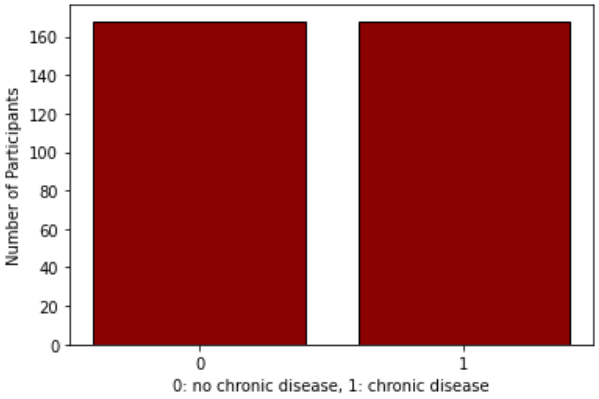

Figure 2 Histogram of the first subset of individuals with a chronic illness

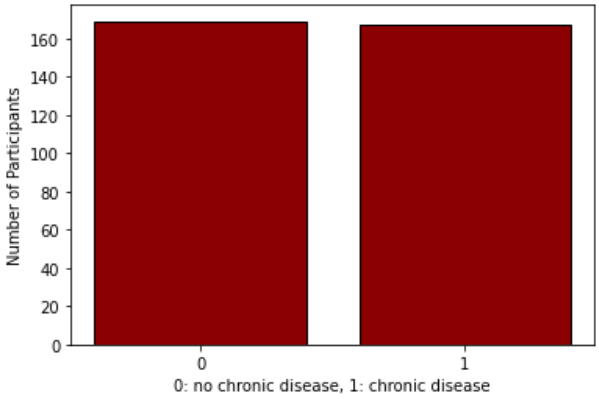

Figure 3 Histogram of the second subset of individuals with a chronic illness

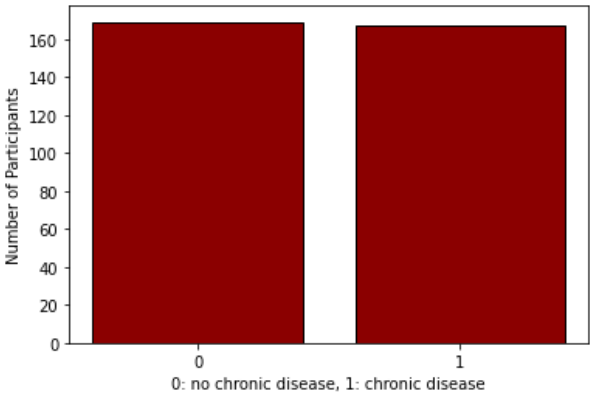

Figure 4 Histogram of the third subset of individuals with a chronic illness

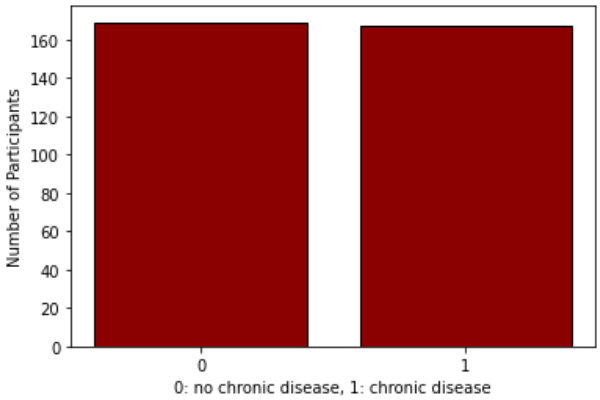

Figure 5 Histogram of the fourth subset of individuals with a chronic illness

CONCLUSION

The goal of this analysis is to offer readers a look at the relationship between psychological distresses and chronic illnesses post-COVID-19. Using an open-access dataset and Logistic regression, it is studied whether psychological distresses and other general independent variables can predict having chronic illnesses or not. Because of the binary definition of chronic illnesses, the Logistic regression method is used. The analysis shows that the independent variables (mainly psychological distresses) cannot explain/predict an individual to have chronic illnesses. Moreover, it is recommended to use more independent variables in future studies. In addition, using more observations or separate datasets may help to confirm or refute the finding of this research. Furthermore, it is shown a more balanced dataset regarding

the value of chronic illness variable can help to improve the accuracy of the model. Finally, the results should be investigated using other analytical methods for further validation.

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Papers: Data Analytics and Statistics Instruction

CURRICULA REVISIONS TO BETTER PREPARE STUDENTS WITH THE NECESSARY SKILLS

(An Invited Session for the DSI Data, Analytics and Statistics Instruction SIG)

Session Chair: **Bob Andrews**, Virginia Commonwealth University, randrews@vcu.edu
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ABSTRACT

The first portion addresses ways to promote data analytics in course offerings to respond to the CPA Evolution, which presents changes in the Certified Public Exam format effective January 2024 that emphasizes the call for increased skills and knowledge of developing technologies, such as data analytics, throughout the core and disciplines content of the exam. The second portion addresses proposed undergraduate quantitative course changes to better prepare students with programming and software skills to include more fluency in Excel and knowledge of the capabilities of Python, R, SQL, Tableaux, and power BI.

DATA VISUALIZATION AND EXPLORATORY DATA ANALYSIS TO UNDERSTAND BUSINESS PROBLEMS

(An Invited Session for the DSI Data, Analytics and Statistics Instruction SIG)

Session Chair: **Bob Andrews**, Virginia Commonwealth University, randrews@vcu.edu
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Samira Nichols, University of Central Arkansas, sshirzaei@uca.edu
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ABSTRACT

Discussion of effective data visualizations tools for providing useful information for business understanding that is essential for obtaining statistical/analytics insights. Second presentation is for Critical Thinking in Analytics, a "first course" to help students get an equal footing for both programming and understanding of analytics. Students use Excel, SAS, R, and Python to perform Exploratory Data Analysis for individual and team assignments moving from small and clean to larger dirty data. They write executive summaries of insights and a compare and contrast paper discussing the advantages and disadvantages of using one tool vs the other(s) for stipulated techniques.

UNIVERSITY OF CENTRAL ARKANSAS OVERVIEW

Our college started an MS in Applied Data Analytics program in the fall of 2021. At that time, we required a research project as their capstone course. Not only was this a resource-intensive course, but the students also wanted to replace it with more application-oriented courses. This resulted in us replacing the research portion of Predictive Analytics with SAS (we now teach SAS and then R in this class). We also added courses in SQL and Simulations to the program. The final change was a redesign of our Critical Thinking course. We no longer needed a course to get them started with their final research project, but we did need a course to bring all students up to a basic level of understanding of how to program and the fundamentals of analytics. Students entering the MS-ADA program have a wide array of undergraduate degrees from history to computer science. This new course focuses on Exploratory Data Analysis with Excel, SAS, R, and Python.

DEVELOPING SEARCH AND ANALYSIS SKILLS FOR SUCCESSFUL DATA ANALYTICS

(An Invited Session for the DSI Data, Analytics and Statistics Instruction SIG)

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ABSTRACT

Successful data analytics begins with the quality of the data used for analysis. The first presentation addresses developing superior data analytic search skills in a class that requires students to demonstrate their preparation to apply their acquired skills to their future endeavors by preparing a comprehensive 8-10 page analytic paper. The second portion describes data analytics examples used in the accounting profession that prepare students for the changing Certified Public Accounting (CPA) licensure requirements. Demonstrations focus on the use of Power BI in accounting education and ways to use Power BI for more advanced data analytics within QuickBooks.

EFFORTS TO INCREASE UNDERGRADUATE ENGAGEMENT AND PERFORMANCE

(An Invited Session for the DSI Data, Analytics and Statistics Instruction SIG)

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Baback Vaziri, James Madison University, vaziribx@jmu.edu
Luis Novoa, James Madison University, novoadlj@jmu.edu

ABSTRACT

First is a report on developing a college Undergraduate Teaching Assistant (UTA) program to support both faculty and students and to increase student engagement. The program has 16 required hours of training workshops and monthly check-in meetings. UTAs assist faculty as they employ online, hybrid, or in-person teaching tools and techniques to increase student engagement and learning. The second reports on an intensive boot camp session prior to the start of the semester for an undergraduate management science course. Descriptive results will be given on how this session affected students' perceptions and performance in the course.

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INSTRUCTION AIDS: AUTOMATIC EXCEL GRADING PLATFORM, REAL-LIFE DATA SETS & A TEACHING GAME

(An Invited Session for the DSI Data, Analytics and Statistics Instruction SIG)

Session Chair: **Bob Andrews**, Virginia Commonwealth University, randrews@vcu.edu
Presenters: **Michael King,** George Mason University, mking34@gmu.edu
Tobin Turner, Presbyterian College, jtturner@presby.edu
Rick Hesse, Pepperdine University, rickhesse@aol.com

ABSTRACT

1) Has grading of homework, tests or exams become an untenable task due to increasing class sizes, remote learning complexities, unpredictable GA availability or pressure to spend more time on research or other activities? *ExPrep*, an automatic, custom, MS Excel worksheet grader can dramatically reduce grading time and improve grading consistency. The session will feature a basic overview to the *ExPrep* platform, a discussion of the specific values of utilizing this third-party grading platform, and finish with a live hands-on demonstration for participants. 2) A look at several real-life accessible data sets that students could use in class, and talk about how real-life data requires judgment calls on analysis and thinking critically for the what (and why) of using the data. 3) A demonstration of a simplified version of the famous TV game Deal or No Deal?®, complete with supporting files, that can be used to provide a "real-world" lesson in expected monetary values and risk.

INTERACTIVE SESSION FOR SOFTWARE/PROGRAMMING & SUPPORT RESOURCES FOR DATA, ANALYTICS & STATISTICS INSTRUCTION

(An Invited Session for the DSI Data, Analytics and Statistics Instruction SIG)

Session Chair: **Bob Andrews**, Virginia Commonwealth University, randrews@vcu.edu
Workshop Leaders from the DASI team and the McGraw Hill Business Statistics and Analytics editorial team:
Kellie Keeling, University of Denver, kkeeling@du.edu
Eric Weber, eric.weber1@mheducation.com
Kristen Salinas, Kristen.Salinas@mheducation.com

ABSTRACT

This session is designed to be an open conversation with those attending; the Data, Analytics and Statistics Instruction (DASI) Team and the McGraw Hill editorial team about additional support and content development for Decision Sciences instructional material. The DASI Specific Interest Group of DSI will give an overview of what it currently does and obtain suggestions for what it can possibly do to better support data, analytics and statistics instruction. McGraw Hill is looking to incorporate programming languages and statistical analysis preparatory material to support courses utilizing tools such as Python, R, SAS, Power BI, Tableau, etc. They are looking for guidance on the scope of content, the type of assessment items and platform/software recommendations. Come help shape the education of thousands of students!

INTRODUCTORY BUSINESS ANALYTICS INSTRUCTION

(An Invited Session for the DSI Data, Analytics and Statistics Instruction SIG)

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Presenters: **Vernon Richardson,** University of Arkansas, vrichardson@walton.uark.edu
Leslie Hendrix, University of South Carolina, Leslie.Hendrix@moore.sc.edu

ABSTRACT

Part 1: Overview of the introduction to business analytics at the University of Arkansas as a business core course that provides 1) a foundation to analytics, 2) hands-on learning using Excel, Tableau and Power BI labs, 3) applications to marketing, accounting, finance and operations questions and 4) a final project where students get to address their own question using data. Prerequisite knowledge for business statistics and software tools, including Excel, will also be addressed. Part 2: Using R in business analytics classes and beyond at the Darla Moore School of Business at the University of South Carolina, where all undergraduate business students learn basic programming skills in R, in addition to Excel. This talk discusses why and how we teach coding to students who have no coding experience and why we think it is important. Teaching R in our statistics courses allows for a deeper understanding of statistical concepts and the ability to cover more modern methods with a nod toward machine learning methods. Practical advice will be given for motivating, teaching, and assessing these skills

PERSPECTIVES ON DATA ANALYSIS INSTRUCTION FOR TODAY'S STUDENTS

(An Invited Session for the DSI Data, Analytics and Statistics Instruction SIG)

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ABSTRACT

Numerous aspects of data analysis instruction are not the same today as they were a few years ago, not least of which is the availability of ChatGPT. To effectively lead a class, one should be aware of changes in the incoming students, the available technology, the data analysis world, and the administration's expectations. Session leaders with a breadth of experience teaching classes that address data analysis will present their views and attendees will be invited to participate and guide the topics discussed. Topics can include student characteristics, administration expectations, learning aids (AI technology, etc.), computational software, needed support for students, employer/subsequent class expectations or evaluation methods.

STRATEGIES FOR A PYTHON BASED COURSE & USING R STUDIO AND QUARTO FOR R AND PYTHON

(An Invited Session for the DSI Data, Analytics and Statistics Instruction SIG)

Session Chair: **Bob Andrews**, Virginia Commonwealth University, randrews@vcu.edu
Presenters: **Yanni Ping**, St. John's University, pingy@stjohns.edu
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ABSTRACT

Python and R are top languages for today's business students. Effective student engagement is challenging in a code-based classroom. The session begins discussing strategies to engage students effectively in a Python-based business course for using the right technology and highlighting practical applications by employing a Jupyter Notebook to demonstrate how these strategies are facilitated in a coding-based teaching environment. The second portion of the session will demonstrate the use of R Studio and Quarto markdown notebooks to teach R and Python in the same file. This is useful for advanced courses where students have experience with either R and/or Python.

Papers: Healthcare, Public Sector and Not for Profit Management

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IMPROVING USABILITY OF HEALTH IT: PHYSICIAN REVIEW SYSTEM

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ABSTRACT

Selecting a physician from the physician review sites (PRS) is a challenging and complex task for patients. This paper addresses the issue of multiple ratings in the PRS application with analytical techniques of dimension reduction and text mining to address conflicts between narrative and star ratings. We collected and integrated 5135 patient review data from two PRS websites: Vitals and Healthgrades. Our findings indicate that PCA reduces the complexity of multiple rating metrics from seven metrics to one capturing 78-85% of rating information, and sentiment analysis alert the inconsistencies between numeric and narrative ratings.

INTRODUCTION

The physician selection decision is a challenging and complicated process for patients. While the development of the physician review sites (PRS) such as Vitals, Healthgrades, and RateMDs [31] [25], has made it easy to access physician reviews from the Web, and their popularity has increased by more than 70% of surveyed patients use online reviews [11]. Comparing the result in 2013, when only 25% of patients used online reviews to evaluate doctors, it becomes evident that online reviews have been an essential and dependable tool for evaluating a physician. An experimental study showed that comments and ratings are two crucial features for online review users when choosing a physician [2]. Usability research on PRS has found several shortcomings that prevent potential use.

First problem is the number of online reviews for each physician is generally low, making the overall physician rating unreliable [22]. Also, physician reviews are scattered across different PRSs. This requires them to visit and analyze reviews from various PRSs to determine the physicians' rating [15][8][17]. Patients are likely to visit physicians rated by many users [9]. This results in a time-consuming activity prone to errors by patients lacking technical abilities and knowledge on how to filter and combine thousands of physician reviews.

Second challenge for PRS users is the number and complexity of quality metrics. In fact, online reviews of physicians and quality metrics are organized differently on different PRSs, with the physician's ratings presented with seven or more metrics (shown in Figure 1) overloading users with too much information [15], making the task complex and

confusing for patients [5]. In general, rating metrics are varied with no consistency, validity, or transparency on how the overall score is calculated by each PRS [10].

Final issue is the conflict between narrative comments and star ratings, as shown in Figure 1. The narrative comments are not always comprehensible, informative, and presented to patients in an appropriate format [29]. For example, in many cases, the same patient gives a star rating score of 1-star with a positive comment like this: "This doctor is professional and knowledgeable. Great physician!" These conflicts cause confusion leading to mistakes and bad decisions.

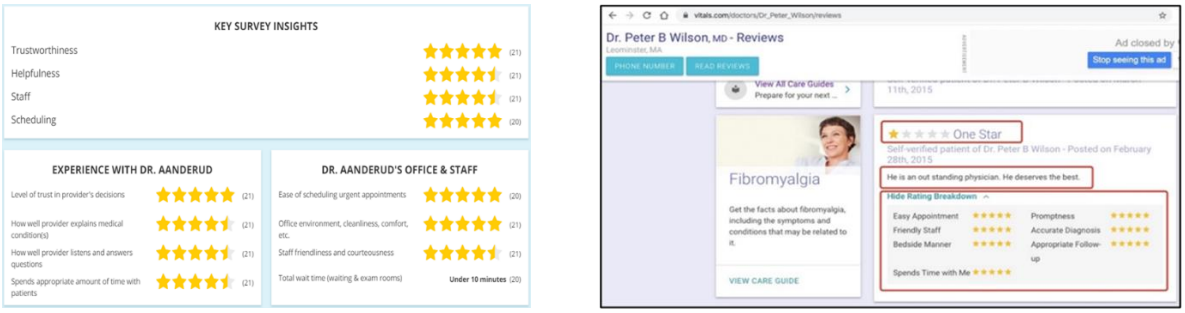

Figure 1. Examples of Rating Metric Complexity and Rating Conflicts

Hence, it is essential to enhance review accuracy by addressing problems associated with inconsistent ratings. The narrative comments posted for physicians are not always comprehensible, informative, and useful unless they are consolidated, summarized, and presented to patients in an appropriate format requiring natural language processing capabilities [29]. Furthermore, some researchers argue that patients may not make reliable reviewers of physician quality. The reason is that patients are not professional, knowledgeable, and skilled enough to comment on the quality of healthcare they receive and thus, they focus more on the customer service of the physician office [9].

Research Gaps and Potential Contributions

The above problems suggest a need for integrating or consolidating physician review data from multiple PRSs and analyzing the data with data mining techniques and presenting the integrated results in visual formats for easier understanding and better decision making. In this paper, we will address these issues of information overload with analytical techniques of dimension reduction, like Principal Component Analysis (PCA), to reduce the overload experienced by users and text mining techniques to address conflicts between narrative and numerical rating. In addition, we plan to develop an integrated dashboard website, in the next phase (not part of this paper), for patients to simplify the analysis of reviews from multiple websites.

The previous research on PRS mainly focuses on analyzing individual websites and the difference between various websites. In this study, we aim to integrate physicians' online reviews through a systematic, analytics-driven process. One of the contributions of this study is reducing the multiple metrics used on PRSs to a lower dimension. Different metrics would confuse the patient's selection decision; whereas, integrating those metrics can

enable patients to use physician reviews more effectively. This is a novel perspective that focuses on dimensionality reduction across websites. In addition, an incorrect rating would impact a physician's reputation, especially when the review number is low. Previous research rarely focused on how to identify incorrect ratings. This research enables incorrect rating identification and improvement.

In this exploratory study, we focus on two popular PRSs in the U.S.: Vitals, and Healthgrades [16][30][17]. We notice that these two websites have seven dimensions of quality metrics to measure each physician. The dimensionality reduction that we propose and implement in this study helps patients use a lower dimension to measure physicians' quality and make decisions. We explore how to improve the quality of patients' decision-making with the overloaded metrics by using PCA [14]. Additionally, using sentiment analysis, which is a commonly used text mining technique, we transform the textual physician comment to a sentiment score, which also helps us identify inaccurate ratings if the ratings and sentiment scores do not match.

The paper is structured as follows. We provide related works and research questions in section 2. We present the methodology in section 3. We show results in section 4. We discuss our findings in section 5. In the last section, we conclude our research.

RELATED WORKS AND RESEARCH QUESTIONS

The electronic word-of-mouth (eWOM) shown on a website is an important source of information relied upon by users when making a choice. Compared to traditional (offline) WOM, eWOM offers greater convenience, anonymity, many-to-many communication, and a lack of restrictions with regard to time and space. As a result, eWOM exerts greater and wider influence than traditional WOM. For example, the online health community shows physicians' eWOM, including the doctor's voting heart and whether s/he has received service star rating recognition [19].

Number of Reviews

The number of reviews is an important factor for eWOM. The eWOM quantity is a type of peripheral cue for the less involved consumers, which impacts the type of elaboration routes they take when forming perceptions and attitudes toward a product [24]. A greater number of reviews implies a higher level of concern over the issue in question, and when consumers read a large number of reviews, they can affirm or change their previous opinions, attitudes, and even their purchase intention [33]. Moreover, consumers are more easily persuaded when they read greater eWOM quantities written by the people who have purchased them. [33] discovered that the influence of review valence on booking intention is strengthened with the number of reviews. [9] stated that a higher number of reviews resulted in a more positive attitude toward the rated physician. These studies have shown that aided by quantity, online reviews generate greater eWOM effects. We, therefore, propose our first question:

(1) To what extent does the number of reviews increase per physician when multiple PRSs are used?

Information Overload

Every individual has limited cognitive capability, so the problem of information overload would appear when the information load exceeds an individual's cognitive capability [12]. Information overload can affect individual's ability to select their priorities, lead to poor decision making, and feel anxiety and stress [6][12]. One of the reasons leading to information overload in consumers' decision-making is the number of alternatives or the number of product attributes. Information overload can cause choice overload and unwanted effects on individuals, such as negative emotions and decreased satisfaction. Previous research underscores that reducing the level of information overload can positively affect individuals' decision processes [12]. In the physician review systems, multiple metrics for example, Vitals, Healthgrades, RateMDs, Yelp et al, provides several dimensions about the physicians and their services. The information broadens consumers' consideration sets with minimal effort and cost. However, patients require additional time and resources to process this information. Information overload makes decision-making difficult [20]. Therefore, we propose the second question:

(2) Can dimensionality reduction techniques, such as PCA, reduce information overload for patients?

Conflicts or Biases between Comments and Numerical Ratings

Online reviews provide a platform where consumers can fully reveal their emotions and a window through which businesses can better understand consumers' needs and desires. The eWOM effect generated by online consumer reviews can strongly influence future consumers in terms of affection and cognition, both of which affect their purchase intentions and behavior [35]. An individual can take specific actions to express emotion depending on the nature and meaning of the emotion and on the individual's purpose. Consumers usually show emotions related to consumption through their online reviews [35]. Users of PRSs might be more likely to visit physicians who are positively rated by a large number of users and less likely to visit poorly rated physicians. Negative ratings can be very harmful to physicians [3]. Online reviews are influential. On some platforms, online reviews contain narrative comments and numerical ratings. When there are conflicts or biases between them, it would be harmful for physician's reputation with the incorrect information. Based on the preceding discussion, this study raises the following questions:

(3) Can text mining techniques including sentiment analysis, identify and address the inconsistencies between narrative comments and numeric star ratings in the PRS?

Although online reviews are critical for patients' selection of their physicians [32], only a few researchers have investigated the effects of online reviews on patients' decisions. One study demonstrated that patient-generated and system-generated information could reflect the quality of physicians' service outcomes and delivery processes [36]. They found that positive information about the quality of physicians' services, whether patient-generated or system-generated, positively influenced both the patients' visits and website consultations. Word-of-mouth information about physicians reflects the physicians' service

quality and positively affects patients' office appointments [21]. However, there has been very little research exploring how to improve the quality of patient decision-making by reducing information overload from PRS websites and how to deal with inaccuracy in PRS ratings.

METHODOLOGY

In this pilot study, we use data analytics methods to address the proposed research questions. For the first research question, we first integrated and analyzed data from two PRSs. Next, we applied the dimensionality reduction technique (PCA) to reduce information overload. Finally, we utilized sentiment analysis to identify conflicts between narrative comment and star rating.

Dimensionality Reduction

Dimensionality is the number of variables, characteristics, or features present in the dataset. These dimensions are represented as columns, and the goal is to reduce the number of them. In most cases, those columns are correlated and, therefore, there is some redundant information that increases the dataset's noise. This redundant information impacts negatively in the Machine Learning model's training and performance, and that is why using dimensionality reduction methods becomes of paramount importance. It is a very useful way to reduce the model's complexity and avoid overfitting. Dimensionality reduction compresses features, reduces overfitting and noise, and increases efficiency and performance [27]. In our research, we compare and select the most appropriate one from three of the most used algorithms for dimensionality reduction PCA, random projection (RP), and independent component analysis (ICA).

Based on our purpose of reducing the dimension of quality metrics in the PRS websites, the PCA is considered a dimension-reduction technique that can reduce a set of variables to a small number of variables that still contains most of the information derived from the original set of variables used to analyze the sample [23]. PCA is one of the most frequently used multivariate data analysis methods in exploratory data analysis. By using PCA, complex data can be easily analyzed. PCA uses a mathematical procedure that turns a set of possibly correlated response variables into a new set of non-correlated variables, called principal components. The PCA can be performed on either a data matrix or a correlation matrix, depending on the measured variables. PCA's primary goal is to achieve data reduction, that is, to represent the p-dimensional data using s (< p) linear combinations of the original variables. The development of principal components does not require a multivariate standard assumption.

Random projection is another powerful dimensionality reduction method that is computationally more efficient than the PCA. It is commonly used in datasets that have too many dimensions for PCA to be directly computed. The basic premise is to reduce the number of dimensions of our dataset by multiplying it to a random matrix which will project the dataset into a new subspace of features.

ICA is a method for dimensionality reduction similar to PCA or Random Projection in the sense that it takes a set of features and produces a different set that is useful in some way. But while PCA tries to maximize variance, ICA assumes that the features are mixtures of independent sources, and it tries to isolate these independent sources that are mixed in the dataset. The motivation behind ICA would be to take the original set of features and try to identify those of them that contribute independently to the dataset.

Sentiment Analysis

The comments on PRS websites are very important for physicians and patients. Patients get more details of the physician's professional skills, attitude to their patients, workplace environment, etc. When patients review a physician, their sentiment, opinions, and attitude would be included in their comments. Potential information is hidden in the patients' comments. Sentiment analysis is a contextual mining approach to identify, extract, and classify the subjective emotions (positive, negative, and neutral) within text data. The previous studies for sentiment analysis mainly focus on two categories, supervised sentiment analysis and lexicon-based sentiment analysis [28][26]. Using supervised learning method, it is usually determining and labelling the sentiment of the data first and treating it like a text classification problem. It needs the actual people to classify the data. This process time-consuming and laborious. For the lexicon-based approaches, they are utilized to overcome the limitations of supervised learning methods. Many developed sentiment lexicons are applied, such as Subjectivity Wordlist, SentiWordNet, MPQA subjectivity lexicon, LIWC (Linguistic Inquiry and Word Count) lexicon, VADER (Valence Aware Dictionary and Sentiment Reasoner), and WordNet-Affect. These resources can be used in a wide variety of domains and extract emotions from reviewers' perspectives. VADER, which is used as a sentiment analysis tool to get the emotional scores, is a lexicon and rule-based sentiment analysis tool which are generally labeled according to their semantic orientation as either positive or negative [1]. It is a suitable tool to analyze our data. Our purpose to do sentiment analysis is to get the sentiment scores from the comments and compare them with comment score for determining whether the conflict between comment score and sentiment score. LIWC is also a good method to analyze textual data, which comprises several dictionaries that capture conscious and unconscious psychological phenomena related to cognition, affect, and personal concerns. However, based on our data and research purpose, the sentiment scores of the comments are required and VADER is better than LIWC. Therefore, we use VADER as a tool of sentiment analysis.

VADER uses a combination of a sentiment lexicon is a list of lexical features (e.g., words) which are generally labeled according to their semantic orientation as either positive or negative. VADER talks about Positivity and Negativity and tells us about how positive or negative a sentiment is. The sentiment score is computed by summing the valence scores of each word in the lexicon, adjusted according to the rules, and then normalized to be between -1 (most extreme negative) and +1 (most extreme positive) [13]. This metric is always used in a single unidimensional measure of sentiment.

In our research, we seek whether the conflict exists between the numerical rating and narrative comment. The scale of numerical rating is from 1 (worst) to 5 (best). But the scale of sentiment score from VADER is from -1 (worst) to +1 (best). In order to make them comparable, we transform the sentiment score from [-1, 1] to [1, 5] in order to compare with the comment score by Equation (1) below:

$$Transformed\ Sentiment\ score = Sentiment\ score * 2 + 3 \quad (1)$$

The variables and their definitions are shown in Table 1.

Variables	Definition
Total Score	The average of whole comment scores calculated by the website
Quality Metrics	The metrics provided by each website. For example, Easy appointment, Promptness, Friendly staff, et al.
Comment score	The rating score by each patient or reviewer
Sentiment score	The sentiment score from comments calculated by VADER
Transformed sentiment score	A scale from 1 to 5, transformed from sentiment score by Equation (1)

Table 1. Variables and Definition

On the PRSs, each physician has several ratings from different patients. Each patient or reviewer has two types of information: numerical rating and narrative comment. We define numerical rating as comment score. Total score is an overall score of per physician, calculated with the average of the whole comment scores by the websites. We use VADER to calculate the sentiment score from the narrative comment. To be comparable in the same scale, transformed sentiment score is calculated by Equation (1). PRS websites always provide the quality metrics, for example, in Vitals, the quality metrics include seven dimensions: Easy appointment, Promptness, Friendly staff, accurate diagnosis, Bedside manner, Spends time with patients, and Appropriate follow-up. When patient or reviewer rates a physician, these quality metrics are always rated.

Data

We collected data from Vitals.com and Healthgrades.com in April 2020. We selected the physicians within a scope of 50 miles from Boston, and where the number of reviews was at least five reviews per doctor. The dataset includes the primary physician's information, total score, and seven quality metrics and narrative comments associated with those doctors. The ratings were on a 5-star rating scale with a minimum of one for poor and five for excellent. We compared the two datasets collected from Vitals and Healthgrades and selected a group of 256 doctors who had at least five reviews on each of those websites. For addressing the third question, we also collected a total of 5135 narrative comments were analyzed to identify the conflict with the star ratings of the websites.

RESULTS

Descriptive Statistics

Table 2 shows descriptive statistics on the numeric ratings from HG and Vitals. For convenience, we use the abbreviate to represent different variables shown in parenthesis in the following sections. The average numbers of reviews on HG and Vitals are 13.13 and 14.68, respectively. The average Total Score on HG and Vitals are 3.90 and 4.02, respectively. For the seven-quality metrics on HG and Vitals, the mean numbers of them are approximately 4.0 and 3.8, respectively.

PRS Metrics	Min	Max	Mean	Std.	PRS Metrics	Min	Max	Mean	Std.
Reviews on HG (N=256)	5	54	13.13	8.29	Reviews on Vitals (N=256)	5	102	14.68	11.18
Total Score (TSH)	1.0	5.0	3.90	0.81	Total Score (TSV)	1.3	5.0	4.02	0.73
Trustworthiness	1.0	5.0	4.01	0.80	Easy Appointment (Appointment)	1	5	3.80	0.87
Explains Condition Well (Explanation)	1.0	5.0	4.04	0.79	Promptness	1	5	3.70	0.95
Answers Questions (Answers)	1.0	5.0	4.00	0.82	Friendly Staff (Staff)	1	5	3.83	0.92
Time Well Spent (Times-pent)	1.0	5.0	4.05	0.79	Accurate Diagnosis (Diagnosis)	1	5	3.79	0.97
Scheduling	2.0	5.0	4.02	0.65	Bedside Manner (Manner)	1	5	3.91	1.01
Office Environment (Office)	2.0	5.0	4.23	0.60	Spends Time with Patients (Time-spent)	1	5	3.89	0.95
Staff Friendliness (Staff)	1.5	5.0	4.10	0.66	Appropriate Follow-up (Follow-up)	1	5	3.71	1.00

Table 2. Descriptive Statistics on the 5-Star Numeric Ratings from HG and Vitals

Number of Reviews

To address the first research question, we first calculated the increased number of reviews per doctor when using two websites (instead of one). The minimum number of reviews on

Vitals and HG was 5 and the maximum number of reviews on Vitals was 102, which was much higher than the maximum number of reviews on HG (54). However, the mean number of reviews was very close, 14.68 for Vitals and 13.13 for HG. The increase of the percentage of review per physician on Vitals is between 20% and 920% and from 10.87% to 500% on HG. The mean increase percentage is more than 110% for all these two PRSs. While the results are obvious, a key benefit of integrating reviews from multiple websites is increasing the sample size, allowing us to apply data analytics and mining techniques for improving ratings results for users.

Patient Reviews	N	Minimum	Maximum	Mean	Std.
Number of Review in Vitals	256	5	102	14.68	11.185
Number of Review in HG	256	5	54	13.13	8.292
Total Number of Reviews in Vital and HG	256	10	124	27.82	16.64
Percentage of review per physician increase on Vitals	256	20.00%	920.00%	113.59%	94.31%
Percentage of review per physician increase on HG	256	10.87%	500.00%	126.37%	80.14%

Table 3. Descriptive Statistics of Number of Reviews

Dimensionality Reduction

We use RP and ICA as two methods of dimensionality reduction. However, the results of these two methods show that they are not appropriate for our research purpose. Therefore, we select PCA as the method of dimensionality reduction.

Principal Components Analysis (PCA)

In this research, we apply the PCA procedure in SAS. There are seven quality metrics in the HG dataset, including Trustworthiness, Explanation, Answers, Time-spent, Scheduling, Office, and Staff. In the Vitals dataset, there are also seven quality metrics: Appointment, Promptness, Staff, Diagnosis, Manner, Time-spent, and Followup. The total number of observations in each group is 256. We summarize the correlations between different metrics. We find most correlation coefficients are higher than 0.74 in HG and 0.66 in Vitals, indicating that both websites' quality metrics are highly correlated.

Then, we apply for the first step of PCA to check the correlation matrix's eigenvalues. The larger eigenvalues are extracted first. Because there are seven quality metrics, seven eigenvalues can be extracted. From the results shown in Table 4 and Table 5, the largest eigenvalues are 5.94 in the HG dataset and 5.50 in the Vitals dataset, accounting for 84.84% and 78.62% of the standardized variance in these two datasets, respectively. The first component, whose eigenvalue equals 5.9389, should be retained based on the eigenvalues-greater-than-one rule since the other eigenvalues are smaller than one. We use the scree plot to find the "elbow" point. The results also show the curve essentially flattens out after the first factor in both groups. Thus, we select one principal component.

	Eigenvalue	Difference	Proportion	Cumulative
1	5.9389	5.3879	0.8484	0.8484
2	0.5510	0.3437	0.0787	0.9271
3	0.2073	0.0586	0.0296	0.9567
4	0.1488	0.0698	0.0213	0.9780
5	0.0790	0.0408	0.0113	0.9893
6	0.0381	0.0012	0.0054	0.9947
7	0.0369		0.0053	1.0000

Table 4. Eigenvalues of the Correlation Matrix of HG

	Eigenvalue	Difference	Proportion	Cumulative
1	5.5037	4.9736	0.7862	0.7862
2	0.5300	0.2230	0.0757	0.8620
3	0.3070	0.0601	0.0439	0.9058
4	0.2469	0.0748	0.0353	0.9411
5	0.1721	0.0231	0.0246	0.9657
6	0.1490	0.0577	0.0213	0.9870
7	0.0913		0.0130	1.0000

Table 5. Eigenvalues of the Correlation Matrix of Vitals

We summarize the factor pattern of Factor one in each group shown in Table 6. The factor pattern is often referred to as the factor loading matrix in factor analysis. The elements in the loading matrix are called factor loadings. Hence, the factor loadings indicate how strongly the variables, and the factors or components are related. Based on factor one in HG, the first component has large positive loadings for all seven-quality metrics. The correlations with all quality metrics are higher than 0.87. Also, there are high correlations between factor one and all seven variables (all seven quality metrics higher than 0.81). We conclude the factor one can be used as our principal component.

HG		Vitals	
	Factor 1		Factor 1
Trustworthiness	0.95763	Appointment	0.81985
Explanation	0.95723	Promptness	0.86518
Answers	0.95556	Staff	0.84126
Time-spent	0.94062	Diagnosis	0.92285
Scheduling	0.88215	Manner	0.91651
Office	0.87267	Time-spent	0.93329

Staff	0.87633	Follow-up	0.90143

Table 6. The Factor Pattern of Factor One

We construct two new metrics: F1(HG) and F1(Vitals) by using the standardized scoring coefficients from PCA (shown in Table 7). Each component is expressed as a linear combination of the standardized observed variables. Based on the results shown in the two tables, the principal component of the HG group is computed as:

$$F_1(\text{HG}) = 0.1613 \times Trustworthiness + 0.1612 \times Explanation + 0.1610 \times Answers + 0.1584 \times Timespent + 0.1485 \times Scheduling + 0.1469 \times Office + 0.1476 \times Staf \quad (2)$$

$$F_1(Vitals) = 0.1490 \times Appoinment + 0.1572 \times Promptness + 0.1529 \times Staff + 0.1677 \times Diagnosis + 0.1665 \times Manner + 0.1696 \times Timespent + 0.1638 \times Followup \quad (3)$$

F1(HG) can explain 84.84% of information of the seven quality dimensions in Healthgrades site, and F1(Vitals) can explain 78.62% of information of the seven quality dimensions in Vitals site.

HG		**Vitals**	
	Factor1		**Factor1**
Trustworthiness	0.1613	Appointment	0.1490
Explanation	0.1612	Promptness	0.1572
Answers	0.1609	Staff	0.1529
Time-spent	0.1584	Diagnosis	0.1677
Scheduling	0.1485	Manner	0.1665
Office	0.1469	Time-spent	0.1696
Staff	0.1476	Follow-up	0.1638

Table 7. Standardized Scoring Coefficients for Computing Component

The above results support the use of a single principal component. This single principal component constructed by PCA is a new metric, we may call it as quality metric, captures between 78-85% of the seven-quality information on each PRS website. Therefore, patients can use this single quality metric to make their decisions. Dimensionality reduction does result in a loss of some information. However, the loss is small (15%) and PCA is effective at filtering noise and decreasing redundancy. By using PCA as a tool of dimensionality reduction, the information overload is solved that the principal component successfully reduces the information overload. Patients who want to focus on one dimension, like scheduling appointments, will always have access to the metrics from the original website.

Sentiment Analysis

When we checked the PRSs, we found some reviewer's comment scores are not consistent with their narrative comments. For example, the narrative comment is highly positive, but the physicians get a negative numeric comment score, creating a mismatch between numeric and narrative ratings (shown in Figure 1). Our purpose of using sentiment

analysis is to solve the third question: whether the conflict exist between the comment score and sentiment score. If the difference exists, it will help patients identify the incorrect ratings. We get the sentiment scores by using VADER. The sentiment score is in a scale of [-1, 1], which is a different scale with the comment rating. Then, we use Equation 1 to transform sentiment scores. After we transform them to the same scale of the comments score (shown in Table 8), we compare the transformed sentiment score with the comment score.

	N	**Minimum**	**Maximum**	**Mean**	**Std.**
Comment score	5135	1	5	3.79	1.77
Sentiment score	5135	-1	1	0.41	0.63
Transformed sentiment score	5135	1.01	4.99	3.82	1.26

Table 8. Descriptive Statistics of Comment Score and Sentiment Score

We used the Paired t-test to evaluate the difference between comment score and transformed sentiment score. The result of the Paired t-test analysis is shown in Table 9. The results show the mean difference between comment score and sentiment score is -0.019, and it is significant at p-value < 0.05 level, which indicates the conflict exists between comment score and transformed sentiment score. Therefore, using the transformed sentiment score could help patient identify the inconsistent and inaccurate comment score. Furthermore, the physician's total score could be more accurate when the inconsistent comment score is identified. We conclude that the transformed sentiment score is a good metric to know a physician well.

Mean (Comment score) – Mean (Transformed sentiment score)	-0.019
Standard error Mean	0.008
95% Confidence Interval of the Difference	[-0.035, -0.0026]
t-test	-2.274
Sig. (2-tailed)	0.023
N = number of comments	5135

Table 9. Paired t-test Results between Comment Score and Transformed Sentiment Score

DISCUSSION

Number of Reviews

The number of reviews is essential for online review sites. People benefit from reading a large number of reviews. However, for PRS sites, the big problem is the insufficient reviews. We propose integrating reviews from multiple PRS sites to alleviate it. The results support our conclusion that the mean percentage of the number of reviews increasing is more than 110% in both PRS sites. Otherwise, we should pay attention to the group of reviewers. In one study [7], 24% of 0nline product reviewers are older millennials aged 25 to 34. The second largest group is aged 45 to 54 with 20%. We need to know who will write

a review for the physician and introduce measures to increase the number of reviews. Based on the special area which is different with the products, physicians’ reputation and the patients' privacy are important. Therefore, some physicians and hospitals agree with patients that they should not rate the physicians and hospitals. Some patients do not have the heart to write reviews because of their illness. Physicians and hospitals should encourage patients to express their experiences and suggestions in order to provide more information for other patients. Physician’s requirements would be an essential factor in making the number of reviews larger.

Dimensionality Reduction

Multiple dimensions provide more information on products, services, and people. Consumers browse their interested information and make a decision in their minds. However, when they confront redundant dimensions of information, they need more time and sources to deal with and make their decisions inefficient. We advocate more information offered by professional sites, but we are more supportive of efficient information with fewer dimensions and strongly convincing expression and experience for consumers. In PRS sites, most people who review are always patients. Whether they write their experiment or comments for the physician they have seen or are looking for an appropriate doctor, they all need to review the physician's information. It is better that patients can make a decision when they only read the information they want. From our study on two PRS websites, we find dimensionality reduction can help us get this goal. Dimensionality reduction does result in a loss of some information. By not keeping all the eigenvectors, there is some information that is lost. However, if the eigenvalues of the eigenvectors that are not included are small, we are not losing too much information. PCA can effectively find an optimal representation of a data set with fewer dimensions. It is effective at filtering noise and decreasing redundancy. Patients can only read one dimension with around 80% information instead of seven dimensions after PCA. The limitation of using the dimensionality reduction is the data loss of 15-22% with the dimension reduction from multiple metrics to single metric. This will be tested with our integrated dashboard system which will evaluate the system use impact with users.

Sentiment Analysis

One important aspects of online review sites is the reviewer's ratings and comments. Reviewers provide their feelings and experience on the products, services, and others. The incorrect ratings and comments lead to incorrect selection decisions. We find there are many cases that the ratings are not consistent with their comments. Therefore, the reviews and ratings are necessarily inaccurate. Reviewer's narrative reviews always contain their sentiment, and sentiment analysis offers a way to construe review's sentiment and provide a score that shows the extent of their attitude. We are supportive of applying this method to identify comment’s sentiment and compare it with ratings on online review websites. One limitation of the sentiment analysis is the trust of the reviews. Most of the patients do not have enough professional knowledge and background. Many physicians believe that the reviews are not trustable because of the common mistakes. Our integrated dashboard system will evaluate on the analysis of trust in reviews.

Physician's Response

Research shows that response to reviews may increase confidence [18][34] and mitigate the effect on negative reviews [4]. The physician's response on their comment is also very important. We recommend PRS sites to add this function allowing physician response to mitigate the influence of negative comments.

CONCLUSION

This study focuses on improving the quality of decision making by patients with PRS site by using PCA, Paired T-test, and Sentiment analysis techniques. The online reviews from patients are critical for physicians as they help them improve their service quality. A higher number of reviews per physician and a higher rating score, and highly recommended reviews could help the patient select doctors more compatible with their needs. Currently, PRS websites provide a few reviews and many metrics, which increases confusion and complexity for patients. We analyzed reviews by integrating the data from two websites and find that the mean percentages of the number of reviews increased by 110% just from two sites. We applied PCA to successfully reduce the rating dimensions from seven to one, and still capture 84.8% and 78.6% of the information derived from the original set of variables in the two PRS websites: HGs and Vitals. This supports our conclusion that we physician review quality metrics can be reduced and help patients make their physician selection decisions efficiently. By using Paired T-test, we find differences between comment scores and transformed sentiment scores from our sentiment analysis of the comments, indicating that sentiment scores can help patients identify inconsistent and inaccurate comment scores.

The results from this study are encouraging, and we are now building an integrated dashboard to display our results of single metric and sentiment score along with the original star ratings of the website for each doctor. This will allow users to quickly compare physician ratings from multiple sources and make better decisions. Our next goal is to validate our results with a field study using design science research methodology with PRS users. A post-use survey will ask users for feedback on the integrated PRS dashboard comparing it with the existing PRSs on its usability and decision-making process. Our goal is to provide a consistent composite metric and present them in an easy-to-use and understandable format for patients, allowing them to make reliable decisions. Reliable, informed, and appropriate physician selection decisions can lead to improved healthcare outcomes for society and reduced healthcare costs for patients, providers, payers, the government, and the healthcare system.

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Integrating Machine Learning in Electronic Health Record to Detect Medicaid Fraud and Abuse

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ABSTRACT

According to the National Health Expenditure Accounts (NHEA), U.S. healthcare spending grew 9.7 percent in 2020, reaching $4.1 trillion, or $12,530 per person. As a share of the nation's Gross Domestic Product, health spending accounted for 19.7 percent. On the other hand, the National Heath Care Anti-Fraud Association estimates conservatively that healthcare fraud costs the nation about $68 billion annually. 95% of U.S. healthcare providers have adopted Electronic Health Records (EHR) for their practice and billing. The existing medical fraud and abuse detection systems are efficient at catching errors, verifying eligibility, checking procedure codes, etc., but are far from efficient at exploring patterns that could flag fraudulent or abusive behaviors. Considering the two facts above, this paper presents an EHR-based fraud detection and prevention system, which integrates machine learning technology and EHR. The EHR-based fraud detection and prevention system trains the Isolation Forest (IF) algorithm on the Medicare Part B dataset (2019 and 2020 data) and validates it on the List of Excluded Individuals/Entities (LEIE) database. By developing the EHR-based fraud detection and prevention system in openEMR, the most popular open-source EHR, this paper showcases a creative approach to efficiently detect and prevent medical fraud, and then to promote the delivery of evidence-based, high-quality, accessible, and cost-effective care to patients.

Keywords: Medical Fraud, Detection and Prevention, EHR, Machine Learning

MAPPING POTENTIAL BEHAVIORAL AND VIOLENT CRISES IN 911 POLICE REPORTS TO ENABLE THREAT ASSESSMENT AND PRIORITIZATION FOR MULTI-LEVEL PREVENTION CAPABILITIES

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ABSTRACT

Interactions between first responders and individuals with behavioral crises pose complex challenges for police officers (Wells & Schafer, 2006). People in these crises have behavioral health challenges (mental, developmental, substance use disorders) and are likely to respond/act differently under stress/duress than what first responders may be prepared to handle (Lipson, Turner & Kasper, 2010). Often, these individuals are taken to jail, the ER or left in the community. In many instances, these are not appropriate dispositions and may result in increased threats to themselves, first responders, or the family/community rather than resulting in appropriate de-escalation.

In order to move upstream in detecting these crises, assessing their degree of threat, and mapping prevention capabilities, we need a clear definition and scope of the existing problem (Heath, 2020). The quantity and nature of such cases remains unclear. In a 2010 study in Canada, 7%–30% of calls involved mental illness (Coleman & Cotton, 2010). In Boston, in 2017, the rate was estimated at 0.8% (Morabito, et al., 2018). Individuals with behavioral health challenges are more likely to invoke a first responder call: 911, police, and fire/EMT services are more likely to be called to the scene especially if social disruption is occurring (Teller, et al. 2006). Clearly, based on existing research, there is great variability in estimating behavioral and violence related crisis. Consequently, inappropriate resources are being deployed in communities.

Formal coding schemes like NIBRS or IAED used in 911 emergencies tend not to track the behavioral crises unless that is the only nature of a call (Hashmi et al. *in press*). Consequently, possibility of early identification, detection, preventing crisis and promoting overall wellness and safety of the individual and the larger community is currently not available/built. This study addresses this need.

In our partner research site there are five 911 call centers, more than 10 police forces, six fire and EMS providers, each with their own coding, signal and incident recording systems. Using a sample of data from the 911 incident police reports from the largest force through our

cooperative agreements with these stakeholders have developed analytics using a combination of supervised text mining, natural language modeling, and topic modeling to detect and categorize potential behavioral and violent crises in order to enable threat assessment and prioritization for deploying multi-level prevention strategies. The combined use of Natural Language Processing (NLP), Machine Learning (ML), Artificial Intelligence (AI), with manual coding (MC) enables us to develop and corroborate the assessment of first responder incident reports and categorization of cases for transparency and audit. Our methods import data from police incident report files, categorize data, identify and prioritize cases needing primary, secondary preventions and produce related analytics.

Predictive Analysis of the Environmental Friendliness of U.S. Congress Members using Machine Learning Techniques

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ABSTRACT

Founded in 1969 as a non-profit organization, the League of Conservation Voters (LCV) tracks the voting records of Congress members on environmental issues in its National Environmental Scorecard. Such a scorecard is a nationally accepted index used to rate members of Congress on the most important environmental issues of the year, such as energy, climate change, and spending for environmental programs. In this study, we employ various machine learning methods including KNN, Random Forest, SVM, Xgboost, etc., to predict the LCV Scores of congress members. Our results indicate that the Xgboost outperformed other models with the lowest RMSE. It also shows that Party affiliation show the most significant effect on LCV scores. Besides, the percentage of college-educated, unionization rate and population density at the state level are also essential factors in predicting LCV scores.

RE-ENGAGING COMMUNITY OUTREACH AFTER COVID THROUGH A DISABILITY FILM FESTIVAL AT A METROPOLITAN UNIVERSITY

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ABSTRACT

COVID decimated community engagement at colleges. Clients in the community deferred engagement at colleges. Disadvantaged people could not be effectively engaged in outreach projects by students, and students could not be engaged on projects in helping the people. Efforts of pandemic projects done remotely could not be as ideal as projects done physically. Community outreach at colleges did not have discernable engagement impacts in a COVID environment as in an earlier environment of expectations.

For an anticipated paper, the author is analyzing the benefits of community outreach that is in a post-COVID environment. The outreach is a program devoted to people with disabilities in the community of a metropolitan university. The program is a *Celebration of People with Disabilities in Films* Festival for the community at the university. The films are educational and exciting in outreach. The films are of people with disabilities living lives like people without disabilities. These films are important not only for people with disabilities but particularly for students in learning of a demographic disadvantaged in the community. These films are especially important as the students are in other outreach programs with people with disabilities. The author is analyzing the experiences of the students at the Festival in learning more of the people with disabilities, so that they can be more attuned to those with disabilities. The author is also analyzing the experiences of the people with disabilities and siblings at the Festival. From the findings, the author is attempting to furnish the benefits of re-engaging community outreach in a post-COVID environment.

The paper is anticipated to benefit college faculty considering post-COVID community engagement. The paper is on a distinctive outreach that could be beneficial to college faculty. The author desires to inform faculty of the impacts of an outreach program of students with those disadvantaged in the community, from research-in-progress. The author hopes to inspire faculty to involve students with those with disabilities. This paper on community outreach in a post-COVID environment, when published, will be timely.

THE ROLE OF AGE, EDUCATION LEVEL, AND IT SELF-EFFICACY IN INDIVIDUALS' INFORMATION TECHNOLOGY CHANGE READINESS IN HEALTHCARE ORGANIZATIONS

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ABSTRACT

Individuals' IT-change readiness is one of the primary determining factors of organizational Information Technology (IT) change intervention's success. We conducted in-depth qualitative interviews with 18 employees from two health-care companies. Based on our interviews with healthcare professionals, IS professionals and management in healthcare organizations, we found that IT self-efficacy contributed to individuals' IT-change readiness. Demographics of the participants played an indirect role in that education level positively related to IT self-efficacy and age inversely influenced IT self-efficacy.

Papers: IS, IT, Blockchain Technology and Social Media

CORE VS. DIVERSITY IN INFORMATION SYSTEMS (IS) RESEARCH: A SURVEY

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ABSTRACT

In the early IS research, scholars were seeing IS research as under theorized, which does not engage in the core matter of the IT artifact. In this research paper, we investigate the research trends in IS discipline from three journals (i.e., MIS Quarterly, Journal of Management Information Systems, and Information Systems Research) from 2015 to 2019) to determine the research focus of IS Discipline. We adopted a procedure for the classification from Culnan's classification of IS reference disciplines as a method to determine the research focus of the IS discipline. The Culnan's classification of IS reference disciplines comprises of 1) core IS research field (CISR), 2) related applied disciplines for IS research (RAD), and 3) basic underlying disciplines (BUD). The results show that the IS research trends in five years emphasize diversity through research methods, problems, and theoretical foundations to account for IS phenomena

Keywords: Core, Diversity, Information Systems (IS) Discipline, Reference Discipline, IS Research

1. Introduction

The Information Systems (IS) research has seen some prevailing concerns about its research focus. In the early IS research, scholars had diverse views on IS research that led to debate on whether IS research should emphasize core IS discipline or diversify in its research. From the previous literature review, the IS as a research discipline has three arguments. The first argument was that IS research should depend on a reference discipline. The term reference discipline is defined as a discipline providing extensive input to other disciplines [1]. The reference discipline also means "those disciplines X that provide foundational, methodological, or other inputs to another discipline/s Y such that the state of knowledge in Y is advanced through inputs provided by X. In other words, if Y cites X to develop and advance the state of its knowledge, X becomes a reference discipline for Y, and vice versa" [1]. Scholars that have held a view of IS research as a reference discipline believe that IS is an applied research field that evolved and emerged from reference disciplines. For example, information systems research was seen as an interdisciplinary area that focuses on the impact of information systems on human behavior (e.g., individuals, groups) and organizations [2, 3]. Peter Keen calls for IS discipline to borrow and learn from reference disciplines in methods, theories, and quality research because reference disciplines are more mature [4]. According to Culnan (1986), IS reference disciplines can be seen into three classes that include MIS fundamental theory (such as systems theory or information concepts), basic underlying disciplines (such as

economics) and related applied disciplines (such as accounting or management science) [5]. A study claimed that IS was coined from another field like computer science, linguistics, organizational theory, political science, management, and psychology to promote diversity [6, 7]. It should be noted that the early progress and acceptance of IS research was based on a multidisciplinary approach [8].

The second argument was IS research should not depend on reference discipline, but it should diversify through research methods, problems, and theoretical foundations used to account for IS phenomena. The scholars with this view emphasize that if IS continued to depend on the reference disciplines, the MIS will be threatened and will lack focus. They argued that it would become a fundamental strategic blunder for IS research when it relies on reference disciplines. This means that there will be disintegrated, deserted, and demised IS disciplines [9]. The dynamic nature of IS discipline has referred disciplines less impact due to technological advancement that changes quite often. According to the Kuhnian model of scientific advancement, IS is a technology that cannot be controlled by any imposed structure or paradigm [10]. A study argued that information systems are applied fields to which practitioners in the industries are expecting IS research to focus on discoveries that are instantly put into practice [6, 7]. They claimed that IS research that focuses on discovering behavioral issues usually deviates from these practitioners' expectations because it takes much more depth in researching behavioral science to generate output [8].

The third argument was IS research is discipline itself. IS discipline has successfully developed and matured to be a research area and research tradition. For example, Baskerville and Myers (2002) argue that IS discipline has been singularly successful in developing its research perspective and its research tradition. They believe that IS research is now serving other fields of research [11]. "The ability of IS research to serve as a foundation for further IS research is evidence of the maturing of the field" [11].

This study evaluates these three arguments through a literature review to determine the research trends in IS discipline to fill the gap. This paper is structured into five parts. The first part presents the introduction and definitions of terms and acronyms. The second part discusses the literature review. The third part explains the methodology, the fourth discusses the results, and the last presents the discussion and conclusion.

2. The Related Studies

Human existence has shown progressing stages of evolution, starting from the first wave known as the agricultural era in the 1800s, the second wave called the industrial era in the early 1960s, to the third wave known as the information era that began in the 1960s. These three evolutionary stages significantly impact the way people earn their living and attain their power [12]. The information era called the knowledge economy has impacted organizations' success through knowledge creation and distribution in terms of growth, value, and improving living standards [13]. It marks the beginning of the emerging field of information systems. Many higher educations started to mount degree programs in management information systems (IS) alongside its curriculum development [12]. The research interest and material in the field of information systems started to grow in the 1960s. In the early 1960s through the late 1970s, the research in IS discipline focused more on a multidisciplinary field with little or no concern about a specific theory or perspective rules. For example, Halawi and McCarthy

(2006) say IS research interest in the late 1970s was in a multidisciplinary field with no perspective rules or definite theory. According to them, the major multidisciplinary fields contributing to IS research include management science, computer science, sociology, operations research, psychology, and economics. Similarly, the early progress and acceptance of IS research was based on a multidisciplinary approach [8]. Furthermore, the advocacy for IS diversity has pressured IS scholars to diversify their research to include other disciplines that provide a change in the IS discipline. For instance, the created MIS Quarterly journal in 1977 with Editors of a different discipline, and the first International Conference on Information Systems (ICIS) was held in December 1980 with the favor of others field [14]

However, the article presented by Peter G. W. Keen at the first International Conference on Information Systems (ICIS) held in December 1980 ignited the need for theory in IS discipline. According to Keen (1980), IS researchers need to borrow from and learn from the theoretical foundations, formal methods, and exemplars of good research in multiple reference disciplines [4]. Similarly, European academics advocated using theories to encourage diversity in IS research [9]. It was recognized that the ideal use of theory for diversity is a knight of change [15]. A study indicated that theory is the catalyst that prevents the IS discipline from being entirely driven by technology because a theory provides a structure for the research approach. Without it, the IS research may become slow in progressing, lack of research focus, and a cumbersome dissemination process of research knowledge [16].

The literature review about the actual state of IS research field has been debated for many years ago. This debate has created diverse views from researchers in the IS discipline. The recognizable views are: (1) IS research to depend on a reference discipline [4]; (2) IS research should not entirely depend on reference discipline but to diversify through research methods, problems, and theoretical foundations of reference discipline to account for IS phenomena [9]; and (3) IS discipline has successfully developed and matured to be a research area [11]. The evolution of these views was systematic because all the three recognized views occur when IS research is facing a particular challenge. The first view in which scholars encourage IS researchers to focus on reference disciplines is that at that time IS discipline is facing challenges of research methods, theories, and quality research [4, 10]. Therefore, the IS scholars at that time emphasized the concept of interdisciplinary research to focus on the impact of information systems to human behavior and organizational behavior. It was believed that interdisciplinary research would give IS discipline more focus because IS field is applied research that has evolved and emerged from reference disciplines. In the second view, IS research faces challenges of the proliferation of theories, frameworks, and models from the reference disciplines [11]. From this time, the IS scholars emphasized testing and enhancing empirical research results through a diversity of problems to be addressed, theoretical foundations and reference disciplines used to account for IS phenomena, and (c) research methodology [9]. The last view was when the IS discipline is facing challenges of maturity. IS research has successfully developed and matured to be a research area where many other disciplines are now learning, and adopting IS research. For example, Davis (2000) says that the academic field of information systems has emerged and developed due to organizations using a unique knowledge of information and communications systems. Quoting from [17] about the uniqueness of IS discipline that is serving teaching and research as:

> "The academic field of information systems has developed because organizations use a specialized body of knowledge about information and communications systems.

> Teaching and research support these organization needs. The field may be defined in terms of observed information systems in organizations and also in terms of the function or field of activity for system planning, development, management, and evaluation. Since the systems deal with capture, repositories, processing, and communication of data, information, and knowledge, these are also defined" [17, pp. 61].

2.1 Information System as a Discipline

Information System (IS) discipline has for long tried to meaningfully and resiliently be identified within the institutions that comprise its organizational field. Benbasat and Zmud (2003) portray that IS discipline is still struggling establishing collective identity even after 30 years. It is believed that IS Scholars do diverse research and teaching, but these activities are making the IS discipline more ambiguous for the discipline's central identity. For discipline to establish central identity, it needs to possess these three features including central character, distinctiveness, and temporal continuity to which IS has passed all these features. IS discipline has made some significant progress in the institutionalization of IT as an integral part of today's organizational and economic contexts due to the interdisciplinary nature of IS research [18]. Furthermore, IS discipline is seen as an important area for businesses through providing 'offshore' business services, support a convenient communication media, reduce transaction costs, and provide access to contents [19]. Galliers (2004) calls for acceptance and pluralism of IS research because of the inter- and trans-national nature of IS as a field of study [20]. Lyytinen and King, (2004) argue that the IS field is a more identifiable academic enterprise that goes beyond building and designing systems to providing an insight into the organizational mission, diffusion, adoption, and effects of systems. They believe that IS has passed the litmus test for disciplinary legitimacy of the use of salience of the issues studied, the production of strong results, and the maintenance of plasticity [21]. It is recognized that IS research, teaching, and practice are based on diversity, flexibility, and development. The major areas in IS research include reference disciplines, external environment, core IT, organizational settings, IS management, IS usage, IS development and operation, and IS educational research [22].

2.2 Establishing IS research

IS research has been subject for debate since its inception, however, the motivations behind the research controversy on IS discipline were two, which include 1) intellectual inquiry and practice because of IS researchers are mainly members of faculties of management, and management as a field of study and education has a rich history of debate on these topics, and 2) external market demand for professional information systems talent [23]. To overcome these motivations, researchers recommend the IS discipline to establish IS research focus that will make the discipline meaningfully and resiliently identify within the institutions that comprise its organizational field. For example, Galliers (2006) contends that IS research needs to focus on the core of the discipline to survive [2]. Hwang and Wang (2015) examine IS core curricula in the United States of America with aim of identifying the IS core topics. In their study, they found that IS core topics focus on fundamentals of information systems, data and

information management, enterprise architecture, IT infrastructure, IS project management, system analysis and design, IS strategy, management, and acquisition [24]. On the other hand, scholars call for IS research to focus on social process of knowledge creation [19] and design to attract a community of practice [25]. Chilcott (2001) contends that Information System is associated with different perspectives, interests, and levels of sophistication that requires models (e.g., use diagrams, charts, maps, and other artifacts) of reality to help understand it. Because "a good model helps us to manage complexity and supports shared understanding" [26]. IS research should emphasize more open to practices through richer theorizing that broaden the knowledge ecology and permit the creation of good IS knowledge [27]. Benbasat and Weber (1996) call for diversity in IS research in which they recommended three areas of diversity that consist of: 1) methods; 2) problems; and 3) theoretical foundations and reference disciplines [9]. In a similar assertion, Burgess, Grimshaw, and Shaw (2017) stress the importance of IS research diversity through focusing on research methods, topics, and social processes that govern knowledge creation [28]. In addition, diversity is paramount in IS research because information systems make use of technological systems such as metadata, technological standards, user interfaces, programming languages, algorithms, and operating systems that are never neutral or static but dynamic that require constant enhancements and upgrades [29]. Gable (2019) argues that IS discipline has continued to adapt rapidly to changing technologies and environment at the meta-level with diversity, hence, the IS research should emphasize the creation of knowledge and establishment of identity of the field through having a trans-disciplinary character, working across boundaries with heterogeneous stakeholders and real-world problems [30]. Furthermore, there were calls for IS research to focus on sociotechnical research [31, 28]. Because IS research field is seen as a socio-technical system of knowledge production whereby social aspects deal with the interactions between researchers and demographic aspects of research subject under investigation, while the technical aspects focus on research topics and research methods [31, 28]. It is believed that IS researchers should reflect more on the diversity of the field's social and demographic aspects ([28]. Because social organization of scientific fields are organized by three key dimensions including political dependence of researchers, research topics, and research methods that are subject to diversity [32].

In summary, the literature review indicates that the field of Information Systems (IS) research has witnessed three central debates from various scholars both within and outside the discipline. As a result, conducting an empirical study to the IS research would play a vital role among IS discipline.

3. Methodology

The paper has investigated the research trends in IS discipline from three journals (MIS Quarterly, Journal of Management Information Systems, and Information Systems Research) throughout 5years (2015 to 2019).

The paper has categorized recent publications in IS into three classes to determine the trends in IS research. The procedure for the classification was adopted from Culnan's classification of IS reference disciplines [5]. Culnan (1986) has categorized IS reference disciplines into three categories (1) a research field itself (such as systems theory, information concepts, models, frameworks), IS research as basic underlying disciplines (such as economics, psychology,

sociology, and political science), and IS research as a related applied discipline (such as accounting, management science, computer science, and finance). Table 1 depicts the classes of IS research to be investigated.

Table 1: classes of IS research adopted from Culnan's categorizations

SN	Classes	Details	Remark
1.	Core IS research field (CISR)	IS models, frameworks, and concepts, system theory, information Technology evaluation,	The topics must have pure IS-related words without any flavor. The topics may include information retrieval, parallel and distributed computing, computer networks, cybersecurity, databases, information and communication technologies, artificial intelligence, social media, mobile devices, the Internet of things (IoT), the Internet Big Data Analytics, Smart Home Technology, Knowledge management systems, multimedia, and Cloud Computing.
2.	Related applied disciplines for IS research (RAD)	Accounting, Management Science, Computer science, and finance	The topics that have IS wordings with flavors of finance, organizational performance, Motivating Employees, human resource, marketing, consumer behavior, sale, commerce, Accounting Information Systems, computation, algorithms, computational complexity, computer design, programming language design, programming methodology, data structures, robotics, machine learning, software engineering
3.	Basic underlying disciplines (BUD)	Economics, psychology, sociology, and political science	The topics that have is wordings with flavors of economic growth, theories for psychology, culture and identity, families and households, health, work, poverty and welfare, global development, behavioral approach, cultural pressure, nature of political conflicts, international relations, jobs and unemployment, immigration, education, trade and globalization, unions and labor standards, wages, incomes and wealth, prejudice and discrimination, social cognition, person perception, attitudes, social control, persuasion, attraction, love

4. Result Presentation

Descriptive statistics were used for the analysis. Each research topic published in the three journals for the five years was accounted for based on the classification type. The decision was taken based on the highest frequency and percentage of count from the classes.
The results from MIS quarterly publications within 5year (2015-2019) revealed the core IS research (CISR) is having 103 (38%) of the publication while the remaining 167(62%) is for reference discipline with Related applied disciplines for IS research (RAD) and Basic

underlying disciplines for IS research (BUD) having 87(32%) and 80(30%) respectively. Table 2 depicts the results of MIS quarterly publications. From the results, the five years publications of MIS quarterly have the highest research focus on core IS research, followed by IS discipline with flavors of Related applied disciplines (i.e., Accounting, Management Science, Computer science, and Finance). The least was IS discipline with flavors of Basic underlying disciplines (i.e., Economics, psychology, sociology, and political science). However, the overall publications focus of MIS quarterly journal are more toward reference disciplines than in core IS research.

The results from Journal of Management Information Systems (JMIS) publications within 5year (2015-2019) revealed the core IS research (CISR) is having 78 (37%) of the publication while the remaining 132(63%) is for reference discipline with Related applied disciplines for IS research (RAD) and Basic underlying disciplines for IS research (BUD) having 59(28%) and 73(35%) respectively. Table 3 depicts the results of Journal of Management Information Systems (JMIS) publications. From the results, the five years publications of the Journal of Management Information Systems (JMIS) have the highest research focus on core IS research, followed by IS discipline with flavors of Basic underlying disciplines (i.e., Economics, psychology, sociology, and political science), and the least was IS discipline with flavors of Related applied disciplines (i.e., Accounting, Management Science, Computer science, and Finance). However, the overall publications focus of Journal of Management Information Systems (JMIS) are more toward reference disciplines than in core IS research.

The results from Information Systems Research (ISR) publications within 5year (2015-2019) showed the core IS research (CISR) is having 88 (32%) of the Publication while the remaining 187(68%) is for reference discipline with Related applied disciplines for IS research (RAD) and Basic underlying disciplines for IS research (BUD) having 104(38%) and 83(30%) respectively. Table 4 depicts the results of Information Systems Research (ISR) publications. From the results, the five years publications of MIS quarterly have the highest research focus on IS discipline with flavors of Related applied disciplines (i.e., Accounting, Management Science, Computer science, and Finance), followed by core IS research, and the least was IS discipline with flavors of Basic underlying disciplines (i.e., Economics, psychology, sociology, and political science). However, the overall publications focus of Information Systems Research (ISR) journal are more toward reference disciplines than in core IS research.

Table 2: MIS quarterly (MISQ) publications within 5year (2015-2019)

SN	Publication date	Classes				Publication quarterly	
		CISR Publication Count	RAD Publication Count	BUD Publication Count	Combine RAD and BUD count	Total count (N)	Total percentage (%)
1.	Mar-15	1	9	1	10	11	4.07
2.	Jun-15	7	2	1	3	10	3.70
3.	Sep-15	8	3	0	3	11	4.07
4.	Dec-15	4	2	4	6	10	3.70
5.	Mar-16	5	3	3	6	11	4.07
6.	Jun-16	0	1	13	14	14	5.19
7.	Sep-16	5	5	3	8	13	4.81
8.	Dec-16	9	2	0	2	11	4.07
9.	Mar-17	9	5	2	7	16	5.93
10.	Jun-17	4	4	6	10	14	5.19
11.	Sep-17	4	7	4	11	15	5.56
12.	Dec-17	5	6	4	10	15	5.56
13.	Mar-18	7	7	2	9	16	5.93
14.	Jun-18	3	3	9	12	15	5.56
15.	Sep-18	6	3	6	9	15	5.56
16.	Dec-18	4	4	6	10	14	5.19
17.	Mar-19	6	8	1	9	15	5.56
18.	Jun-19	6	2	6	8	14	5.19
19.	Sep-19	6	6	3	9	15	5.56
20.	Dec-19	4	5	6	11	15	5.56
Total (N) MIS Quarterly (5yrs)		**103**	**87**	**80**	**167**	**270**	**100.00**
Total (%) MIS Quarterly (5yrs)		**38.15**	**32.22**	**29.63**	**61.85**	**100**	

Table 3: Journal of Management Information Systems (JMIS) publications within 5year (2015-2019)

SN	Publication date	Classes				Publication quarterly	
		CISR Publication Count	RAD Publication Count	BUD Publication Count	Combine RAD and BUD count	Total count (N)	Total percentage (%)
1.	Vol. 26 No. 1, 2015	4	4	2	6	10	4.76
2.	Vol. 26 No. 2, 2015	5	2	4	6	11	5.24
3.	Vol. 26 No. 3, 2015	4	5	1	6	10	4.76
4.	Vol. 26 No. 4, 2015	3	4	2	6	9	4.29
5.	Vol. 27 No. 1, 2016	4	3	3	6	10	4.76
6.	Vol. 27 No. 2, 2016	5	2	5	7	12	5.71
7.	Vol. 27 No. 3, 2016	3	3	4	7	10	4.76
8.	Vol. 27 No. 4, 2016	5	1	5	6	11	5.24
9.	Vol. 28 No. 1, 2017	2	0	7	7	9	4.29
10.	Vol. 28 No. 2, 2017	3	1	7	8	11	5.24
11.	Vol. 28 No. 3, 2017	4	2	5	7	11	5.24
12.	Vol. 28 No. 4, 2017	4	3	4	7	11	5.24
13.	Vol. 29 No. 1, 2018	3	7	1	8	11	5.24
14.	Vol. 29 No. 2, 2018	6	3	2	5	11	5.24
15.	Vol. 29 No. 3, 2018	4	4	2	6	10	4.76
16.	Vol. 29 No. 4, 2018	3	3	4	7	10	4.76
17.	Vol. 30 No. 1, 2019	4	4	3	7	11	5.24
18.	Vol. 30 No. 2, 2019	2	6	2	8	10	4.76
19.	Vol. 30 No. 3, 2019	6	1	4	5	11	5.24
20.	Vol. 30 No. 4, 2019	4	1	6	7	11	5.24
Total (N) JMIS (5yrs)		**78**	**59**	**73**	**132**	**210**	**100.00**
Total (%) JMIS (5yrs)		**37.14**	**28.10**	**34.76**	**62.86**	**100**	

Table 4: Information Systems Research (ISR) publications within 5year (2015-2019)

SN	Publication date	Classes				Publication quarterly	
		CISR Publication Count	RAD Publication Count	BUD Publication Count	Combine RAD and BUD count	Total count (N)	Total percentage (%)
1.	Mar-15	2	6	4	10	12	4.36
2.	Jun-15	5	4	3	7	12	4.36
3.	Sep-15	5	2	3	5	10	3.64
4.	Dec-15	6	2	4	6	12	4.36
5.	Mar-16	3	4	5	9	12	4.36
6.	Jun-16	4	6	3	9	13	4.73
7.	Sep-16	6	4	1	5	11	4.00
8.	Dec-16	9	2	4	6	15	5.45
9.	Mar-17	4	7	1	8	12	4.36
10.	Jun-17	5	3	4	7	12	4.36
11.	Sep-17	1	7	4	11	12	4.36
12.	Dec-17	4	6	4	10	14	5.09
13.	Mar-18	4	7	2	9	13	4.73
14.	Jun-18	9	2	2	4	13	4.73
15.	Sep-18	2	4	6	10	12	4.36
16.	Dec-18	4	6	5	11	15	5.45
17.	Mar-19	4	10	6	16	20	7.27
18.	Jun-19	4	7	6	13	17	6.18
19.	Sep-19	3	7	12	19	22	8.00
20.	Dec-19	4	8	4	12	16	5.82
Total (N) ISR (5yrs)		**88**	**104**	**83**	**187**	**275**	**100.00**
Total (%) ISR (5yrs)		**32.00**	**37.82**	**30.18**	**68.00**	**100**	

The results from the summary of the three Journals publications within 5year (2015-2019) showed the core IS research (CISR) is having a total of 269 (36%) of the Publications while the remaining 486(64%) is for reference discipline with Related applied disciplines for IS research (RAD) and Basic underlying disciplines for IS research (BUD) having 250(33%) and 236(31%) respectively. Table 5 depicts the results summary of the three journals. From the results, the five years publications of the three Journals have the highest research focus on core IS research, followed by IS discipline with flavors of Related applied disciplines (i.e., Accounting, Management Science, Computer science, and Finance), and the least was IS discipline with flavors of Basic underlying disciplines (i.e., Economics, psychology, sociology, and political science). However, the overall publications focus of three Journals are more toward reference disciplines than in core IS research.

In examining the publications capacity of the three Journals, Information Systems Research (ISR) has the highest with 275(36.4%), followed by MISQ with 270(35. 8%), and the least was JMIS with 210(27.8%).

Table 5: Summary of the three Journals publications within 5year (2015-2019)

Journal	Publication date	CISR	RAD	BUD	RAD & BUD	Total count (N)	Total count (%)
MISC	Mar-15 to Dec-19	103	87	80	167	270	35.76
JMIS	Vol. 26(1) 2015 to Vol. 30(4) 2019	78	59	73	132	210	27.81
ISR	Mar-15 to Dec-19	88	104	83	187	275	36.42
Total (N) All three Journal (5yrs)		**269**	**250**	**236**	**486**	**755**	**100**
Total (%) All three Journal (5yrs)		**35.63**	**33.11**	**31.26**	**64.37**	**100**	

5. Discussion and Conclusion

The results of the three journals (i.e., MIS Quarterly, Journal of Management Information Systems, and Information Systems Research) for a period of 5years (2015 to 2019) publications revealed that IS research is diversified. In analyzing the results, two patterns of IS research publications were identified. The first pattern was that the publications in the three Journals are more toward reference disciplines than in core IS research. The second pattern was that the publications in the three Journals are encouraging core IS research. The results from this paper are consistent with the idea of IS discipline as a unique subject matter that accommodates research articles from other disciplines as long as they are of high quality [11]. The research articles' recognition from other disciplines promotes the diverse paradigms in IS research [9]. Benbasat and Weber (1996) identify three types of diversity within IS discipline include (1) problems address diversity; (2) theoretical foundations and reference disciplines diversity; and (c) research methodology diversity. From the results of this paper, the three journals are still recognizing the research diversity within IS discipline [9].

In analyzing the results from Culnan's classification of IS reference disciplines [5], the three journals have distinctive focus and priority. First, the five years publications of MIS quarterly have the highest research focus on core IS research, followed by IS discipline with flavors of Related applied disciplines (i.e., Accounting, Management Science, Computer science, and Finance), and the least was IS discipline with flavors of Basic underlying disciplines (i.e., Economics, psychology, sociology, and political science). Second, the five years publications of the Journal of Management Information Systems (JMIS) have the highest research focus on core IS research, followed by IS discipline with flavors of Basic underlying disciplines (i.e., Economics, psychology, sociology, and political science), and the least was IS discipline with flavors of Related applied disciplines (i.e., Accounting, Management Science, Computer science, and Finance). Last, the five years Publications of Information Systems Research (ISR) have the highest research focus on IS discipline with flavors of Related applied disciplines (i.e., Accounting, Management Science, Computer science, and Finance), followed by core IS

research, and the least was IS discipline with flavors of Basic underlying disciplines (i.e., Economics, psychology, sociology, and political science).
In conclusion, the research trend in IS discipline in recent years emphasizes diversity. The interpretation is that IS research is not entirely dependent on reference discipline but has diversified through research methods, problems, and theoretical foundations to account for IS phenomena

6. Limitation and Future Research

This research paper is limited to both time and scope. We considered 5 Years of published articles in three Journals, which to some extent has yield a good direction on IS research. However, we believe that IS research needs to be extended to account for the aftermath of COVID19 (i.e., between March 2020 and now). The pandemic has changed the mode of operation, interaction, and collaboration for businesses (i.e., practitioners) and educational institution (i.e., academia), which may alter the research focus and the trend of research requirement for publication of articles. Another limitation associated with this research paper is the scope, where we considered three Journals (MIS quarterly, JMIS, ISR). Although, we made the selection based on the advocacy for IS diversity that led to the creation MIS Quarterly journal in 1977 with Editors of a different discipline. We added two more IS Journals to provide a more robust way of making inference.
In future research, we recommend that further empirical research need to focus on high quality articles from all the high impact IS Journals. Considering high quality articles will provide a room to determine the effect size that will help us in addressing questions such as what will happen if IS research focuses only on its core, what type of diversity suite the IS research, and what are areas of IS research adopted by other disciplines.

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The Role of Blockchain Governance Within Business Processes

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Abstract

The hype of blockchain has come and gone. Organizations are unsure of the expectations of Blockchain application. As the role of blockchain is under consideration for projects, the role of governance is critical for organizations. The research will look at an effort to develop blockchain governance and the potential case study opportunities for research.

Introduction

Organizations have looked to information technology to improve business processes. One application that has been seen with great anticipation is blockchain technology (BCT). As BCT has emerged from finance applications, it is seen as an opportunity to transform business processes in various industry sectors (Akram et al., 2020). These business processes include healthcare, energy, supply chain management, transportation, agriculture, and others. As projects have been implemented, challenges have been discovered. Challenges include lack of adoption, rising implementation costs, scalability, regulations, security and privacy challenges, energy consumption, interoperability, lack of standardization, integration with legacy systems, and others (dataconomy.com, 2022).

Another challenge is the maturity of the organizations, who are developing the BCT business implementations; initiating the BCT projects, and running the BCT products and services. As many of them are early adopters, like small and midsize enterprises and start-ups with highly motivated innovators, it can come short with the governance and compliance mentality due to limited budgets and often times because of strong technology mindset. (Casper Labs - The State of Enterprise Blockchain Adoption in 2023)

Several of these challenges are related to governance processes. There are several definitions of governance. One definition of governance "implies the processes and institutions that guide and restrain the collective activities of the group" (Keohane and Nye, 2000). Another definition of Governance "ensures that stakeholders needs, conditions and options are evaluated to determine balanced, agreed-on enterprises to be achieved; setting direction through prioritization and decision making; and monitoring performance and compliance against agreed-on direction and objections" (isaca.org, 2023). This paper will look at the role of governance within blockchain applications. The focus will look at identifying supply chain processes to measure for future studies.

Background

Industries such as food and fashion account for multi trillion dollars in revenue, and account for a substantial percent of global exports (statista.com, 2023; Morgan, 2015). These industries have a substantial impact on environment due to production and supply chain management processes. Apparel industry has huge environmental impacts (de Brito, Carbone, & Blanquart, 2008; Park & Dickson, 2008). Supply chain management processes such as returns costs industries over $50 billion per year (statista.com, 2023).

Blockchain Technology

As organizations attempt to address these issues with suppliers, BCT is seen to create transparency and reducing friction between all parties. Blockchain Technology is defined as a distributed ledger technology sharing data between parties (Crumbly and Welch, 2021). As data is shared between organizations, it is processed by third party miners who confirm source and accuracy. If an unknown party is participating in activities, all parties are notified (intellipaat.com, 2023).

Challenges within Blockchain Technology Use

As BCT applications have been developed within organizations, several challenges occurred. These include lack of adoption, interoperability, and lack of standardization (dataconomy.com, 2022). This level of uncertainty has caused implementation to stall or completely stop. One method of identifying requirements is BCT governance. BCT governance research with the IEEE project committee has identified following components: People, Process, Policy, Practice, and Incentive (Coskun et al., 2023). These elements are critical to develop compliance between partners within production, supply chain management, and other processes. Without the transparency required to ensure compliance, organizations can claim compliance without confirmation. This gap destroys trust between manufacturers, retailers, and suppliers.

Blockchain Governance Use Cases

The study is researching BCT as a solution to reduce returns in the apparel industry. The development of governance is based upon a reverse logistics measures framework (Speh et al. 2015). The framework identifies actors in returns along with performance measures.

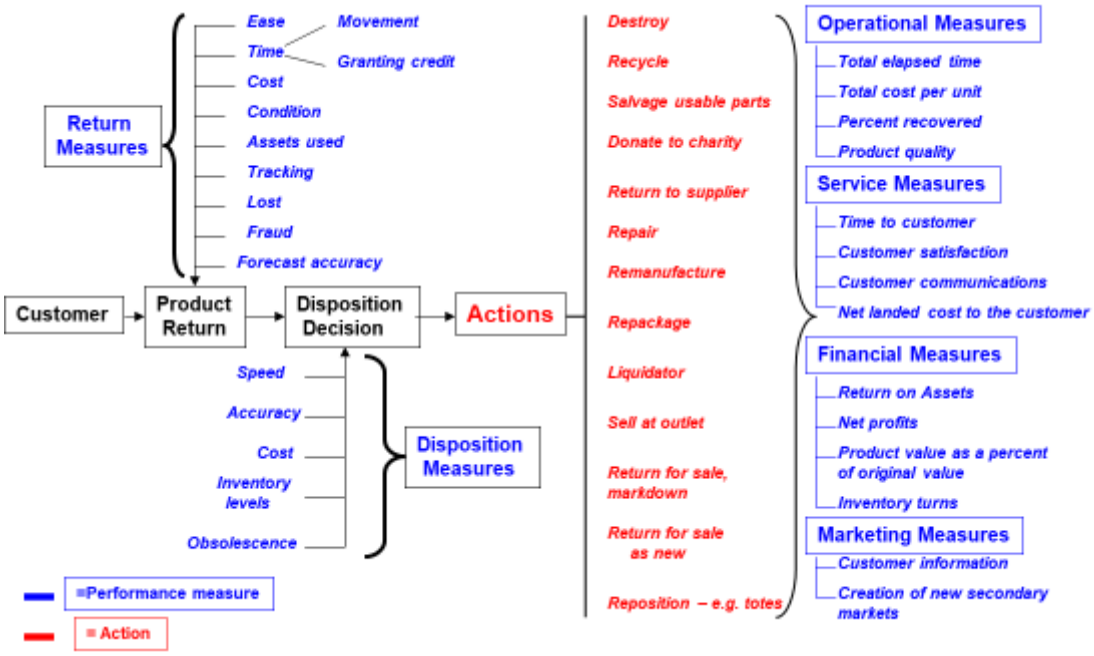
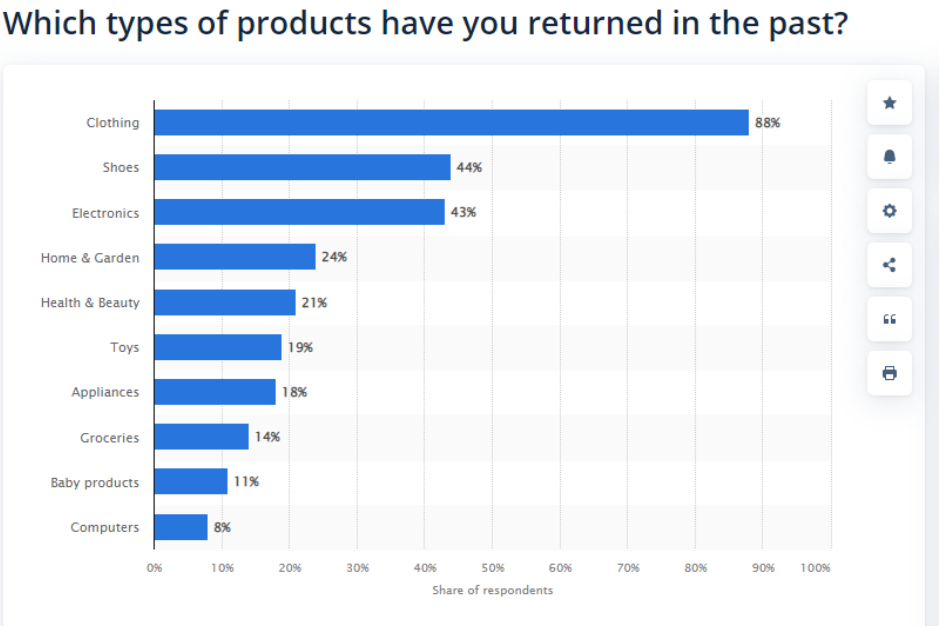


Figure 1. Framework of Reverse Logistics Performance Measurement

The apparel industry has received less attention on the topic of sustainability compared to other similarly polluting industries (Carter & Liane Easton, 2011), even though its global, social and environmental impact serves as a tremendous challenge. In the last years, the products are purchased increasingly over E-Commerce. Retailers offer the incentive of return of products after the customer delivery (statista.com; 2019, 2023). https://www.statista.com/chart/16615/e-commerce-product-return-rate-in-europe/ Apparel is particularly vulnerable to loss of value given the short window in which items stay in style. With a new fashion season coming every three months, items shipped back at the very end of a 30-day return window leaves little time to process, restock and resell returned goods before the next collection hits the racks.



https://www.statista.com/statistics/806122/most-returned-items-reverse-logistics-united-states/#:~:text=This%20statistic%20depicts%20the%20results,consumers%20reported%20returning%20these%20items.

Figure 2. Purchased Product Returns USA 2019

Blockchain is a great tool for transparency in SCs that provides many opportunities. Nonetheless, its future implementation on a broad scale triggers a discussion regarding ethical and sustainable considerations that are significant to mention. (Alicja Jordan, Louise Bonde RasmussenThe role of blockchain technology for transparency in the fashion supply chain). Blockchain Governance is most needed to deliver the best compliant solution with BTC. The following table identifies key stakeholders in reverse logistics and their role in creating value in the process.

	Revenue Enhancement	*Cost Reduction*	*Loss Avoidance*	*Sustainability*
Upstream raw or partially processed material provider				
Producer/manufacturer of t-shirts	*Reposition*	*Recycle* *Donate to charity*	*Destroy* *Salvage Usable Parts* *Repair* *Remanufacturer* *Sell at Outlet*	*Repair* *Remanufacturer*
Retailer	*Reposition*	*Donate to charity*	*Return to manufacturer* *Repackage* *Liquidator* *Sell at Outlet* *Resell at markdown*	

End customer/wearer		*Donate to charity*		
Logistics Provider for returns	*Return to manufacturer Repair*			
Financial Services to process any payments				
Post return participant	*Liquidator*			

Table 1. Key Stakeholders in Reverse Logistics T-Shirt Life Cycle

Blockchain Governance Design Plan

Blockchain Governance Design Plan (BGDP) (Coskun et al., 2023) will require the following:

- Governance principles: In alignment with the principles of the solution being developed, the governance for the solution may need to abide by certain principles, such as a need to be participatory, inclusive, fair, and transparent, among others.
- Centralized vs. decentralized governance, permission less vs. permissioned solutions: Depending on the business needs, a blockchain solution may be owned and/or controlled by a centralized or decentralized governance model, with some variation depending on the level of decentralization supported. A blockchain solution may also be permissioned, permission less, or hybrid depending on the use case to be supported.
- On-chain vs. off-chain governance: A blockchain solution may include requirements for algorithmic, on-chain governance that automatically executes when given conditions are met, or a solution may require off-chain governance with human involvement and/or oversight for certain aspects. On-chain governance may be provided using the same chain or a different chain supported by an external, third-party application.

Blockchain Governance Design elements is based on a 4P + I framework (Coskun et al., 2023).

- People: Describes the stakeholders who are involved in or impacted by the governance of the target and the structure of organization of members that support the governance functions
- Process: Describes the decision making, communication and coordination processes that will support the creation of policies for the governance of the target.
- Policy: Describes the types of policies, their implementations and supporting activity necessary to implement governance.
- Practice: Describes the methods to translate the policies into activities. Incentives: positive or negative motivations to influence the designed governance outcome for the given targets

Methodology

Our purpose was to start the work of creating the BGDP for our Reverse Logistics use case. As such, we did not complete the full BGDP. Our next steps would focus on two items:

1. Work through the Risk and specific use case Success Metrics followed by building out each of the ToG (Targets of Governance). The latter, especially, will help generate support for the project and its realization.
2. Select which of the additional considerations will be helpful to create a more effective governance plan.

There are many threads in our reverse logistics case. We would also circle back to our initial work to revisit the business case and business value to refine to where the best place to focus is such as methods to avoid returns in the first place, prevent waste, establish product lifecycle management, or create overall strategy for returns. For example, during our calls, we kept coming back to the scenario where t-shirts are dumped in under-developed markets.

Key findings

The BGDP is an effective means to set up the initial governance for a blockchain solution. Though we didn't focus on the governance of the implementation of the blockchain solution, it also acts as a catalyst to more confidently create the actual solution by laying out key foundational governance points.

- Overall, the BGDP document ask questions, define governance strategies and objectives, and develop structures with processes. Questions include:
    - Identifying measures
        - Identifying key stakeholders
        - Business value
        - Governance principles
        - Risks
    - Governance is clearly defined identifying the following for the project
        - Design components
            - Inputs
            - Elements

- The need of a governance starts with the Business Case and a few Use Cases for the initiation and development and implementation of the project.

- Using an existing framework of Reverse Logistics helped a lot. We used Framework of Reverse Logistics Performance Measurement- Speh, Hanna, Crumbly (2015)

As we worked through the BGDP framework, we found additional items to create a larger scope governance document. They include:

1. A workflow definition to show handoffs and process.
2. A Blockchain Implementation assessment with Scalability, Operational Performance and Security aspects. This gives us the Domain and Tech Requirements for the KPI definitions.
3. A Solution Architecture

4. Development implementation (both coding and project structure) governance
5. The usage of applicable standards such as 12N, OBADA, and UN Traceability for Sustainable Garment and Footwear project
6. Creating the Project Management of the implementation (such as using a RACI matrix and Gantt charts) including solution product lifecycle management.

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Papers: Information Privacy, Security and System Resilience, Business Ethics, Business Law

AI vs. AI: Using AI to Detect AI-generated Phishing Emails in Ransomware Attack Protection

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ABSTRACT

The rise of ransomware attacks over the past few years is an ever-growing problem that has quickly become an extremely serious threat to businesses and government organizations across the globe. Approximately 37% of global organizations said they were the victim of some form of a ransomware attack in 2021. Phishing emails are the most common delivery methods and cybersecurity vulnerabilities causing ransomware infections. The rapid growth of Artificial Intelligence (AI) technologies has provided advanced and cost-effective AI text generation capabilities. Threat actors are taking advantage of these capabilities to deliver malicious phishing campaigns, which puts defending against phishing emails in a more disadvantageous situation. To date, several studies have been conducted to address the challenging threat of ransomware, and have tried to provide detection and prevention solutions. However, there is a lack of survey articles that explore the research endeavors in mitigating ransomware attacks by detecting AI-generated phishing emails. As an effort to review the present status and future prospects in the research area, this paper introduces ransomware, ransomware attacks, and its trends; discusses the state-of-the-art text generation engine (GPT Generative Pre-Trained Transformer); reviews significant researches in detection algorithms and approaches for detecting AI-generated contents; and studies the challenges and future research directions in developing AI models to effectively distinguish between AI-generated and human-generated texts. The works reviewed in this paper are significant studies from scientific article databases: SpringerLink, ACM, IEEExplorer, ScienceDirect, and Arxiv. This work can be used as a simplified ready reference for the present status and future prospects in this research area.

Keywords: Ransomware Attack, Phishing, AI-generated Text, Generative Pre-Trained Transformer (GPT)

1. Introduction

The rise of ransomware attacks over the past few years is an ever-growing problem that has quickly become an extremely serious threat to businesses and government organizations across the globe. Approximately 37% of global organizations said they were the victim of some form of a ransomware attack in 2021 (IDC 2021). Since they cause more and more data breaches, ransomware attacks got more destructive and costlier. According to IBM's report (IBM 2022), the share of data breaches caused by ransomware grew 41% in the last year and took 49 days longer than average to identify and contain. For the 12th year in a row, the United States holds the title for the highest cost of a data breach: the average cost of a data breach in the United States is $9.44M, which is over twice the global average, $4.35M.

Phishing emails are the most common delivery methods and cybersecurity vulnerabilities causing ransomware infections. Phishing email threat is on rise over the past years, which causes 22 % of loss of data breaches (IBM 2022).

The rapid growth of AI models has provided advanced and cost-effective AI text generation capabilities. Threat actors are taking advantage of these capabilities to deliver malicious phishing campaigns, which puts defending against phishing emails in a more disadvantageous situation.

In Digital Shadows’s report Ransomware in Q2 2022: Ransomware Is Back in Business (Righi 2022), the following chart shows that the total ransomware incidents by month has noticeably risen since 2021.

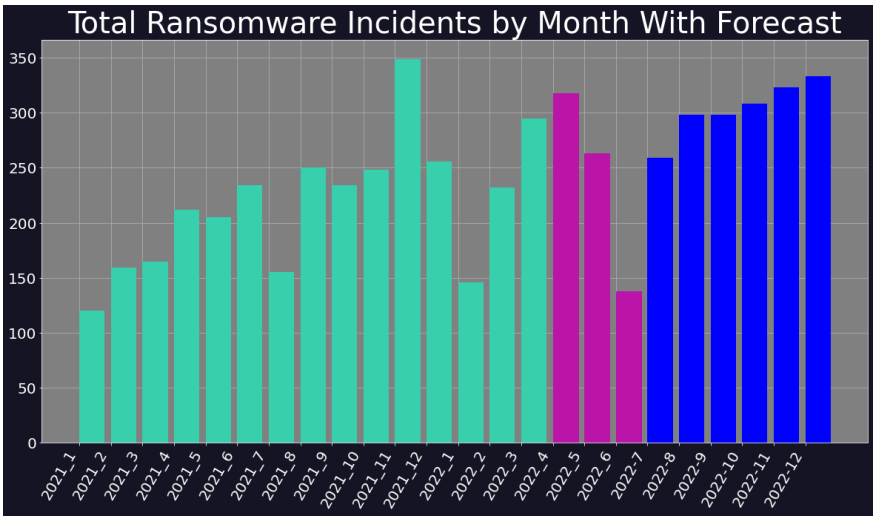

Fig-1: Ransomware Victims by Month Forecast, 2022

To date, several studies have been conducted to address the challenging threat of ransomware, and have tried to provide detection and prevention solutions. However, there is a lack of survey articles that explore the research endeavors in mitigating ransomware attacks by detecting AI-generated phishing emails. As an effort to review the present status and future prospects in the research area, this paper introduces ransomware, ransomware attacks, and its trends (Section 2); discusses the state-of-the-art text generation engine (Section 3); reviews significant researches in detection algorithms and approaches for detecting AI-generated contents (Section 4); provides the most recent datasets for detectors (Section 5); and studies the challenges and future research directions in developing AI models to effectively distinguish between AI-generated and human-generated texts. Finally, section 7 concludes the study. The works reviewed in this paper are significant studies from scientific article databases: SpringerLink, ACM, IEEExplorer, ScienceDirect, and Arxiv. The main contributions of this work include: (1) It provides the first survey on the important, rapidly evolving area of detection AI-generated phishing emails to mitigate ransomware attacks, which can be used as a simplified ready reference for the present status and future prospects in this research area; (2) The work analyzes the existing researches, challenges and propose several promising research directions to guide future work in this area.

2. Ransomware and Ransomware Attacks

In recent years, ransomware have become a great threat to the computer and smart device users. Ransomware has been referred as scarewares that are designed basically to frighten users and force them

either to quickly purchase the software used to protect user's private data, or to prevent irreversible damages (Aurangzeb S, Iqbal, and Islam 2017). However, today's ransomware is a type of effective tools used by threat actors to gain financial benefits (ransom). In this section, we cover the definitions of ransomware, its brief history, ransomware attacks steps, ransomware attacking mechanisms and the payment methods in ransomware attacks.

2.1 What is Ransomware?

National Institute of Standards and Technology (NIST) defines ransomware as a type of malicious attack where attackers encrypt an organization's data and demand payment to restore access. Attackers may also steal an organization's information and demand an additional payment in return for not disclosing the information to authorities, competitors, or the public (NIST 2022).

In the Stop Ransomware program (CISA, 2022), Cybersecurity & Infrastructure Security Agency (CISA) states that Ransomware is a form of malware designed to encrypt files on a device, rendering any files and the systems that rely on them unusable. Malicious actors then demand ransom in exchange for decryption. CISA has set up a website StopRansomware.gov as the U.S. Government's official one-stop location for resources to tackle ransomware more effectively.

In spite of the different definitions, most ransomware share all or some of the following characteristics: device locking, data encryption, data deletion, data stealing, sending threatening messages, ransom payment, and et al. (Aurangzeb S, Iqbal, and Islam 2017).

2.2 Ransomware History

Ransomware has a long history. The first ransomware attack was reported in 1989, generally it is recognized as the "AIDS Trojan" (Choi, Scott, LeClair 2016). Since them, ransomware have being evolved and spread using different social engineering techniques and employing more advanced encryption techniques to conceal user data and demand ransom (Aurangzeb S, Iqbal, and Islam 2017). In this paper (Drake, 2022), the author groups the History and evolution of ransomware attacks to several phases:

- The emergence of ransomware (1989). This is the emerging of the "AIDS Trojan" ransomware.
- The early years (2005–2009). In this phase, ransomware started using secure asymmetric encryption. The "Archiveus" Trojan and "GPcode" were the most notable of these early ransomwares. For example, the "Archiveus" Trojan is the first ransomware to use RSA, which encrypted all files in the "My Documents" folder.
- Ransomware embraces cryptography (2009–2013). The typical ransomware examples of this phase include "Vundo", "WinLock" Trojan, "Reveton" ransomware and its variants.
- Ransomware becomes dominant (2013–2016). "CryptoLocker", "Gameover Zeus" botnet, "FileCoder", "Spyeng", "Oleg Pliss", and "Patcher" emerged in this phase. "FileCoder" is the first true ransomware for Mac, which was discovered in 2014. Through the "Find my iPhone" feature, this ransomware used stolen accounts to remotely lock iPhones, and then demanded a ransom for the phone to be unlocked.
- The emergence of RaaS (2016–2018). Ransomware- as-a-Service (RaaS) emerged in 2016. In RaaS, ransomware programmers writes ransomware code and collaborates with hackers. Examples of RaaS include "Ransom32", "Shark", "Petya", "notPetya", "EternalBlue", "LeakerLocker", "WannaCry", and et al.

- Ransomware and malware merge (2018-2019). In this phase, ransomware started to steal a victim's data and locked his files to demand ransom. For example, "GandCrab" merged with "Vidar" information-stealing malware, and quickly became the most popular RaaS, and the most active strain of ransomware between 2018 and 2019.
- The rise of leak sites (2019–2020). The "Maze" ransomware emerged in November 2019, which leaked 700 MB worth of documents stolen from Allied Universal in an attempt to pressure them and future victims into paying the ransom. "Sodinokibi" is another example of phase.
- Ransomware today (2020–present). Making use of the advanced and cost-effective AI text generation capabilities, ransomware continues to threaten and undermine organizations.

2.3 How Ransomware Attacks Work

The implementation details of different ransomware attacks vary from one ransomware variant to another, however, successful ransomware needs follow the same key stages: Infection – gaining access to a target system; Data Encryption – encrypting the victim's data; and Ransom Demand - demanding a ransom from the victim (Brewer R 2016; Rudd EM 2016).

Like any other malicious software, there are a number of different ways, through which ransomware can gain access to a victim's systems. However, different than traditional malware attacks, nowadays ransomware attacks heavily depend on phishing emails as their infection vector. Phishing emails usually contain malicious contents, for example, links to a website hosting a malicious download, or an attachment that has downloader functionality built in. If the email recipients fall for the phish, they download and executed ransomware on their computers. By exploiting the vulnerabilities of the victim's system, ransomware can gain critical access to the computers (Olaimat, Maarof, and Al-rimy 2021; Zimba 2017; Deka, Dipjyoti, Sarma, and Panicker 2016). Besides phishing emails, other mechanisms include self-propagation, SMS messages, third-party app stores, exploiting server vulnerabilities, brute force passwords, exploit kits, downloader and Trojan botnets, social engineering tactics, drive-by-downloads, and et al.

Ransomware's popularity was influenced and promoted by both the rapid growth of AI text generation technologies, and the emerging of other new technologies, for example, cryptocurrencies and anonymous Tor network. Cryptocurrencies are entirely digital currencies unassociated with any banks or governments. The anonymity of cryptocurrencies makes them powerful tool for financing crime. In fact, most of the threat actors demand Bitcoin for the ransom, more specifically, 98% of ransoms are paid in Bitcoin. Between January 2013 and July 2019, approximately $144.35 million was paid (Wang, Pang, Chen, Zhao, Huang, and et al. 2021).

3. AI-generated Text

A language model is a probability distribution over sequences of words. Given any sequence of words of length *m*, a language model assigns a probability $P(w_{(1)}, \ldots, w_{(m)})$ to the whole sequence. (Jurafsky, Martin et al. 2021).

AI language models learn the probabilities of a sequence of words that occur in a commonly spoken language and predict the next possible word in that sequence. They are essential for numerous NLP tasks like: Language Translation, Text Classification, Sentiment Extraction, Reading Comprehension, Named

Entity Recognition, Question Answer Systems, News Article Generation, and et al. (Du, Qian, Liu, Ding, Qiu, Yang, Tang, 2021).

AI language models in natural language processing have become immensely popular since the release of BERT by Google and been used in ransomware attacks. For example, threat actors are using AI language model Generative Pre-trained Transformer GPT-2 and GPT-3 to synthetically generate text in ways that mimic the style and substance of human-created phishing emails. In a small study, researchers found that they could use the AI language model GPT-3, along with other AI-as-a-Service (AIaaS) platforms, to significantly lower the barrier to entry for crafting spear phishing campaigns at a massive scale (Kreps, McCain, Brundage, 2022).

In this section, we briefly discuss about the popular AI language models, including BERT, RoBERTa, MUM (T5), Turning-NLG, GPT-2 and GPT-3.

3.1 BERT

Bidirectional Encoder Representations from Transformers (BERT) is one of the first developed transformer-based self-supervised language models.

One of difference between BERT and other language models is that by jointly conditioning on both left and right context in all layers, BERT is designed to pre-train deep bidirectional representations from unlabeled text. Specifically, BERT is pre-trained with unlabeled language sequences from the BooksCorpus (800 M words) and English Wikipedia (2,500 M words). As an encoder-only bidirectional transformer, BERT has 340 M parameters (Deepa 2021, Causevic 2022).

By taking the advantages of the pre-trained BERT model, you can fine-tune the model with just one additional output layer to create state-of-the-art models without substantial task-specific architecture modifications. Then new model can be used for a wide range of tasks, such as question answering and language inference, etc. (Devlin J, Chang MW, Lee K, Toutanova K. 2018).

Conceptually, BERT is simple, but it obtains new state-of-the-art results on eleven natural language processing tasks, which makes it is empirically powerful. The tasks include pushing the GLUE score to 80.5% (7.7% point absolute improvement), MultiNLI accuracy to 86.7% (4.6% absolute improvement), SQuAD v1.1 question answering Test F1 to 93.2 (1.5 point absolute improvement) and SQuAD v2.0 Test F1 to 83.1 (Devlin J, Chang MW, Lee K, Toutanova K. 2018).

3. 2 RoBERTa

RoBERTa stands for Robustly Optimized BERT Pre-training Approach. It was presented by researchers at Facebook and Washington University.

For all language models, training them is computationally expensive, which is often done on private datasets of different sizes. During training, hyperparameter optimization, or tuning have significant impact on the final results. The goal of RoBERTa was to optimize the training of BERT architecture in order to take lesser time during pre-training. Since it is based on BERT, RoBERTa has almost similar architecture as compare to BERT. The authors of RoBERTa made some simple design changes in its architecture and training procedure to improve the results on BERT architecture. These changes are: Removing the Next Sentence Prediction (NSP) objective, Training with bigger batch sizes & longer sequences and dynamically

changing the masking pattern (Liu Y, Ott M, Goyal N, Du J, and et al. 2019; RoBERTa 2022). These changes substantially improved the performance of BERT model.

Since BERT's release, several alternative versions were launched. Besides RoBERTa, other variants include ALBERT, ELECTRA, XLNet, DistilBERT, SPANBERT and BERTSUM (360DigiTMG Team 2021). Figure-2 shows the common characteristics of BERT and variant models.

Comparison	BERT October 11, 2018	RoBERTa July 26, 2019	DistilBERT October 2, 2019	ALBERT September 26, 2019
Parameters	**Base:** 110M **Large:** 340M	**Base:** 125 **Large:** 355	**Base:** 66	**Base:** 12M **Large:** 18M
Layers / Hidden Dimensions / Self-Attention Heads	**Base:** 12 / 768 / 12 **Large:** 24 / 1024 / 16	**Base:** 12 / 768 / 12 **Large:** 24 / 1024 / 16	**Base:** 6 / 768 / 12	**Base:** 12 / 768 / 12 **Large:** 24 / 1024 / 16
Training Time	**Base:** 8 x V100 x 12d **Large:** 280 x V100 x 1d	1024 x V100 x 1 day (4-5x more than BERT)	**Base:** 8 x V100 x 3.5d (4 times less than BERT)	[not given] **Large:** 1.7x faster
Performance	Outperforming SOTA in Oct 2018	88.5 on GLUE	97% of BERT-base's performance on GLUE	89.4 on GLUE
Pre-Training Data	BooksCorpus + English Wikipedia = 16 GB	BERT + CCNews + OpenWebText + Stories = 160 GB	BooksCorpus + English Wikipedia = 16 GB	BooksCorpus + English Wikipedia = 16 GB
Method	Bidirectional Transformer, MLM & NSP	BERT without NSP, Using Dynamic Masking	BERT Distillation	BERT with reduced parameters & SOP (not NSP)

Figure-2 Common characteristics of BERT and variant models

3.3 MUM (T5)

On May 20th, 2021 Google held its developer conference I/O and announced a new algorithm for their search engine: MUM, a Multitask Unified Model (Wieschollek 2021). MUM is the technology that powers the sophisticated Google Search today, which focuses on interpreting and analyzing podcasts, videos, and images across multiple languages to come up with the best answers to modern search demands.

MUM takes over the heritage of BERT and tries to focus even more on complex and long-tail search queries and on solving the user's request as efficient as possible. MUM has the potential to transform how Google helps you with complex tasks. MUM uses the T5 text-to-text framework and is 1,000 times more powerful than BERT and has higher scores in efficiency. According to Google, MUM stands out in three major categories (Nayak, P. 2021):

- MUM is multimodal and handles diverse media types
- MUM handles more complex search queries
- MUM overcomes language barriers

3.4 Turning-NLG

Turing Natural Language Generation (T-NLG), created by Microsoft, is a 17 billion parameter language model, which outperforms the state of the art on many downstream NLP tasks (Corby Rosset 2020). T-NLG is a Transformer-based generative language model, it can generate words to complete open-ended textual tasks. T-NLG can be used to complete an unfinished sentence, generate direct answers to questions, and summarize input documents (Corby Rosset 2020).

3.5 Generative Pre-trained Transformer GPT-2 and GPT-3

GPT-2 is released in Feb 2019, it is an unsupervised deep learning transformer-based language model. The model is open source and is trained on over 1.5 billion parameters to generate the next sequence of text for a given sentence. As the successor of GPT-2, GPT-3 is known to go further with the following tasks: writing essays, text summarization, language translation, answering questions, and producing computer code. Being trained on a whopping 175 billion parameters, GPT-3 takes the GPT model to a whole new level. In comparison, that is 10 times more than the next largest LM, the Turing NLG with 17 BN parameters (Brown, Mann, Ryder, and et al. 2020). Fig-3 shows the comparison of all available language models parameter wise.

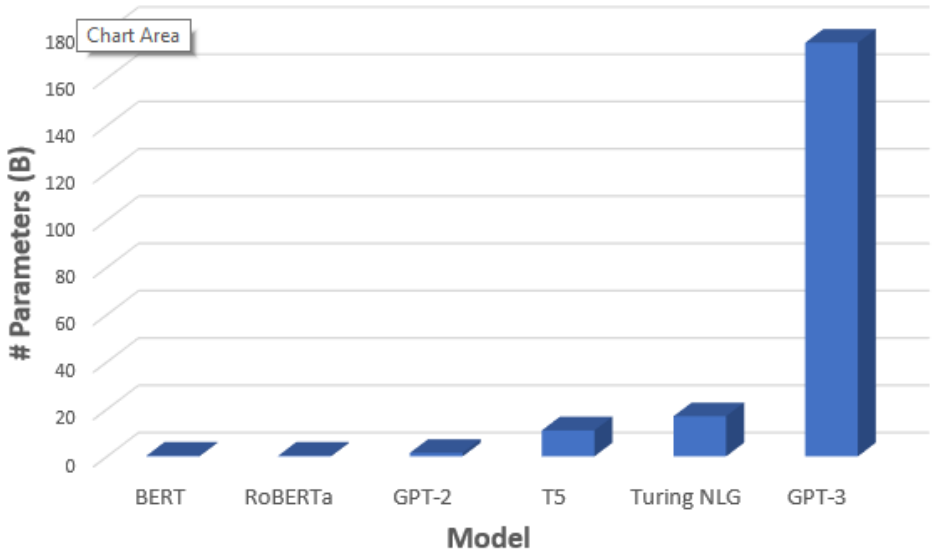

Fig-3: Comparison of all available language models parameter wise

GPT-3 is based on the concepts of transformer and attention similar to GPT-2. It has been trained on a large and variety of data like Common Crawl, webtexts, books, and Wikipedia, based on the tokens from each data. The following table 1 shows the training corpus of GPT-3.

Datasets	**Quantity (Tokens)**	**Weight in Training Mix**	**Epochs elapsed when training for 300 BN tokens**
Common Crawl (filtered)	410 BN	60%	0.44
WebText2	19 BN	22%	2.90
Books1	12 BN	8%	1.90
Books2	55 BN	8%	0.43
Wikipedia	3 BN	3%	3.40

Table-1: the training corpus of GPT-3

There are several GPT-3 examples and variants in terms of sizes, architectures and Learning hyper-parameters. Here are the details of the different variants of GPT-3 model:

Model Name	n_{params}	n_{layers}	d_{model}	n_{heads}	d_{head}	Batch Size	Learning Rate
GPT-3 Small	125M	12	768	12	64	0.5M	6.0×10^{-4}
GPT-3 Medium	350M	24	1024	16	64	0.5M	3.0×10^{-4}
GPT-3 Large	760M	24	1536	16	96	0.5M	2.5×10^{-4}
GPT-3 XL	1.3B	24	2048	24	128	1M	2.0×10^{-4}
GPT-3 2.7B	2.7B	32	2560	32	80	1M	1.6×10^{-4}
GPT-3 6.7B	6.7B	32	4096	32	128	2M	1.2×10^{-4}
GPT-3 13B	13.0B	40	5140	40	128	2M	1.0×10^{-4}
GPT-3 175B or "GPT-3"	175.0B	96	12288	96	128	3.2M	0.6×10^{-4}

Fig-4: Details of variants of the GPT-3 model

GPT-3 could be used by attackers to generate realistic-looking phishing emails, fake reviews of a new website or service.

Other common models include XLM model (Lample and Conneau, 2019), XLNET model (Yang et al., 2019), Plug and Play Language Models (PPLM) model, FAIR (Nget al., 2019).

4. Using AI to Detect AI-Generated Content

Before the emerging of AI-based detectors, human detection is the only practical way to discriminate between human- and machine-generated text samples. Since human education on language models' limitations and the rapid increase in the amount of information or data, human detection is not sufficient in current era.

Recently, various AI-based detectors have been developed for identifying machine generated text from human written text, and it has shown that some detectors can be as accurate as or even more accurate than human detection.

Some efforts have been made on combining human visual interpretation skills and common sense and computers' statistical speed to defend against online malicious activities, which involves both humans and AI. Giant Language Model Test Room (GLTR) is an example of this approach (Gehrmann, Strobelt, Rush 2019). In this section, we discuss the most influential detectors which have AI involved.

4.1 Giant Language Model Test Room (GLTR)

Researchers from Harvard University and MIT-IBM Watson Lab have created an AI-powered tool for spotting AI-generated text (Gehrmann, Strobelt, Rush 2019): Giant Language Model Test Room (GLTR). This system is used to detect whether a specific piece of text was generated by a language model algorithm. You can download the source codes of GLTR from GitHub (GitHub 2022).

The basic idea is that GLTR takes the same models that are used to generated fake text as a tool for detection. For example, GLTR has access to the GPT-2 117 M language model from OpenAI. It can use any textual input and analyze what GPT-2 would have predicted at each position. GLTR computes how the observed following word ranks, and gives a ranking of all of the words that the model knows. GLTR uses this positional information to overlay a colored mask over the text that corresponds to the position in the ranking. For example, a word that ranks within the most likely words is highlighted in green (top

10), yellow (top 100), red (top 1,000), and the rest of the words in purple. The output of GLTR is a direct visual indication of how likely each word was under the model. Figure-5 illustrates some example outputs of GLTR (Gehrmann, Strobelt, Rush 2019).

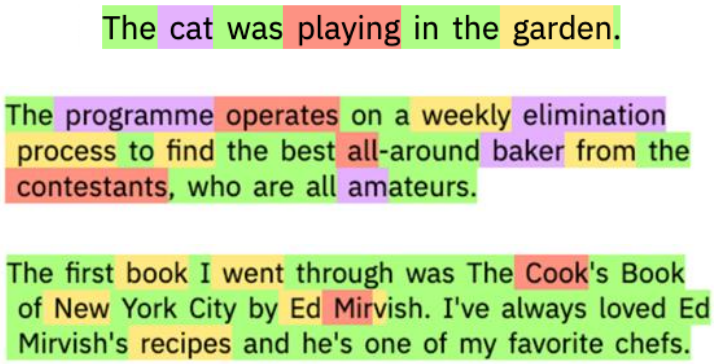

Figure-5 Example outputs of GLTR

4.2 GPT-2 and GPT-3

GPT-2 and GPT-3 can be used as a text generating model, it can be used as a text detection model too. Since the initial GPT-2 release, Solaiman and his team have conducted in-house detection research on GPT-2 (Solaiman, Brundage, and et al. 2019), and they grouped ML-based automated detectability systems roughly fall into three categories (listed in order of complexity) (Solaiman, Brundage, and et al. 2019):

- Simple classifiers: This classifiers in this category are trained from scratch to discriminate between outputs from a language model and some base "true" distribution. These can have relatively few parameters and be easily deployable.
- Zero-shot detection: Uses a pre-trained generative model (e.g., GPT-2 or GROVER) to outputs from itself or similar models, e.g. via probabilities assigned by the model to strings of text. The model does not undergo additional training.
- Fine-tuning based detection: Fine-tunes a language model to "detect itself" with higher performance and accuracy over a range of available settings (Top-K14, Top-P15).

In his work, Solaiman trained a logistic regression detector on TF-IDF unigram and bigram features. They could detect outputs from the models at accuracies ranging from 88% at 124 million parameters to 74% at 1.5 billion parameters; and could successfully detect outputs at accuracies ranging from 97% at 124 million parameters to 93% at 1.5 billion parameters with constraint of Top-K to 40. Solaiman tested a simple "zero-shot" baseline using TGM to evaluate total log probability, and thresholds based on this probability to make the prediction, and found that the 1.5 billion parameter GPT-2 model can detect Top-K 40 generations with between 83% and 85% accuracy (Solaiman, Brundage, and et al. 2019).

4.3 GROVER

In recent years, online disinformation and fake news has emerged as a major societal problem. With the development of AI technology which can be used by adversaries to generate fake news, the situation is getting worse. Grover is a model for neural fake news - both generation and detection. However, it probably can also be used for other generation tasks, such as AI-generated phishing emails (Zellers,

Holtzman, and et al. 2019). GROVER's goal is to reliably detect this "neural fake news" to minimize its harm.

Zellers's study result shows that the best way to detect neural fake news is to use a model that is also a generator since the generator is most familiar with its own habits, quirks, and traits, as well as those from similar AI models. The best defense result in a testing with limited access to neural fake news articles shows that Grover has over 92% accuracy at telling apart human-written from machine-written news. Grover can easily detect its own generated fake news articles, it also works well on fake news generated by other AIs (Zellers, Holtzman, and et al. 2019).

4.4 Real or Fake Text (RoFT) tool

The RoFT tool (Dugan et al., 2020) was developed to tackles the tasks of evaluating quality differences between natural language generation (NLG) systems and understanding how humans perceive the generated text. Through the RoFT tool's website, users can try to detect machine-generated text in a variety of domains. RoFT asks humans to detect the sentence boundary at which the text transitions from human written text to machine generated text. In a detection task, RoFT uses a passage, its first several sentences are from a real human-written text source and the next several sentences are a machine-generated continuation. RoFT shows a passage of text one sentence at a time to annotators, lets uses to guess where the boundary is, and why do they think a sentence is machine-generated, and give an explanation for their choice.

4.5 TURINGBENCH

Uchendu et al. presented the TURINGBENCH benchmark environment with datasets and tasks to systematically study the so-called "Turing Test" problem for neural text generation methods. TURINGBENCH is comprised of (1) a dataset with 200K human- or machine-generated samples across 20 labels {Human, GPT-1, GPT-2_small, GPT-2_medium, GPT-2_large, GPT-2_xl, GPT-2_PyTorch, GPT-3, GROVER_base, GROVER_large, GROVER_mega, CTRL, XLM, XLNET_base, XLNET_large, FAIR_wmt19, FAIR_wmt20, TRANSFORMER_XL, PPLM_distil, PPLM_gpt2}, (2) two benchmark tasks–i.e., Turing Test (TT) and Authorship Attribution (AA), and (3) a website with leaderboards. TURINGBENCH's preliminary experimental results show that FAIR_wmt20 and GPT-3 are the current winners, among all language models tested, in generating the most human-like indistinguishable texts with the lowest F1 score by five state-of-the-art TT detection models (Uchendu, Ma, et al. 2021).

5. Datasets for Detectors

The accuracy of a detector highly depends on quality of its training datasets. This section provides the most recent datasets for detectors.

5.1 RealNews Dataset

RealNews is a large corpus of news articles from Common Crawl. Data is scraped from Common Crawl, limited to the 5000 news domains indexed by Google News. The authors used the Newspaper Python library to extract the body and metadata from each article. News from Common Crawl dumps from December 2016 through March 2019 were used as training data; articles published in April 2019 from the April 2019 dump were used for evaluation. After deduplication, RealNews is 120 gigabytes without compression (Zhao, et al. 2020; Solaiman, Brundage, and et al. 2019).

5.2 Amazon Customer Reviews Dataset

Amazon Customer Reviews is one of Amazon's iconic products. In a period of over two decades since the first review in 1995, millions of Amazon customers have contributed over a hundred million reviews to express opinions and describe their experiences regarding products on the Amazon.com website. This makes Amazon Customer Reviews a rich source of information for academic researchers in the fields of Natural Language Processing (NLP), Information Retrieval (IR), and Machine Learning (ML), amongst others. Accordingly, we are releasing this data to further research in multiple disciplines related to understanding customer product experiences. Specifically, this dataset was constructed to represent a sample of customer evaluations and opinions, variation in the perception of a product across geographical regions, and promotional intent or bias in reviews (Amazonaws.com 2022).

5.3 WebText

WebText is an internal OpenAI corpus created by scraping web pages with emphasis on document quality. The authors scraped all outbound links from Reddit which received at least 3 karma. The authors used the approach as a heuristic indicator for whether other users found the link interesting, educational, or just funny. WebText contains the text subset of these 45 million links. It consists of over 8 million documents for a total of 40 GB of text. All Wikipedia documents were removed from WebText since it is a common data source for other datasets (Radford, Wu, et al. 2019).

5.4 Wikipedia

Per Wikipedia.org itself, it is a free online encyclopedia, created and edited by volunteers around the world and hosted by the Wikimedia Foundation. Wikipedia is written and maintained by a community of volunteers through open collaboration and a wiki-based editing system. Wikipedia is the largest and most-read reference work in history. It is consistently one of the 10 most popular websites ranked by Similarweb and formerly Alexa; as of 2022, Wikipedia was ranked the 5th most popular site in the world. It is hosted by the Wikimedia Foundation, an American non-profit organization funded mainly through donations (Wikipedia 2022).

Other popular datasets include FEVER (Ferreira, Vlachos 2016), Liar dataset (Wang 2017) FEVER dataset, Kaggle (Kaggle 2022), et al.

6. Discussion

Although several research works show the successes of applying various AI-based detecting models in detecting AI-generated phishing emails, there are challenges that hinders the adopting these models in real world tasks. The nature of ever-changing characteristics and features of phishing emails makes categorizing phishing emails more challengeable. To achieve a higher accuracy, qualified datasets are needed to train and verify whether the model is working fine or not. However, there are very few yet high quality datasets available in this research field. Some models achieves a high accuracy, but the result is on a specific dataset, and is time-consuming. Recently, the rapid growth of AI models has provided advanced and cost-effective AI text generation capabilities. Threat actors are taking advantage of these capabilities to deliver malicious phishing campaigns, which puts defending against phishing emails in a more disadvantageous situation, and make the researchers and developers in continuous situations realize that the research is still far from finished in this area. To overcome these challenges, future research directions include: developing new phishing detection techniques and new models to increase

detection accuracy and decrease high-false alarm, especially when novel AI-based phishing approaches are used; and creating high quality datasets to train AI models and verify detection results.

7. Conclusion

After briefly introducing ransomware and ransomware attacks, this survey carries out a systematic review of popular models used to generate text, and used to detect AI-generated text. This work also discusses the commonly used datasets in this research area. The limitations of the existing phishing emails detection models and future research directions are presented also. AI-generated phishing emails is an evolving challenge since the rapid development of AI models used to generate phishing emails.

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Deepfake video forensics in cybersecurity – a select review of methods and tools for creation and detection

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Abstract

Video forensics plays a critical role in cybersecurity, particularly to assist with response to ransomware incidents. Mainly due to the rapid development of AI/ML, Deepfake has emerged as a big challenge in video forensic investigations. A Deepfake is a media file that has been altered deceptively using Deep Neural Networks (DNNs). Over 85 thousand harmful Deepfake videos, crafted by expert creators, were detected between December 2018 and December 2020, per the 'The State of Deepfakes 2020' report. The report mentioned that the number of expert-crafted videos has been doubling every six months. The task of detection can have a large scale, considering that 400 hours of video are uploaded to YouTube every minute worldwide and YouTube viewers watch over a billion hours of video on the platform every day. Generating fake videos through free open software can be easy. The underlying DNNs may be Convolutional Neural Networks, Long Short-Term Memory or Generative Adversarial Networks. Detection can be very difficult and this is an open problem. The quality of "faking" is more dependent on the quality of the source videos, than on the DNN methods used. The broad objectives of the study are to review the state-of-the-art in Deepfake video detection, and to develop a prospectus for a research agenda in this area. The works reviewed are significant studies from a search range from 2017 to current date. We looked at the following scientific article databases: SpringerLink, ACM, IEEExplorer, ScienceDirect, and Arxiv. We used following keywords for search: "deep fake", "deep fake tools", "deep learning" "deepfake detection", "cybersecurity". The significance of this work is that it can serve as a simplified ready reference for state-of-the-art tools available to create and detect Deepfake. This can also serve as a readable prospectus for research agenda in this area.

Keywords: Deepfake, forensic, cybersecurity, video, deep learning

1. Introduction

With the advancement of Artificial Intelligence and Deep learning techniques, Internet has become a common ground for false information through online media and news articles that are manipulating the viewers (Vamsi, et al., 2022). Use of AI methods involves the falsification, fabricated and forged videos brilliantly executed videos, making it difficult to distinguish the original videos (Jafar, Ababneh, Al-Zoube, & Elhassan, 2020). The rise in

these videos and news has been a major threat to democracy. Today, one in five people use YouTube as their source of news and information platform and with the advent of false news, there is a need for tools to authentic the video (Anderson, 2018). Users upload billions of hours of video on YouTube to share information, bogging, advertisement, knowledge-sharing, news, or other security information. However, these videos can be manipulated with machine learning and deep learning methods in the generation of realistic fake contents.

The term "Deepfake" is a combination of "Deep Learning" and "Fake" and it explores the realistic creation that are more convincing with deep learning support and algorithms (Rana, Nobi, Murali, & Sung, 2022). This term is coined when one of the Reddit users posted a fake pornographic video applying the face-swapping technology in 2017 (Gamage, Ghasiya, Bonagiri, Whiting, & Sasahara, 2022). Contents created by this technology are improving over the year with better video quality, making it almost original by using powerful techniques to swap faces in image and video, facial expression, lip-syncing, eyes and overall expression looking like a real content (Passos, et al., 2022). Deepfake creators use artificial intelligence algorithm to imitate the work and characteristics of real human and it becomes extremely hard to identify because these algorithms create virtually legitimate videos (Khichi & Kumar Yadav, 2021).

To create deepfakes video, a Generative Adversarial Networks (GANs) is used that combines a generative network and discriminative network with faceswap technology where fake images are developed with encoder and decoder in generative networks and legitimacy is provided with discriminative network (Rana, Nobi, Murali, & Sung, 2022). This model utilizes larger images and videos data to train the models in order to create analogous expression and movements for realistic images (Nguyen, et al.) Zao, a recent deepfake mobile tool to create deepfake videos famously available in China, uses a few seconds to generate new videos of facial features onto celebrities faces in real time (Wu, Ma, & Zhang, 2021). Other tools like deepfakes web lets us to create deepfakes videos in web that uses powerful GPUs, large images and videos datasets.

This application of deep fake has some positive application such as video dubbings of other languages or movies, virtual clothing's (Mirsky & Lee, 2022) but these technologies are creating more unethical and malicious videos in cybersecurity that may jeopardize human integrity and impact democracy. Moreover, anybody can swap faces to create fake videos of committing crimes, increases the effectiveness of phishing and BEC attacks, make identity fraud easier and so on (Bateman, 2020). Since, the growing sophistication of deepfakes and available methods have made it possible to get access to any security breaches that uses voice, faces and iris, biometrics. A bad actor could create a fake video mentioning about the criminal activity undergoing in the company such as financial crimes that could impact business, reputation and stock prices (McCammon, Tweedie, & Curran, 2020). Likewise, celebrity pornographic is on rise where a bad actor could defame a well-known celebrity by disseminating fake porn videos on the internet (Harris, 2018).

Government and law enforcement are implementing new laws and regulations to regulate and criminalize the creation of deepfake videos, likewise social media platforms such as Facebook, twitter are taking steps to deal with deepfakes videos. Facebook’s deepfake detection tool is aiming to developing a robust deepfake detection tool where more than 34,000 models were generated to detect the authenticity of videos. Recently, more deepfake creation tools are available, therefore many deepfake related research are undergoing to detect and regulate these unethical practices (Zobaed, et al., 2021).

This work organizes as follows. Section 2 introduces the most recent and popular deepfake content generations software, section 3 explores about the deep learning networks used in creating deepfakes. Further, section 4 introduces various deepfakes detecting software and their detail architecture is compiled, section 5 addresses the most recent datasets used for deepfake detection and section 6 discusses the challenges and works considered in this study. Finally, section 7 provides conclusion to the study.

1.1 Selection criteria

The works described and analyzed were obtained from a search range from 2017 to current date. We looked at the following scientific articles databases: SpringerLink, ACM, IEEExplorer, ScienceDirect, and Arxiv. Additionally, we used following keywords for search: “deep fake”, “deep fake tools”, “deep learning” “deepfake detection”, “cybersecurity”.

1.2 Motivation

Research interest in manipulated and fake detection is on rise over the past years because of their impact on us. Many research papers are based on detection mechanism including various deep learning methods and tool. Therefore, studies on these techniques became crucial. This field is new and contributes ground for academic research. As we know, deepfakes is unethical techniques that creates problems, unsafe in the society. Various studies tried to solve deepfakes problems by detecting and analyzing using powerful Artificial Intelligence techniques (Guarnera, Giudice, & Battiato, 2020), (Zhou & Lim, 2021); these works motivated the study.

1.3 Goals

This work provides an overview of most recent and significant deepfake generation software and detection tools in videos. It also elaborates the architectures and frameworks for these tools. This study proposes to review the free open software tools available for creation of deepfakes and automatic detection of Deepfake video for the human face.

2. Deep learning based deepfake Creation

2.1 DeepFaceLab

The recent work (Perov, et al., 2020), proposed DeepfakeLab which is an open-sourced software for creating deepfakes that uses maturity pipelines for better face-swapping results. It offers the combination of flexible and loose coupling structure for pipeline. There are kinds of two videos in DeepFakeLab; one is a source video that comprises the faces to deepfake and a destination video that consists of original video where deepfake faces are used. DeepFaceLab detects the faces and makes a different file for each face before the Individual frames that are converted to image sequences. Once these are done, it then trains the neural network to learn deepfakes from images and applies deepfakes to the original image.

2.2 *Face2Face*

This is an expression-based method where the facial expression of one person is transferred to another person (Thies, Zollhofer, Stamminger, Theobalt, & Niessner, 2016). It introduces a real time facial reenactment system where 3D face model is reconstructed by modifying the facial expression based on monocular RGD data. Facial expression can be transferred online obtained through RGB source actor to target actor and modification of target video is performed in photo-realistic fashion. Transfer function is implemented that maps deformation from source image to target by transferring facial expression in real time facial swapping. For this, pose estimator is used where face detector detects the face and then pose estimator is applied to the face.

2.3 FaceSwap

FaceSwap is based on graphical techniques that uses facial landmarks and generates 3D templets that are mixed to replace target identity utilizing face alignments, Gauss Newton Optimizer and image blending (Tolosana, Vera-Rodriguez, Fierrez, Morales, & Ortega-Garcia, 2020). Larger data containing the video of the target is generated where the frames are extracted from the video, identifying the faces and aligning them into the same size. Then, those extracted frames are trained with neural network to convert one face to another and finally all the converted faces are merged into original frame (Passos, et al., 2022).

2.4 DeepSwap

DeepSwap is online tool that lets users to create fake videos by using powerful artificial intelligence and deep learning algorithms. Data are sourced from their internal sample and does not comprise of users' data allowing users to share files while protecting the privacy. One of the major advantages of DeepSwap technology is it can swap five faces in a single video making it more effective method compared to other (DeepSwap, 2022).

2.5 DeepFake Faceswap

Deepfake faceswap is composed of encoder that utilizes two sets of faces, making the model learn from those sets of faces and decoder that uses two decoders where it will reconstruct the images (Passos, et al., 2022).

3. Models used in Deepfake Creation

Various neural network models with generative networks are used or combined to create deepfakes. In this section, we provide a brief introduction to these networks.

3.1 Neural Networks

Neural networks are composed of node, input layer, hidden layers and output layers that are connected to each other’s sequentially and are assigned with weight and threshold. The node gets activated when the output of any node is above the threshold and sends data to next layer. When a data is trained, neural networks learn while improving the accuracy therefore they are powerful method for classification problems (Wang, 2003).

3.2 Generative Neural Networks

Deepfake are created with the combination of encoder-decoder, Convolutional Neural Network (CNN), Generative Adversarial Networks (GAN), Image-to-Image Translation (pix2pix), Recurrent Neural Networks (RNN).

3.2.1. Encoder-Decoder Networks (ED): encoder takes in the inputs and outputs features maps while decoder takes the feature vectors and outputs the best match (Badrinarayanan, Kendall, & Cipolla, 2017).

3.2.2. Convolutional Neural Network (CNN): CNN has convolutional layer which is the first layer where computational occurs through filters, pooling layers reduces the dimension of the input and fully connected layers where each node in output layers are connected to previous one (Albawi, Mohammed, & Al-Zawi, 2017).

3.2.3. Generative Adversarial Network (GAN): In GAN, two neural networks (Generator and Discriminator) compete to find better accuracy. GAN is unsupervised method that produces own training data. In GAN, the generator acts to generate new data instances while discriminator evaluates them (Goodfellow, et al., 2020).

3.2.4. Image-to-Image Translation (pix2pix): pix2pix learns mapping between input and output images using training datasets. It can either be paired or unpaired (Isola, Zhu, Zhou, & Efros, 2017).

3.2.5. Recurrent Neural Network (RNN): In RNN there is a hidden states that can remember some sequences and outputs from previous are taken as input to current step (Mikolov, Karafiát, Burget, Černocký, & Khudanpur, 2010).

4. Deepfake Detection

4.1 FaceForensis++:

This is a large-scale forensic dataset containing around 1000 original videos which were manipulated with deepfakes, faceSwap, face2face and neuralTextures sourced from YouTube videos. These datasets are used in training to generate realistic forgeries. For facial manipulation, this applies forgery detection pipeline where the images are processed by face tracking method and extracts the facial region by applying conservational crop. For performances, this dataset is evaluated with various classification methods. They introduced forensic transfer learning approach in this dataset (Rossler, et al., 2019).

4.2 Microsoft’s Video Authenticator Tool

Launched by Microsoft this tool works with the public datasets form Face Forensics++ and been tested with DeepFake Detection Challenge Dataset. This tool analyzes videos and photos and generates a manipulation score called “a percentage chance or confidence score” whether the video has been altered or not. The working feature of this tool is it detects the blending boundary of the deepfake and greyscale elements that maybe hard to detect by human eyes.

4.3 FakeBuster

FakeBuster is a new technology that is used in detecting fake video conferencing and manipulated faces which has been tested in zoom and skype video conferencing. It is based on PyQt toolkit-GUI based programs where it uses Python MSS library for recording, OpenCV for image processing and Pytorch to train model using 3D Resnet. It works with the recorded videos with detect faces, that shows all the faces in the screen. If any Face icon, they want to check can be done by clicking find imposter button with the deep learning algorithm. A color-coded prediction scores from 0 to 1 are shown by the time-series graph at regular interval, where green color indicates no manipulation, orange, red and yellow shows higher chances of presence of manipulation. It also has features of face tracking, face frame segmentation and deepfake prediction (Mehta, Gupta, Subramanian, & Dhall, 2021).

4.**4 FakeCatcher:**

FakeCatcher detects the biological signs of the person having pulse in the fake video. It uses photo plethysmography technique for observing the blood flow in the pixels, detects the frames and finally runs signatures through the classifiers which detects if the video is fake or not (Ciftci, Demir, & Yin, 2020).

5. Datasets for DeepFake Detection

This section provides the most recent datasets for deepfake detections.

5.1 **WildDeepFake**

WildDeepFake Datasets consists of 7314 face sequences from 707 real and deepfake videos collected from the Internet to provide individual poses, facial expressions. The data is divided into 6,508 from training and 806 for testing purpose (Zi, Chang, Chen, Ma, & Jiang, 2020).

5.2 DeepForensics-1.0

DeepForensics-1.0 is a large-scale dataset for real world face forgery detection that includes 60,000 videos having 17.6 million frames of automatically generated faces. The videos were collected from 100 actors all around the world showing various poses, expression, fear, anger, happiness in a distinct angle (Jiang, Li, Wu, Qian, & Loy, 2020).

5.3 Celeb-DF

Celeb-DF is a large-scale deepfake video datasets that consists of real and deepfake synthesized videos available throughout YouTube. It consists of 590 real and 5,639 deepfake videos having over 2 million video frames and having average length of the video of 13 seconds with 30 frames per seconds. These videos were collected from celebrities’ interviews in YouTube (Li, Yang, Sun, Qi, & Lyu, 2020).

5.4 DeeFake Detection Challenge

DeepFake Detection Challenge (DFDC) consists of more than 10,000 videos and has two version one with preview dataset having around 5,000 videos featuring two facial modification algorithms and full datasets of around 124,000 videos featuring eight different facial modifications algorithms. The full datasets are available in Kaggle to create a better model to detect forged videos (Dolhansky, et al., 2020).

6. Discussion

The constant advancement of false content generation though machine learning and deep learning have posed a threat to the cyber security realm having the threat of technological advancement move from theoretical to reality one (Chi, Maduakor, Alo, & Williams, 2020). According to the report by VMware’s annual Global Incident Response, increasing number of voice and face altering technological jumped 13% last year only (VMware, 2022). Rise in these technological advancements could sparks fear in the public domain as one can swap faces making it look real only to defame others (Mustak, Salminen, Mäntymäki, Rahman, & Dwivedi, 2023). Voices can also be swapped, pornographically contents, child-porn, could create an unethical environment and the likeness of face-swapping could lead to political upheaval (Masood, et al., 2022). Categorizing state of art research for various deepfakes creation and detection software pose a critical task to know the appropriate methods that might control increasing number of unethical, forged and manipulated contents on the internet. Significant research has

been carried in this field to examine the creation and detection of deepfakes using deep learning methods.

Various deepfake creation tools are available on the internet using state-of-art deep learning algorithms. Deepfacelab (Perov, et al., 2020) is one of the famous deepfakes tool for video manipulation which introduced pipeline and series of batch files to produces deepfakes. Likewise, Zao when became available in China became the most downloaded app overnight, is a new app that uses deep learning modes to create a seemingly authentic deepfakes. This app is undoubtedly popular in China because it creates videos within a second unlike powerful other models (Allen, 2021). Another tool Deepfake web uses a powerful deep learning algorithm to absorb various complexities of face data, but it is time consuming, as training would take more than four hours (Deepfakesweb).

Similarly, more powerful DeepFake Detection tools are available today in internet that detect the authenticity of the video. Mehta et al., 2021 proposed a novel model to combat deepfakes by using python library in video conferencing and meetings. The imposter button uses deep learning models to classify whether image frames are manipulated or not. (Ciftci, Demir, & Yin, 2020) proposed another software called FakeCatcher that uses biological signals analysis on fake and authentic videos. This utilizes signal-processing methods in original and deepfakes videos through various color combination

The study by (Lyu, 2020), indicates that current deepfakes generation methods are lacking behind by not producing good details on facial and skin hairs and urges to use real voices to make the video more realistic. But (Guarnera, Giudice, & Battiato, 2020) presented a novel approach to counter this problem by using convolutional traces which is based on the feature extracted by EM algorithm which uses GAN architectures to generate realistic face and voices. Similarly, (Guera & Delp, 2018) proposes the use of Convolutional Neural Network for extracting frame level features to train recurrent neural networks after mixing features of multiple frames to outputs whether the sequence being deepfake or not. In the work of (Zhou & Lim, 2021) , they proposed a framework in which they extracted latest features representation from audio and video using late fusion and they are jointly connected between low-level features to encode spatial and temporal data to higher semantic representations to that using synchronization patterns between audio and video boosted the performances of deepfake detections.

7. Conclusion

This work highlights the most significant research on video forensics through deep learning techniques. Besides, it also presents most relevant advances in the field. It is necessary to study on various deepfakes tools and detection in order to combat them. There is an increasing challenge ahead because of development of generative networks, implying more realistic videos that are invisible to human eyes making it more challenging and difficult for detection.

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EXAMINING THE EFFECTS OF VIRTUAL WORK ON CYBERSECURITY BEHAVIOR

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ABSTRACT

The Science of Security (SoS) initiative at the National Security Agency organizes its research into the so called Five Hard Problems (5HP), one of which is understanding and accounting for human behavior. Our study focuses on behavioral aspects of cybersecurity and is motivated by the COVID pandemic which has increased the virtual component of organizational work. More importantly, the prediction is that even after the pandemic is brought under reasonable control the footprint of online activities will remain extensive. Specifically, the work from home (WFH) component of organizational work is taking on increased significance. In this paper, we propose a theoretical model that incorporates WFH factors into existing models of intent to perform cybersecurity behaviors. Typically, existing models of cybersecurity behavior link two broad categories of latent variables – threat appraisal and coping appraisal – with some form of behavioral intent. These two latents, in turn, are derived from established theories such as the theory of planned behavior, protection motivation theory and deterrence theory. We see WFH as a moderator in the relationship between the driving latents and behavioral intent. Our research characterizes different dimensions of WFH which feed into latents based on Herzberg's two factor motivation-hygiene theory of job satisfaction. A survey instrument is being developed based on this model and will be administered in the next phase of the study. Interestingly, this conceptualization of WFH in terms of job-satisfaction has an important implication for cybersecurity. Heretofore, the literature has generally viewed WFH as a negative force when it comes to cybersecurity. However, this job satisfaction view reveals that WFH can also be a positive force in cybersecurity behavioral intent. While WFH presents impediments such as isolation from work and frequent interruptions, it also provides spatial and temporal flexibilities that have a positive impact on job satisfaction, which in turn can have a positive impact on cybersecurity behavioral intent. We develop testable hypotheses based on this moderating influence view of WFH. The managerial implication of our work is that these positive elements of WFH should be taken into consideration in developing organizational strategies for cybersecurity resilience.

Human Factors: A Vulnerability in Risk Management Process

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Information Technology (IT) risk is the likelihood that a loss occurs when a threat exploits a vulnerability. Losses can adversely affect both the survivability and profitability of any organization. While tangible losses may be more visible and quantifiable, intangible losses can devastate an establishment. Organizations face threats in many ways: natural threats like tornadoes, earthquakes, hurricanes, or man-made threats. Man-made types are those posed by humans and can be intentional or accidental, which may be from an internal or external entity.

IT security risk experts ensure critical business functions and operations are protected against risks by using the best risk management techniques to identify and mitigate the risks from expected and unexpected sources. However, managing organizational cyber and IT security risks are daunting and essential to any organization's successful security program. It starts with risk identification, assessments, including cybersecurity risk assessment and ultimately, risk controls.

Risk assessment is a significant component of an organization's overall risk management process. It helps stakeholders identify and evaluate threats and vulnerabilities and the likelihood of an asset exploit. All risk assessment methodologies, including the National Institute of Standards and Technology (NIST) special publication 800-39, have provided education in many ways, standards, and best practices to stakeholders on identifying threats, vulnerabilities, and the likelihood of internal and external risks. To improve risk assessment reporting and promote risk intelligence, Artificial Intelligence (AI), particularly Machine Learning (ML) with high capability to analyze a large amount of data and cyber risk metrics, was integrated into risk management to revolutionize the process. Still, cyber-attacks and data breaches on government agencies, defences, high-tech companies and many small businesses and organizations are not abating. In recent times, there have been troubling number of cyber incidents in 2022 alone. This raises an important question – Are risk assessment methodologies failing in overlooking organizations' cyber and IT security risks or is human factor in the decision-making at several levels of risk assessments a significant vulnerability to the entire risk management program and defences?

In this paper, we attempt to take a deeper look at risk assessment, particularly in the human decision-making aspect of the risk management program. Also, we present cautionary notes that will help to facilitate informed decision-making at all levels in risk management.

This is a blank abstract to make Ex Ordo happy.

WHEN PENNYMAC AS DEBT SERVICE PROVIDER AND TRUSTEE NAMED IN A DEED OF TRUST, (A) OBTAINS FORCE-PLACED INSURANCE ON IMPROVED REAL PROPERTY, FOR WHICH PENNYMAC HAS NO BENEFICIAL INTEREST, AND (B) CHARGES THE BORROWER FOR THE COST THEREOF, HAS PENNYMAC (1) BREACHED THE DEED OF TRUST AS WELL AS (2) VIOLATED THE REAL ESTATE SETTLEMENT PROCEDURES ACT?

A Case Study

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ABSTRACT/INTRODUCTION

During the Great Recession, there was a proliferation of real estate foreclosures.[1] As a result, mortgage borrowers lost their jobs, stopped paying their contractually required, mortgage indebtedness payments, including interest, principal, taxes, and property insurance.[2] In these cases, to protect their security interest in real estate, mortgage lenders, including mortgage indebtedness servicer providers, would (1) obtain force-placed insurance (FPI) on the real estate secured by the Mortgage/Deed of Trust and (2) charge the borrower for the "cost" of such hazard insurance coverage.[3] However, banking practices that arose during this period became abusive (e.g., exorbitant FPI profits, commissions, and kickbacks) and, accordingly, were subject to increased scrutiny.[4]

In response, Congress enacted the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank).[5] The purpose of Dodd-Frank was to "promote financial stability of the United States by improving accountability and transparency in the financial system, to

[1] Stacy Johnson, **Next Bank Scandal? Force-Placed Homeowners Insurance**, MONEY TALKS NEWS (Nov. 15, 2010), http://www.moneytalksnews.com/next-bank-rip-off-forced-place-homeownersinsurance/.
[2] *Id.*
[3] Daniel J. Neppl, **Force-Placed Insurance: 3 Things to Watch in 2012**, LAW 360 (Apr. 11, 2012), http://www.law360.com/articles/328781/force-placed-insurance-3-things-to-watch-in-2012; see also *Caplen v. SN Servicing Corp.*, 343 F. App'x. 833, 834 (3d Cir. 2009) ("Under the terms of the note and mortgage, the [homeowners] agreed to carry hazard insurance on the property and to provide evidence of insurance to the bank; if they failed to do so, the bank was authorized to 'force place' insurance on the property - that is, to independently obtain insurance and add the cost of the premiums to the principal due under the note - in order to protect its security interest in the property.").
[4] Edward Wyatt, **A Mortgage Practice Gets a Closer Look by Regulators**, N.Y. TIMES (Mar. 26, 2013), http://www.nytimes.com/2013/03/27/business/economy/regulators-review-costs-of-forceplaced-insurance.html.
[5] Pub. L. No. 111-203, 124 Stat. 1376 (2010).

end 'too big to fail,' to protect the American taxpayer by ending bailouts, [and] to protect consumers from abusive financial services practices."[6]

In particular, Title X of Dodd-Frank created the Consumer Financial Protection Bureau ("CFPB") to investigate violations of consumer protection laws and enact rules regarding consumer protection statutes.[7] Moreover, Section 1022(b)(1) of Dodd-Frank, 12 U.S.C. 5512(b)(1), authorizes the CFPB to prescribe rules (e.g., Regulation X) "as may be necessary or appropriate to enable the Bureau to administer and carry out the purposes and objectives of the Federal consumer financial laws, and to prevent evasions thereof."

As an example, in 2013, the Bureau published final rules "that make major changes to the mortgage loan servicing requirements of Regulation X, which includes the provision relating to FPI."[8] In particular, "the term "force-placed insurance" means hazard insurance obtained by a servicer on behalf of the owner or assignee of a mortgage loan that **insures the property securing such loan**."[9] Moreover, " [a] servicer may not assess on a borrower a premium charge or fee related to force-placed insurance unless the servicer has a reasonable basis to believe that the borrower has failed to comply with the mortgage loan contract's requirement to maintain hazard insurance."[10]

As a mortgagee, PennyMac has "in rem rights" in the real estate that are identified as security in a Deed of Trust.[11] However, recently, PennyMac, as a creditor and debt service provider, has used 12 C.F.R. § 1024.37(b) to excuse its abusive actions (e.g., illegal FPI charges, commissions, and kickbacks) in taking control of real estate for which PennyMac has no security interest. *See PennyMac v. Johnson and Wijayaningsih*, 20 CVS 2436 (Superior Court, Forsyth County, NC 2020).

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[6] H.R. 4173, 111th Cong. (2010).
[7] Thomas P. Vartanian et al., **Title X Overview: Bureau of Consumer Financial Protection**, AM. BANKERS ASS'N, http://www.aba.com/Issues/RegReform/Pages/RR10_overview.aspx.
[8] Karen C. Yotis, **Force-Placed Insurance: Another Multi-Billion Dollar Industry Caught in the Regulatory Cross Hair**, LEXISNEXIS LEGAL NEWSROOM (May 6, 2013, 4:19 PM), http://www.lexisnexis.com/legalnewsroom/insurance/b/insuranceregulation/archive/2013/05/06/forceplaced-insurance-anothermulti-billion-dollar-industry-caught-in-the-regulatory-cross-hairs.aspx
(citing Mortgage Servicing Rules under the Real Estate Settlement Act (Regulation X); Final Rule, 78 Fed. Reg. 10,696 (Feb. 14, 2013) (to be codified at 12 C.F.R. pt. 1024)).
[9] 12 C.F.R. § 1024.37(a)(1).
[10] 12 C.F.R. § 1024.37(b).
[11] *Henriquez v. Green Tree Servicing, LLC* (*In re Henriquez*), 536 B.R. 341, 348 (Bankr. N.D. Ga. 2015); *Thomas v. Seterus Inc.* (*In re Thomas*), 554 B.R. 512 (2016).

Accordingly, the three primary objectives of this article are:

(1) To establish the factual background of the case study [*PennyMac v. Johnson and Wijayaningsih*, 20 CVS 2436 (Superior Court, Forsyth County, NC 2020)] concerning PennyMac's actions (e.g., FPI charges, commissions, and kickbacks) in taking control of real estate for which PennyMac has no security or beneficial interest.

(2) To establish (a) the North Carolina law at issue with regard to the rights of a trustee in a deed of trust and a lender, who is the beneficiary in such Deed of Trust, and (b) the federal consumer protection law with regard to forced-placed insurance (FPI), obtained by a lender upon default by said borrower of the provisions of such Deed of Trust.

(3) To apply the law at issue to the factual background for purposes of arguing that, under the facts given, PennyMac, as beneficiary and trustee of a Deed of Trust, has (a) breached said deed of trust and (2) violated RESPA.

This article argues that if these objectives are met, the general public [including (1) the citizens of North Carolina, (2) the North Carolina Commission on Banks, (3) the North Carolina Department of Insurance, and (4) real estate owners, in general] will have a greater understanding of the law with regard to the rights of each party to a Deed of Trust and be better able to defend against **unscrupulous banks and their loan service providers who illegally charge borrowers with the "cost" of forced-placed insurance (FPI).** In particular, as a result of such increased understanding, and the implications thereto, it is expected that PennyMac will be motivated to change its business practices with respect to its loan servicing business, at least with regard to **forced-placed insurance (FPI).**

In a case study approach that employs an IRAC (Issue, Rule, Application, Conclusion) structure, similar to that of an I.R.S. Revenue Ruling, this article accomplishes its purpose and objectives in a stepwise fashion, as follows.

- In Part I (The Factual Background), the factual background of the case study is presented.
- In Part II (The Law at Issue), (a) the North Carolina law with regard to the rights of a lender, who is the beneficiary in a Deed of Trust, and (b) the federal consumer protection law regarding forced-placed insurance (FPI) by a lender against a borrower, upon default by said borrower of the provisions of a Deed of Trust, are presented.
- In Part III (Application), the law at issue, as presented in Part II, is applied to the factual background, as presented in Part I, for the purpose of arguing that PennyMac, as beneficiary and trustee of a Deed of Trust, under the facts given, has (a) breached said Deed of Trust and (2) violated RESPA.
- In Part IV (Conclusion), implications of the legal findings in Part III are discussed with a view toward extending the current research to address other possible violations of state common law and federal statutory law by PennyMac, based upon the factual background as presented in Part I, which again would require PennyMac to rethink the manner in which it conducts its loan servicing business, likely resulting in imminent changes.

I.
THE FACTUAL BACKGROUND SURROUNDING PENNYMAC OBTAINING FORCE-PLACED INSURANCE ON IMPROVED REAL PROPERTY, FOR WHICH PENNYMAC HAS NO BENEFICIAL INTEREST, WHEREUPON PENNYMAC CHARGES THE BORROWER FOR THE COST THEREOF

The factual background of the case study is presented as follows.

1. On 7 November 2008, Johnson purchased Lots 16&18 for cash and immediately purchased hazard and flood insurance from the Farm Bureau, which he maintained until 2018.
2. In August 2012, Johnson purchased Lots 13,15&17 (vacant land) from Homer E. Wright, Jr. for cash, whereupon, to avoid the Town's Sewer District Fee on undeveloped parcels, in 2 instruments of combination, effective June 12, 2013, Johnson combined Lots 16&18 with Lots 13,15&17 to make one developed parcel (Parcel #235IM21).
3. In June 2013, Johnson submitted a Uniform Residential Loan Application to Weststar Mortgage, Inc. ("Weststar") for the purpose of "refinancing" (debt consolidation).
4. Johnson's loan was approved by Weststar about 17 July 2013, with a closing date of 19 July 2013, whereupon the closing papers were electronically transmitted to Johnson about 18 July 2013.
5. Weststar had previously informed Johnson that questions about said closing papers could be raised, but that questions about the property description on the Deed of Trust, which secured the Note, could not be raised.
6. When Johnson received the closing documents, a Deed of Trust and Note were included in those documents.
7. In great detail, the Deed of Trust specifically described the property to secure the Note as Lots 13,15&17 (and no other); accordingly, (a) Johnson did not question the legal description of the property identified in the Deed of Trust, because Johnson believed that Weststar expressly intended that Johnson, as borrower, irrevocably grant and convey to the named Trustee with power of sale, Lots 13,15&17 (and no other), and (b) on 19 July 2013, Johnson intended (and did, in fact) irrevocably grant and convey to the named Trustee with power of sale, Lots 13,15&17 (and no other).
8. Finally, to provide for a more even cash outflow, Johnson elected to set up an escrow account with Weststar for the purpose of paying not only taxes, but also hazard and flood insurance, for the entire developed parcel.
9. In two letters dated 8 August 2013 and 2 September 2013, PennyMac informed Johnson that (a) PennyMac had purchased the Note and (b) such "transfer of your mortgage loan to the Creditor does not affect any terms or conditions of the Mortgage/Deed of Trust or Note;" accordingly, on 2 September 2013, PennyMac had knowledge of the specific Property (i.e., Lots 13,15&17) securing the Note.
10. "PennyMac is a mortgage service provider. Force-placing insurance is a lucrative business for mortgage lenders and servicers (referred to generically as lenders). As a mortgage service provider, PennyMac outsources the tracking and processing of forced lender-placed hazard and flood insurance to Assurant. Accordingly, PennyMac is a client of Assurant. As a result, by contract, Assurant has the exclusive right to place the forced hazard or flood insurance in every instance in which one of the borrowers of PennyMac violates a Deed of Trust and fails

to properly insure the improvements on Property, secured by said Deed of Trust, in which PennyMac has a beneficial interest."

11. "Assurant has been a leading provider of forced lender-placed insurance coverage in the U.S. Force-placing insurance is a lucrative business for Assurant. In 2010, Assurant collected approximately $2.7 billion in premiums through its specialty insurance division, which is primarily devoted to force-placed insurance. Assurant provides its lender clients with the tracking of insurance, both hazard and flood. Moreover, by contract, Assurant has the exclusive right to place the forced hazard or flood insurance in every instance in which one of the borrowers of its lender clients violates a Deed of Trust and fails to properly insure the improvements on Property, secured by said Deed of Trust, in which the lender has a beneficial interest. Assurant exercises such exclusive right by causing a subsidiary insurance company (e.g., [(*Insurance Company*) *to issue*] forced lender-placed hazard insurance to a particular lender (e.g., PennyMac). When such subsidiary issues the forced lender-placed hazard insurance, the lender receives a kickback, commission, qualified expense reimbursement, or other compensation (e.g., subsidized insurance tracking services) and charges the borrower with the 'cost' of such forced lender-placed hazard insurance, the 'cost' of which is established by Assurant."
12. "In the case of PennyMac, Assurant has caused [*Insurance Company to issue*] forced lender-placed hazard insurance to PennyMac, in instances where one of the borrowers of PennyMac violates a Deed of Trust and fails to properly insure the improvements on Property, secured by said Deed of Trust, in which PennyMac has a beneficial interest. When [*Insurance Company*] issues forced lender-placed hazard insurance to PennyMac, PennyMac receives a kickback, commission, qualified expense reimbursement, or other compensation (e.g., subsidized insurance tracking services). PennyMac also charges the borrower with the 'cost' of such forced lender placed hazard insurance, the 'cost' of which is established by Assurant."
13. Shortly after September 2017, Johnson called PennyMac from South Carolina, for the purpose of having PennyMac discontinue paying for the Farm Bureau insurance policies, as of April (dwelling insurance) and May (flood insurance), 2018, because Johnson's daughter was planning to enter college in Fall 2019 and Johnson wanted to decrease his expenses in preparation, whereupon PennyMac responded that hazard insurance on the home (on Lots 16&18) was required to insure PennyMac's interest in Lots 13,15&17 (vacant land).
14. In 2018, over Johnson's objections, **PennyMac used Johnson's escrow funds to electronically pay to renew the Farm Bureau hazard and flood insurance**, even though PennyMac knew that neither hazard insurance nor flood insurance on Lots 16&18 would insure PennyMac's security interest in Lots 13,15&17 (vacant land).
15. After PennyMac allowed Johnson to close his elective escrow account, nevertheless, **through Letters (transmitted by the U.S. Mails) dated 31 August 2018 and 17 September 2018** to Johnson, PennyMac declared that Johnson must pay for hazard insurance on Lots 16&18, or else, suffer economic harm, even though PennyMac knew that neither hazard insurance nor flood insurance on Lots 16&18 would insure PennyMac's security interest in Lots 13,15&17 (vacant land).
16. After September 2018, **Johnson called PennyMac 3 times from South Carolina** and received the same response from PennyMac (i.e., hazard insurance on the home (on Lots 16&18) was required to insure PennyMac's beneficial interest in Lots 13,15&17); however, during the last call, PennyMac offered not to require hazard insurance on Lots 16&18 to

insure PennyMac's beneficial interest in Lots 13,15&17, if Johnson separated Lots 13,15&17 from Lots 16&18, but flood insurance would still be required, unless FEMA changed the flood zone designation.

17. On 22 March 2019, based upon the offer made by the PennyMac, and in reliance thereof, Johnson prepared and recorded an Instrument of Separation, which separated Lots 13,15&17 (i.e., undeveloped Parcel #235IM2104, which incurs an additional property tax of $600/year) from Lots 16&18 (i.e., developed Parcel #2235IM21).
18. Notwithstanding the foregoing, **through letters (transmitted by the U.S. Mails) dated 10 May 2019 and 14 June 2019** to Johnson, PennyMac stated that Johnson must pay for hazard insurance on Lots 16&18 ("We require you to maintain Hazard insurance on your property at all times"), or else, suffer economic harm, even though PennyMac knew that neither hazard insurance nor flood insurance on Lots 16&18 would insure PennyMac's beneficial interest in Lots 13,15&17 (vacant land).
19. In May 2019, after Johnson explained the PennyMac situation to Farm Bureau, Farm Bureau called PennyMac and told PennyMac that Farm Bureau could not write an insurance policy that would insure PennyMac's beneficial interest in Lots 13,15&17 (vacant land); nevertheless, **PennyMac told Farm Bureau** that hazard insurance on Lots 16&18 was required to insure PennyMac's beneficial interest in Lots 13,15&17 (even though PennyMac knew that neither hazard insurance nor flood insurance on Lots 16&18 would insure PennyMac's beneficial interest in Lots 13,15&17), so in reliance on such declaration from PennyMac to Farm bureau, **Johnson purchased from the Farm Bureau a Personal Injury Coverage (PIC) policy and renewed his flood insurance** on Lots 16&18, to insure PennyMac's beneficial interest in Lots 13,15&17 (vacant land).
20. Before 16 July 2019, **PennyMac electronically notified Assurant** that hazard and flood insurance with respect to the improvements on Lots 16&18 were required, because PennyMac had a beneficial interest in Lots 13,15&17 (vacant land), even though both PennyMac and Assurant knew that neither hazard insurance nor flood insurance on Lots 16&18 would insure PennyMac's beneficial interest in Lots 13,15&17 (vacant land).
21. Before 16 July 2019, **Assurant (a) electronically notified PennyMac** that hazard and flood insurance on Lots 16&18 had lapsed and (b) through its contract with PennyMac for the tracking and processing of insurance, **electronically communicated with Insurance Company**, causing **Insurance Company to electronically issue lender forced-placed hazard insurance for the improvements on Lots 16&18 to PennyMac** (without PennyMac having any beneficial interest in Lots 16&18), which generated revenue for PennyMac, Assurant and Insurance Company through PennyMac charging Johnson with the cost of such insurance, even though Insurance Company, Assurant and PennyMac each knew that neither hazard insurance nor flood insurance on Lots 16&18 would insure PennyMac's beneficial interest in Lots 13,15&17 (vacant land).
22. On 16 July 2019, **PennyMac sent Johnson, via the U.S. Mails**, a Certificate of Coverage Placement with respect to lender forced-placed hazard insurance, between PennyMac and Insurance Company, for the hazard insurance coverage regarding the improvements on Lots 16&18. In the attached letter, PennyMac declares:

> "**your loan agreement requires that you provide us with proof of acceptable and continuous homeowner's insurance** on an annual basis. . . **we have purchased a Lender-Placed Insurance to protect our interest in the dwelling structure**, by advancing funds from your escrow account. . . [**we] will explain**

> **the increase in your monthly payment to recover the amount advanced as well as future insurance payments**."

23. **On 16 July 2019, 12 August 2019, 19 August 2019 and 17 September 2019, PennyMac sent Johnson statements, via the U.S. Mails,** showing that **PennyMac (a) charged Johnson $2880 for lender forced-placed insurance and increased Johnson's monthly payment from $1506.82 to $2106.81**, even though PennyMac knew that neither hazard insurance nor flood insurance on Lots 16&18 would insure PennyMac's beneficial interest in Lots 13,15&17 (vacant land).
24. About 20 August 2019, Johnson separately complained to (a) the North Carolina Commissioner of Banks and (b) the North Carolina Department of Insurance, whereupon the North Carolina Commissioner of Banks suggested that Johnson consult with an attorney to determine his legal rights.
25. In responding to an inquiry by the North Carolina Department of Insurance, Assurant declares:

> **[Assurant and Insurance Company] have worked closely with PennyMac . . .The lender placed Fire/Allied certificate** (numbered MLR07769715085) that was issued on Mr. Johnson's property, 111 Se 14th Street, Oak Island, NC 28465 with an inception date of May 9, 2019 **remains in effect at this time, at the direction of PennyMac . . ."**

even though Assurant knew that (a) PennyMac had no beneficial interest in Lots 16&18 and (b) neither hazard insurance nor flood insurance on Lots 16&18 would insure PennyMac's beneficial interest in Lots 13,15&17 (vacant land).

26. On 17 October 2019, in an Assignment of Deed of Trust from the Mortgage Electronic Registration Systems, Inc. (MERS) to PennyMac, PennyMac became the Trustee, as well as the holder of the Note.

II.
THE LAW AT ISSUE

A court will read RESPA and particularly Regulation X as integrated set of laws and regulations. *Coppola v. Wells Fargo Bank, N.A. (In re Coppola*), 596 B.R. 140, 2018 Bankr. LEXIS 3383 (Bankr. D.N.J. 2018).

In 78 Fed. Reg. 10696, dated February 14, 2013, the Bureau of Consumer Financial Protection (BCFP) issued its final rules and official interpretations regarding its Mortgage Servicing Rules Under the Real Estate Settlement Act (Regulation X - 12 C.F.R. Part 1024). There the BCFP recognized:

> **"There is evidence that borrowers were subjected to improper fees that servicers had no reasonable basis to impose, improper force-placed insurance practices, and improper foreclosure and bankruptcy practices.** *See* Kurt Eggert, *Limiting Abuse and Opportunism by Mortgage Servicers*, 15 Housing Pol'y Debate 753 (2004), available at http://ssrn.com/abstract=992095 (collecting cases). . .
>
> > [T]he amendments to section 6(k) of RESPA in section 1463 of the Dodd-Frank Act evince **Congress's intent to establish reasonable protections for borrowers to avoid unwarranted force-placed insurance coverage**." Bold added. 78 Fed. Reg. 10696,10700,10714,

Under 12 U.S.C. § 2605. Servicing of mortgage loans and administration of escrow accounts:

. . .

(f) Damages and costs. Whoever fails to comply with any provision of this section shall be liable to the borrower for each such failure in the following amounts:

(1) Individuals. In the case of any action by an individual, an amount equal to the sum of—

(A) any actual damages to the borrower as a result of the failure; and

(B) any **additional damages**, as the court may allow, **in the case of a pattern or practice of noncompliance with the requirements of this section**, in an amount not to exceed $2,000.

(2) Class actions. In the case of a class action, an amount equal to the sum of—

(A) any actual damages to each of the borrowers in the class as a result of the failure; and

(B) any additional damages, as the court may allow, in the case of a pattern or practice of noncompliance with the requirements of this section, in an amount not greater than $2,000 for each member of the class, except that the total amount of damages under this subparagraph in any class action may not exceed the lesser of—

(i) $1,000,000; or

(ii) 1 percent of the net worth of the servicer.

(3) Costs. In addition to the amounts under paragraph (1) or (2), **in the case of any successful action under this section, the costs of the action, together with any attorneys fees incurred in connection with such action as the court may determine to be reasonable under the circumstances.**

(4) Nonliability. A transferor or transferee servicer shall not be liable under this subsection for any failure to comply with any requirement under this section if, within 60 days after discovering an error (whether pursuant to a final written examination report or the

servicer's own procedures) and **before the commencement of an action under this subsection** and the **receipt of written notice of the error from the borrower, the servicer notifies the person concerned of the error and makes whatever adjustments are necessary** in the appropriate account **to ensure that the person will not be required to pay an amount in excess of any amount that the person otherwise would have paid.**

(g) Administration of escrow accounts. If the terms of any federally related mortgage loan require the borrower to make payments to the servicer of the loan for deposit into an escrow account for the purpose of assuring payment of taxes, insurance premiums, and other charges with respect to the property, the servicer shall make payments from the escrow account for such taxes, insurance premiums, and other charges in a timely manner as such payments become due. Any balance in any such account that is within the servicer's control at the time the loan is paid off shall be promptly returned to the borrower within 20 business days or credited to a similar account for a new mortgage loan to the borrower with the same lender.

(k) Servicer prohibitions.
(1) In general. A servicer of a federally related mortgage shall not—
(A) obtain force-placed hazard insurance unless there is a reasonable basis to believe the borrower has failed to comply with the loan contract's requirements to maintain property insurance;
. . .
(2) Force-placed insurance defined. For purposes of this subsection and subsections (l) and (m), the term "force-placed insurance" means hazard insurance coverage obtained by a servicer of a federally related mortgage when the borrower has failed to maintain or renew hazard insurance on such property as required of the borrower under the terms of the mortgage.
(l) Requirements for force-placed insurance. A servicer of a federally related mortgage shall not be construed as having a reasonable basis for obtaining force-placed insurance unless the requirements of this subsection have been met.
(1) Written notices to borrower. A servicer may not impose any charge on any borrower for force-placed insurance with respect to any property securing a federally related mortgage unless—
(A) the servicer has sent, by first-class mail, a written notice to the borrower containing—
(i) a reminder of the borrower's obligation to maintain hazard insurance on the property securing the federally related mortgage;
(ii) a statement that the servicer does not have evidence of insurance coverage of such property;
(iii) a clear and conspicuous statement of the procedures by which the borrower may demonstrate that the borrower already has insurance coverage; and
(iv) a statement that the servicer may obtain such coverage at the borrower's expense if the borrower does not provide such demonstration of the borrower's existing coverage in a timely manner;
(B) the servicer has sent, by first-class mail, a second written notice, at least 30 days after the mailing of the notice under subparagraph (A) that contains all the information described in each clause of such subparagraph; and

(C) the servicer has not received from the borrower any demonstration of hazard insurance coverage for the property securing the mortgage by the end of the 15-day period beginning on the date the notice under subparagraph (B) was sent by the servicer.
(2) Sufficiency of demonstration. A servicer of a federally related mortgage shall accept any reasonable form of written confirmation from a borrower of existing insurance coverage, which shall include the existing insurance policy number along with the identity of, and contact information for, the insurance company or agent, or as otherwise required by the Bureau of Consumer Financial Protection.
(3) Termination of force-placed insurance. Within 15 days of the receipt by a servicer of confirmation of a borrower's existing insurance coverage, the servicer shall—
(A) terminate the force-placed insurance; and
(B) refund to the consumer all force-placed insurance premiums paid by the borrower during any period during which the borrower's insurance coverage and the force-placed insurance coverage were each in effect, and any related fees charged to the consumer's account with respect to the force-placed insurance during such period.
(4) Clarification with respect to Flood Disaster Protection Act. No provision of this section shall be construed as prohibiting a servicer from providing simultaneous or concurrent notice of a lack of flood insurance pursuant to section 102(e) of the Flood Disaster Protection Act of 1973 [42 USCS § 4012a(e)].

(m) Limitations on force-placed insurance charges. All charges, apart from charges subject to State regulation as the business of insurance, related to force-placed insurance imposed on the borrower by or through the servicer shall be bona fide and reasonable.

Part 1024
Real Estate Settlement Procedures Act (Regulation X)
§ 1024.1 – § 1024.41

Under § 1024.31 Definitions:

Hazard insurance means insurance on the property securing a mortgage loan that protects the property against loss caused by fire, wind, flood, earthquake, theft, falling objects, freezing, and other similar hazards for which the owner or assignee of such loan requires insurance.

§ 1024.37 Force-placed insurance.

(a) *Definition of force-placed insurance* -

(1) *In general.* For the purposes of this section, the term "force-placed insurance" means hazard insurance obtained by a servicer on behalf of the owner or assignee of a mortgage loan that insures the property securing such loan.
. . .

(b) *Basis for charging borrower for force-placed insurance.* A servicer may not assess on a borrower a premium charge or fee related to force-placed insurance unless the servicer has a reasonable basis to believe that the borrower has failed to comply with the mortgage loan contract's requirement to maintain hazard insurance.

(c) *Requirements before charging borrower for force-placed insurance* -

(1) *In general.* Before a servicer assesses on a borrower any premium charge or fee related to force-placed insurance, the servicer must:

(i) Deliver to a borrower or place in the mail a written notice containing the information required by paragraph (c)(2) of this section at least 45 days before a servicer assesses on a borrower such charge or fee;

(ii) Deliver to the borrower or place in the mail a written notice in accordance with paragraph (d)(1) of this section; and

(iii) By the end of the 15-day period beginning on the date the written notice described in paragraph (c)(1)(ii) of this section was delivered to the borrower or placed in the mail, not have received, from the borrower or otherwise, evidence demonstrating that the borrower has had in place, continuously, hazard insurance coverage that complies with the loan contract's requirements to maintain hazard insurance.

(2) *Content of notice.* The notice required by paragraph (c)(1)(i) of this section shall set forth the following information:

. . .

(iv) A statement that requests the borrower to provide hazard insurance information for the borrower's property and identifies the property by its physical address;

(v) A statement that:

(A) The borrower's hazard insurance is expiring, has expired, or provides insufficient coverage, as applicable;

(B) The servicer does not have evidence that the borrower has hazard insurance coverage past the expiration date or evidence that the borrower has hazard insurance that provides sufficient coverage, as applicable; and

(C) If applicable, identifies the type of hazard insurance for which the servicer lacks evidence of coverage;

(vi) A statement that hazard insurance is required on the borrower's property, and that the servicer has purchased or will purchase, as applicable, such insurance at the borrower's expense;

(3)
Format. A servicer must set the information required by paragraphs (c)(2)(iv), (vi), and (ix)(A) and (B) in bold text, except that the information about the physical address of the borrower's property required by paragraph (c)(2)(iv) of this section may be set in regular text.

III.
THE LAW AT ISSUE, PRESENTED IN PART II, IS APPLIED TO THE FACTUAL BACKGROUND, PRESENTED IN PART I

IV.
CONCLUSION:
IMPLICATIONS OF THE LEGAL FINDINGS IN PART III

Papers: Innovative Education, Assessment, Engaged Learning Curriculum, Teaching and Pedagogy

A Survey of the Impact of Machine Learning in Higher Education System

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Abstract

Machine learning has evolved rapidly in the past two decades. It is now responsible for rapid technological advances in different fields. One of the most prominent examples is self-driving cars. In addition, it plays a key role in vital and sensitive areas such as Agriculture, Banking, and Insurance. However, only recently have people started applying it to one of the most important industries in every country in the world, higher education. There are different objectives for applying machine learning. For example, some schools aim to use machine learning to reach or exceed retention goals, while others try to use machine learning to determine struggling students in different courses early in the semester before they drop their classes. This is a survey about the recent progress in utilizing machine learning to shake up the traditional higher education system.

As mentioned in this article [**Error! Reference source not found.**], institutions use indicators such as low grades and poor attendance to identify students who are at risk. However, these

indicators often only provide us with a subset of at-risk students, and such students are identified too late in a semester. Machine learning could be used as a part of a holistic approach to better identify vulnerable students early after studying the existing data. It is just one of many benefits of using machine learning in the higher education system. In our presentation, we will discuss the different benefits of applying machine learning in the system and the major challenges of machine learning in higher ed in detail based on new research results. With this survey, we provide a roadmap for people to continue doing cutting-edge research on this new application of machine learning.

Keywords: machine learning, higher education, enrollment, retention

1. Introduction

Machine learning is a subfield of Artificial Intelligence, it is devoted to understanding and building methods that 'learn', that is, methods that leverage data to improve performance on some set of tasks based on Wikipedia [2]. Machine Learning boosted productivity in every aspect of human society from the domain of agriculture to the field of transportation. Leading to advances such as improving crop yields, building driverless cars, and reducing traffic congestion. However, it has not been introduced in the area of higher education until very recently, and the traditional methods of recruiting and retaining students have persisted in higher education in the US. In this paper, we discuss some new approaches in higher education with the assistance of machine learning and their benefits to different educational institutions in the US.

In the next section, we will discuss what machine learning can do to improve the existing recruitment process and help enroll students in colleges/universities.

2. Machine Learning and Enrollment

Since the start of the Covid pandemic, we have seen a drastic drop in undergraduate enrollment in US schools. The data has shown that there was a 3.6 percent drop in enrollment in the fall, of 2020 and another 3.1 percent drop in enrollment in the fall of 2021. It means between the fall of 2019 and the fall of 2021, a million fewer undergraduate students enrolled [3] and it is a very alarming statistic. Almost all US schools except elite ones have been hurt by such a challenge and the long-term trend could be far worse since the number of high school graduates is projected to decrease from 2027 through 2037 [3]. Machine learning could be a great tool to mitigate such a long-term issue for school administrators. We will look at an example of a non-profit university's approach to enrollment with the help of machine learning. The school took the following three steps:

a. Allocating 'top of funnel' marketing spending to those most likely to apply

The school came up with a machine-learning model to predict the most likely applicants. As a result, the university was able to target the top 10% of possible applicants (the most likely applicants) with its market spending, in particular the students who have not applied. Therefore, more efficiently disburses the money and gets a better return for the investment. Furthermore, the

school could have the opportunity to decrease the spending and still reach the same recruiting goal or have a more competitive applicant pool.

b. Focusing yielding efforts on archetypes that predict the high likelihood of matriculation.

The institution then developed a similar machine-learning model to determine the likelihood of applicants enrolling based on the wealth of data. Then the administrators could identify the top 40% of applicants (people who are more likely to matriculate). Furthermore, the high-potential applicants were segmented into five categories based on different factors such as their interests. Consequently, the administrators could better tailor their pitches to high-potential applicants during the yielding period.

c. Identifying undertapped 'look alike' markets.

Based on a wealth of data, a machine learning model was able to determine predictive characteristics for markets with high enrollments. Therefore, it could find other markets that have such characteristics and allow the university to reach out to these new markets for recruitment. As a result, the school increased its applicant pool by 15 to 20 percent from these new counties. In the meantime, it reduced the expenditure in the markets with fewer similarities. [1]

For the school, the initiative has been very impactful. The model predicted 85 percent of candidates who submitted an application. A similar model predicted that 35 percent of applicants were most likely to enroll at that point of the cycle[1]. As a result, the administration can make consequential and smart choices to achieve different objectives such as the desired number of incoming students.

3. Machine Learning and Student Retention

During the pandemic**,** student retention rates dropped in many universities and colleges in the US. For example, retention rates at public two-year colleges dropped by 4.9 percent due to the pandemic [4]. There is ongoing research and attempts on improving retention rates with the help of machine learning. The following is an online university's experience in supporting students' success over the pandemic. As with many other schools, the online university saw a notable drop in student retention. The university started multiple initiatives including focus groups and nudge campaigns, however, the results fell short of expectations. As a result, the institute turned to an advanced analytics approach to pursue its bold aspirations (set a high bar for students' success and achieve marked and sustainable improvement to retention) [1]. The school proceeded as follows:

a. Identify key factors that differentiate the students who graduated from the university and the students who did not continue.

The institution was able to build a machine-learning model based on historical data over a ten-year period. Then it refined the model and applied it to the current student body. This model was able to produce five at-risk student archetypes. They are:

1. Students with academic needs

2. Noncommittal students
3. Committed to the current path
4. Distinctive academic achievers
5. Average academic performers

The remarkable result is that the model identified the last three at-risk student archetypes even though they are counter-intuitive. Furthermore, these three archetypes account for about 70 percent of the students most likely to discontinue enrollment. The largest at-risk group is actually distinctive academic achievers, they are roughly 40 percent of the at-risk students identified. The university came up with short and medium-term initiatives to mitigate the retention drop.

b. Invest in short and medium-term strategies to drive retention improvement

The university launched a set of targeted interventions focused on tailored support to students in each archetype to increase retention. Actions included scheduling more touchpoints with academic and career advisers, expanding faculty mentorship, and creating alternative pathways for students to satisfy their knowledge gaps [1].

4. Risks Associated with Machine Learning Models.

As mentioned previously, machine learning models provide university and college administrators with valuable insights so that they could handle the challenges such as enrollment and retention much more effectively. However, there are pitfalls with such models if they are not implemented correctly.

a. Bias could be introduced inadvertently during the building of a model based on race, age, or gender or it could be introduced if a new model is based on an existing model with bias.

b. An incorrect model could be produced if we have any use case decisions that would exclude the students from certain interventions or if we do not test relevant factors to remove unconscious bias.

c. Falsely consider machine models as the replacement for the existing student support process.

d. The model may be skewed toward a particular group if the performance of the model is not checked regularly [1].

5. Conclusion and Remarks

In this paper, we barely scratch the surface of what machine learning can do in higher education. As we discussed in the paper, it can be a vital tool to enhance recruiting process, and improve the retention rate during this challenging time for higher education. However, it can also support accurate student assessment, high customization, better user experience, etc. [5]. There is

unlimited potential for using machine learning in higher education, for example, in China, about 60 thousand schools are testing a paper grading system allowing them to evaluate students' essays automatically [5]. I encourage readers to learn more about machine-learning models as related to higher education. In particular, administrators in higher education should consider incorporating machine-learning models to better serve their students and community.

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Can robotic tutors help overcome learning loss?

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ABSTRACT

Each state in the United States has shown at least a 10 percent drop for students in mathematics and reading. The use of artificial intelligence (AI) to assist in teaching students is part of the evolving classroom of computer technology employed by some school systems. The use of AI and robots is expanding into our homes and classrooms. The use and acceptance of AI as a teaching instrument to assist a human teacher or replace a human teacher can be linked to business applications posed by companies such as Amazon and Boston Dynamics. In China, Squirrel AI is a tutoring software which students could use at private-tutoring facilities. Squirrel AI is believed by the backer to be in a safe zone with plans to expand into the United States. Squirrel AI tablets are now being given free in China to their public schools.

INTRODUCTION

Can your kids and grandkids read and do math to their grade level? Each state in the United States has shown at least a 10% drop for these kids as reported in 2022. The closing of K-12 schools during 2021 and 2022 seems to have contributed to the decline in 4th and 8th graders not learning the mathematics and reading skills according to news printed and broadcast last week. Who should the educational institutions focus on in K-12 or college? As a college professor, and yes, previous high school teacher, our students need help in learning and learning how to learn. We as teachers need to refocus on all these levels of teaching and learning. But what is the starting point?

Our starting point may not be with the fourth and eighth graders or any one level. It might be an artificial teacher. The use of artificial intelligence (AI) to assist in teaching students is part of the evolving classroom of computer technology employed by school systems.

The use of artificial intelligence (AI) to assist in teaching students is part of the evolving classroom of computer technology employed being employed by school systems. AI is used by different businesses and home applications already. The use of AI can be confusing. Part of the reason for this confusion is that AI can be classified by many different definitions. The term AI used in this analysis can use any of those definitions and includes the use of machine intelligence or robots thinking machines. Each of these terms are defined in this paper. The focus on this analysis reflects the facts that there is strong demand for AI technology and will grow within the next three years.

While the focus of this analysis is replacing human teachers with AI teachers or AI technology, the use of AI is expanding. For instance, "Amazon has recently shown a growing interest in robots both in and out of its facilities" (Herrera, 2022, p. B7). Along with Amazon, Boston Dynamics has been working on robotics for office and home use for over three decades (p. B7). A representative of Boston Dynamics, Mr. Player, states that their company "wants to put robots in homes and is focused on making them feel safe to humans" (p. B7). These two companies are just two of many companies dealing with the application and manufacturing of AI systems. One of the significant features of the relationship between humans and AI systems for people to trust them (p. B7). This trust aspect is critical for the use and acceptance of AI teachers from all levels of education from K-12 to college to work-related tutoring. Part of this trust of

such AI technology is already upon the general population at home, the office, logistics and manufacturing. Mr. Player sees "a future where robots … are going to be ubiquitous" (p. B7).

The use and acceptance of AI as a teaching instrument to assist a human teacher or replace a human teacher can be linked to these business applications posed by companies such as Amazon and Boston Dynamics. However, there is another linkage for this AI teacher application. That is how such similar technologies have been accepted by people. This linkage is that technology acceptance is tied to the imperfections in how we as humans evolve to accept or reject new technologies (Barash, 2022, p. A15). Barash reviewed a book by Telmo Pievani, entitled, Unintelligent Design. Barash indicates that "evolution is not perfect but is rather the result of unstable and precarious compromises" (Barash, 2022, p. A15). One interesting aspect of this compromise feature is the acceptance of technology is from such examples as the automobile from the use of a horse and buggy, the use of the telephone, television, home and office cybersecurity systems, the mobile phone over the past two decades and today the emerging AI technology based self-driving automobile and truck. Today, the acceptance of gaming and simulations at home, the office and in the classrooms of K-12 and college ubiquitous. Simulations can be based in AI technology.

In China, there are two companies that have been developing and implementing AI tutors. One of these companies has moved to the U.S. One company developed an AI teaching system called Squirrel AI (Lu & Hao, 2022, p. A18). The AI tool, Squirrel AI is a "tutoring software powered by artificial intelligence, which students could use at private-tutoring facilities" (Lu & Hao, 2022, p. A18). This Squirrel AI is believed by the backers "to be in a safe zone" with "plans to expand into the U.S." (Lu & Hao, 2022, p. A18). In China, this "Squirrel AI has pivoted from working with private-tutoring facilities to making smart tablets loaded with its learning software"

(Lu & Hao, 2022, p. A18). These AI based tablets are now being given sold to the public as well as given "free to public schools" (Lu & Hao, 2022, p. A18).

STATEMENT OF THE PROBLEM AND HYPOTHESIS

The Problem

The problem statement is how many and where will AI teachers be developed and deployed in K-12 schools and colleges and universities in the U.S. by 2025?

Hypothesis

The use of artificial intelligence (AI) to assist in teaching students is part of the evolving classroom of computer technology employed by school systems

LITERATURE REVIEW

Background And History

There are remote or online colleges that were established more than thirty years ago, which are not the same as those face-to-face classrooms K-12 and colleges being forced online due COVID-19. The American Public University System (APUS) is one such totally online college offering a full range of accredited degrees. These totally online classrooms are where the students and teachers do not interact in a live or in person setting. Students in such online remote colleges are adults ranging in age from 22 to75, with most looking for a new career using a new college degree. These students are attending classes from onboard a Navy ship, on an island, in a foreign country or as you next door neighbor.

Teaching online for such college students is operationally, geographically, physically, and mentally different, and more challenging than teaching that same course inside a classroom that was caused by the COVID-19 pandemic impact. These remote online classrooms are totally

virtual. The online teachers exchange feedback with each student concerning their written paper assignments and peer-level text-like discussions within a scheduled due date each week, such as Thursday and Sunday. There is not a live session or connection between teacher and student.

AI was and continued to be investigated to support both the live and virtual remote online human teacher and student classroom activities. AI is being considered to replace repetitive tasks of teachers, to release the human teacher to devote more individual or personal time to each student in their classroom. There is research underway at American Public Education University of exploring the development of courses with AI and robotics that can be used inside and outside the classroom environment. Some scholars are looking to understand the range of impacts on society and culture that is changing as AI increases in its applications and advertisements.

Artificial Intelligence "is changing human thought, knowledge, perception, and reality – changing the course of human history" (Kissinger, H. A, et al, 2021, p. 5). While this is recent, these thoughts or beliefs from people is not new. "In 1943, … researchers created the first modern computer." And since that time people have been questioning and challenging the use of the many different terms used to describe computers. From 1943 up to today people continue to ask, "Can machines think? Are they intelligent? Could they become intelligent?" (Kissinger, H. A, et al, 2021, p. 55). Such questions and concerns about the application of AI in business and home continue to be asked or thought since growing evidence show that AI has "the capacity to shape human activity in ways that may not be clearly understood – or even clearly definable or expressible – by the human user" (Kissinger, H. A, et al, 2021, p. 109). People in business from the stock market to academics to retail stores are excited and still a bit cautious since "AI can

analyze data faster than the unaided human mind can contemplate" (Kissinger, H. A, et al, 2021, p. 193).

With that concept as a leading focus, online college students at APUS were asked in 2020 a series of questions regarding their acceptance of and understanding of AI technology as a replacement for their human teachers. This online education experiment was at the undergraduate level. The online teaching parameters was not live human interaction with these students. Teachers and student interacted offline in a scenario of non-live exchanges of words and task and written assignments. Comments between student and with teachers was like performing and exchange of texting messages.

The goal of this research was to examine how these online college students would accept or reject AI as a teacher or teacher's assistant since such AI "black box systems are already a mainstay of modern business" (Ward, 2022, p. 137). It was felt that since "at every turn, humanity will have three primary options: confining AI, partnering with it, or deferring to it" (Kissinger, H. A, et al, 2021, p. 210), it was expected that most of these students would choose one of these options

Justification Of the Problem

The justification of the problem statement of how many and where will AI teachers be developed and deployed in K-12 schools and colleges and universities in the U.S. by 2025, is founded on the evolutionary actions from the current advancements and applications of AI teachers and AI tutors already being delivered to students and other consumers. This first part of this foundation is that the acceptance of technology is based on the imperfection that the consumer, such as students and teachers and parents, follow in understanding this AI technology as part of their life. Such imperfections lead these people "on a convincing whirlwind tour of the dangers as well as

the impossibility of perfection" (Barash, 2022, p. A15) for such an AI teacher to replace a human teacher. The second part of this foundation is the AI teacher technology already developed and the plans for increased development over the next three years, 2025. The combination and linkage of the various aspects of these parts is the foundation.

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RESEARCH QUESTIONS

There are two types of research questions, process based and research-based questions.

Process Based Questions:

1. Does this research help in the understanding of the common practices of how human teachers in an online university such as APUS interact with their students?
2. Does this research create uncertainty in the common practices of how human teachers in an online university such as APUS interact with their students?
3. How can this gap in understanding and knowledge about humans versus AI systems as a teacher be better or more completely defined?
4. Will this research paper change the assumptions?
5. Does this research open new avenues for thinking about AI and humans as teachers?
6. Will this research impact the field of college online learning?
7. Will this research impact the field of college online teaching?

Research Based Questions:

1. What are the assumptions that are being used to define the relationship or differences between human and AI teachers?

2. Can a collaboration of human and AI teacher be productive for student engagement in the classroom?
3. Will AI teachers be normal in the next five years?
4. Will AI teachers become a threat to students?
5. Will AI teachers become a threat to teachers?
6. Will AI teachers become a threat to universities?

RESEARCH DESIGN

The research methodology used in this research is survey research (Kerlinger & Lee, 2000). One of the most powerful research methods is with interviews and schedules of questions. A set of questions or a questionnaire method will be used. The question will come from those listed earlier in this paper. The survey method will also include a panel. This panel will focus on the impact of the use of AI tutors or AI instructors on students' behavior and learning. Mail questionnaires will also be used for those persons in geographic areas. While there may be a drawback in what will be the number of responses, the geographic range of the audience will shed light on variance in understanding AI as a tutor.

A basic analysis paradigm will be the comparison of positive attitudes to negative attitudes to the various applications of AI as replacement for human teachers (Kerlinger & Lee, 2000).

DATA COLLECTION

The validity of survey data may be checked by interviewing respondents in all forms of these surveys several times. While the specific data for each respondent is important, it is generally found that using averages produced best results (Kerlinger & Lee, 2000).

The application of survey instruments will be conducted primarily with students. The research method will include a nonrandom sample size of at least 100 students who attend an online university (Kerlinger & Lee, 2000).

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Embedding STEM-based Modules to Integrate Design and Systems Thinking in Accounting Courses

JIAHUA ZHOU

JENNIFER BUSHELLE-EDGHILL

Introduction

1. Motivations and Background Introduction
2. Learning Objectives Description
3. Course Module Design
4. A Course Prototype to Embed Technology-oriented Skills in Accounting Curricula
5. Conclusion

Motivations and Background Introduction

1. The profession and academics have called for a broader range of technology-oriented IT skills in accounting graduates (AACSB, 2018; AICPA &NASBA, 2020).

2. The CPA Evolution Curriculum project (AICPA and NASBA, 2020) requires significant technology-oriented IT skills. The new CPA exam will launch in 2024.

3. Employers want accounting graduates to acquire the necessary IT skills in a college education.

Accounting Pedagogic Solution -- Challenges

- Traditional accounting education is outcome-based, using standardized, objective measurement with routinized conditions.
- Accounting is one of the most conservative professionals. It does not encourage creativity and design thinking, which is necessary for IT skills training.
- Technology-oriented skills are ordered hierarchically; lower-level skills serve as prerequisites for higher-level skills. Accounting students have no or low technology background.

Accounting Pedagogic Solution -- Opportunities

- Accounting is a highly applicable discipline. Some interdisciplinary pedagogic mechanisms from data science can be integrated with accounting domain knowledge.
- It is approachable to combine systems thinking and design thinking and embed IT techniques teaching in accounting education.
- Embedment mechanism (Fawns et al., 2021): (1) embed adaptive practices in formal syllabus requirements. (2) Embed abstract in embodied knowledge. (3) Embed technology use in professionalism.

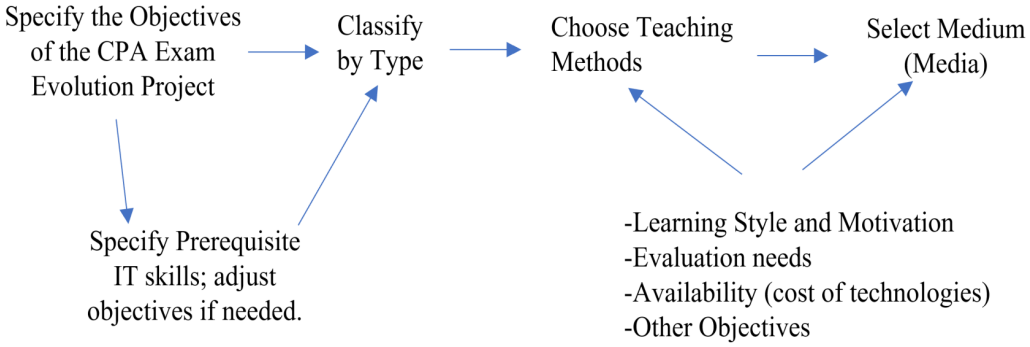
Course Module Design --Education objective as a Starting Point

Accounting competency (a three-layer concept):

- The First Layer: A set of professional knowledge, analytical skills, and technology-oriented IT skills.
- The second layer (built on the first layer): includes several functions (cognitive, integrative, relational, and moral functions.
- The third layer (mindset development): includes attentiveness, curiosity, and active learning mindsets.

The Logic Map to Explore Teaching Methods for the CPA Exam Curriculum Evolution

Figure 1: The Logic Map to Explore Teaching Methods for the CPA Exam Evolution



(Adapted from the Figure 1 from Bonner, 1999)

Conditions Analysis to Interconnect Objectives and Teaching Approaches

1. Conditions are the intermediaries derived from a large body of educational and cognitive psychology literature to guide teaching approaches to achieve objectives.

2. Bonner (1999) demonstrated five conditions for accounting learning objectives.

- The first describes expected performance, which helps students to retrieve information from memory.
- The second is to facilitate the recall of a well-organized knowledge base.
- The third is to deliver meaningful material.
- The fourth facilitates material elaboration, allowing students to interact with examples in a new context and apply the learned skills.
- The fifth is to elicit expected performance and provide practice, facilitating students to apply the learned skills and knowledge to solve problems.

CPA Curriculum Evolution Learning Objectives Description

Table 1: Three Layer Learning Objective Description

Items		Learning Objectives Description
First Layer	LO 1.1	Concept of data
	LO 1.2	Concept of data generation pipeline
	LO 1.3	Mechanism of data management and information systems
Second Layer	LO 2.1	Data analytics skill
	LO 2.2	Analytics software application skill
	LO 2.3	System design
Third Layer	LO 3.1	Active learning mindset
	LO 3.2	Real-world question solution development

IT Techniques Teaching, Design Thinking, and Systems Thinking

1. The intersection of data, technology, and accounting domain knowledge offers opportunities to regenerate the style of action, thinking, and reasoning to teach accounting students technology-oriented skills.

2. Three principles for the course design:

- Real-world questions can activate students’ learning motivation.
- The interconnectedness of the course module offers a big picture and improves students’ learning depth.
- Task-based assignments can strengthen students’ consciousness and re-activate their learning motivation.

Map the Conditions to the Teaching Objectives and Develop the Integrated Solution

1. Explore a **balance** to influence accounting domain knowledge and technical skill development.

2. Facilitate a **balance** to let students see both "the trees and the forests."

3. **Combine** systems and design thinking –

To achieve different teaching objectives with the best teaching methods.

Table 3: Description of the Technology-oriented Course Modules and Their Integration

Course Module	Teaching Objectives	Teaching Methods	Assessment Approach	Interconnection Links
Data Module	Techniques of data gathering, data management and data analytics.	Video demonstration; Interactive lecture; Group discussion; Online open-source self-learning.	Provide data-driven solutions for real-world question-oriented assignment; Present and communicate the data analysis result with each other.	The internal link: the whole procedure from raw data collection through the presentation of analytics results needs to be consistent. The cross-modules link: the fitness between data and technologies.
Technologies Application Module	The application skills of related technologies and Information Systems.	Video demonstration; Interactive lecture; Group discussion; Online open-source self-learning.	Task-based group project to applicate the targeted technologies with a solution; Present and demonstrate the technology application.	The internal link: the fitness between database feature and related Information Systems. The external link: technologies application must fit to related data input.
The Module for the Intersection of technologies and accounting domain knowledge	Business process analysis; Systems control and design.	Interactive lecture; Group discussion;	Group project with a real-world case study.	The internal link: accounting has specific domain requirements for information systems. The external link: data and related technologies are the two basic components of the information design.

The Instructor's Role in the Embedded Pedagogic Design

The Instructor's Role:

In this design, the role is changed from an authoritative transmitter of knowledge to one akin to a partner in a shared learning experience. It is more like a conductor in an orchestra to let each team member present their best music.

(1) The embedded platform enables a dynamic teaching strategy to achieve different teaching objectives.

(2) It is a conversation platform that guides students to take advantage of online open source.

(3) In this platform, the task-based assignments (projects, case studies, presentations, and group discussions) act as the function of the conductor's baton to manage the learning process.

Assumption Test for a Prototype Course (ACCT 300)

Assumption 1:

Embedding an integrated real-world-case-oriented project can activate students’ interest and improve STEM-based IT techniques learning engagement.

Assumption 2:

Design-oriented tasks can achieve the big picture of the integration of accounting domain knowledge and IT engineering logic.

Five Challenges for the ACCT 300 Course Design

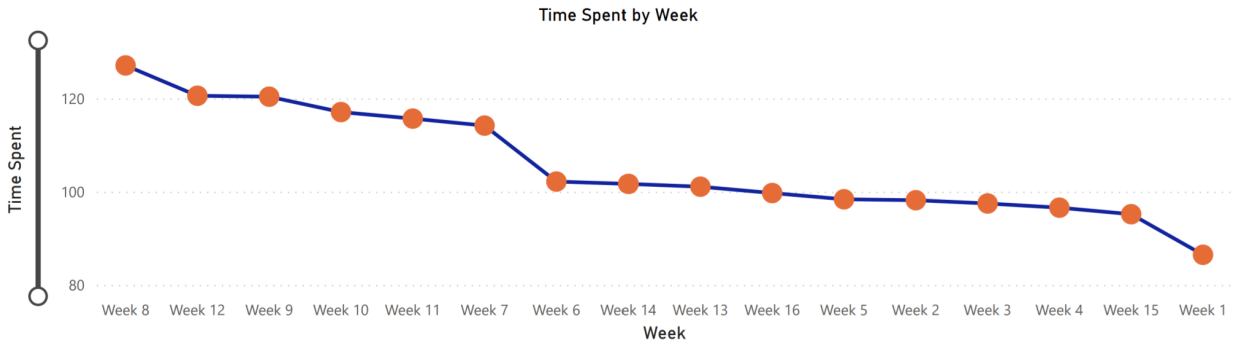
1. Formulate the primary mechanism of an Accounting Information System.
2. Design an AIS using the REA (Resource, Event, Agent) data model and the relational database techniques.
3. Extract and communicate useful information for stakeholders.
4. Apply data analysis and data visualization analytics.
5. Apply accounting software packages (MS ACCESS, MS Power BI, and MS Azure).

Quantitative evidence to validate the two assumptions

Table 4: The T-test Result for the Time Spent on Canvas

	Spring 2021 (Tradition)	Fall 2021 (Newly Designed)	Difference
Observations	37	45	
Mean	1260.97 (minutes)	1692 (minutes)	432.73 (minutes)
T-value			1.994* (0.047)

* means the difference is statistically significant.



Time Spent Pattern

Conclusion

- The combination of systems thinking and design thinking offers dynamic pedagogic solutions to teach IT techniques in accounting education.
- Embedment mechanism provides effective solutions to teach accounting students STEM-based IT skills.
- A real-world-case-oriented project can activate students’ interest and improve engagement in IT skills training.
- Design-oriented tasks can achieve the big picture by integrating domain knowledge and IT engineering logic.

Knowledge Retention Issues Related to End of Course Performance: Accounting Principles Course

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We have previously explored the role of knowledge retention from the first course in accounting principles to the second course and how an initial targeted experimental intervention may reduce the negative impact poor retention has on mid-course student performance. Here we extend this line of research to explore the question of whether this intervention improves overall end of course student performance. Earlier research found evidence that the intervention was able to overcome knowledge deficit midway through the course. Here we find the intervention did not improve overall end of course performance.

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Papers: Management, Marketing, Accounting, Economics and Finance, Strategy, Organizational Behavior Organizational Theory, Human Resource Management, Consumer Behavior, International Business

A REVIEW OF LITERATURE ON JAPANESE MANAGEMENT IN SMALL AND MEDIUM-SIZED ENTERPRISES

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ABSTRACT

Japanese management has always been unique and examining what is special about them will have immense implications for SMEs worldwide. Given this, this study aims to review the Japanese SMEs literature to identify research arenas that have been explored in the past and aids in classifying the factors that make Japanese SMEs unique and successful. Using a systematic review approach, 63 studies were identified and analyzed which helped to identify seven themes associated with Japanese SMEs. This review points out a few methodological shortcomings in the literature, identifies gaps and recommends several avenues for future research. It also highlights several implications for both practitioners and policy makers.

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INTRODUCTION

Japan is a country with immense potential and strength, that sets benchmarks for other countries through various aspects of its economy. One such aspect is the brilliant performance of Japanese SMEs. According to a report by OECD [33], 99.7% of total businesses in Japan are SMEs and these employ more than 34 million people. Japanese SMEs have always been a learning lesson for many economies and have received substantial attention from policymakers and practitioners. Additionally, management scholars have also considered and compared Japanese SMEs to SMEs various countries and other cross-country studies. The Japanese economy has suffered many difficulties such as the bubble economy burst (1990s) or natural disasters such as earthquakes and tsunamis disrupting the livelihood of millions, however SMEs in Japan were continually able to support the economy and have inspired other countries to learn and imitate from their success [37]. Thus, the main purpose of this study is to identify factors that make Japanese management so distinctive and unique.

Japanese SMEs heavy reliance on technology, innovation, R&D, and their culture that adds to the value of an SME, makes it quite intriguing to know how SMEs in Japan function to differentiate themselves by creating a niche for their products. Furthermore, these SMEs also support a variety of large firms running in the country with the required raw materials and services. Moreover, SMEs in Japan constantly focus on improving the quality of their products and services. Therefore, given these attributes of Japanese SMEs, it makes it inevitable to not know what makes them so rare and what can we learn from their success. Thus, by identifying the unique characteristics and attributes of Japanese SMEs, the study aims to provide help to other developing economies with significant impact on their economic, social, and environmental growth. Hence, by conducting a systematic review on the Japanese SMEs literature, this study has identified the themes or aspects that have been investigated previously. This review has also helped in answering the main research question i.e., what makes Japanese SMEs and Japanese management so unique and different?

Methodology

A systematic literature review process was applied to get a holistic view of the existing literature and synthesizing the studies to define the main research questions for the study[13] [22]. Using mainly three databases namely, ProQuest, Scopus and EBSCO, relevant articles were searched using keywords "Japanese SMEs", "Small and Medium Enterprises", & "Japan SMEs". Keeping the search limited to business and management related journals, checking the focus of the papers, and filtering any duplicates, the total number studies included in this review were 63 articles. Furthermore, to ensure the quality of the articles considered for this review, this paper considers only journals listed in Scopus. Using the Australian Business Deans Council (ABDC, 2019) as a benchmark for the quality of the journals, 49% of the reviewed articles were ranked A* or A, 27% were ranked in the category B, and 5% of the articles were in journals listed in C category. The remainder of the studies (19%) were not in the journals listed in the ABDC; however, they were all indexed in Scopus.

Although a high number of studies in a variety of journals have showcased interest in the functioning of Japanese SMEs, there is still a need for top scholars to explore further to identify more learning opportunities, challenges, and lessons that are associated with Japanese management and SMEs. In addition to reviewing articles from various journals, secondary sources such as newspaper articles, webpages, and global reports were also reviewed to understand the current scenario of SMEs in Japan.

Overview and research findings

Our systematic review approach has helped in identifying seven themes on the Japanese SMEs literature from 1996 to 2021. These are (1) Firm management (2) Innovation, Technology, and R&D, (3) Internationalization, (4) Financial support- banking and finance, (5) CSR, sustainable development, and ethics, (6) Entrepreneurship and (7) History, legal framework, and policies. The most noticeable theme identified is "firm management" with 24% of the papers focusing on it, followed by the themes that are numbered above based on priority or attention they have received in the literature. The literature reviewed has helped in identifying challenges and motivations to start an SME in Japan, to measuring various aspects of firm management that impact firm performance and growth such as risk perception, international mindset, business networks, internet capabilites, entrepreneurial orientation, R&D, innovation, total qualitative management (TQM), and digital marketing. Furthermore, the literature also emphasizes on the support that is provided by the Japanese governement in terms of financial assistance, credit-guarantee systems and eased FDI[28] [19]. Lastly, a field of research that is getting attention in the literature is the aspect of sustainability and the implementation of CSR activities by SMEs in Japan and its impact on firm performance.

Under the firm management theme, it has been pointed out that smaller organizations tend to be flexible when they face opportunities and challenges. Similarly, Japan being a collectivist country, they have been able to run their businesses in a close-knit pattern, which helps them to create a work environment that is based on cultural values, trust, and loyalty[7]. Although the close-knit management helps the firm to grow independently but proves to be a hindrance when it comes to an external or third-party involvement. However, [11]has argued that the Japanese family run SMEs evolved after the bubble burst in the 1990s and adapted to the changes to diversify and grow. Additionally, family run Japanese SMEs have shown inclination towards behaviors that focus on long-term orientation and highly risk averse. Therefore, relying more on building stronger customer relationships rather than just focusing on the growth of the business[8]. Thus, given the limitations of traditional family run SMEs, younger SMEs in Japan are showing a more adaptive behavior and are centering on more intangible resources such as style of leadership, reputation, intellectual property, management systems, and focus on maintaining informal social networks[2]. These social networks are helping a Japanese SMEs to grow locally as well as internationally. Japanese SMEs have also been an integral part of the manufacturing industry in the country by providing to larger firms as suppliers, they have also started exploring new processes that helped in inventing new products that are for the greater good of the country [38]. Thus, Japanese SMEs place immense importance on the links within and between firms, leadership styles, focusing on culture, and most importantly the quality of the product or service. Quality assurance and continuous quality improvement techniques are rigorously implemented to maintain the standard and excel the business [17] [27]. Apart from the internal strengths of the SMEs, the external support the SMEs receive from the government through its policies is also worth appreciation. These government initiatives not only helped the SMEs to compete but have also helped them thrive that has helped the economy grow by creating new jobs and retaining the existing SMEs. Some of the government initiatives include the credit guarantee system, loans, relationship banking, availabilty of information, reporting and ease of procedures to start a SME[10]. Moreover, educational policies such as starting them young for entrepreneurship, innovational competitions and collaborating educational institutions with different kinds of firms for either research or consultation has added to the growth of young Japanese entrepreneurs and SMEs [13] [32] [36].

Subsequently after firm performance and management, Japanese SMEs heavy reliance on innovation, R&D, and technology has tremendously helped them retain the quality and standards of their products and services. Collaborating with R&D institutes and educational institutions, SMEs have retained their position in being strong with respect to information collaboration and knowledge sharing resources [36]. Though family run Japanese SMEs are lagging with respect to accepting the digital revolution, a step towards improvement is to invest in IT innovation [30], which will help these SMEs grow further and compete in foreign markets. Strategies such as leapfrogging, state skipping, and path creation will only benefit Japanese SMEs in catching up with technologies that are followed in other countries [31]. Furthermore, the government support to Japanese SMEs with respect to intellectual capital and innovation has helped them in realizing their strengths and weaknesses, which aids in better strategic planning and fostering communication within and outside the firm [24].

Internationalizing or overseas expansion of Japanese SMEs has faced certain challenges such as raising funds, adapting to organizational changes, and creating a network of communication outside the firm [21]. Therefore, to enter or explore new markets, Japanese SMEs need to alter their business model and rely on forming alliances and joint ventures with local firms in the foreign markets. Challenges such as different cultural contexts be it social or linguistic, in addition to the challenges of educating foreign markets with Japanese cultural values and identity [16]. Japanese products are an integral part of the Japanese people's identity and values, therefore, expanding abroad requires SMEs to consider strategies that efficiently help in cultural transposition, adaptation, and selectively targeting their customers [37]. Moreover, models such as the Uppsala and SCOPE have been used in the literature that have focused on how Japanese SMEs initiated internationalization [1] [35]. Furthermore, in the end it is the Japanese management and the leadership style that helps in selecting the apt location for investments, right strategy for entry mode and innovation that is required to expand abroad [29] [34].

Another important aspect that has been discovered through the literature is the spirit of entrepreneurship in Japan [26]. Though Japan being a risk-averse country, many individuals still take a risk in terms of starting a new business even though us on a small scale [3]. The main credit for the Japanese entrepreneurial spirit is the education system and the economy's dependence on SMEs. The collaboration between universities and businesses has resulted in development of innovative ideas at an early stage or development of individuals, that has helped to adopt digitalization and network development. The total early-stage entrepreneurship in Japan is a positive indicator that showcases the impact of small businesses on the growth of the economy [25]. Moreover, the entrepreneurial spirit in the country right now is increasing diversity, spreading knowledge, increasing competition, and developing an economy with innovative solutions [20].

Japanese SMEs or also considered to be firm believers of ethics, sustainability, preserving their culture and giving back to their society. Therefore, many Japanese SMEs place high importance on customer satisfaction [19]. Moreover, given the small size or scale of activities conducted by the SMEs, it is easier to implement CSR activities that positively impacts the society. SMEs in Japan also emphasize on the importance of a right ethical leadership that helps in sustainable development and management of CSR activities that helps to improve the image of the firm in the long run, in addition to achieving customer loyalty and boosting an employee's pride [12]. SMEs have also adopted various policies that aim to mitigate waste, CO2, and NOx emissions, and reducing the use of plastics for sustainable

development[39]. Thus, these activities significantly impact the financial and the non-financial performance of the firms in Japan [4] [12].

Lastly, a few studies have also indicated the advances in the legal framework and policies with respect to SMEs in Japan. The Japanese legal framework has become more supportive and diversified with respect to various civil and administrative policies, which was not the case earlier [15]. Moreover, with the current COVID-19 pandemic various macroeconomic policies have been suggested in the literature that includes innovative funding, credit guarantee systems, and crowdfunding that helps SMEs to fill in the infrastructure gap with respect to technology and digitalization [39].

Limitations, Implications and Future Research

This review like any other study also has a few limitations that would be addressed, so it helps and gives future studies a direction to explore this topic further. Firstly, limited search of studies using only three keywords may have restricted the scope of finding more relevant articles. Secondly, only three databases were considered to find articles relevant to Japanese SMEs. Thirdly, a thematic analysis given an overall view of the literature rather than just focusing on one topic particularly.

Furthermore, a few methodological implications are suggested which can be helpful for future researchers. This review indicates that 32% of the studies rely on qualitative data techniques as interviews (structured/semi-structures) and observations and lack empirical evidence. Moreover, most of the studies have focused on SMEs in the manufacturing or technology-oriented sector making the studies skewed towards a certain industry. Thus, there is a need to examine SMEs in different industries and fields using large scale quantitative studies with the help of data collection that gives a wider insight into Japanese SMEs. Additionally, a dearth in the use of longitudinal data also indicates a gap that needs to be filled in the future with respect to mapping the development of Japanese SMEs over the years and comparing them to SMEs all over the world.

A few practical implications that can be drawn from this review are; though areas such as technology, innovation, R&D, firm management, and internationalization have received enough attention in the literature, yet emerging topics such as entrepreneurship, CSR, and sustainable development are to be investigated further. Furthermore, this systematic review can help future researchers in identifying an all-inclusive framework that is well-grounded in theory that considers internal and external factors that affect the performance or functioning of an SME. Moreover, this framework can be used in other emerging or developing economic such as the MENA region, where the growth of SMEs is quite evident in the recent times. Also, future researchers need to focus on the performance of the Japanese SMEs that have expanded overseas as compared to the conservative Japanese SMEs that refrain from going global. That is, examining the impact of Japanese culture on internationalization. Although, a few studies in the review have compared Japanese SMEs with SMEs in different countries, there is still gap in the literature with respect to comparing Japanese SMEs with SMEs in the MENA region[5]. This for instance can help in recognizing differences or similarities between SMEs in Japan and Middle Eastern countries. Moreover, studies can also focus on applying the Japanese way of running SMEs in the Middle East to measure the success formula in different contexts and countries. Emerging contexts such as business model innovation [6] [23], strategic decision-making for internationalization[9], and SMEs during the Covid-19 pandemic [8] [39] can also be investigated further with respect to Japanese SMEs and their counterparts in the

Middle East. Furthermore, it would also be interesting to know the impact of the recent Covid-19 pandemic on the functioning of Japanese SMEs, and how have they coped with this challenge in comparison to past crises. Lastly, it is also evident from the studies reviewed that research done on Japanese SMEs is not well grounded in theory and a better theoretical framework is required to empirically investigate Japanese SMEs in the coming future.

To conclude, this review on Japanese SMEs aims to renew the perspective of scholars and practitioners intending to link and expand the current themes into different avenues and prospects. The disintegrated literature on SMEs in Japan has been amalgamated to paint a clear picture and identifying dominant themes that have been in focus for a while. The review has provided many importance insights into Japanese SMEs, that can be applied in different settings and countries.

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BETTER SOONER THAN LATER? EFFECTS OF ADOPTING DRONE-ENABLED INVENTORY OBSERVATION ON AUDITOR LIABILITIES

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BETTER SOONER THAN LATER? EFFECTS OF ADOPTING DRONE-ENABLED INVENTORY OBSERVATION ON AUDITOR LIABILITIES

ABSTRACT

Audit firms have begun to explore the use of drones for inventory observation (PWC 2016; EY 2017). Despite the usefulness of drones in inventory observation in an audit, practitioners are hesitant in using the new technology due to the possible additional litigation and regulatory risks (Christ, Emmett, Summers, and Wood 2021). In this study, we investigate whether using drones for inventory observation, while it being consistent or inconsistent with the audit industry norms, might increase auditors' legal liabilities. We employ a 2 (inventory observation medium: drones versus human staff) x 2 (audit industry norms: consistent vs. inconsistent) between-participants design. Our results show that jurors assess higher negligent likelihood to auditors who use drones in inventory observation, if using drones was not the audit industry norm at the time of audit. However, our results also show that, if most other audit firms have already adopted drone-enabled inventory observation, jurors assess higher negligent likelihood to auditors who do *not* use drones in their inventory observation. Our results also show that this interaction effect is mediated through perceived foreseeability of the auditor over the audit failure. Our findings provide practical insights that, while adopting drones for inventory observation earlier than other audit firms may increase potential current legal liabilities, adopting later may also increase potential legal liabilities. This study also provides theoretical implications about the interaction between conventionality (i.e., previously used practice) and normalcy (i.e., widely used practice) which has been hardly distinguished in the empirical tests of the literature of normality bias.

BETTER SOONER THAN LATER? EFFECTS OF ADOPTING DRONE-ENABLED INVENTORY OBSERVATION ON AUDITOR LIABILITIES

INTRODUCTION

Audit firms have begun to explore the use of drones for inventory observation (PWC 2016; EY 2017). Drones can fly around the inventory storage area and provide live-video streaming and recording of inventory counts, and those with Radio-Frequency Identification (RFID) tracking systems can also assist verification of the client's inventory records (Sidhu 2018). Using drones is particularly helpful in circumstances where physical visits to and meetings with the client may be impracticable, such as during the pandemic (KPMG 2020). Several academics also suggest the usefulness of drone technology in inventory observation. For example, Christ et al. (2021) provide evidence that using drones and automated counting software can substantially increase the efficiency and accuracy of the inventory counts. They also conduct interviews with audit partners who predict that drones are likely to improve the accuracy and completeness of inventory observation in audits. However, these audit partners also expressed fear of additional litigation and regulatory risk when adopting such new technology, despite the usefulness and benefits of the technology.

Psychology literature commonly finds that those who use unconventional methods are judged more harshly than those who follow conventions, which is referred to as normality bias (Kahneman and Miller 1986). Normality bias is often studied in the context of medical lawsuits where a conventional medical practice is also the practice that is more widely used in the industry, that is, the context in which conventionality (i.e., having been previously used) and normalcy (i.e., being widely used in the reference group) coincide (Baron and Ritov 2004). For example, a newer medical practice has fewer trial records for side effects, and it is used more cautiously in the industry. As time passes, the newer practice establishes more trial records, and, by the time that the newer practice becomes the industry norm, it may not be considered

new anymore. An audit practice is slightly different. In an audit, benefits of a new audit technology, relatively speaking, can be easily measured by the speed, completeness, and accuracy of the work outcome (e.g., Christ et al. 2021). Because the audit industry expects fast switching, usually within a few years, to the new and advanced technologies as they become available (PCAOB 2017), the audit industry norms can change even when the newer technology is still considered "new".

In this study, we investigate whether the use of drones (versus human staff) in inventory observation in an audit interacts with consistency (versus inconsistency) with assumed audit industry norms in affecting jurors' assessments of negligent likelihood. We conduct an experiment using a 2 (inventory observation medium: drones vs. human staff) × 2 (industry norms: consistent vs. inconsistent) between-participants design. Our juror trial case utilizes the Big Time Gravel case (Kadous 2000, 2001), in which a hypothetical accounting firm was accused of insufficient observation of inventory. Adapting the case, we inform participants that while human staff traditionally have completed inventory observation, drones have also become available for this task in recent years. In the main experimental task, we manipulate the inventory observation medium to be either drones or human staff, and whether or not this inventory observation method (i.e., drones or human staff, depending on the research conditions) is being used by most other audit firms at the time of the audit.

Prior literature indicates that jurors may use counterfactual reasoning when the audit practice is not consistent with the industry norms and an audit failure has occurred (Kadous and Mercer 2012). Being inconsistent with the norms creates an environment where individuals can easily question "what if" an alternative action (i.e., following the norms) had been taken (Kahneman and Miller 1986; Prentice and Koehler 2002). We adopt the Culpable Control Model (Alicke 2000), which builds on the counterfactual reasoning theory, to investigate the cognitive process when jurors attribute blame. Our theory indicates that, when an

unconventional (compared to conventional) method is used, jurors would assess other salient attributes with comparatively heightened sensitivity. Specifically, when auditors use drones for their inventory observation rather than human staff, theory suggests that jurors will assess the foreseeability of auditors over the audit failure to be greater (less) when the use of drones is inconsistent (consistent) with the industry norms. A comparatively heightened (reduced) foreseeability assessment would then result in higher (lower) negligent likelihood assessments, when compared to the circumstances in which human staff is used. Consistent with our predictions, jurors assess higher negligent likelihood for auditors who have used drones in inventory observation than those who have used human staff, if the drone inventory observation method is not consistent with the industry norms. However, jurors assess lower negligent likelihood for those auditors who have used drones compared to those who have not, if the drone inventory observation method is consistent with the industry norms. Our results also show that this interaction effect is mediated by the perceived foreseeability of the auditor over the audit failure.

Our findings provide both practical and theoretical insights. Essentially, we find that jurors assess higher negligent likelihood when auditors use a method (drone or human observation) that most other audit firms are not using. This means that, given the increasing usage of drones in an audit (KPMG 2020), while being an early adopter of drone-enabled inventory observation technology may increase potential current legal liabilities, not adopting drones for inventory observation may also increase potential legal liabilities. Together with the findings from the prior research that drone-enabled inventory observation increases accuracy and completeness of inventory observation (Christ et al. 2021), this indicates that audit firms should consider using drone-enabled technology while trying to increase public awareness of benefits of drone-enabled inventory observation in an audit. This is especially so given that

records of better prior performance can be used as a defense strategy in case of a technology-failure related legal trial.

This study also extends the literature on the normality bias. In the prior literature, conventional methods often coincide with industry norms (Baron and Ritov 2004). For example, findings of prior medical studies often show that a doctor who uses a newer medical practice that is also not the practice consistent with the industry norms (and causes the onset of a severe side effect, for example) is judged comparatively more harshly (e.g., Prentice and Koehler 2002). In addition, in the accounting literature, normality bias is typically investigated in the context of industry norms or firm norms only. For example, Kadous and Mercer (2012) investigate the effect of accounting standard precision on jury verdicts when the client revenue-recognition reporting is more versus less aggressive and the reporting choice is consistent with industry norms versus not. Koonce, Miller, and Winchel (2015) investigate investor reactions to managers' derivative use when the use is consistent with the industry norms or firm norms. In comparison, our study differentiates conventionality and normalcy. Our results show statistically significant interaction effects between conventionality and normalcy; thus, for contexts in which a conventional method and industry norms may not be entirely consistent, it may be useful to consider distinguishing the two constructs.

Our study also extends the literature on normality bias by investigating the processes through which conventionality and normalcy affect jurors' judgments. Compared to investigations into *whether* norms affect jurors' judgments, investigations into the *process through which* norms affect jurors' judgment are less explored. Our findings indicate that using an unconventional method may increase the saliency of consistency with the industry norms. Our findings also indicate that conventionality and industry norms may not always affect juror judgments in the same direction and to the same extent. In addition, our mediated moderation analysis indicates that the interaction between drone usage and industry norms affects jurors'

negligent likelihood assessment through their assessment of the foreseeability of the auditor over the audit failure.

The remainder of the paper is organized as follows. Section 2 presents relevant theories and hypotheses developed for the study. Section 3 describes the methodology used to test the hypotheses and Section 4 presents our analyses and results. Discussions and concluding remarks are presented in the final section.

THEORY AND HYPOTHESES

Drone-Enabled Inventory Observation

Noticing benefits that the advanced technology provides, audit firms have begun to explore advanced technology related to data analytics and data recording, including use of drones. Drones can navigate through the client inventory storage location and scan inventory codes. In particular, drones with Radio-Frequency Identification (RFID) tracking systems can assist verification of the client inventory record, speeding up the verification process, while maintaining accuracy and improving completeness of the process **(**Ovaska-Few 2017; Sidhu 2018). Drones are therefore particularly useful for clients with large quantity of inventory, such as large retailers and manufacturers (Sidhu 2018). Drones are also useful for inventory observations at client sites where human access may be difficult; drones can access inventory located in places which may be unsafe or difficult for a human visit (e.g., mining sites or sites near areas experiencing an onset of transferrable diseases) (Sidhu 2018).

While using drones is expected to improve accuracy, completeness, and speed of processing inventory records, it is not entirely free from potential fraud or error. For example, while drones can scan through codes on the outside of boxes into which goods may be placed, it would not be able to make a decision as to whether the interior of one or more boxes needs to be investigated (Sidhu 2018). In addition, similar to a human auditor visit to the client site, if the visit is arranged much in advance, clients can move inventories between the sites,

fraudulently increasing the volume of the inventory of the site at which the visit is expected to occur.

Using a New Technology, Norm Distinction, and Auditor Liability

With increasing interest in the potential use of advanced technology in an audit, there is a developing line of literature about the effects of such use. Many of these studies focus on investigating whether individuals are averse to, or appreciate, the judgment provided by the new audit technology. For example, Commerford, Dennis, Joe, and Want (2019) find that auditors tend to be averse to the judgments provided by artificial-intelligent (AI) audit systems as compared to human specialists. Emett, Kaplan, Mauldin, and Pickered (2021) also find that auditors evaluate data processed by algorithm-based data analytics to be of poorer quality than those processed by human staff. In terms of jurors' judgments in the case of an audit failure, Kipp, Olvera, Robertson, Jesse, and Vinson (2021) find that jurors deliver more negligent verdicts when auditors use algorithm-based data analytics compared to those prepared by human staff. On the other hand, Barr-Pulliam, Brown-Liburd, and Sanderson (2019) find that mock jurors provide fewer negligent verdicts when auditors have used data analytics, rather than traditional audit sampling, when it is known that it provides greater completeness and accuracy. Libby and Witz (2020) also find that, in cases where there was an independence conflict by auditors, jurors offer fewer negligent verdicts when auditors have used analytical procedures computed by AI rather than hand computed. Taken together, the literature appears to indicate that individuals may be averse to relying on a new audit technology when the benefits of using the new technology are not apparent (e.g., Commerford et al. 2019; Emett et al. 2021; Kipp et al. 2021). Individuals, however, may value the use of a new audit technology

when its comparative benefits are rather obvious (e.g., Barr-Pulliam et al. 2019; Libby and Witz 2020).[1]

Psychology literature observes a tendency among people to judge those who have not followed the norms more harshly even if the consequence of following or not following the norms may be identical, a phenomenon referred to as "normality bias" (Kahneman and Miller 1986). Prentice and Koehler (2003) find that people may judge a physician more harshly if the physician did not use a "normal" (i.e., previously and widely used) method. Prentice and Koehler (2003) speculate that this is because an "abnormal" (i.e., newer and rarely used in the industry) action encourages jurors' counterfactual reasoning (i.e., what if the defendant had taken an alternative, or more normal, action). Although normality may include notions of norms (i.e., acting consistent with others) and conventionality (i.e., acting consistent with what has been generally done in the past) (Kahneman and Miller 1986), this line of research tends not to distinguish these two in their experiments (Baron and Ritov 2004). In many cases, a "normal" method is a method that is conventional (i.e., previously used) as well as common (i.e., widely used), and an "abnormal" method is the one which is not either.

Prior accounting research has identified different types of norms in various accounting contexts. For example, Sunder (2005) distinguishes social norms which include the concept of conventions (i.e., what has been generally done before) and what is socially accepted (i.e., what is currently accepted in the industry), and professional standards when discussing accounting norms. Koonce et al. (2015) distinguish industry norms (i.e., professional practice that is widely used in the industry) and firm norms (i.e., switching to an alternative professional practice or not), when investigating the effect of norms in investor reactions to a firm's derivative use.[2]

[1] Given the mixed findings in the prior literature, in this study, we do not focus on any main effects on jurors' judgments from using technology.
[2] In Koonce et al. (2015), firm norms are manipulated in such a way that a firm continues to follow its derivative use policy or not (i.e.., switching to an alternative method). On the other hand, the conventionality construct includes a notion of prior acceptance by the public, compared to the issue of switching versus not switching (Prentice and Koehler 2003).

However, to the best of our knowledge, in the prior literature, conventionality and normalcy have not yet been separately tested in the investigation of juror judgments of norms in the case of an audit failure.

Research indicates that information about norms is more mutable than other attributes when jurors assign blame for an adverse outcome (Kahneman and Miller 1986). Kahneman and Miller (1986) also indicate that, if a norm is violated, mutability of other salient attributes also increases. In accounting, Kadous and Mercer (2012) observe that mock jurors assign more negligent verdicts to auditors when they have used an audit method inconsistent with the industry norms. Similarly, Koonce et al. (2015) find that investor reactions to managers' derivative use are more unfavorable when the derivative use is inconsistent with the industry norms or firm norms. We therefore contend that, if an audit firm has used drones as the main medium for their inventory observation (i.e., less conventional method) and an audit failure occurs, compared to when human staff was used for inventory observation, jurors will assess higher negligent likelihood if using drones was *inconsistent* with the industry norms at the time of audit.

In a case where the action is inconsistent with the norms, if jurors assess attributes with heightened sensitivity (Kahneman and Miller 1986; Alicke 2000), it means that, when subsequent salient attributes indicate positive rather than negative implications, it would also be assessed with heightened sensitivity. For example, Connolly and Reb (2003) show that, if individuals are given a choice to get a new vaccination that has not been used before (i.e., less conventional practice), but the benefits of such vaccination are well specified, and risks and benefits are also well balanced, a majority of people will decide to take the vaccination. That is, individuals react to information about the benefits of the vaccination sensitively towards positive directions. This indicates that, if a less conventional method (i.e., use of drones in our case) is used in an audit, but with other salient attributes, such as consistency with industry

norms, it will have positive implications in the perceived audit quality; these attributes are also likely to affect the final judgment to a greater extent, when compared to circumstances in which a more conventional method (i.e., human staff) is used. We therefore contend that, if an audit firm has used drones as the primary medium for their inventory observation and an audit failure occurs, then jurors will offer *lower* negligent likelihood assessments as compared to when human staff conducts inventory observation if using drones was *consistent* with the industry norms at the time of audit.

This interaction effect between inventory observation medium and consistency with industry norms is captured formally in our first hypothesis:

> **Hypothesis 1.** In the case of an audit failure, jurors will assign higher (lower) negligence to the auditor if drones are used for inventory observation, if most other firms use human staff (drones) for inventory observation at the time of the audit.

Culpable Control Model and Norm Distinction

In terms of the cognitive process that jurors go through when attributing blame, the literature on counterfactual theory and the literature on the Culpable Control Model suggest that jurors attribute blame for an adverse outcome by invoking counterfactual reasoning, questioning "what if" an alternative action had been taken in the given circumstances (Kahneman and Miller 1986; Miller and McFarland 1986; Alicke 2000). The literature finds that individuals perceive attributes that are not consistent with the norms more saliently than other attributes because inconsistency with the norms encourages individuals to consider "what if" (Kahneman and Miller 1986; Prentice and Koehler 2003; Kadous and Mercer 2012). That is, consistency or inconsistency with the norms is naturally used as a focal comparing point in assessing an event or a circumstance (Kahneman and Miller 1986). In this process, jurors assess causal links between several possible attributes and the adverse outcome (Kahneman and Miller 1986).

The Culpable Control Model argues that blame attribution begins with individuals' spontaneous affective reactions to the harmful events and to the individuals involved. The spontaneous affective reactions then influence the assessment of controls of the involved actor over the harmful event, while assessment of controls includes assessing the actor's foreseeability, causation, and intentions for the adverse event (Alicke 2000). In this process, foreseeability is investigated in general legal trial cases, but causation and intentions are often investigated in cases where the actor has apparently caused the adverse outcome or the actor's intention is known (Lagnado and Channon 2008). Our earlier discussion indicates that, if jurors notice that an action is not consistent with the norms, they assess other salient attributes with heightened sensitivity (Alicke 2000). Attributes assessed with heightened sensitivity are more closely linked to the perceived foreseeability of the actor over the adverse outcome compared to attributes assessed with decreased sensitivity (Lagnado and Channon 2008). That is, if drones are used (less conventional approach) rather than human staff (more conventional approach), and if this approach is *inconsistent* with the industry norms (i.e., other salient attribute), inconsistency with the industry norms would be assessed with heightened sensitivity and, thus, auditors' foreseeability over the audit failure would also be assessed higher. Similarly, if drones are used rather than human staff, and if this approach is *consistent* with the industry norms, consistency with the industry norms would also be assessed with heightened sensitivity, resulting in decreased perception of the auditors' foreseeability over the audit failure. The Culpable Control Model indicates that heightened (decreased) foreseeability would result in increased (decreased) negligence assessments (Alicke 2000; Backof 2015). Together, this indicates that auditors' foreseeability is likely to mediate the interaction between the inventory observation medium and industry norms and the negligence assessment, which leads to the following additional hypothesis:

> **Hypothesis 2.** In the case of an audit failure, if drones are used for inventory observation and use of drones is inconsistent (consistent) with the industry norms at the

> time of audit, auditors' foreseeability over the audit failure will be assessed higher (lower) than when human staff is used, resulting in increased (decreased) negligence assessments.

Our model includes a mediated moderation effect; that is, perceived foreseeability mediates between the interaction between drone usage and industry norms on negligence assessments. Our theoretical model is graphically depicted in Figure 1:

INSERT FIGURE 1 ABOUT HERE

METHODOLOGY

We employ a 2 (inventory observation medium: using drones vs. human staff) × 2 (audit industry norms: consistent vs. inconsistent) between-participant experimental design. In each of the four research conditions, the background information included the following description about the use of human staff and drones in inventory observation:

> Traditionally, human audit staff visit the client's site in person to investigate a sample of assets. In recent years, drones and automated counting software have also become available for use in audit inventory observation.

We provide this description to participants at the initial stage of the task to make sure that all participants are aware that using human audit staff (drones) for inventory observation is a more traditional (less traditional) audit practice.

Task

We adapt the Big Time Gravel case used previously by Kadous (2000, 2001), which is an inventory observation case. We modify the time of the incident to be more current and include our manipulations of interest (i.e., use of drones or human staff and consistency or not with industry norms) as noted above. At the start of the task, the participants were informed of necessary information about auditing in order for them to understand the task (e.g., financial statements, materiality, purpose of the audit, auditor negligence, and history and available inventory observation medium, including human staff and drones, in an audit). The legal case

is then presented; the legal context is such that an audit failure happened because the client's inventory was not adequately audited. Specifically, the hypothetical defendant audit firm used a drone (or did not, depending on the research condition) for inventory observation, and failed to identify that the client fraudulently inflated their inventory balance. In addition, we noted that most other similar-sized audit firms also have been using (or have not been using) drones for inventory observation. The client fraudulently moved inventories between their different sites, disguising to have sufficient inventory, which the audit firm failed to notice. That is, the audit failure is not related to the superiority of the inventory observation medium used at the client site; rather, it relates to whether the audit firm applied sufficient skepticism when advising the client regarding their site visits.

Participants

We recruited 200 Amazon Mechanical Turk workers who are U.S. citizens and 18 years of age or older to participate in our experiment. Amazon Mechanical Turk workers are considered a common proxy for jurors (e.g., Grenier, Lowe, Reffett, and Warne 2015; Maksymov and Nelson 2016; Brown, Grenier, Pyzoha, and Reffett 2019). The 200 participants were randomly assigned to the four research cells.

In their response to the experimental materials, 59 participants (29.5%) indicated that they have CPA qualifications; 26 participants (13.0%) indicated that they are attorneys, 21 of whom also indicated that they are CPAs. Participants with these types of professional qualifications may be more knowledgeable in issues relating to an audit failure and may offer different judgments. Robustness testing after excluding these participants did not change the statistical inferences of our results reported later. Some prior research indicates that gender, education levels, and juror experience may affect participant judgments. In our data, 123 (61.5%) of the participants indicated that they are male, 136 (68.0%) indicated that they have received at least some college education, and 55 (27.5%) indicated that they have experience

in serving as a juror. Statistical inference of our results reported later does not change after excluding the participants who have never served as a juror. We also ask whether participants have prior knowledge about drone technology and, if so, the valence of their experience with drone technology (e.g., positive vs. negative). The mean of participants' prior experience valence is 0.443, where 1 indicates positive and -1 indicates negative, suggesting that their experience with drone technology was comparatively positive in general. In addition, the extent to which participants feel positive or negative about drones from their prior experience is not significantly different across the four research conditions ($F = 1.689$; $p > 0.100$).

Process Variables

Studies about normality bias discuss that the bias may affect jurors' emotions and attribution of blame. We therefore include questions in our experimental instrument that allow measurment of jurors' emotional reactions and attribution of blame, adopting Backof's questionnaire (2015) which builds on Alicke's (2000) Culpable Control Model. These questions include participants' spontaneous affective reactions and their assessed foreseeability, causation, and intention of auditors related to the audit failure. Detail of questions and scales are listed below. We use the average of foreseeability and controllability as a mediating variable, referred to as foreseeability.[3]

Dependent Variable

Consistent with Backof's (2015) measure in the Culpable Control Model, we use jurors' assessments of auditor negligence as the dependent variable. This includes the negligent verdict, either negligent or not negligent, and the assessed likelihood of negligence, on an 11-point scale.

[3] The correlation between foreseeability and causation is statistically significant (Pearson correlation = 0.596, $p < 0.001$). Our statistical inferences reported later remain the same when we either use foreseeability or causation separately as a single mediator.

Task

Participants completed the research instruments online. Participants began by reading general information about the study. They were informed that the research task was about juror assessments of auditor liability in the case of a financial statement fraud and that they would be assuming the role of being a juror in the hypothetical lawsuit using the facts presented in the case. They were required to complete the task in one sitting and independently. They were also informed that their participation was voluntary and that individual responses would remain anonymous. Those participants who agreed to participate proceeded, and the next page asked the age and citizenship of the participants. Only those individuals who were 18 years old or older and who were U.S. citizens were allowed to proceed to the next page.

Participants then read a brief introduction about the subsequent pages that introduced accounting concepts as well as details of case facts about a lawsuit against a hypothetical accounting firm that failed to detect a fraud. They were informed that they would be provided with review questions, and that they would be allowed to proceed only if they answered all of the review questions correctly. The review questions were true/false questions relevant to the accounting concepts and the case facts, and were provided in order to encourage effortful information processing (Peercher and Piercey 2008), and we tracked the number of times participants attempted to answer these questions.

The next page introduced accounting and auditing concepts, including financial statements, materiality, purpose of the external audit process, auditor negligence, and inventory observation in audits. In terms of inventory observation in audits, the research materials described that one of the important duties of auditors is to ensure that the actual value of assets of the client are not materiality different from what is reported in the financial statements and that, traditionally, human audit staff visit the client's site in person to investigate a sample of assets, and in recent years, drones and automated counting software have also become available

for use in asset observation. Participants were also told that auditors can use a drone to capture high-quality images of the assets and process these images with an automated-counting software.

Participants then read an introduction of the case facts and a transcript from the negligence lawsuit, including the plaintiff's and defendant's opening statements, their witnesses' testimonies, and their closing statements. The case facts were adapted from Kadous' (2000) Big Time Gravel case, in which Big Time Gravel materially overstated its oil and gas inventory by double-counting the items in the sites where the audit firm did not observe. In terms of inventory observation medium, participants who were in the human staff (drone) condition read the following:

> At the end of 2017, Jones & Company completed their inspection of half of our sites, using their audit staff specifically trained (their drones specifically designed) for the inventory observation, and watched (filmed) our lot managers pace off the sizes of the piles. I think the auditors reviewed the managers' calculations afterwards.

The transcript also described whether this method was consistent with the audit industry norm at the time of the inspection. Specifically, participants in the research conditions of being consistent (inconsistent) with the audit industry norms read the following:

> The inventory observation method of using audit staff (using drones) was consistent (inconsistent) with the method being used by most other similarly-sized audit firms at the time of the inspection.

Participants were then required to select the final verdict between the auditor being negligent or not, as well as the likelihood of the auditor negligence on an 11-point scale (0 = not at all likely, 10 = extremely likely). Participants then read brief descriptions about compensatory damages and punitive damages and were asked, if they deemed the audit firm to be negligent, to indicate a dollar amount of compensatory damages and of punitive damages that they recommend be awarded to the plaintiff on 11-point scales in million-dollar increments, respectively (0 = $0 million, 10 = $10 million). The next pages included questions examining the participants' belief in factors of importance in making their negligence verdicts.

Specifically, one question asked participants to indicate the extent to which they believed it was important that the defendant auditor used an inventory observation medium that had been used in previous audits (salience), on an 11-point scale (0 = very low importance, 10 = very high importance). The other question asked participants to indicate the extent to which they believed it was important that the defendant auditor used an inventory observation medium that most other audit firms were using at the time of the audit, on an 11-point scale (0 = very low importance, 10 = very high importance).

The next few pages included questions for investigation of cognitive factors involved in the Culplable Control Model. We included questions from Backof (2015), and all questions used 11-point scales. We asked for participants' spontaneous affective reactions to the defendant auditor (0 = very negative, 10 = very positive). We also asked for participants' affective reactions to the plaintiff (0 = very negative, 10 = very positive). We also asked participants the extent to which the defendant auditor should have been able to predict the audit failure (0 = very little extent, 10 = very high extent) and the extent to which the defendant auditor should have been able to control the quality of the inventory inspection (0 = very little extent, 10 = very high extent). Additionally, we asked participants to indicate the extent to which the defendant auditor was the cause for the plaintiff's loss (0 = not at all the cause, 10 = completely the cause) and the extent to which the auditor intended to conduct a quality audit (0 = not at all intended, 10 = completely intended). And we asked about the likelihood that the auditor would have had knowledge about the fraud perpetrated by the client but chose not to report it (0 = definitely had no knowledge, 10 = definitely had knowledge). Finally, we asked participants to indicate the extent to which the defendant auditor complied with the auditing standards (0 = no compliance, 10 = full compliance).

The final section of the instrument included questions about manipulation checks. We also asked the extent to which participants were familiar with drone technology on an 11-point

scale (0 = not at all familiar, 10 = very familiar), and the nature of their knowledge about drones (1 = positive, -1 = negative). We also asked participants' gender and whether they were a CPA or an attorney, respectively. Consistent with prior research, we also requested their education levels, employment position / status, residence, and ethnicity, as well as their experience as a juror.

RESULTS

Manipulation Checks

In total, 41 participants (20.5%) failed one or both of the manipulation checks and are excluded from the analysis reported here. However, including those participants in the analysis does not change our statistical inferences reported. The remaining 159 usable responses are reasonably well balanced across experimental condition, as shown in Table 1.

INSERT TABLE 1 ABOUT HERE

Table 2 presents descriptive statistics for our key variables of interest. Notably from Table 2, on average 82% of participants deemed the defendant auditor to be negligent. Also, on average, our participants assigned a higher-than-midpoint assessment for the foreseeability of the fraud by the defendant auditor, the auditor causation for the loss, and the intention by the defendant auditor to conduct a quality audit. On average, our participants had a slightly positive spontaneous affective response to the auditor.

INSERT TABLE 2 ABOUT HERE

Tests of Hypotheses

Negligence assessments by experimental condition are reported in Table 3. The patterns of means are consistent with our expectations, in that participants on average assess higher (lower) negligent verdict percentages (Panel A) and negligence likelihoods (Panel B) when drones are used for inventory observation, if most other firms use human staff (drones) for

inventory observation at the time of the audit. The data in Table 3 suggest an interactive effect, as predicted by H1.

INSERT TABLE 3 ABOUT HERE

Specifically, recall that our H1 predicts that, in the case of an audit failure, jurors will assess higher (lower) negligence when drones are used for inventory observation, if most other firms use human staff (drones) for inventory observation at the time of the audit, compared to when human staff is used for inventory observation. That is, the difference between industry norms conditions will be more evident in the drones condition than in the human staff condition. Table 4 presents our ANOVA results, for both negligent verdict (Panel A) and negligence likelihood (Panel B) as the dependent variable. For negligent verdict, we find a statistically significant interaction effect between observation medium and consistency with industry norms (F = 3.81, one-tailed p = 0.026). We also find a significant interaction effect for negligence likelihood (F = 6.61, p = 0.006).

INSERT TABLE 4 ABOUT HERE

Separately, for negligent verdicts, we find a *negative* (but not statistically significant) simple effect of the use of drones (as compared to human staff) when consistent with the industry norms (mean values of 73% vs. 84%; t = –1.55, one-tailed p = 0.126) but a significantly *positive* effect of the use of drones (as compared to human staff) when inconsistent with the industry norms (92% vs. 79%; t = 2.00, p = 0.049). Our statistical inferences are consistent when we use negligence likelihood as the dependent variable. A statistically significant negative simple difference between the drones and human staff conditions is observed when consistent with the industry norms (6.16 vs. 7.03; t = –2.04, p = 0.045) but a positive difference when inconsistent with the industry norms (7.69 vs. 6.89; t = 2.36, p = 0.021). This means that participants assessed negligence likelihood to be higher when drones (rather than human staff) are used for asset observation and it is not the industry norm, but they

assessed higher negligence likelihood when human staff (rather than drones) are used and it is the industry norm. In short, the results support our H1

Recall that H2 predicts a mediation effect of foreseeability. Specifically, it predicts that, if drones are used rather than human staff for inventory observation, and if using drones is inconsistent (consistent) with the industry norms at the time of the audit, auditors' foreseeability over the audit failure would be assessed higher (lower) than when human staff (the traditional approach) are used, resulting in increased (decreased) negligence assessments. Our ANOVA and simple effect test results reflect data patterns consistent with this prediction. Our ANOVA results using foreseeability as the dependent variable, as presented in Table 5, indicate a statistically significant interaction effect between asset observation medium and consistency with industry norms (F = 5.68, one-tailed p = 0.009). Untabulated simple effects also show a *negative* and significant difference between the drones and human staff conditions when consistent with the industry norms (mean values of 6.32 vs. 7.11; t = –2.18, p = 0.032) but a *positive* and marginally significant difference when inconsistent with the industry norms (7.71 vs. 7.17; t = 1.91, p = 0.060).

INSERT TABLE 5 ABOUT HERE

To test our full mediated-moderation model, we use the Hayes Approach to conditional process analysis, with Model 8. The results of that analysis are presented in Table 6, for both negligent verdict (Panel A) and negligence likelihood (Panel B). Regardless of whether negligent verdict or negligence likelihood is used as the dependent variable, foreseeability is a significant positive predictor of negligence assessments; however, the interaction term is no longer significant in predicting negligence assessments. This analysis suggests that, when foreseeability is included as a mediator in the model, consistency with industry norms no longer interacts with the asset observation medium in influencing negligence assessments. This therefore reflects a full mediation of the moderation.

INSERT TABLE 6 ABOUT HERE

Figure 2 shows the standardized factor loadings for the components of our mediated-moderation model, showing again that after inclusion of foreseeability as a mediator in the model, there is no longer a significant interaction between consistency with industry norms and asset observation method in predicting negligent verdict (Panel A) or negligence likelihood (Panel B). And, consistent with H2, we observe a significant negative interaction between consistency with industry norms and asset observation method in predicting assessments of foreseeability (the mediator).

INSERT FIGURE 2 ABOUT HERE

Additional Analysis

Culpable Control Model

Prior literature indicates that normality bias and omission bias affect how jurors attribute blame. Specifically, normality bias affects jurors' attribution in that it influences jurors' assessment of the auditors' foreseeability over the audit failure. We use Alicke's (2000) Culpable Control Model to explore the specific attribution processes through which jurors attribute blame for the audit failure, which leads to their negligence assessments. Our test results show that, consistent with prior research, participants' indirect spontaneous reactions influence their assessed foreseeability, causation, and quality intention of the auditors over the audit failure, and then these factors ultimately influence their evaluations of auditor negligence. In addition, consistent with our prediction that foreseeability plays the role of the mediator between the attributes and negligence assessments, the causal link between foreseeability and negligence assessments is statistically significant. Figure 3 shows the standardized loadings for our Culpable Control Model analysis, which are generally consistent with Backof (2015) and other related studies.

INSERT FIGURE 3 ABOUT HERE

Salience of Normalcy vs. Conventionality

Our theory assumes that participants will perceive industry norms to be more salient when a less conventional practice such as drone observation is used. In our experimental materials, we asked participants the extent to which they believed that it was important for the defendant auditor to be using an inventory observation medium that most other audit firms were using at the time of the audit. The mean response was 7.09 (standard deviation = 2.015), with the response scale ranging from is 0 ("very low importance") to 5 ("moderate importance") to point is 10 ("very high importance"); this suggests that participants, on average, perceived that information about industry norms is of high importance. We also asked the extent to which they believed that it was important for the defendant auditor to be using a previously-used inventory observation medium. The mean response for this question was 6.91 (standard deviation = 2.052), with the same response scale range / labels; this suggests that participants, on average, perceived that the conventionality information is important. Notably, when drones (less conventional approach) are used, as compared to when human staff is used (more conventional approach), industry norms are perceived more importantly (t = 2.253, one-tailed p = 0.026, untabulated). This result is consistent with our theoretical assumption that, when a less conventional audit practice is used, information about industry norms becomes more salient, compared to when a more conventional audit practice is used.

Familiarity

A newer approach is less familiar and can be avoided due to unknown consequences of the approach. That is, any tendency to avoid using a newer approach might decline as familiarity with the approach increases. Alternatively, as jurors become more familiar with drone technology, and as they become more aware of accuracy and completeness benefits that the technology can bring for the audit firm, they may judge an audit failure more harshly,

thinking that the audit firm could have done better, by utilizing the technology well. As an additional analysis, we test whether familiarity with the drone technology might reduce (or increase) the negligence assessments of the jurors. Our results show a statistically significant correlation effect between familiarity and negligence likelihood (Pearson correlation = +0.23; two-tailed p = 0.003), suggesting that as familiarity with the drone technology increases, the jurors actually assess *higher* negligent likelihood. This is opposite to what we would have expected. When we re-run our statistical analyses for Hypothesis 1 and Hypothesis 2, using ANCOVA with drones familiarity as a co-variate, our statistical inferences reported earlier are unchanged. Specifically, we continue to find a significant interaction effect between asset observation medium and consistency with industry norms on negligence assessments (for negligent verdict, F = 3.66, one-tailed p = 0.029; for negligence likelihood, F = 7.09, p = 0.004) (untabulated). Also, the interaction effect between asset observation medium and consistency with industry norms on foreseeability also remains statistically significant (F = 7.16, p = 0.004) (untabulated). In short, we observe a tendency to assess higher negligence in our setting as familiarity with the drone technology increases, but our statistical inferences reported earlier remain even after including familiarity with the drone technology as a covariate in our statistical tests.

DISCUSSION

Audit firms have begun to explore the use of drones for inventory observation (PWC 2016; EY 2017). Drones can process inventory codes at much faster speeds than humans and can also navigate to certain locations that a human may have difficulty reaching. Drones also do not suffer physical fatigue or illness. Therefore, drones are particularly helpful for customers with a large quantity of inventories as well as in the circumstances in which physical visits to inventory sites may be impracticable, including when there is an onset of pandemic disease. Academics and practitioners also point towards the usefulness of drone technology in inventory

observation. However, practitioners are concerned that they may be exposed to more litigation risks if they involve a technology that has not previously been widely used.

In this study, we investigate whether and how the use of drones in an audit interacts with consistency with the audit industry norms regarding the inventory observation medium (i.e., inventory observation medium used by other audit firms), affecting jurors' negligence assessments of the auditor in the case of an audit failure. Building on the normality bias, we predict and find that, in the case of an audit failure, jurors assess higher negligence for auditors who used drones in inventory observation than those who have not, if most other audit firms have not yet adopted drone-enabled inventory observation at the time. Importantly, we predict and find that jurors also assess higher negligence for those auditors who did *not* use drones, compared to those who did, if drone-enabled inventory observation *was* the industry norm. We utilize the Culpable Control Model when investigating jurors' attribution of blame. We find that perceived foreseeability by the auditors of an audit failure is the mediating variable between the interaction between the inventory observation medium and consistency with industry norms on negligent assessments.

This study has practical implications for audit firms. Our results indicate that, while adopting drones for inventory observation may increase legal liabilities when most other audit firms have not yet adopted the technology, not adopting drones for inventory observation may also increase legal liabilities if most other audit firms have already adopted the technology. Given that our additional analysis shows that jurors' negligence assessments actually increase as familiarity with the drone technology increases, and that familiarity with this technology is likely to increase as time passes, and given that our results indicate that not adopting drones for inventory observation increases negligence assessments when most other firms have already adopted the technology, audit firms may benefit by considering using drone technology in a timely manner. This study also extends the accounting literature by investigating the effect

of adopting drones for inventory observation on juror judgments. There is a developing literature exploring the effect of using advanced technology in audits on jurors' judgments. We contribute to this line of literature by distinguishing conventionality and normalcy as associated with the use of advanced technology. It also extends the psychology literature by investigating the process through which the normality bias affects blame attribution processes by jurors, when conventionality and normalcy are distinguished.

Although not the focus of this study, our data show, surprisingly, in the research conditions in which human staff rather than drones complete the inventory observation, the effect of industry norms is not statistically significant. In our research materials, in order to maintain internal validity, and also to make sure that participants have the necessary knowledge for our experimental task, we informed all participants that traditionally human staff has completed inventory observations in an audit, whereas drones have become available in recent years. It is possible that participants considered this information more salient than the information related to industry norms, resulting in statistically insignificant results in terms of industry norm differences in the human staff condition. Prior studies often observe that industry norms affect accounting stakeholders' judgments; however, to the best of our knowledge, although the circumstances and/or contexts in which industry norms become less salient to accounting stakeholders have been observed in some research conditions in prior studies (e.g., in Kadous and Mercer (2012), the main effect of industry norms are statistically significant but comparatively less salient in the precise accounting standard research condition compared to the imprecise accounting standard condition), that issue has not yet been the focus of prior research. Given that industry norms are often used as an important comparison basis when assessing implications of accounting practices or accounting values, it would be interesting to investigate in which contexts and/or circumstances accounting stakeholders may become less sensitive to industry norms. Future research may consider investigating this issue.

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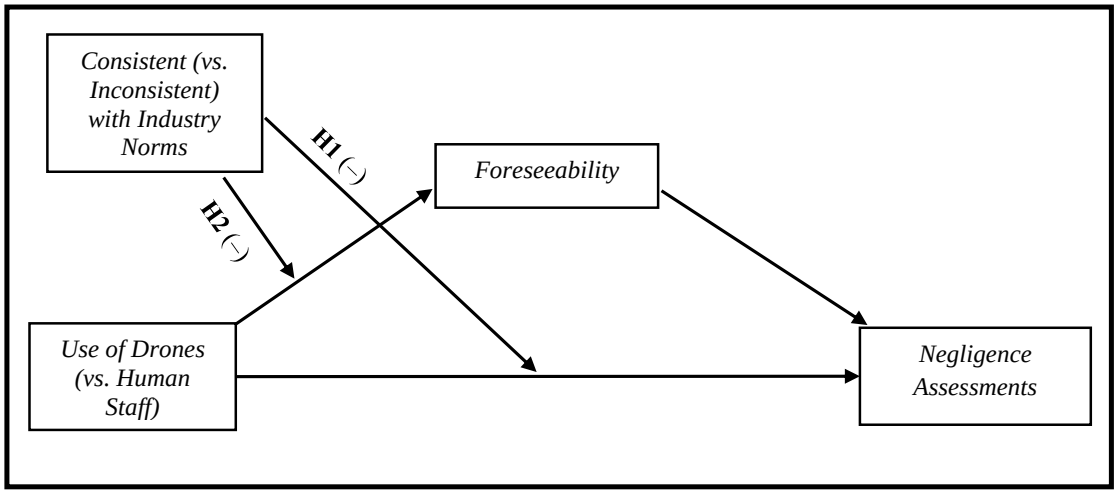
FIGURE 1
Conceptual Model for the Effect of the Use of Drones (vs. Human Staff) and Industry Norms (Consistent vs. Inconsistent) on Jurors' Negligence Assessments

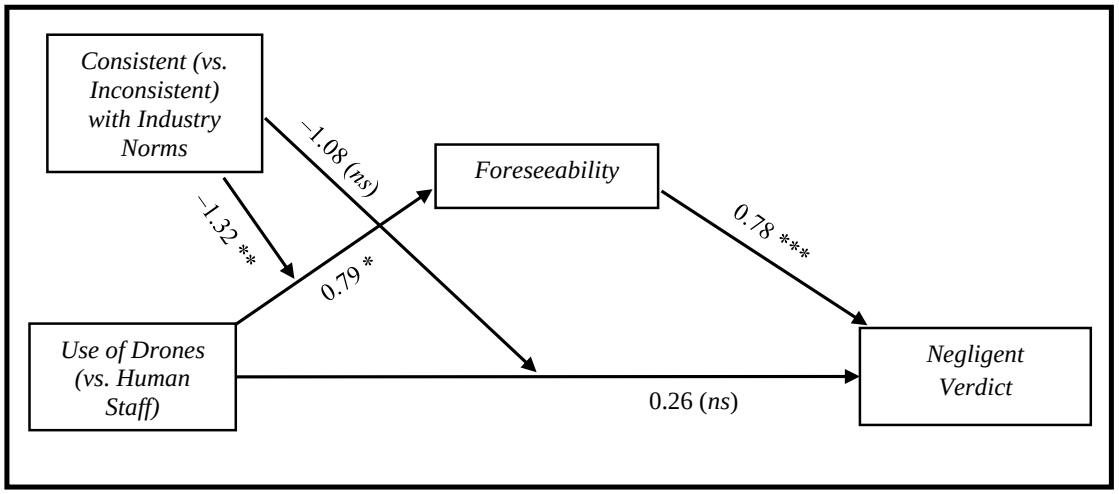


Hypothesis 1. In the case of an audit failure, jurors will assign higher (lower) negligence to the auditor if drones are used for inventory observation, if most other firms use human staff (drones) for inventory observation at the time of the audit.

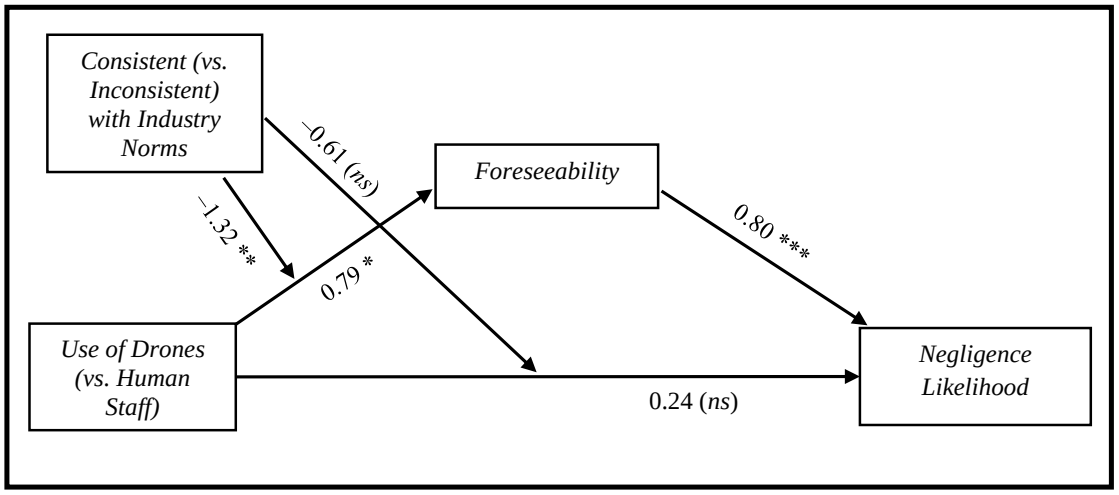
Hypothesis 2. In the case of an audit failure, if drones are used for inventory observation and use of drones is inconsistent (consistent) with the industry norms at the time of audit, auditors' foreseeability over the audit failure will be assessed higher (lower) than when human staff is used, resulting in increased (decreased) negligence assessments.

FIGURE 2
Standardized Factor Coefficients for the Mediated-Moderation Analysis (Hayes Approach, Model 8)

Panel A. Negligent Verdict

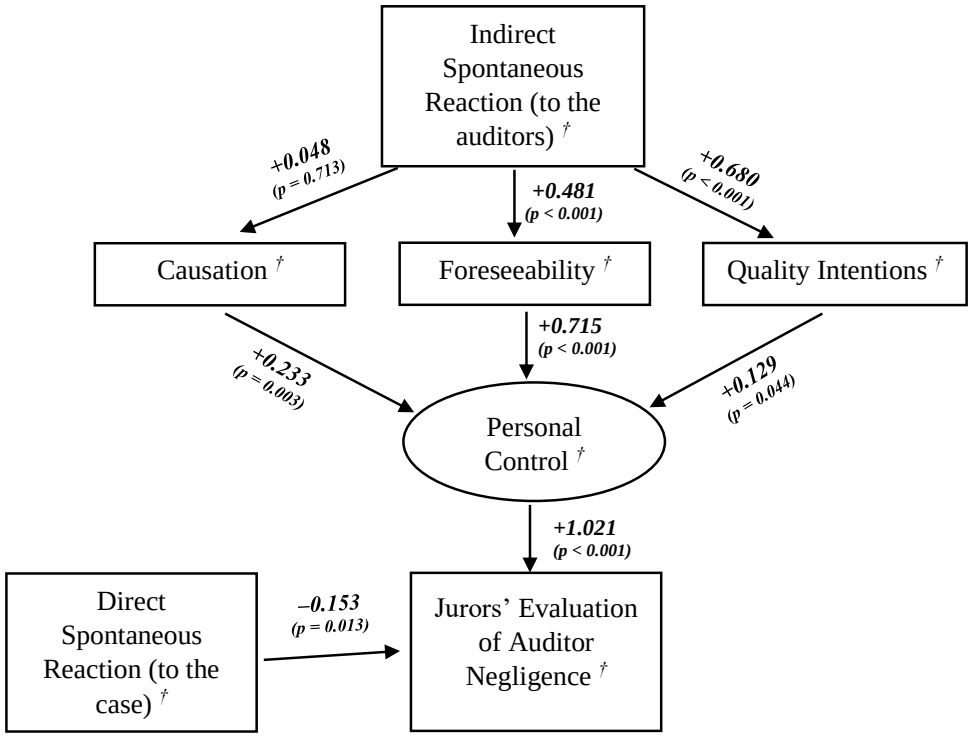


Panel B. Negligence Likelihood



*, **, *** indicates statistical significance at the 0.05, 0.01, and 0.001 levels, respectively

Figure 3
Standardized Factor Loadings for the Culpable Control Model



All reported *p*-values are based on two-tailed tests.

† *Indirect Spontaneous Reaction* (to the auditors) can vary between 0 (very negative) and 10 (very positive) and refers to the jurors' assessed feelings toward the auditors.

Causation can vary between 0 (not at all the cause) and 10 (completely the cause) and refers to the jurors' perception of the extent to which the auditors caused the audit failure.

Foreseeability can vary between 0 (very little extent foreseeable) and 10 (very high extent foreseeable) and refers to the jurors' perception of the extent to which the auditors could have foreseen the audit failure.

Intentions can vary between 0 (not at all intended) and 10 (completely intended) and refers to the jurors' perception of the extent to which the auditors intended to conduct a quality audit.

Direct Spontaneous Reaction (to the case) can vary between –10 (very pro-plaintiff) and +10 (very pro-defendant) and refers to the jurors' affective reactions to the case that directly influences the jurors' negligence verdict; it is calculated by subtracting each participant's feelings toward the plaintiff from each participant's feelings toward the audit firm.

Jurors' Evaluations of Auditor Negligence is a factor score based on auditor blameworthiness, which can vary between 0 (none of the blame) and 10 (all of the blame), and negligence likelihood, which can vary between 0 (not at all likely) and 10 (extremely likely).

TABLE 1
Usable Responses, by Experimental Condition

		Consistency with Industry Norms		
		Consistent	Inconsistent	*Total*
Asset Observation Medium	Drones	45	39	*84*
	Human Staff	37	38	*75*
	Total	*82*	*77*	***159***

TABLE 2
Descriptive Statistics for Key Variables

Variable	*Obs. (n)*	*Mean (μ)*	*Standard Deviation*	*Median*	*Min.*	*Max.*
Asset Observation Medium [a]	159	0.472	0.50	0	0	1
Consistency with Industry Norms [b]	159	0.484	0.50	0	0	1
Negligent Verdict [c]	159	81.8%	0.39	1	0	1
Negligence Likelihood [d]	159	6.912	2.09	7	0	10
Foreseeability [e]	159	7.047	1.78	7	0	10
Causation [f]	159	6.943	2.11	7	0	10
Intentions [g]	159	6.943	2.21	7	0	10
Spontaneous Affective Reaction [h]	159	6.182	2.45	6	0	10

[a] *Asset Observation Medium*, as randomly assigned, is coded as 0 for the drones condition and 1 for the human staff condition.
[b] *Consistency with Industry Norms*, as randomly assigned, is coded as 0 for the consistent condition and 1 for the inconsistent condition.
[c] *Negligent Verdict* is coded as 0 for not negligent and 1 for negligent, and then reported as a percentage.
[d] *Negligence Likelihood* can vary between 0 (not at all likely) and 10 (extremely likely).
[e] *Foreseeability* (by the auditor), as reported here, is the average of the assessment of foreseeability, which can vary between 0 (very little extent foreseeable) and 10 (very high extent foreseeable), and the assessment of controllability, which can vary between 0 (very little extent controllable) and 10 (very high extent controllable).
[f] *Causation* (by the auditor) can vary between 0 (not at all the cause) and 10 (completely the cause).
[g] *Intentions* (for a quality audit) can vary between 0 (not at all intended) and 10 (completely intended).
[h] *Spontaneous Affective Reaction* (to the auditor) can vary between 0 (very negative) and 10 (very positive).

TABLE 3
Negligence Assessments, by Experimental Condition

Panel A. Negligent Verdict [a]

Mean Values ***[Standard Deviations]***		***Consistency with Industry Norms***		
		Consistent	Inconsistent	*Total*
Asset Observation Medium	Drones	73% [*0.447*]	92% [*0.270*]	*82% [0.385]*
	Human Staff	84% [*0.374*]	79% [*0.413*]	*81% [0.392]*
	Total	*78% [0.416]*	*86% [0.352]*	***82% [0.387]***

[a] *Negligent Verdict* is coded as 0 for not negligent and 1 for negligent, and then reported as a percentage.

Panel B. Negligence Likelihood [b]

Mean Values ***[Standard Deviations]***		***Consistency with Industry Norms***		
		Consistent	Inconsistent	*Total*
Asset Observation Medium	Drones	6.16 [*2.421*]	7.69 [*1.625*]	*6.87 [2.216]*
	Human Staff	7.03 [*2.166*]	6.89 [*1.752*]	*6.96 [1.955]*
	Total	*6.55 [2.337]*	*7.30 [1.725]*	***6.91 [2.091]***

[b] *Negligence Likelihood* can vary between 0 (not at all likely) and 10 (extremely likely).

TABLE 4
ANOVA Results for Negligence Assessments (Hypothesis 1)

	Sum of Squares	Deg. of Freedom	Mean Square	*F*-Stat	*p*-Value [b]
Panel A. Negligent Verdict [a]					
Asset Observation Medium [c]	0.00	1	0.00	0.02	0.895
Consistency with Industry Norms [d]	0.23	1	0.23	1.58	0.211
Medium × *Consistency* (**H1**)	0.56	1	0.56	3.81	0.026
Error	22.91	155	0.15		
Panel B. Negligence Likelihood [e]					
	Sum of Squares	Deg. of Freedom	Mean Square	*F*-Stat	*p*-Value [b]
Asset Observation Medium [c]	0.33	1	0.33	0.08	0.779
Consistency with Industry Norms [d]	22.33	1	22.33	5.40	0.021
Medium × *Consistency* (**H1**)	27.34	1	27.34	6.61	0.006
Error	640.77	155	4.13		

[a] *Negligent Verdict* is coded as 0 for not negligent and 1 for negligent, and then reported as a percentage.
[b] Reported *p*-values are based on one-tailed tests where directional effects are predicted and two-tailed tests otherwise.
[c] *Asset Observation Medium*, as randomly assigned, is coded to 0 for the drones condition and 1 for the human staff condition.
[d] *Consistency with Industry Norms*, as randomly assigned, is coded to 0 for the consistent condition and 1 for the inconsistent condition.
[e] *Negligence Likelihood* can vary between 0 (not at all likely) and 10 (extremely likely).

TABLE 5
ANOVA Results for Foreseeability [a] (Hypothesis 2)

	Sum of Squares	Deg. of Freedom	Mean Square	*F*-Stat	*p*-Value [b]
Asset Observation Medium [c]	1.22	1	1.22	0.41	0.521
Consistency with Industry Norms [d]	23.22	1	23.22	7.85	0.006
Medium × *Consistency* (**H2**)	16.81	1	16.81	5.68	0.009
Error	458.64	155	2.96		

[a] *Foreseeability* (by the auditor), as reported here, is the average of the assessment of foreseeability, which can vary between 0 (very little extent foreseeable) and 10 (very high extent foreseeable), and the assessment of controllability, which can vary between 0 (very little extent controllable) and 10 (very high extent controllable).
[b] Reported *p*-values are based on one-tailed tests where directional effects are predicted and two-tailed tests otherwise.
[c] *Asset Observation Medium*, as randomly assigned, is coded to 0 for the drones condition and 1 for the human staff condition.
[d] *Consistency with Industry Norms*, as randomly assigned, is coded to 0 for the consistent condition and 1 for the inconsistent condition.

TABLE 6
Mediated-Moderation Analysis (Hayes Approach, Model 8)

Panel A. Negligent Verdict [a]				
	Parameter Estimate	Standard Error	*Z*-Stat	*p*-Value [b]
Intercept	–3.58	1.01	–3.55	0.004
Asset Observation Medium [c]	0.26	0.66	0.39	0.695
Consistency with Industry Norms [d]	0.51	0.77	0.67	0.504
Foreseeability [e]	0.78	0.16	4.78	< 0.001
Medium × *Consistency*	–1.08	1.01	–1.06	0.144
Panel B. Negligence Likelihood [f]				
	Parameter Estimate	Standard Error	*t*-Stat	*p*-Value [b]
Intercept	1.07	0.49	2.17	0.032
Asset Observation Medium [c]	0.24	0.34	0.71	0.477
Consistency with Industry Norms [d]	0.42	0.34	1.25	0.215
Foreseeability [e]	0.80	0.07	11.52	< 0.001
Medium × *Consistency*	–0.61	0.48	–1.25	0.106

[a] *Negligent Verdict* is coded as 0 for not negligent and 1 for negligent, and then reported as a percentage.
[b] Reported *p*-values are based on one-tailed tests where directional effects are predicted and two-tailed tests otherwise.
[c] *Asset Observation Medium*, as randomly assigned, is coded to 0 for the drones condition and 1 for the human staff condition.
[d] *Consistency with Industry Norms*, as randomly assigned, is coded to 0 for the consistent condition and 1 for the inconsistent condition.
[e] *Foreseeability* (by the auditor), as reported here, is the average of the assessment of foreseeability, which can vary between 0 (very little extent foreseeable) and 10 (very high extent foreseeable), and the assessment of controllability, which can vary between 0 (very little extent controllable) and 10 (very high extent controllable).
[f] *Negligence Likelihood* can vary between 0 (not at all likely) and 10 (extremely likely).

The complete manuscript has been removed/withdrawn in January 2023. The paper’s abstract remains in *ex ordo* and the authors will present the material at the Conference scheduled time.

COVID 19 AND THE PERFORMANCE OF RETAIL REAL ESTATE INVESTMENT TRUSTS

Abstract

The steady decline of the retail sector in the years preceding Covid-19 had already had severe consequences for the Real Estate Investment Trusts (REITs) that owned the commercial property in the malls, shopping centers, and high streets. COVID-19 only accelerated the push towards digitization of business models as consumers shifted to online shopping even more. This study benchmarks the operating performance of retail REITs on a quarterly basis to analyze the winners and losers within the retail REIT category. Based on return on assets, earnings before interest taxes, depreciation, and amortization margin, revenue growth per year, capital utilization ratio, and interest cost as a percentage of basic earning power of a retail REIT, we found that only three out of 21 retail REITs have been consistently performing well relative to their peers from September 2019 to December 2021. The study also finds that a sharp decline in return on assets, EBITDA margin, and revenue growth started in March 2020 and bottomed out in June 2020.

Keywords: real estate investment trusts (REITs), benchmarking, data envelopment analysis,

COVID 19 AND THE PERFORMANCE OF RETAIL REAL ESTATE INVESTMENT TRUSTS

I. INTRODUCTION

Data envelopment analysis (DEA) is a linear programming technique to evaluate the relative performance of an organization. Historically, the main applications of DEA have been in the evaluation of not-for-profit organizations. However, this technique can also be successfully applied to other applications that involve cost benefit analysis and multi-criteria decision making. In fact, DEA has emerged as a powerful quantitative, analytical tool for measuring and evaluating the performance of a business entity. Recently, many researchers have successfully applied DEA to different types of entities engaged in a wide variety of activities in many contexts worldwide. DEA is a generic

tool used to measure the relative efficiency of homogeneous decision-making units (DMUs). DEA models usually deal with crisp data and do not assume any mappings between the inputs and outputs. DEA is best suited for applications that involve multiple inputs and outputs that can contribute to the overall efficiency of a given DMU. Further, the DEA model does not assume any functional form and the inputs and outputs directly measure the relative efficiency of a unit within the industry. In fact, DEA is most suited for this particular class of evaluation as the modeling technique does not require any specific functional form while making allowances for factors contributing to the overall efficiency of a given unit. Further, DEA identifies efficient and inefficient units in a given framework where the performance evaluation results are considered in their pertinent context, i.e. standing amongst all the units considered for evaluation. Furthermore, DEA compares each inefficient unit with a specific set of efficient units called the "peer group." Thus, the "peer group" can serve as role-model units as they are identical with the units under analysis. Hence, a given business entity can study these role-model (comparable units) to identify the success factors that can improve their efficiency. In addition, DEA is preferable to other methods, such as regression analysis or other multi criteria decision-making models as they contextualize results. The DEA models can also easily incorporate the scale efficiencies that can be particular helpful in studying the economies of scale for a given business entity. The details of the DEA modeling are presented in section iv. In recent times, COVID has been a major factor that impacted every industry. Given, DEA modeling's ability to provide a contextual efficiency analysis of a business entity within the industry, this technique should be an integral part of a firm's business intelligence and

analytics model. This study illustrates the use of DEA as a novel business intelligence modeling tool for retail real estate investment trusts (REITs). This study develops a decision support system using data envelopment analysis (DEA) modeling to study the performance efficiency of the retail REIT sector, and develop a business intelligence tool for decision-makers

Retail real estate investment trusts (REITs) own and manage retail real estate and rent out space in those properties to tenants. Retail REITs are REITs that concentrate on large regional malls, outlet centers, grocery-anchored shopping centers, and power centers with big box retailers. Net lease REITs own freestanding properties and structure leases so that tenants pay both rent and most of a property's operating expenses. The Covid-19 outbreak, and subsequent lockdown affected REITs severely in 2020, with the SNL U.S. REIT equities index total return down 7.5 percent in 2020, trailing the S&P 500's total return of 16.3 percent. Hotel and retail REITs (both down 30%) were the worst performers, as hotels and retail stores were shut down, but office REITs also underperformed (down 22.5 percent). Covid-19 may have been the deciding factor in the demise of many shopping malls. There was an increase in retail store closures prior to the Covid-19 outbreak and saw shopping malls as particularly vulnerable due to ongoing anchor issues, which had resulted in reduced cash flow and increased capital expenditure needs. The coronavirus has only exacerbated these issues, as nearly all malls have been forced to close.

In this study, the quarterly operational results of retail REITs are benchmarked. This research is crucial for a number of reasons. First of all, although several studies have examined the efficiency of REITs in general, relatively little research has been published

on the performance of retail REITs in particular. There will be more focus on retail REITs as e-commerce-driven internet retailing becomes the new standard. As a result, analyzing and comprehending the performance of retail REITs may help investors make wiser financial choices.

Second, the S&P 1500 index divides real estate investment trusts (REITs) into nine subcategories, with retail REITs making up the biggest subcategory and accounting for 25.7% of the industry's capitalization. Studying the performance of retail REITs is crucial given the significance of retail REITs within the REIT sector.

Third, the REITs business is controlled by a few large firms. The ten biggest retail real estate investment trusts (REITs) in the United States have a combined market value of about 122 billion US dollars as of May 2021. With almost 40.2 billion US dollars in outstanding shares of stock, Simon Property Group was the biggest REIT by market capitalizatio. (S&P Survey 2021). As a result, it is critical to investigate the relative performance of retail REITs, a sector dominated by huge corporations and experiencing considerable transition as a result of e-commerce.

By analyzing their relative performance, this study distinguishes between retail REITs that are more efficient and those that are less efficient or inefficient. As far as we know, there hasn't been any research done exclusively on retail REITs. Therefore, this research contributes to the body of literature by examining the relative performance of retail REITs, a significant part of the US financial markets, and the REIT sector. As a consequence, this study evaluates the performance of retail REITs from September 2019 to December 2021. We compare a REIT's performance to that of its industry peers as well as to its own historical performance.

II. PREVIOUS STUDIES

The Data Envelopment Analysis (DEA), a non-parametric method, has been shown to be useful in examining many elements of business organizations in several recent studies. DEA has traditionally been used to compare the efficiency of homogenous operational units such as schools, hospitals, utility enterprises, sales outlets, prisons, and military operations, in contrast to other methodologies. This section assesses the current research in the literature that have used DEA to investigate REITs. The literature review may be divided into two categories: studies that focus on REIT performance and studies that analyze REITs using data envelopment analysis**.** From 1995 through 2006, Anderson, Benefield, and Hurst (2015) investigated the impact of property type diversity in equity real estate investment trusts. They discovered high correlations between property type diversification and return on assets, return on equity, and Tobin's Q. Brounen and de Koning (2012) presented an analysis of the emergence and performance of real estate investment trusts (REITs). They discovered that typical asset pricing models are now more suited to explaining REIT stock price swings. They also stated that over the last decade, REIT stock outperformance has been strongest in Europe and has been favorably connected to company size, property level, specialized type, and geographic portfolio emphasis. Hardin, Hill, and Hopper (2009) discovered that real estate investment trusts (REITs)-owned and managed multifamily buildings generated higher effective rents at the property level than non-REIT-owned properties. In the market investigated, REIT property level performance outperformed non-REIT property level performance after correcting for favorable operational size and brand impacts.

Lewis, Springer, and Anderson (2003) used stochastic frontier methods to examine the cost efficiencies of real estate investment trust funds. Anderson and Springer (2003) created a set of selection and portfolio creation criteria based on REIT operational efficiency and price to net asset value. Devaney and Weber (2005) characterized REIT performance as a manufacturing process in which each REIT generates a desired output (return) and an undesirable output (risk) using managerial technology inputs that differ considerably from one that integrates risk. They also discovered that market value is negatively associated to inefficiency while being strongly connected to leverage. Anderson, Fok, Springer, and Webb (2002) used data envelopment analysis to calculate technical efficiency and economies of scale for real estate investment trusts. They discovered that REITs are technically inefficient, with technical inefficiencies caused by both poor input utilization and an inability to function at constant returns of scale.

III. DATA ENVELOPEMENT ANALYSIS MODEL

Data envelopment analysis (DEA) is a linear programming methodology developed by Charnes, Cooper, and Rhodes (1978). DEA is a non-parametric technique that empirically quantifies the relative efficiency of a finite number of entities called decision-making units (DMUs) such as companies, hospitals, banks, countries or in general some kind of policy-making units (PMU). A DMU/PMU is a homogenous entity that transforms inputs into outputs. Typically, all DMUs work with a similar set of inputs and outputs. However, the DMUs might be working differently to combine inputs to generate outputs. Further, all DMUs deal with their own specific set of internal and external factors that impact each DMUs performance as well as productivity potential. The objective of DEA is to apply a systematic analytical methodology using multiple inputs and outputs to provide a relative

assessment of a unit's efficiency. These relative efficiency scores can serve as an operational benchmark for each DMU. Furthermore, the DEA model's non-parametric procedure only uses the data observations and the basic assumptions necessary for optimization to derive relative efficiency scores. The DEA model offers a comprehensive assessment of a DMU's efficiency using all the factors that affect a unit's performance. All the efficient units that use resources most optimally are deemed 100% efficient and the others receive a lower score.

The basic premise of DEA methodology is to identify comparative inputs and outputs of DMUs or PMUs. The analyst can easily identify inputs as variables that should be minimized while outputs as parameters that should be maximized to gain maximum efficiency. The DEA model does not need any specifications of costs of the inputs or outputs. DEA is a benchmarking tool that calculates the relative efficiency of the DMU/PMU using the ratios of inputs and outputs. DEA calculates an efficiency score – ratio of virtual outputs and virtual inputs in accordance with the Charnes-Cooper or Banker-Charnes-Cooper model. The most efficient DMUs/PMUs get an efficiency score of 1. They are called frontier points whose virtual inputs and virtual outputs (as per the DEA model) are equal. These 100% efficient units are on the efficiency frontier. Seiford and Thrall (1990) describe the efficiency frontier as a piece-wise linear surface that envelopes all the data points. The inefficient DMUs are below the effectiveness frontier as their virtual output falls short of virtual input. The frontier points are also called "benchmarks" or "best practice" DMUs/PMUs. Further, the DEA model can discriminate between efficient and inefficient units and recommend feasible improvements for any efficient unit's operational performance. The efficiency frontier envelopes all the units, hence defining the production

possibility set. Thus, the efficiency frontier presents a standard of best achievable performance, and frontier units are a threshold to measure the performance of the inefficient units. In addition, the frontier units exhibit full capacity output given the level of fixed inputs, hence a threshold or a best practice to compare the performance of an inefficient unit. The DEA model projects each inefficient unit radially on the efficiency frontier using a formulated model to calculate the maximal improvement to inputs and/or outputs (stepping up outputs / contracting inputs in the same proportion) (Cooper et. al. 2007, 2011). Thus, one or more frontier units are part of the reference set of all DMUs. Further, being a best practice/benchmark unit, the frontier points serve as their own reference set. However, the inefficient units, behind the frontier, can identify a best practice point on the frontier that is a linear combination of the reference set.

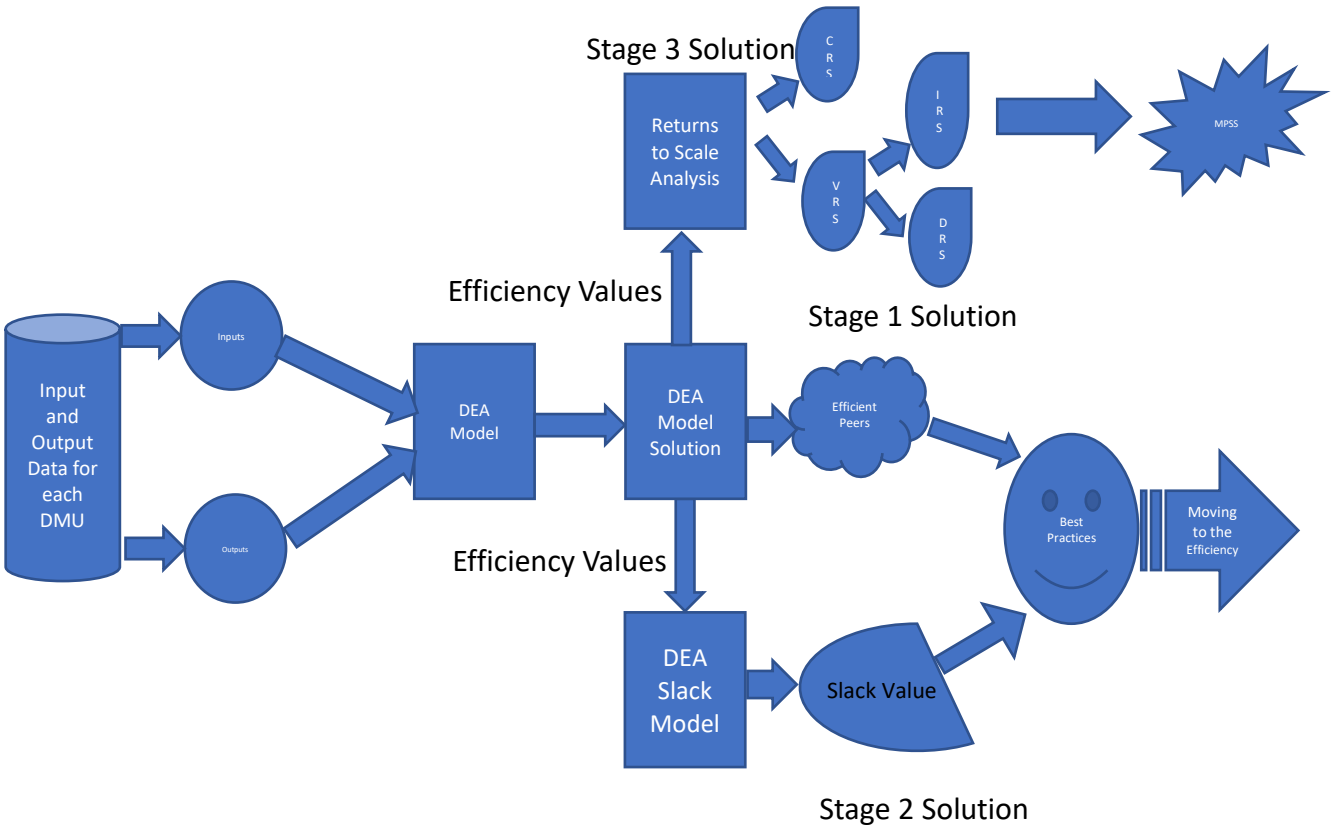
An inefficient unit's reference set, also called "peers" are the corner points of the current frontier facet, hence, most directly comparable to calculate the inefficient DMU's efficiency rating. Thus, the reference set can provide an insight into why the unit is underperforming and investigate areas of weakness. Although, the reference set constitutes of all efficient units having the most similar input/output orientation, however, all reference sets are not equal contributors in the DEA modeling to determine the inefficient unit's target values. The DEA model gives weights to all the "peers" adding up to 1 or 100% showing the contribution of a reference set unit in percentage terms. Thus, the reference set unit with the highest percentage has the largest contribution, subsequently followed by units having lower weights with decreasing contributions. To develop a strategy to improve their unit's performance, an inefficient unit's management can study the policies of their "peer" units with highest contributions. If a specific reference set unit

of an inefficient branch predominates with a very high weight (percentage), then we should use this "peer" as the main benchmark for the inefficient branch. Likewise, if an inefficient unit's reference set has two efficient units with comparable weights, then we should use both units as a reference point. Thus, the reference set of an inefficient unit enables decision makers to understand factors leading to the unit's under-performance and the major areas of weakness.

The DEA model calculates the radial distance (shortfall) to the frontier for each non-frontier (inefficient) unit to determine scope for possible improvements. Besides allocating an efficiency score, the DEA methodology also provides "slack" values (the contraction of inputs or expansion of outputs) for inefficient units to reach the frontier. Further, the model also assesses slack values for an efficient unit that can move up on the efficiency frontier to further improve productivity. Thus, the model can enable decision-makers to set targets as they devise policies to improve performance. Figure 1 illustrates the steps involved in the DEA modeling process. The DEA model uses a given set of inputs and outputs, typically non-negative values to determine virtual inputs and outputs. In addition, sometimes the modeler changes the scale of the inputs or outputs to make the entire data set more comparable. The DEA model uses a non-parametric and basic assumptions of linear programming (as illustrated below) to calculate an efficiency score for each DMU. Further, the model works in three stages. In stage 1, the DEA methodology finds peers for each inefficient unit and calculates their respective weights. As explained above, the decision maker can investigate the best practices of the most predominant peer(s). In stage 2, the DEA methodology uses the given efficiency scores to calculate the slack values or target (benchmark) values that can make these inefficient units efficient by placing them

on the efficiency frontier. In stage 3, the DEA model uses scale efficiencies by comparing CRS and VRS efficiencies to determine IRS and DRS economies of scale. We also use the scale efficiencies to calculate the most productive scale size. The details of scale efficiencies are discussed below.

Figure 1: THE DEA MODELING STEPS



Finally, the DEA methodology can use different DEA models depending on the requirements of the study. We can select DEA models depending on a given set of technical features such as model orientation (input or output), model metric (radial or non-radial), and production possibility set display (CRS, DRS, IRS, or VRS). Using model-orientation, DEA model has three variants: input-oriented, output-oriented, and non-oriented (Cooper et. al., 2007). The traditional input-oriented and output-oriented determine the efficient

projection path to the envelopment surface (Charnes et. al., 1995). The production process of a firm directs the selection of input or output orientation. The objective of input-oriented model is to minimize the use of inputs to produce a given level of outputs. On the other hand, the output-oriented model seeks to maximize the level of outputs given the level of inputs. The non-oriented model uses non-radial measures of efficiency and seeks both an increase in outputs and a decrease in inputs simultaneously. Thus, the efficiency measure does not preserve the input-output mix in the efficiency score. Using the model metrics, there are two DEA variants: radial and non-radial models. Radial models apply CCR model (Charnes, et. al, 1978) using proportional changes in the level of inputs or outputs. Alternately, non-radial models such as slack-based measure (SBM) of efficiency uses slacks for each input or output as opposed to proportional changes in variables (Tone, 2001).

The generalized version of various DEA models that we use in this study is listed in Table 1.[1]

Table 1: Generalized DEA Models (Zhu, 2003)

Frontier	Type	Input-Oriented	Output-Oriented
		$\text{Min } \theta - \varepsilon(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+)$	$\text{Max } \phi - \varepsilon(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+)$
		Subject to	
		$\sum_{i=1}^{n} \lambda_j x_{ij} + s_i^- = \theta x_{io}$ $i=1,2,...,m$	$\sum_{i=1}^{n} \lambda_j x_{ij} + s_i^- = x_{io}$ $i=1,2,...,m$

[1] There are multiple versions of the DEA model. For more details on the two-stage DEA model refer to Zhu (2003).

$$\text{CRS} \quad \sum_{j=1}^{n} \lambda_j x_{jj} + s_i^+ = y_{iro}\ r=1,2,\ldots,s\ ; \qquad \sum_{j=1}^{n} \lambda_j y_{rj} + s_r^+ = \phi y_{ro}\ r=1,2,\ldots,s$$

$$\lambda_j \geq 0,\ j=1,2,\ldots n \qquad \lambda j \geq 0,\ j=1,2,\ldots n;$$

$$\text{VRS: Add } \sum_{j=1}^{n} \lambda_j = 1;\ \text{NIRS: Add } \sum_{j=1}^{n} \lambda_j \leq 1;\ \text{NDRS: Add } \sum_{j=1}^{n} \lambda_j \geq 1$$

Where s are the slack variables; x represents input variables; y represents output variables; λ is a scalar factor, and θ and ϕ represent efficiency score of a DMU. In addition, CRS is constant returns to scale, VRS is variable returns to scale, NIRS is non-increasing returns to scale, and NDRS refers to non-decreasing returns to scale2. Zhu (2003) shows that we can explore RTS by calculating the efficiency scores in empirical applications using the following theorem:

The CRS efficiency score is equal to the VRS efficiency score if and only if CRS prevail on DMUo.

$\sum_{j=1}^{n} \lambda_j^* < 1$ if and only if IRS prevail on DMUo.

$\sum_{j=1}^{n} \lambda_j^* > 1$ if and only if DRS prevail on DMUo.

where λ_j^* *is the alternate optima.*

[2] The original CCR (Charnes, Cooper, and Rhodes) Model is Constant Returns to Scale. It is built on the assumption that if an activity (x, y) is feasible, then, for every positive scalar t, the activity (tx, ty) is also feasible. Thus, we can scale the inputs and outputs linearly without increasing or decreasing efficiency. Non-Decreasing Returns to Scale implies that changing all inputs by the same proportion changes the output by a greater extent than the proportional value. Similarly, in Non-Increasing Returns to Scale scaling up is interdicted, while scaling down is permitted. Variable Returns to Scale combines these three possibilities – NDRS, CRS, and NIRS for different ranges of output.

Further, using the concept of the most productive scale size (MPSS) (Banker, 1984), we can write a linear program for a given unique scale efficient target. As illustrated by Zhu (2003), consider the following input-oriented CRS envelopment model.

Min $\sum_{j=1}^{n} \lambda_j^*$

subject to

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta^* x_{io}, \; i = 1,\ldots,m$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{ro}, \; r = 1,\ldots,s \qquad (1)$$

$\lambda_j \geq 0$,

where θ^* is the input-oriented CRS efficiency score.

Based on the optimal solution for (2) (i.e., $\sum_{j=1}^{n} \lambda_j^*$), we can find the scale-efficient, largest MPSS target value for a DMUo using the following values:

$\text{MPSS}_{\max}$: $x_{io}^T = \theta^* x_{io} / \sum_{j=1}^{n} \lambda_j^*$

$$y_{io}^T = y_{ro} / \sum_{j=1}^{n} \lambda_j^* \qquad (3)$$

As illustrated above, we should also consider multiple factors while applying the DEA methodology. These factors relate to the choice of the DMUs for a given DEA application, selection of inputs and outputs, choice of DMUs for a given DEA application, selection of inputs and outputs, choice of a particular DEA model (e.g. CRS, VRS, etc.) for a given application, and choice of an appropriate sensitivity analysis procedure (Ramanathan, 2003). Further, as DEA is a non-parametric technique, the DEA literature does not offer

any standard specification search strategy. However, the quality of the analysis depends on the choice of the inputs/outputs included in the DEA model. The selection of DMUs depends on two main factors – homogeneity and the number of DMUs. The basic premise of homogeneity is a critical assumption. We should consider DMUs that are homogenous in every respect and perform similar tasks, and accomplish similar objectives. In our study, we can consider retail REITs as homogenous as they compete with each other in the same industry. Furthermore, another important consideration is the total number of DMUs used by the DEA model. The number of DMUs should be reasonable enough to span a wide arena of units including high performance units and underperforming units. In addition, a wide span of DMUs enables the DEA model to capture the relation between inputs and outputs. Some simple rules of thumb exist in the literature that guide the selection of inputs and outputs, and the number of participating DMUs3. In our study, the relationship among these firms is an important consideration as they all pertain to the retail sector of the EITS in real estate industry. Therefore, we select the envelopment models for our analysis. Further, we should also choose, whether to use input-orientation or output-orientation for the DEA model. Typically, an analyst should choose the input-orientation

[3]The following are the guidelines for DMU model selection:

a. The number of DMUs is expected to be larger than the product of number of inputs and outputs (Darrat et. Al., 2002; Avkiran, 2001) to discriminate effectively between efficient and inefficient DMUs. The sample size should be at least 2 or 3 times larger than the sum of the number of inputs and outputs (Ramanathan, 2003).
b. The criteria for selection of inputs and outputs are also quite subjective. A DEA study should start with an exhaustive, mutual list of inputs and outputs that are considered relevant for the study. Screening inputs and outputs can be quite quantitative (e.g. statistical) or qualitative that are simply judgmental, use expert advice, or use methods such as analytical hierarchy process (Saaty, 1980). Typically inputs are the resources utilized by the DMUs or condition affecting the performance of DMUs. On the other hand, outputs are the benefits generated as a result of the operation of the DMUs, and records higher performance in terms of efficiency. Typically, we should restrict the total number of inputs and outputs to a reasonable level. As the number of inputs and outputs to a reasonable level. (Ramanathan, 2003).

versus output-orientation depending on whether there is more control over inputs versus outputs. Alternatively, the decision maker should also determine if the focus of the study is to maximize outputs (output-orientation) or minimize inputs (input-orientation).

IV. DATA

To evaluate the performance of retail real estate investment trusts, we looked at five financial measures calculated by using data from their income statements and balance sheets. The EBITDA percentage margin (EBITDA), return on assets (ROA), revenue growth per year, interest as a percentage of earnings before interest and taxes (EBIT, and the capital efficiency ratio are used in the DEA model.

This collection of ratios is frequently used by financial analysts to analyze a company's financial performance. For this study, we used Standard & Poor Net Advantage's quarterly financial statement data from September 2019 to December 2021. A list of the 21 retail Real Estate Investments Trusts included in this study is presented in Appendix 1. The five financial measures are below:

1. ***Earnings before Interest, Taxes, Depreciation, and Amortization percentage margin (EBITDA)***--EBITDA is a metric used to assess a company's operational success. Essentially, it is a method of assessing a company's performance without taking into consideration the influence of financing decisions, accounting decisions, or tax conditions.

2. ***Interest as a %age of earnings before interest and taxes***--The interest coverage ratio measures how readily a corporation can pay interest on existing debt. The ratio is computed by dividing a company's profits before interest and taxes (EBIT) for the same period by its interest expenditures. We use interest a percentage of EBIT to examine the interest burden of an REIT based its basic earning power.

3. ***Return on Assets (ROA***) is a statistic used to evaluate the efficacy of use of assets in making a profit. Return on assets is a tool used by managers and financial analysts to determine how effectively a company is using its resources to make a profit. When a firm's ROA rises over time, it indicates that the company is squeezing more profits out of each dollar it owns in assets. Conversely, a declining ROA suggests a company has made bad investments, is spending too much money and may be headed for trouble.

4. ***Capital Consumption per Dollar of Revenue Ratio*** of a company uses the contribution of a company's capital to generate revenue for its shareholders as a measure of a company's efficiency. The ratio of how much a corporation spends on generating revenue vs how much it receives in return is known as capital efficiency. Capital efficiency, at its most basic level, is a measure of how efficiently a company uses its cash to function and produce more efficient measures. Furthermore, investors should examine this ratio on a regular basis to ensure that assets are being used properly and that income is increasing at a healthy rate. This ratio is calculated by dividing a company's total assets by its revenues. A higher ratio shows that a firm uses more total assets per dollar of revenue produced, whereas a lower ratio suggests that a company uses fewer total assets per dollar of revenue earned. As a result, a smaller ratio indicates that revenue can be generated with fewer resources. As a result, the capital efficiency ratio should be used as an input variable that should be minimized.

5. ***Revenue growth per year*** is a measure of a company's revenue growth over the previous year.

V. METHODOLOGY

We begin our analysis by examining the data used in this study. Figure 1a to 1e shows the trends in quarterly return on assets, EBITDA margin, total asset turnover ratio, times interest covered ratio, and revenue growth over the previous year for each quarter from September 2019 to December 2021. Figure 1a shows that return on assets declines sharply for retail REITs in March 2020 and continued the downward trend till it bottomed out in June 2020. EBITDA margin mirrored return on assets and plunged in June 2020. Revenue growth took a sharp downward trend in March 2020 and bottomed out in June 2020 before starting an upward trend. Revenue growth started a sharp upward trend when vaccination against COVID-19 started in January 2021. Interest expense as a percentage of EBIT reached its highest level in June 2020 due to a significant decline in the basic earning power of retail REITs. After June 2020, interest expense as a percentage of EBIT has trended downward before it stabilized at around 40% of the EBIT.

<Insert Figures 1a to 1e>

VI. EMPIRICAL ANALYSIS

Because each retail REIT is a homogeneous unit, we use the DEA technique to generate and compare efficiency ratings on a scale of 1 to 100 for each DMU. We examined and evaluated the efficiency of 21 REITs using quarterly ratios from September 2019 to December 2021. The efficiency scores for 21 retail REITs are summarized in Table 2.

<Insert Table 2 about here>

Table 2 shows that, on average, only three retail REITs have been 100% efficient relative to their peers during the sample period of September 2019 to December 2021. Based on return on assets, earnings before interest, taxes, depreciation, and amortization, revenue growth over the previous year, capital efficiency ratio, and interest as a percentage

of earnings before interest and taxes, only NNN, O, and RPG are 100% efficient relative to their 18 other peers in the retail REIT category. ADC is the least efficient retail REIT with an efficiency score of 64% followed closely by RPT and UBA with an efficiency score of 65%. In September 2019, 6 (ADC, NNN, O, SPG, SKT, and UBA) out of 21 retail REITs were 100% efficient relative to their peers. In December 2019 and March 2020, 5 (ADC, NNN, O, SPG, and SKT) out of 21 are 100% efficient. In June 2020, at the peak of the COVID-19 induced lockdowns and closures, 6 out of 21 retail REITs are 100% efficient relative to their peers, but some of the REITs who were efficient are no longer efficient in June 2020. In June 2020, 100% efficiency relative to their peers is exhibited by ADC, GTY, NNN, O, BFS, and SPG. Performance of retail REITs recovered in September 2021 and there are 10 retail REITs with 100% efficiency. In December 2021, there are 8 REITs that are 100% efficient relative to their peers.

Table 3 ranks retail REITs based on their average efficiency scores for the quarters September 2019 to December 2021.

<Insert Table 3 about here>

Table 3 shows that retail REIT rankings differed on a quarterly basis, with the exception of NNN, O, and SPG, which consistently outperformed peers throughout the sample period. All other retail REITs continued to move up the rankings year after year. The wide disparity in the efficiency scores of different real estate investment trusts demonstrated management skill, as some are significantly more efficient than others.

In addition, we ranked each of the 21 retail REITs based on their performance index. Over the sample period of September 2019 to December 2021, the performance index for each REIT was calculated by dividing the standard deviation of efficiency scores by the

average efficiency score for each REIT. The REIT with the lowest performance index score was the most efficient because it had the lowest coefficient of variation in efficiency scores per unit of efficiency score. Table 4 summarizes rankings for REITs based on a REIT's performance index from September 2019 to December 2021. Based on the mean efficiency score and standard deviation, we calculated the performance index for each REIT as standard deviation divided by mean efficiency score.

<Insert Table 4 about here>

According to the performance index, the most efficient REITs have been NNN, O, and SPG, because they have a performance index score of 0, indicating that they have consistently performed 100% efficiently in comparison to their peers. ROIC, BRX, GTY, WSR, BFS, RPT, FRT, and OHI are also not far behind in terms of performance index although they are not 100% efficient. AKR is the least efficient REIT, with a performance index of 0.30, followed by UE, which has a score of 0.0.28.

VII. SUMMARY AND CONCLUSIONS

Prior to the discovery and spread of the new coronavirus, and the ensuing economic shutdown, enclosed shopping malls had been struggling for years, beginning with the weaker operators, and moving to the "Class A" operators as well. With the limits in place to help prevent the spread of the virus, nearly all retail malls were ordered to close or partially down, forcing their tenants to do the same. This study benchmarked the performance of retail REITs on a quarterly basis from September 2019 to December 2021. It covers the COVID-19 induced lockdowns. We found that, on average, retail REITs performance was showing a declining trend even before COVID-19. COVID-19 only accelerated the decline in ROA and EBITDA margin. ROA and EBITDA hit rock bottom in

June 2020. ROA and EBITDA margin started rising after June 2020, but it is still below the levels of September 2019. We also found that some retail REITs have performed worse than their peers before and during the pandemic. Only three retail REITs have consistently performed better than their peers.

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The complete manuscript has been removed/withdrawn in January 2023. The paper’s abstract remains in *ex ordo* and the authors will present the material at the Conference scheduled time.

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FACTORS AFFECTING AIRLINERS' DECISION OF PURCHASING AIRPLANES

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ABSTRACT

Purchasing airplane is one of the most critical decisions in managing and operating airline companies. The emergence of more interconnected global economies and the expansion of international business operations have led to a steady increase in travel demand after the COVID-19 pandemic. Each airplane purchase includes a sizeable amount of money and consideration. With a clear plan and purchasing strategy, airline companies can buy the ideal range of airplanes for their size and operating requirements. However, if airline companies buy their fleet without a solid strategy, these expensive airplanes will become a financial burden to them. To create a solid airplane purchasing strategy, it is beneficial for airline company leaders to understand the differences between two largest manufacturers of commercial airplanes—Boeing and Airbus. Therefore, the purpose of this paper is twofold. First, it provides a brief comparison between Boeing and Airbus in terms of airplane's operational philosophy including control systems and cockpit differences. Second, the paper discusses the significant elements influencing airline company's airplane purchasing practices. This paper can assist airline companies and airplane manufacturers in making effective decisions regarding their airplane purchasing strategies and policies.

Keywords: Boeing, Airbus, Aircraft purchasing strategy and policy, Airline management

INTRODUCTION

The American economy hugely benefits from the aviation sector. According to the website [3], commercial aviation represented 5% of the US GDP (equivalent to $1.25 trillion) in 2022. Furthermore, before the COVID-19 pandemic, US airline companies operated 28,000 flights to more than 800 airports in 80 countries, carrying more than 58,000 tons of cargo daily and connecting 2.5 million passengers [3]. The big four airline companies (American, Southwest, Delta, and United) held a 66% market share of domestic US carriers in 2021 [25]. Southwest Airlines, which only operates Boeing 737 and has 700 airplanes, accounted for 17.4% of the domestic market share in 2021 [25]. Southwest is also the sole low-cost carrier among the big four. As we can see, Southwest Airlines' airplane purchasing strategies have made it an indispensable player in the American aviation market. The Airline Deregulation Act of 1978 is a significant advancement for the US aviation sector since it allows airlines to set ticket prices without massive limitations. The opening of the skies also allowed airline companies to develop new routes. After the Airline Deregulation Act, low-cost airlines emerged and competed with legacy airlines. Passengers could choose from an increasing number of airlines and destinations. Eventually, airlines experienced a rapid expansion and decided to grow their fleet. Since the deregulation, airplane fares have decreased by 44.9%,

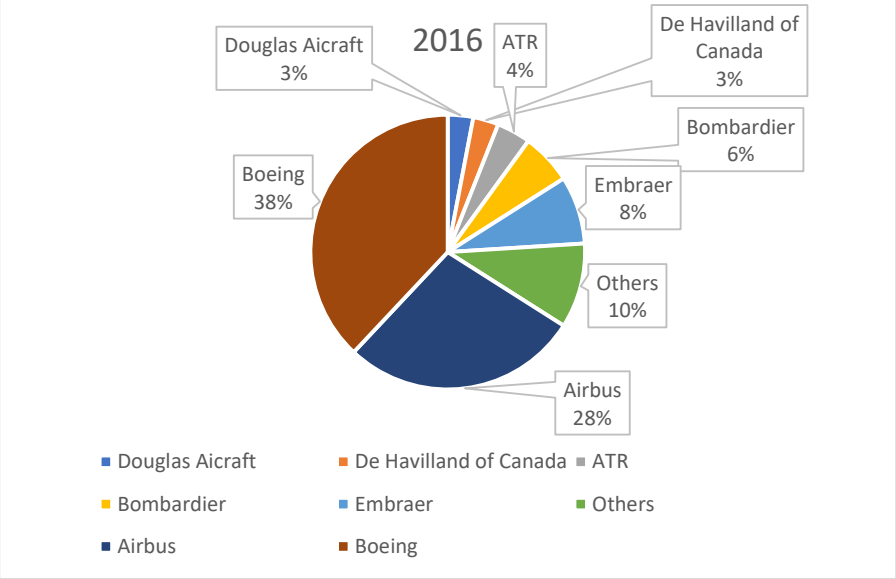
while the demand for air travel has significantly increased, according to an article from *Econlib*--The Library of Economics and Liberty [28].

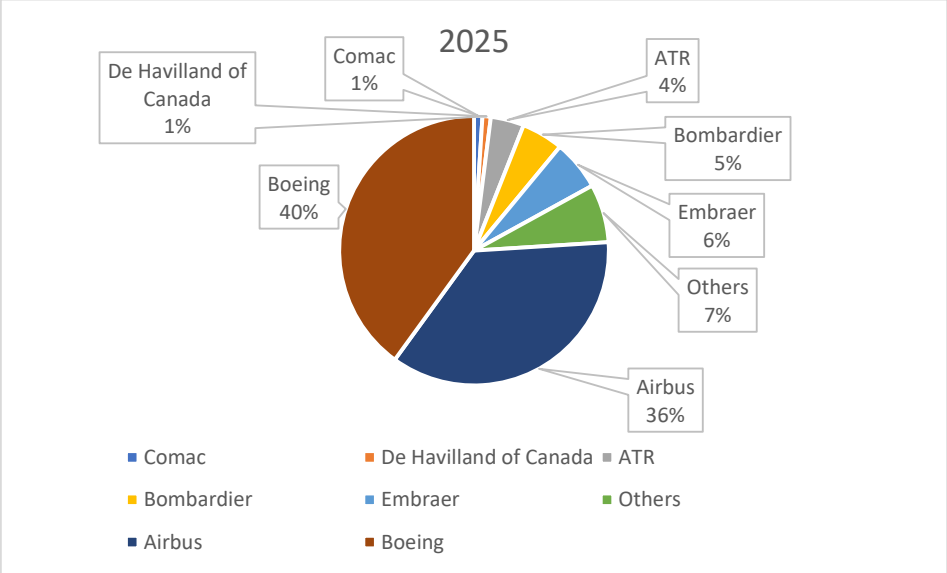
Despite enjoying a tremendous growth in air travel, airline companies must also consider unexpected occasions and be prepared to successfully handle these situations. For example, the COVID-19 pandemic changed our lives unexpectedly and challenged the aviation industry like never experienced in the past. During the pandemic, international passenger traffic dropped by 60 percent in 2019 [22]. For air cargo, the global CTKs (Cargo Tonne-Kilometers) fell 10.6 percent in 2020 [32]. As the aviation industry continues to recover, according to forecasts of airplane demand, 18,000 new airplanes will be needed by airline companies worldwide within the next ten years [33]. Meanwhile, the airlines will be busy updating airplanes, focusing on narrowbody airplanes, which is an excellent sign for the B737 and A320 families from Boeing and Airbus [33]. Undoubtedly, airlines have already predicted future trends and developed plans for purchasing airplanes. The following section provides a brief comparison between Boeing and Airbus in terms of the airplane's operational philosophy including control systems and cockpit differences.

COMPARISON BETWEEN BOEING AND AIRBUS MANUFACTURING COMPANIES

Boeing and Airbus are the two dominant airplane manufacturers in the world. Together, they accounted for almost 70% of the global market share in 2016; and their market share is expected to reach 76% by 2025 [30]. Figure 1 shows a comparative visual of various manufacturers' market share. Although the two companies share the same goal--to create the most reliable and safest airplanes in the world, their design philosophy has been different. This really comes down to how the airplanes are operated by the pilots, something which goes unnoticed by the passengers. These differences could alter airline companies' decisions of purchasing airplanes from Boeing or Airbus.

Figure 1: *2016 vs. 2025 Fleet Market Share*





Note. Adapted from [30]

Operational Philosophy

Airbus places autopilot and hard limitations at the center of its design. Airbus provides complete flight protection by not allowing pilots to exceed specific parameters [14]. For example, Airbus airplanes stop pilots from stalling the airplane or exceeding certain pitch or roll parameters. In contrast, Boeing places the pilots at the center of its design philosophy and ensures that the pilot always has full control. Both design philosophies have benefits and drawbacks. Most accidents result from human error, so manufacturers make lots of effort to eliminate it. Some might argue that the *Airbus hard limits* help prevent unintended human error. However, this requires complex systems that can go wrong. If pilots do not coordinate systems properly, it also could lead to aviation accidents. The following section compares operational philosophy from two different perspectives—control system and difference in cockpit.

Control System: Fly-By-Wire vs. Conventional Mechanical Controls

The Airbus A320 family was the first airliner to feature the digital fly-by-wire flight control system. Most Boeing airplanes still use conventional cables with electrical and hydraulic assistance until the B777 and B787 came out. Traditional mechanical controls mean a direct connection through cables and hydraulically assisted pulleys from the control column to the airplane's flight controls. This means that the pilots can directly manipulate the airplane flight controls to manoeuvre the airplane [14]. On the other hand, the fly-by-wire system means that when the pilot makes an input into the sidestick, the input is turned into an electrical signal. This electrical signal passes through a flight control computer, providing an appropriate output to the flight controls [14]. In other words, pilots do not directly control the airplane. Instead, the computer constantly works out what the pilots try to do, judges if it is safe, and then provides an appropriate control output. Although being lighter and easy-manipulation are the advantages of Fly-by-wire over traditional cables, the fly-by-wire system is complex, and the computer could go wrong or misinterpret the situation [14].

The Difference in Cockpit

The most significant difference between a Boeing and an Airbus cockpit is that the Boeing uses a conventional yoke, and Airbus uses a side stick. According to Airbus, the side stick makes it easier to fly the airplane because, with armrests correctly set, only very fine wrist movements are required to manoeuvre the airplane [19]. The side stick also gives a clearer view of the flight instruments. Moreover, one of the most iconic characteristics of Airbus airplanes is the same cockpit layout. All the controls, handling procedures, and qualities are the same across all Airbus airplanes. Such commonality brings advantages to pilots and airlines. For pilots, they can have a smooth transition from A220 to A380 through straightforward and rapid training. For airlines, commonality leads to lower training costs and increased crew productivity as Mixed Fleet Flying (MFF) is realized, and pilots can fly more than one type of Airbus airplanes during subsequent trips.

FACTORS AFFECTING PURCHASING AIRPLANES

Factors affecting purchasing airplanes can be grouped into four major categories: general, financial, mechanical, and political. General factors are popularity between Airbus and Boeing, airplane capacity, fuel efficiency, flight routes, and customer support. Financial factors can be price, operating cost, and fixed cost. Mechanical factors include airplane life cycle, engine evaluation, safety systems, and cabin design. Political factors can often be beyond the airline company's control. The following section elaborates on these factors.

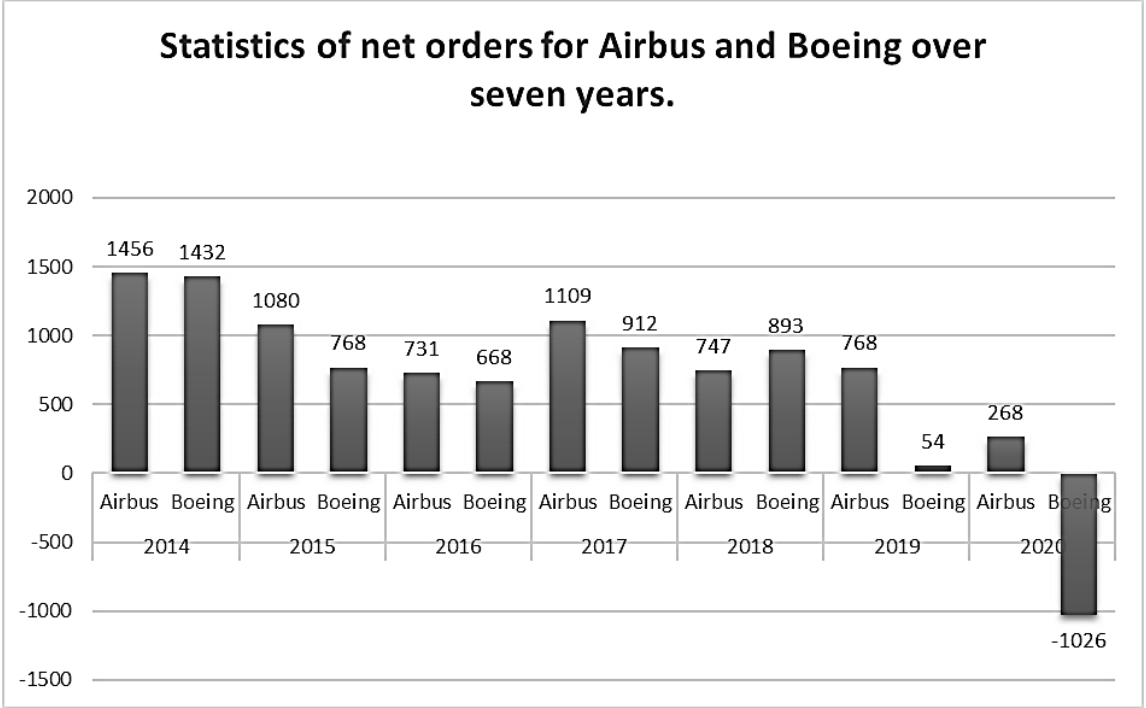
General Factors

Popularity between Airbus and Boeing

Popularity may simply depend on the airliner's discretion when it comes to purchasing airplane, as for Allegiant Airlines, which strictly flies Airbus airplanes. Airlines' option to purchase airplanes is either Airbus or Boeing. During the months of June, July, and August of 2022, Airbus delivered 145 airplanes and won a total of 479 airplane orders [17]. A number of these orders came from the Chinese market, with almost 300 orders from the country's three largest carriers – Air China, China Southern, and China Eastern [17]. Meanwhile, during the same period, Boeing sold 112 airplanes and received an additional 210 orders [17].

As of April 2022, Airbus led jet orders for their airplanes. According to a Seattle Times report, Airbus delivered 190 commercial airplanes in the first four months of 2022 compared to Boeing's 130 [16]. The reason for Boeing's slow start in 2022 is that Boeing is trying to build back consumer confidence into the 737-max program after the two air accidents that caused the 737-max grounding. Since the accidents, Boeing has solved the issue regarding the 737-max airplanes, and orders are starting to come in. Also, the 787 Dreamliner program is picking up momentum after resolving the engineering and supply chain issues that delayed the program's rollout [16]. As we can see from Figure 2, Airbus, since 2014, has had a slight lead in terms of airplane orders compared to its rival Boeing. As mentioned before, 737-Max accidents and COVID-19 have negatively affected Boeing airplane orders. In terms of popularity, Airbus has won this factor because they have more orders than Boeing, so airliners want Airbus airplanes more than Boeing airplanes. General factors such as aircraft capacity, fuel efficiency, flight route, and customer support can further explain the popularity of Boeing and Airbus airplanes. The following section elaborates these subjects.

Figure 2: *Statistics of net orders for Airbus and Boeing over seven years.*



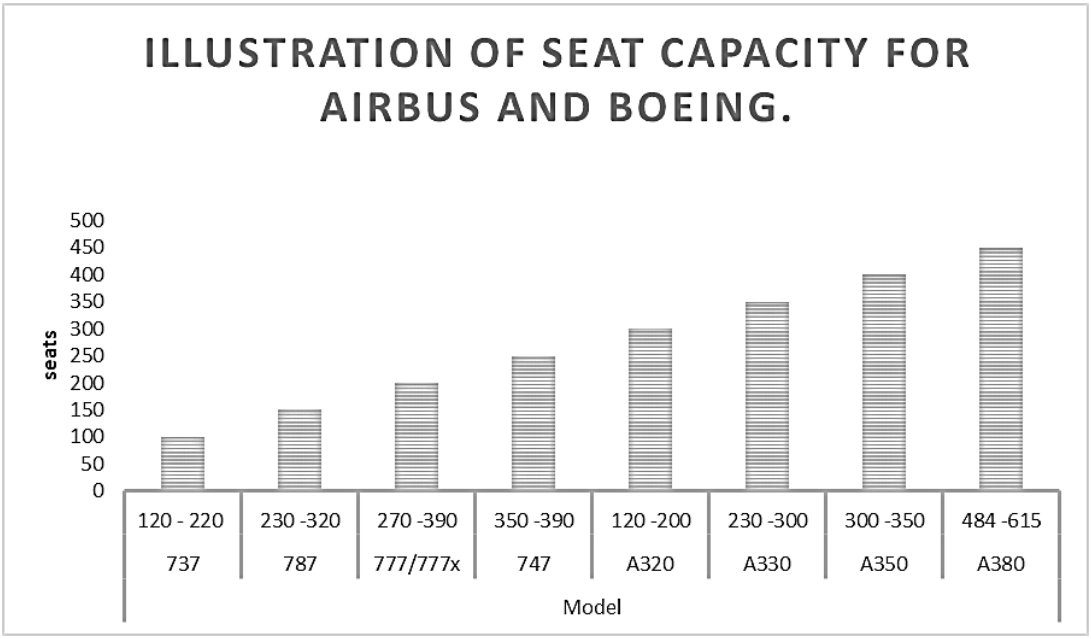
Note. Adapted from [20]

Aircraft Capacity

Airlines that focus on the capacity of the aircraft fly long-distance routes because the airplane is larger and can hold more fuel and passengers. Examples of airlines that focus on capacity are Emirates, Etihad, Qatar, and Singapore [11]. Airliners that fly short routes might prefer aircrafts with less capacity, especially if the airliner is flying to a small regional airport like Sanford International Airport (SFN), Grand Rapids International Airport (GRR), and Long Island MacArthur Airport (ISP). These airports are small and do not have as many air travelers compared to the major regional airports like John F. Kennedy Airport (JFK) in New York. The more passengers an airliner can fly on a single airplane can negate the fuel cost and the extra operating cost of flying a larger airplane.

Another aspect of aircraft capacity is the number of passengers it can hold. As illustrated in Figure 3, an Airbus A380 can hold the largest number of passengers. According to [2], the A380 typically seats more than 500 passengers and provides immediate congestion relief in many busiest airports in the world by offering greater passenger capacity. Airbus has stopped producing the A380 airplane but still provides airplane customer service support for the A380 program. Airbus, at one point, was developing an A380plus superjumbo jet that would have beat its predecessor, the A380. Airbus states that the A380plus would be able to carry up to 80 more passengers flying 300nm further [24]. But the A380plus program was just a concept, and the company currently has no plans in creating this latest version of the A380. For an airliner looking to purchase a new airplane capable of flying substantial number of passengers, the answer would be the Boeing 777-300 which can carry "550 people in a single-class setup and 451 in a two-class configuration" [1]. But for a low-cost carrier or an airliner that cannot afford a new Boeing 777-300, getting a used Airbus A380 could be a reasonable alternative.

Figure 3: *Illustration of product lines for Airbus and Boeing.*



Note. Adapted from [10].

Fuel Efficiency

After labor, fuel is the largest expense that airlines face in their daily operations. According to the International Council on Clean Transportation (ICCT), "Jet fuel use is a major contributor to global carbon dioxide (CO2) emissions, and the ICCT first analyzed the historical trends in fuel efficiency improvement of new commercial jet airplane in 2009" [36, p. 1]. The simplest way to reduce this cost is to use less fuel, which means purchasing more fuel-efficient airplanes. Additionally, sustainability and environmental concerns surrounding the airline industry continue to increase. According to a McKinsey analysis, air carriers reduced their fuel consumption per passenger-kilometer by approximately 39% between 2005 and 2019 with a compound annual growth rate of about 3.4% per year [13]. The most fuel-efficient airplane available for purchase is the Airbus A321neo powered by Pratt & Whitney's GTF engines. According to Frontier Airline's President and CEO Barry Biffle, the A321neo "will be the most fuel-efficient commercial airplane among any US airline. Adding these new A321neos to our fleet will make the greenest airline in the US even greener with these airplanes able to achieve 120 miles per gallon per seat" [5, para. 3].

Flight Route

Route planning plays a major part in the success of an airline and deciding which airplane to buy for that specific route. To remain profitable, airlines want a fuel-efficient airplane that can carry many passengers for longer routes. To maximize profitability for shorter routes, airliners do not need to worry so much about the aircraft's fuel efficiency but more about the aircraft's capacity. Route planning is a major part of any successful airline, and adding new routes is crucial to remain profitable and competitive while picking the wrong route could be disastrous [6]. According to [6], airliners should consider two critical questions before adding new flight routes—how many people want to go there and how much they are willing to pay. Airliners can answer the first question by researching customers' flight itineraries and seeing where people travel from and to. Answer to the second question can be determined by researching how much customers spend on connecting flights to their destinations. Another

consideration for the airliners when choosing a flight route is whether to slow down the competition or not [6]. These three considerations are likely to benefit the airliners in their decision-making for adding new routes to their portfolio.

Customer Support

The last factor that airliners should consider when purchasing airplanes is customer support. Both Airbus and Boeing offer customer support services to their customers after purchasing their airplanes. Airbus offers their customers *Airbus World*, an online portal that provides features such as technical documents and other related information, news, training materials, etc. [34]. This portal is regularly updated by a dedicated team, and it is set up for users having access to diverse levels of information based on their customer profile and job requirements [34]. Just like Airbus, Boeing also has customer support portal with online access for field service, fleet health, operations centers, and technical experts [8]. As both the manufacturers provide extensive customer support programs, neither has an edge over the other, and customer support is offered to airliners no matter how many airplanes they have in their fleet.

Financial Factors

Aircrafts are expensive, long-lasting assets that have a lot of separate parts. Orders for planes are often placed a few years before they are delivered at prices that may include "credits" and other complicated ways to lower the quoted price. As a result of the company's ownership of the airplane, it has more assets, which increases its worth and gives it some choices for generating cash in the event of a financial crunch. Hence, it is crucial to consider the financial factors that might affect this decision. This paper highlights the price, operating costs, and fixed costs as financial factors. The following section elaborates these factors.

Price

The manufacturers usually significantly inflate the advertised prices for airplane. When they make sales announcements, they use list prices rather than the real sum an airline would pay for the airplane. They attempt to conceal true purchase pricing since they do not want potential customers to know how much discount they will provide. Amounts vary depending on the airplane manufacturer. For instance, Delta might have received a greater discount on purchasing the Bombardier C series airplane. With Delta's $5.6 billion "list" order for 75 airplanes from Bombardier, a US-based airline placed a significant order with a Canadian manufacturer, proving the plane's global viability [18] based on price. Since Delta is known for being a strong negotiator, they would have made as many concessions as possible to make it happen. New Airbus narrow-bodies, particularly A321s, would not simultaneously discount at the same rate because of the high demand [18]. Hence, airplane pricing plays a vital role in the decision-making process.

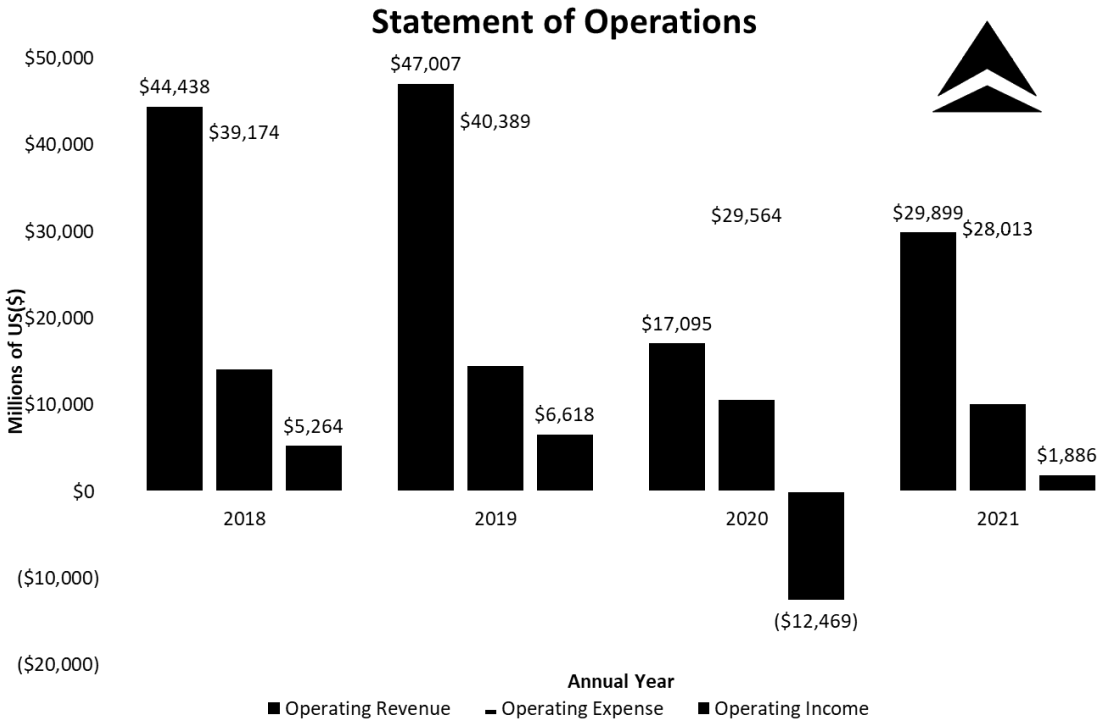
Operating Cost

The operating expenses must be considered before purchasing airplanes. Direct operational costs for each airplane differ based on fuel prices and burn rates, maintenance and associated program subscriptions, and any destination-related fees. Prospective buyers should have an innovative idea of how much and how long major hourly or calendar-based care, like engine or landing gear overhauls, will cost and take. To highlight the factors better, this paper chose Delta Airlines as an example, as it is one of the airlines that uses both Boeing and Airbus aircrafts in its fleet.

Delta Airlines spent $770 million on airplane purchases in 2021 [12]. To streamline and modernise its fleet, Delta has entered into agreements to add 29 used Boeing 737-900ERs and

lease seven used Airbus A350-900s in late 2018 [12]. With COVID-19 pandemic, Delta could consolidate its fleet and retire 18 wide-body 777s and the MD-88 and MD-90 narrow-body fleets, which are all more inefficient and out-of-date [12]. The pandemic also allowed businesses to add more modern planes at reasonable prices. The graph in Figure 4 shows how drastically things have changed--operating costs decreased by 5.25 percent in 2020 and 26.8 percent in 2019. The wide-body fleet renewal is important to Delta's recovery because it will help the airline make money and grow further.

Figure 4: *Illustration of Delta's operations for past four years*



Note. Author's original creation. Adapted from [12].

Fixed Cost

Fixed annual expenditures include hangar space, crew salary and training, insurance, tax, and management fees. Management companies can often add an airplane to their fleet insurance, reduce some costs associated with pilot benefits and training, and include hangar space and cleaning in their rates. Depending on whether flight attendants are scheduled on an international or domestic trip and how long they have worked as a flight attendant for Delta Airlines, their pay can vary widely. The beginning pays for a Delta flight attendant ranges from $33,000 and $45,000 on average, with long-tenured top earners earning up to $118,000 annually [15]. Delta flight attendants receive extra money in addition to their base salary in the form of per diem, incentives, and specific position pay, such as lead flight attendants.

Mechanical Factors

Aircraft Life Cycle

The life cycle of an airplane is the time from purchase to retirement, usually between 20 to 36 years, depending on the airplane model [23]. The life cycle of a Boeing 747 averages about

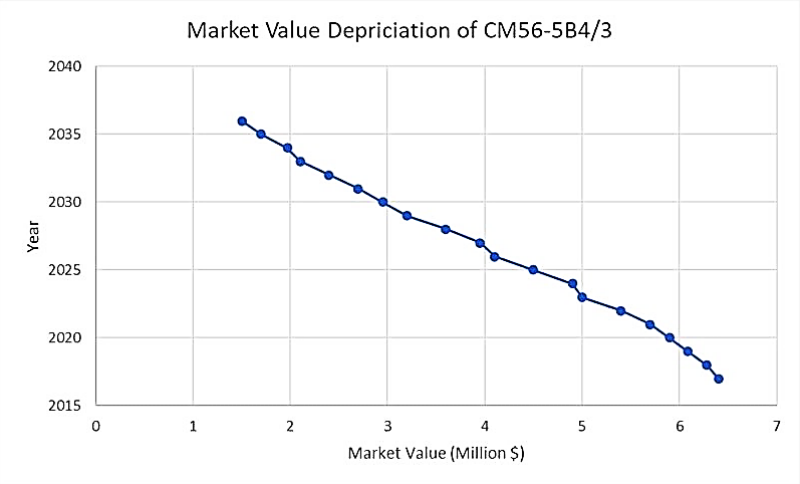
30 years and an Airbus A320 about 32 years. The life span of an airplane can be categorized into two sections--airframe and the economic life span. The manufacturer with pressurization cycles usually sets on the airframe life span. The pressurization cycles cause metal fatigue on the airframe structure, leading to cracks in critical areas. Passenger planes are typically built to withstand a certain number of pressurization cycles before it is retired. A Boeing 747 can sustain 35,000 pressurization cycles, while an Airbus A320 can endure 40,000 pressurization cycles [29].

The economic life span depends on the operating cost of the airplane formed by factors such as fuel prices and maintenance programs (A, B, C, and D checks). An airplane operation can lead to early retirement, although it still has an adequate airframe life span remaining. The airlines primarily consider these factors when deciding which specific airplane(s) to integrate into their fleet. Financial experts have concluded that the airplane's disassembly and breakdown produce more revenue than keeping it in operation through a contract because of the cost of heavy C or D checks [29].

Engine Evaluation

The utility of an engine is closely related to the performance of the carrying airplane. The airplane's life span might be elongated if the engine is adequately and regularly inspected. Consequently, as the airplane reaches the end of its economic life, so does the engine [4]. This correlation can be viewed in Figure 5, depicting the decline in the CFM56-5B4/3's market value as it ages through the years. Figure 5 also relates to the retirement of A320 with CFM56 engines installed. At a certain point, overhauling the engine will produce negative financial benefits. In this case, the engine will be sold as a green time engine or dismantled, disassembled, and sold to salvage. Depending on the green-time lease, engines and airplane purchasing allow airlines to save money by circumventing costly end-of-life restorations.

Figure 5: *Illustration of CFM56-5B4/3's market value as its ages through the years*



Note. Adapted from [4]

Safety Systems

Aviation safety is a crucial factor when airliners determine which planes to purchase. Aircraft safety refers to the forces that increase the chances of an airplane crashing or getting into an accident—even though their probabilities are very low, if not non-existent. Aircraft manufacturers follow strict safety regulations mandated by the FAA. According to Steve

Atkins, the vice president of Airplane Safety and Airworthiness of Boeing Commercial Airplanes, "commercial jet travel is one of the safest modes of transportation" [21]. Over the years, Boeing and Airbus have developed different redundant safety features to drastically reduce flight errors caused by human factors or malfunctioning systems. They have focused airplane designs on functioning in conditions more extreme than normal operating conditions and predicted problems to which they create preventative solutions.

Like the FADEC (Full Authority Digital Engine Control) system, Boeing has developed a PMA (Portable Maintenance Aid) system to allow the line maintenance workers to access the airplane database and pinpoint the problem from remote locations to make troubleshooting and maintaining the airplane more efficient [21]. This system allows discrepancies to be detected before they worsen and cause serious problems to the airplane's capacity to travel safely. Moreover, Boeing has integrated the MCAS (Maneuvering Characteristics Augmentation System) system into newer airplanes to monitor manual flight control, wing flap positions, and angle of attack of the airplane to improve pitch stability and provide finely tuned flight operations [7]. With these new additions to airplane safety features, crew workload is reduced, and the chances of inaccurate data causing accidents are lessened.

Similarly, Airbus has a Safety Management System (SMS) that predicts, handles, and alleviates hazards that could cause flight accidents. Furthermore, Airbus integrates technology such as ROPS (Runway Overrun Prevention System) in their avionics system to avert collision or runway accidents during landing. The system gives airlines and airports the right to use the airplane as a sensor to inform other airplanes and the tower of current runway situations [2]. Each new Airbus has introduced some new technologies to aid in flight safety, like the digital fly-by-wire implemented into the A320 family to make flying easier for the pilots and increase safety during flight. It is a system similar to FADEC, which monitors the flight envelope and prevents pilots from exceeding certain parameters. It also provides some flexibility for the pilots with lower type ratings to operate the airplane, allowing the airlines to save money. In addition to the cockpit safety features, Airbus has a Terrain Awareness and Warning System (TAWS) to reduce airplane terrain accidents by monitoring the environment around the airplane. These features collectively contribute to the airplane's safety and the price at which the airplane can be purchased.

Design of the Cabin

Passenger satisfaction is one of the most significant contributing factors to airline success. Part of the airlines' ability to accomplish this revenue lies in their cabin design selection. The cabin selection should encompass lavatories, lightning, emergency exits, comfortable seating, good floor planning, and in-flight entertainment to enhance passenger comfort. Both Boeing and Airbus design their cabin based on passenger-focused research. With the factors contributing to airplane purchasing, airlines can decide to adhere to the original engineering cabin design to reduce the cost of the airplane, or pay more due to modifications required by the FAA and European Union Aviation Safety Agency (EASA) Type Certificate Data Sheet [9].

Political Factors

Political factors may affect airliners' aircraft purchasing policies. Every airplane deal involves several billion dollars. The geographic locations of an aircraft manufacturer's production line offer lots of job opportunities, making the regions prosperous. Therefore, selling as many airplanes as possible is the most important goal for the manufacturers. Airbus and Boeing have specialized lobbying departments to help shape the policies of the US or foreign

governments. For example, Boeing spends millions each year for the lobbyists in the Congress and the executive branch [26]. Foreign governments are often the main targets of airplane manufacturers. Boeing and Airbus wield formidable political power to influence airlines, especially the foreign state-owned ones. From the airlines' perspective, such influence negatively affects their operations. First, airlines lose negotiation power, so they purchase airplanes at more costs than others. Second, the airplanes that airlines are forced to buy might not suit the airlines' needs.

Republic of China (Taiwan) is a typical example of how political factors work. Taiwan has been a close ally of the United States. The US government has great influence power over the Taiwanese government because of its unique political position. Moreover, Taiwan is the eighth largest US trade partner. US goods and services trade with Taiwan totaled an estimated $105.9 billion (about $330 per person in the US) in 2020, with a $40.2 billion (about $120 per person in the US) trade deficit [31]. The US government always tries to produce ways to mitigate such a huge deficit. Aircrafts are both commodities and bargaining chips in the negotiation between countries. The easiest solution to the trade deficit problem is for Taiwan to buy more Boeing airplanes.

China Airlines is the national airline in Taiwan. When planning to purchase new airplanes, China Airlines encounters several political forces. The government's intentions influence its purchase policies. In early 2022, China Airlines started to evaluate the replacement of old A330s. It considers Boeing 787 and Airbus 330neo to be the main candidates. This deal could be worth up to $5 billion [27], so both Boeing and Airbus want to get this order. On April 14 and 15, 2022, Senator Lindsey Graham led a congressional delegation to Taiwan. During the two-day visit, he met with President Tsai Ing-Wen and other top government officials. On the delegation's meeting with Tsai at the Presidential Office in Taipei, Senator Graham said, "I am hoping in the coming weeks that Taiwan will announce that they are going to buy twenty-four 787 wide-body jets made by Boeing. It would be a tremendous boost to Boeing in South Carolina, and I am hoping Taiwan will make that decision" [35]. Four months after Senator Graham's visit, China Airlines confirmed to purchase exactly 24 Boeing 787s. Although officials of China Airlines claimed that the decision was based on professional analysis without any external pressure, many people believed that political pressures could have taken part in this deal.

CONCLUSION

In summary, airline purchasing strategies and policies depend on many factors. Few important general factors are fuel efficiency, airplane capacity, customer support, flight route, and aircraft popularity. By evaluating these general factors, airliners can decide which aircrafts are suitable to meet their needs and avoid unnecessary spending by purchasing more expensive aircrafts. Financial factors, which include operating cost, price, and fixed cost, are also a significant consideration for airliners. By considering this important factor, Delta modernized its fleet at a reasonable price and reduced its operational costs. Mechanical factors include safety system, engine evaluation, and cabin design. The safety system is a principal element of mechanical factors because nothing is more important than safety, which all airplane manufacturers focus on. A poor buying strategy could endanger passengers' lives in addition to causing financial losses or even the bankruptcy of an airline. Fleet planning requires a detailed understanding of airplane performance, airplane economics, and the finance sector.

Among airplane manufacturers, Boeing and Airbus are by far the most popular options. Collectively, they control 70% of that industry's revenue [30]. Operating an airline's fleet of airplanes generates most of the company's revenue. As a result, an airline's performance depends on evaluating, choosing, and maintaining the best fleet, aligning capacity to demand, and making wise purchase decisions. Major fleet appraisals typically only occur once every few years, which presents a dilemma for airlines. New fleet analysis methods and competencies are frequently unavailable internally and may not keep up with industry advances. Finding the optimal solution to a specific fleet question requires a proper objective assessment that considers economic and non-economic elements to determine which airplane provides the most return on investment. This paper discussed several main factors that could affect the decision to purchase an airplane. By having a better understanding of these factors, airline companies can make informed decisions on what to purchase in a short amount of time.

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This is a blank abstract to make Ex Ordo happy.

Macaroni and Management: Producing and Implementing Culinary Demonstrations to Teach the Four Functions of Management – Planning, Organizing, Leading, and Controlling

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Abstract

Visual learning has achieved a paramount appointment in higher education (Hattie, 2015) as an effective way for students to acquire and enhance beneficial skills and abilities while preparing for post-graduation employment. The field of management is reliant upon potential personnel who are well-prepared for this competitive economic environment. Colleges, universities, and trade schools have embraced visual learning technology as an enticing, entertaining, and effective pedagogy method. An explosion of alternative pedagogy modalities has been realized over the past few years, as the COVID-19 pandemic transformed the way instructors deliver knowledge to a global audience of students (Lipomi, 2020). Many of the previously necessary modalities are now used perpetually (Miranda & Molina, 2020), including the extensive use of video in recorded and live demonstrations, lectures, and interactive classroom experiences (Ghosh, 2022).

Many business management programs offer opportunities for the usage of video technology to enhance learning probabilities (Islam et al., 2020). This study considers personal observations through active participation as a professor teaching management courses and creating videos for immersive learning to facilitate improved classroom performance. The author serves as an assistant professor teaching graduate and undergraduate business and hospitality courses for an AACSB-accredited institution. He holds a doctorate in human resource development, M.B.A. in management, and is pursuing a graduate degree in hospitality management. He spent over twenty-five years in corporate America in information technology, operations management, hospitality, and customer service, and is a former executive chef. Areas of expertise are introduced into the classroom using video technology to enhance student learning by recording cooking demonstrations

Engagement with undergraduate management students has been taking place over the past few years during observational data gathering. The researcher created cooking videos to help explain management principles to undergraduate students and implemented them into the curriculum. Multiple subjects are covered including management foundations, human resources, organizational behavior, and entrepreneurship. The pedagogy approach has been well received, and academic performance has improved.

The study and presentation consider one implementation of a culinary demonstration that explains the four basic functions of management. The instructor created a video of making a pasta dish accentuating different aspects of planning, organizing, leading, and controlling that the students were able to understand at a foundational level. A sample of ongoing assessments reveals the methodology to be effective as grades have improved since implementation.

Innovative teaching in higher education demonstrates positive correlations with retention, graduation, and student engagement (Aasriya, 2021), and this is true in management programs. As the study evolves, one may assume that positive results will continue.

The oral presentation provides an overview of results from foundational management course assessments as well as a demonstration of an example of the produced videos.

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MY GUY SAYS TO WAIT: HOW SOME FINANCIAL ADVICE CAN COST YOU

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ABSTRACT

Those approaching retirement often face the difficult question of when to start taking social security retirement benefits. The common advice suggests waiting until age 70 to take advantage of a larger monthly benefit check but this important decision might rely on more than that increased payment. How long you might reasonably expect to live, the effects on federal and state income taxes, the timing of your cash needs, the coordination with your other retirement savings, and how much of your wealth you wish to leave to your heirs should be considered.

There are, then, several things to consider when making this decision. This paper looks at some of those factors in detail, addresses some key definitions and ideas, then provides examples and discussion to better understand them, wrapping up with a bit of advice.

INTRODUCTION

Those approaching retirement often face the difficult question of when to start taking social security retirement benefits. The common advice suggests waiting until age 70 to take advantage of a larger monthly benefit check but this important decision might rely on more than that increased payment. How long you might reasonably expect to live, the effects on federal and state income taxes, the timing of your cash needs, the coordination with your other retirement savings, and how much of your wealth you wish to leave to your heirs should be considered.

There are, then, several things to consider when making this decision. Let's look at some of those factors in detail, then let's look at an example to better understand them. As always, you should contact your financial advisor, tax professional, and attorney to be sure your strategy makes sense for your particular situation. Before diving in too deep, it's a good idea to address some key definitions and ideas.

BACKGROUND

What's Full Retirement Age?

You can retire from your working career any time you wish—or believe you can afford it. Social Security, however, establishes the age at which you can earn what they call the "Full Retirement Benefit" and that differs depending on the year you were born. For example, those born between 1943 and 1954 reached their full retirement at age 66. For those born in 1955, it's 66 and 2 months; 1956, 66 and 4 months, and so on at two-month increments up to age 67. To collect your "full" benefit, you must achieve this minimum age. If you wait to collect your retirement benefits after that age, the benefits grow at an annual rate of 8%.

What about this 8%?

According to the Social Security Administration, deferred retirement benefits increase 2/3 of 1% for each month after full retirement age. If your full retirement age is 66 and 4 months, deferring benefits until age 70 will mean a 129.33% increase in benefits. In simple terms, this would translate a monthly benefit of $1,673 (the 2022 average benefit reported in August [1]) to $2,164 (or from $20,076 per year to $25,965). This increase is not inconsequential. If you are planning to work after your full retirement age and your budget permits, waiting makes sense. It may even work to your advantage because your benefits are based on the highest 35 years' earnings and since you likely will earn more in the later years than earlier ones, the retirement benefit can be higher. The takeaway here is that every month delayed earns a slightly higher benefit and you don't have to wait full years to earn higher monthly retirement benefits.

What if you need the income now?

Social security retirement benefits can begin at age 62. It's important to realize that just as delayed benefits earn more, taking benefits earlier mean less per month. (Benefits are reduced by 5/9 of 1% per month for up to 36 months, then 5/12 of 1% for earlier.) Reviewing your expected benefits is a good idea and you can get access to your full record at SSA.GOV to see what your likely monthly amounts would be at age 62, your full retirement age, and at age 70. A note of caution, though. These are estimates based on the earnings records at the time of your review. The actual benefit will be slightly different depending on your earnings record and the actual date you start collecting benefits. Regardless, these are solid estimates on which you can build some strategies. In this article, I focus on the alternatives of taking retirement benefits at full retirement age and waiting until age 70, however an analysis could be applied to ages between 62 and the full retirement age [2].

What about other retirement savings?

Many of us socked away money in pensions, 401k, 403b, and/or IRA arrangements over our working careers. Doing so was and is the wise choice. The combination of distributions from these accounts along with social security retirement benefits can make life in retirement more enjoyable, or at least, easier to afford. If you are still working, the best advice is to save as much as possible until you retire. Current law allows additional contributions to defined contribution plans and each additional dollar contributed will pay off in the future. Depending on your situation, it may be beneficial to make contributions to a Roth IRA using after-tax dollars and enjoying tax free earnings on those monies in the future. Consult your financial professionals for more details on how to maximize your retirement savings and remember, the sooner you start, the better.

SOME FACTORS AFFECTING *WHEN*

As mentioned earlier, there are some factors that could influence the decision on when to take retirement benefits. How long you might live after retirement, your comfort with uncertainty about the future, the effects of taxes on spendable money, and passing wealth to your heirs are all important dimensions to this decision.

How long?

We cannot predict our own demise, but a reasonable assessment of life expectancy is part of financial planning. Family history and personal health risks affect our subjective view of our own life expectancy. If there's a strong history of longevity in the family and you are healthy, then you might enjoy the larger deferred monthly benefits, that is, waiting until age 70 to start.

Take it now or wait? An example…

While it's true that taking your benefits at your full retirement age allows your total earnings to accumulate at a lower rate than at age 70, it will take several years for the two accumulated values to equal. We can calculate this breakeven point, the age where these two total values will be the same. In practice, if that breakeven age is greater than your estimated life span, then taking the benefits earlier might make sense for you.

Let's start with a simplifying set of assumptions. Ted is single and born in 1956 so his full retirement age is 66 and 4 months. His full retirement benefit is estimated at $1,673 and if he waits until age 70, that benefit is estimated at $2,164 (129.33% more than the $1,673). If Ted waits to start collecting benefits, he will get $491 per month (or $5,889 per year) more in benefits.

Ted can start taking benefits now which will accumulate in value across the coming years, but if he waits until age 70, he will earn the increased benefits that will also accumulate in value. We might ask how long it will take for those two values to be equal—that is, what's the breakeven point in years? Assuming the benefits do not change from year to year, Ted can earn a total of $73,612 by the time he turns 70 if he starts taking benefits at his full retirement age. Dividing this total ($73,612) by the difference in annual benefits he could earn at age 70 versus those at age 66 and 4 months ($5,889) tells us how many years it will take after age 70 to "break even". In other words, this is how long it will take for the two accumulated values to be equal, which in this case, will take 12.5 years, so Ted will be 82 ½ years old when they are equal. Looked at another way, at age 82 ½ Ted's cumulative benefits are the same under either starting age at $324,562. Before that age, his cumulative Social Security income will be greater by taking the benefits at age 66 and 4 months than waiting until he turns 70. After age 82 ½, his accumulated benefits will be greater if he waits until age 70. If Ted has good reason to believe he will live longer it may be to his benefit to delay taking his retirement benefits.

The future is uncertain

Individual differences in risk tolerance can influence the decision to delay taking the benefits. Those who are more risk averse will opt to "take it now" over waiting because of the uncertainty of one's own future health and financial needs. Choosing to take the money now calms some of those fears by allowing us to see more concrete results. This is aided by an implicit guarantee that social security benefits will be there into the future and will be somewhat protected against inflation by way of an annual cost-of-living adjustment (COLA) each year. Over the last 20 years the annual COLA has ranged from 0% to 5.7% with an average of 2.11%. And the 2023

COLA is 8.7% to help retirees keep pace with this year's price rises brings that annual average to 2.65% [3].

And speaking of concrete results it's important to remember, it's your money. The social security taxes you and your employers paid into the fund represents deferred compensation with the expectation you would collect it at some later date. It's perfectly logical to say, "I earned it and I want it now." And, depending on your situation, the stream of benefits may be more valuable to you now than the promise of more later.

So, a reasonable consideration of life expectancy and personal risk tolerance play an important role in the timing of "When".

WHAT ABOUT TAXES?

The impact of taxation on Social Security benefits are a second factor that can shed light on the timing of benefits. If taxes can be avoided, more cash will be available for current consumption. And supplementing your other retirement income with Social Security income preserves those endowments for later years for future spending.

Are Social Security Retirement Benefits Taxable?

The answer is "yes", "sort of", and maybe "no". As with most tax questions, the answer depends on several factors. Let's look at federal income taxes first, then state income taxes. If social security retirement benefits are your sole source of income, there is no federal tax. Assuming you have income from other sources such as retirement accounts in addition to social security, a portion of the social security benefits are taxable. Anywhere from 50% to 85% of the social security benefits can be taxed depending on your total other income. Depending on the taxpayer's filing status and total other income, differing thresholds affect the taxability of social security benefits. The key takeaway here is the chance to shield some retirement income from federal taxes. At the upper taxable limit at 85%, 15% of social security income is exempt from federal tax. So, in answer to the question, there are circumstances where Social Security retirement benefits are not taxed; and other where only some portion is taxed [4].

How about at the state level?

Most states and local authorities do not tax Social Security retirement benefits. For 2022 these include Alabama, Alaska, Arizona, Arkansas, California, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Mississippi, Nevada, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, Washington, Washington D.C., Wisconsin, and Wyoming.

The remaining states do tax the benefits, but under varying rules (Colorado, Connecticut, Kansas, Minnesota, Missouri, Montana, Nebraska, New Mexico, Rhode Island, Utah, Vermont, and West Virginia) [5].

With varying tax rates and rules, consultation with tax and financial advisors is important to evaluate the impact on the after-tax effects on benefits, but suffice to say, any reduction in tax exposure means more spendable cash now and into the future.

Tax effects, an example…

As mentioned earlier, only a portion of Social Security retirement benefits are taxable at the federal level. Continuing with Ted's information, let's assume Ted's combined income is greater than the threshold amounts so that 85% of Ted's benefits are taxable and his marginal tax bracket is 22%. Neglecting any COLA, his annual benefit is $20,076 and 85% of that is $17,065 which is taxed at 22%, or $3,754, leaving him with $16,322. Instead of taking his Social Security retirement benefit, Ted decides to take the same amount out of his IRA, all of which is taxable. The result would be a tax bill of $4,417 ($20,076 at 22%) for a difference of $663 more in federal taxes paid. Ted lives in Virginia, one of the states with no tax on Social Security benefits. His IRA withdrawal is taxable there at a marginal rate of 5.75%, so he would owe an additional $1,154 in Virginia for a total tax bill of $5,571, leaving him with $14,505. In total, taking his Social Security benefit at his full retirement age saves him $1,817 in taxes over what he would pay if taking withdrawals from his IRA. In this way, Ted subsidizes his retirement income with the benefit of reduced tax obligations. While the same tax shield is available when benefits are deferred to age 70, Ted would give up the use of this tax-preferred $73,612 between his full retirement age and 70 and pay more in federal and state taxes.

Looking at it from a different angle, if Ted wanted a net after-tax supplement of $16,322 (that's the after-tax amount from Social Security), the equivalent draw from the IRA/401k would have to be $22,591; or $2,515 more dollars out of his IRA/401k funds. That is money that can be used for future withdrawals in subsequent years, thus preserving some of the original tax-deferred endowment.

Your investment portfolio may offer additional tax consequences so staying in touch with your financial and tax advisors is recommended.

WHAT ABOUT LEAVING IT TO THE KIDS?

Any dollar spent out of our IRAs or 401(k)s is money that cannot be spent later or passed along to your heirs. By taking social security benefits earlier, we preserve other retirement endowments for a longer time. While it's true that in Ted's case he loses some of that benefit as he approaches 83 years of age, taking his Social Security retirement benefit earlier has allowed him to be less dependent on his other retirement resources while also shielding them from current tax liabilities. Those funds will have had the opportunity to benefit from investment growth, thus increasing in value. An important distinction is Ted's Social Security retirement benefits are a "life annuity" that end at his death, so there is nothing to pass along to his heirs from this fund. Preserving his other retirement monies make them available to his beneficiaries.

CONCLUSION

So, what to do and when?

When given ***one size fits all*** advice, take heed because it fits no-one. This is true of the all-too-commonly heard "My guy says to wait to age 70…" to start taking social security retirement benefits. The lure of a bigger paycheck can distract us from evaluating factors that could mean more spendable income for now and in the future, so taking time with this important decision is crucial. Consulting with your financial, legal, and accounting professionals can result in better quality decisions that can make your retirement savings work for you.

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THE BEVERIDGE CURVE: THE GREAT RECESSION, RECOVERY, AND PANDEMIC EFFECTS

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ABSTRACT

In this work 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 (the beginning of the Job Openings and Labor Turnover Survey) 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. The current position of the vacancy rate versus the unemployment rate in the Beveridge space is unprecedented in the JOLTS data era with exceptionally high vacancy rates relative to unemployment. The background of the current Beveridge Curve analysis is the Federal Reserve's attempts to bring the current inflation rate down. We 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 the post-pandemic period. The idea of the possibility of a soft landing is whether the Federal Reserve is able to engineer a decreased inflation rate without a large increase in the rate of unemployment. A preliminary version of the full paper is available from the authors upon request.

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UNDERSTANDING THE IMPACTS OF PILOTS' MENTAL HEALTH ON AVIATION SAFETY

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ABSTRACT

In aviation, safety is the highest priority. Several recent aviation accidents and incidents have brought the mental health issue of pilots to the forefront of aviation safety. To protect the safety of crew members and passengers, the Federal Aviation Administration (FAA) and other civil aviation authorities across the globe strictly regulate the status of pilots' physical and mental health. The understanding of mental health has significantly changed over time, shifting from an illness-focused definition to a more person-focused one. Mental health is a fundamental component of well-being, which refers to a person's overall health and wellness, including physical, social, emotional, and psychological health. The World Health Organization (WHO) has defined mental health as "a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to her or his community." Mental health determines how we deal with stress, retain information, build relationships, and make choices.

Types of mental health condition pertaining to pilots can be divided into two broad categories: identifying their disqualifying mental health conditions and most common psychological conditions experienced by them. According to FAA (2022), disqualifying mental health conditions for pilots are attention deficit disorder, bipolar disorder, adjustment disorder, personality disorder, psychosis or disconnection from reality, substance dependence or abuse, dysthymia or persistent depressive disorder, suicide attempt, and depression requiring the use of antidepressant medication. Most common psychological conditions experienced by pilots are anxiety, depression, postpartum depression, alcohol misuse, occupational stress, adjustment disorder, mood disorder, relationship problems, and sexual dysfunction (Cahill et al., 2021; The British Psychological Society, 2017). According to a survey conducted by Dr. Brent Blue, a Senior Aviation Medical Examiner, 96% pilots do not think the FAA handles pilots' mental health issues appropriately.

The purpose of this paper is threefold. First, it describes the significance of pilots' mental health and its impact on aviation safety. Second, it explores the state of pilots' current mental health and the causes and side-effects of mental health-related issues. Third, it reviews relevant regulations currently in place and summarizes available resources established by the FAA and civil aviation authorities to support pilots' mental health. The paper concludes by providing useful recommendations beneficial for the pilots, regulatory agencies, and readers interested in getting a better understanding of mental health-related issues in high-stress professions.

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USING THE WORKABILITY INDEX (WAI) AND WORKABILITY SCALE (WAS) TO CALCULATE FUTURE EARNINGS CAPACITY LOSSES

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ABSTRACT

The problem of determining future economic lost in cases of personal injury is difficult, particularly when the injury is a partial injury, and the individual has some capacity of mitigating their income losses in the future. This paper examines one possible approach for examining this issue of future reduced income capacity, the use of the Work Ability Index (WAI) and Work Ability Scale (WAS). In this pilot study, empirical data is analyzed to determine the relationship between scores on the WAI/WAS and verified future income loss. We find a high correlation between the scores obtained on both the WAI and WAS scores, and future economic loss. This suggests that these indices may be very useful in analyzing economic loss and reduced future income capacity in partial disability cases.

INTRODUCTION

In this pilot study, empirical data from a sample of individuals with injuries/conditions is analyzed to determine the relationship between scores on the WAI/WAS and actual future income loss. In these examples, we assume that forensic economists are looking primarily at the loss of future earnings capacity at the individual level, from the perspective of the injured individual or victim. While recognizing there are certainly broader categories of potential damages (e.g., pain and suffering) associated with an injury, the forensic economist generally only examines the issue of lost wages/paid benefits and the impact of an injury on the person's future earnings capacity. In this section we examine the use of the WAI and WAS as a method to examine the impact of a disability on future income.

Work Ability Index and Work Ability Scale

History. The Work Ability Index (WAI) was originally designed to measure various factors related to an individual's ability to function in a work situation. The original WAI consisted of seven "broad" questions related work functioning, but also contained a list of 51 different medical conditions that the person filling out the questionnaire might have been diagnosed with.

Based upon the individual item scores of the seven work dimensions and the list of 51 medical conditions, a total WAI score is obtained. The resulting WAI score would then be used by the occupational therapist to assess an injured or sick individual along a definitional spectrum, ranging from "full work ability" to "unable to work". Several early studies found that this original WAI, with its list of different medical conditions, was both a valid instrument and showed a high correlation with other clinically determined functional capabilities and impacts [5] [7].

However, the original WAI, with its list of 51 conditions, was quickly found to be unwieldy for many clinical applications. In addition, there was some question as to whether the detailed list of different medical conditions added significant information to the instrument when determining work capacity. Radkiewich and Widerszal-Bazyl [14], for example, examined the original, longer version WAI and found that many respondents often did not answer the "medical conditions" list accurately, and that the lengthy medical condition list in the WAI often confused respondents.

Based on these findings, a number of authors proposed revised versions of the WAI with a shorter list of medical conditions or eliminating the list of medical conditions altogether. Nubling et al [12], for example, developed a modified WAI with only 15 medical conditions. In examining the predicative power of the individual items on the instrument, Radkiewich and Widerszal-Bazyl [14] found that the first question in the WAI, the somewhat general or "global" question asking respondents to compare their current work ability level with their overall best level in the past, had the highest discriminating power of all the questions in the longer WAI. Several researchers have therefore proposed simply using the first question in the WAI as a single item, "Work Ability Scale" (WAS) [7] [8] [17]. Gradually, two different instruments found their way into use. The single item "Work Ability Scale" (WAS), with the global question asking respondents to compare their current work ability level with their overall best level in the past, and a revised or "shortened" "Work Ability Index" (WAI) with the seven "broad" questions related to work functioning, but dropping questions related to specific medical conditions.

Validity. Several studies have analyzed the validity of both the WAI and WAS. El Fassi et al. [4] compared the properties of the WAI and WAS using a large sample of workers and concluded that even the shorten WAI was often incompletely filled out (28.3% of the time). In

examining the psychometric characteristics of the scales, they found that the convergent validity between the WAI and the WAS was high with a Spearman correlation of 0.63. The study also showed that the WAS generally discriminated equally well between the various conditions presented.

In another large-scale study Schouten et al. [15] examined different versions of the WAI, and the single item WAS, with respect to actual work performance -- the likelihood of long-term sickness absence of workers. They found that a shortened version of the WAI, without the conditions list, as well as the WAS discriminated between high and low risk of long-term sickness absence, and that the WAI without the conditions list "is a good alternative to the complete WAI" (p. 301). Schouten et al. [15], however, found that the single item WAS somewhat lower in discrimination, although still over 70% accurate. After converting both the WAI and WAS to severity classifications, they found that "poor" work ability (defined by the WAI and WAS) resulted in a 0.55 risk of observed long-term sickness absence, while a "moderate" classification resulted in a 0.19 risk, a "good" classification resulted in a 0.05 risk, and an "excellent" classification resulted in a 0.02 risk. In another large-scale study of the psychometric studies of the single item WAS, Steinstra et al. [16] found that the WAS had good reliability, construct validity, and responsiveness, and showed "good measurement properties". In a study of 750 employees in the petrochemical industry, Adel et al. [1] found that a Persian version of the WAI had good internal consistency and construct validity.

What is interesting in the above studies is that although both the WAI and WAS provide a numerical score, it is often converted into descriptive categories of workability severity. For example, Ilmarinen et al. [8] recommend that a score on the WAS between 0 and 5 indicates a severe impact on work, a score of 6 to 7 is a moderate impact, a score 8 is a small impact, while a 9 or 10 indicates little or no impact. In addition, many of the studies investigating the validity and discrimination characteristics of the WAS and the WAI convert the scores into a severity classification prior to their analysis [1] [4] [8].

The "shortened" WAI has now been translated into over 20 languages. There have been many published studies that have supported the overall linguistic validity in these translations, as well as the reliability of the instruments. While several researchers have investigated the psychometric properties of the WAI and WAS, other than the Schouten et al. [13] few studies exist that tie the

workability scores with actual work activity decreases. In addition, most of the studies examining the construct validity of the WAI/Was have focused on the correlation between sick leave rates and the WAI/WAS scores. Few studies, if any, examining construct validity have examined actual income loss, which is one of the key issues for a forensic economist. Thus, one of the interests in the present study is to directly apply the WAI and WAS to future income capacity using actual injured individuals as the sample, and their known pre- and post-injury income.

A PILOT STUDY

For this analysis we use the shortened WAI (7 questions) and the WAS (first question in the WAI). In particular, the questions are:

1) Current work ability compared with the lifetime best. Assume that your work ability at its best has a value of 10 points, How many points would you give to your current work ability? (0 means that you cannot currently work at all).
2) Work ability in relation to the demands of the job. How do you rate your current work ability with respect to the physical demands of your work[1]? Very good (5), rather good (4), moderate (3), rather poor (2), very poor (1)
3) How do you rate your current work ability with respect to the mental demands of your work? Very good (5), rather good (4), moderate (3), rather poor (2), very poor (1)
4) Estimated work impairment due to condition. Is your illness or injury a hindrance to your current job. There is no hinderance (6), I am able to do my job, but is causes some symptoms (5), I must sometimes slow down my work pace or change my work methods (4), I must often slow down my work pace or change my work methods (3), Because of my condition, I feel I am able to do only part-time work (2), In my opinion, I am entirely unable to work (1).
5) Sick leave during the past 12 months. None at all (5), at the most 9 days (4), 10-24 days (3), 25-99 days (2), 100-365 days (1).
6) Own prognosis of work ability two years from now. Do you believe that, for the standpoint of your health, you will be able to do your current job two years from now? Unlikely (1), not certain (4), relatively certain (7).
7) Mental resource. Have you recently been able to enjoy your regular daily activities? Often (4), rather often (3), sometimes (2), rather seldom (1), never (0)

Sample

We administered the short WAI to a sample of 56 individuals who have suffered an injury or illness in the past four years. 50 of these individuals suffered a physical injury while 5 individuals suffered a traumatic experience resulting in a medical PTSD diagnosis. The scale

[1] In this, and other questions, we refer to the work being performed prior to the injury/illness.

was administered in telephone interviews. In addition, unlike previous studies we determined the annual income prior to the injury or illness (generally from tax returns or other financial documents), the annual income at the time of the interview, if they had to leave their prior work due to the injury and if they have sought/obtained work in another field. We also gathered data regarding age, gender, and whether the industry/illness was associated with PTSD. In almost all cases, the respondents indicated that the injury or illness was permanent,

The median age of the sample is 45, with a low of 25 years and a high of 68 years. Thirty-eight percent of the sample are female, sixty-two percent are male. Nine individuals in the sample have been diagnosed with PTSD (5 without a physical injury, 4 associated with a physical injury). The average reduction in income (post-injury compared to pre-injury) was 51.79%, with a high of 100% reduction in post injury/illness income (e.g, unable to work) to a low of 7%.

Analysis

Table 1 presents the regression results for the WAI and WAS respectively. While we recognize that the actual relationship is asymptotic, with upper and lower limits (1,0), examining the plot graph indicates a fairly linear relationship except at the end points of very high/low WAI/WAS scores, which then becomes asymptotic at 0,1 respectively. The linear regression appears to be a good approximation of the overall relationship (high R^2s) indicating a significant relationship with both measures of workability and post-injury/illness income reduction.

We also estimated a regression model including the variables of age and gender as control variables, but neither age nor gender appeared statistically significant.[2]

[2] Inclusion of the PTSD variable in the model resulted in potential multi-collinearity issues with the WAS/WAI.

Table 1: Regression WAI/WAS and Income Loss				
Coefficient	WAS Model	WAI Model	WAS Model Full	WAI Model Full
Constant	1.184***	1.308***	1.145***	1.266***
WAS	-0.140***		-0.142***	
WAI		-0.036***		-0.037***
Gender (0=F,1=M)			-0.013	0.014
Age			0.001	0.001
R^2, N	0.860, 56	0.781, 56	0.868, 56	0.787, 56
****prob<0.01, **prob<0.05, *prob<0.10*				

We also compared the results of our WAS regressions against the severity classes suggested in prior research regarding the impact of disabilities in general on work and income. For the 7-item WAI, Ilmarinen et al [8] suggest using the classification of poor workability (7-25 points), moderate workability (28-36 points), good workability (37-43 points) and excellent workability (44-49 points); this categorization has been used in several WAI validity studies (see Adel et al [1]). For the WAS, we used Ilmarinen et al [8] classification that 0 and 5 indicates a severe impact on work, a score of 6 to 7 represents a moderate impact, a score of 8 indicates a small impact, while 9 or 10 shows little or no impact. Although not using the WAI/WAS, a number of studies have been published that provide insight as to how disability ratings in general impact a person's income [2] [3] [10] [11]. The Kessler Foundation and National Organization on Disability [10] performed a survey of Americans with Disabilities. From the information provided in the report it was possible to estimate the impact of disabilities on income. Park and Butler [13] looked at the impact of formal physician impairment ratings on wage loss while Bhattacharya et al. [3] examined permanent disability ratings on earnings loss for different impairment categories and different types of impairment categories (we report the "back" impairment category for comparison purposes). Although each of these three studies used slightly different severity classifications, given the results in these three studies, we estimated the predicted income loss based upon severity of disability and compared these impacts with our WAS regression results. The results are show in Table 2.

Table 2: WAS Impact on Income: Severity Comparison

WAS Score	Estimated Future Income Loss (Regression)	Ilmarinen Disability Classification	Proportional Earnings Loss, Kessler [7]	Proportional Earnings Loss, Bhattacharya et al [2]	Proportional Earnings Loss, Park and Butler [11]
2	0.904	Severe	0.51 (Severe)	0.48 (Back, Disability Rating > 50%)	0.55 (Impairment Rating > 25%)
3	0.764	Severe	0.51 (Severe)	0.48 (Back, Disability Rating > 50%)	0.55 (Impairment Rating > 25%)
4	0.624	Severe	0.51 (Severe)	0.48 (Back, Disability Rating > 50%)	0.55 (Impairment Rating > 25%)
5	0.484	Severe	0.51 (Severe)	0.48 (Back, Disability Rating > 50%)	0.55 (Impairment Rating > 25%)
6	0.344	Moderate	0.32 (Somewhat Severe)	0.38 (Back, Disability Rating > 30%)	0.21 (Impairment Rating 10% to 25%)
7	0.204	Moderate	0.31 (Moderate)	0.25 (Back, Disability Rating > 20%)	0.185 (Impairment Rating 0% to 10%)
8	0.064	Small	0.06 (Slight)	0.07 (Back, Disability Rating > 10%)	0.185 (Impairment Rating 0% to 10%)

The regression model from our sample data results in earnings loss estimates similar to the three studies examined, again suggesting the validity of the WAS as an indicator of both workability and income loss. However, due to Ilmarinen et al's [8] wide range of WAS scores (<5) in the "severe" category, for scores of "2" and "3" the regression estimates are significantly higher than the levels suggested in the three severity comparison studies. In addition, given the asymptotic nature of the data, WAS values of 0 and 1 would likely indicate a 100% income loss while WAS values of 9 and 10 would likely indicate a 0% loss, similar to Ilmarinen et al's [8] classification of "little or no" impact. Thus, a WAS score of "6" (indicating moderate impact) on the WAS results in an average income reduction of 34.4%, or a disabled/impacted individual would be expected to earn only 65.6% of their pre-disability income. Using a WAI score of 28, which would be classified as "moderate" by Ilmarinen et al [8] results in a similar 31.3% loss of income. This is not surprising given the Person correlation between the WAS and WAI in our sample was 0.888.

CONCLUSION

Forensic economists are often called upon to analyze these future financial difficulties when lawsuits are filed. However, by its very nature, this is a difficult process when a partial disability is diagnosed, and the inured individual has a potential for future income, or mitigation of loss. This paper extends the analysis of Galbraith and Stiles [6] and discusses some of the economic issues

related to this problem and suggests one approach, using the workability index (WAI) and workability scale (WAS) as a possible approach that a forensic economist might consider when examining the loss of future earnings capacity for victims. The study found a strong correlation with both the WAI and WAS and actual future economic loss, suggesting that these instruments may be an effective tool for the forensic economist.

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VALUE RELEVANCE OF WEB SALES GROWTH RATES AND CONVERSION RATES ON FIRM VALUATIONS

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Understanding the value relevance in e-commerce firms has been a great interest for both academicians and practitioners. There have been some mixed opinions about using financial versus non-financial measures to assess value relevance. Prior research has documented that in market valuations, some non-financial measures have higher value relevance than financial data. For instance, it was seen that web traffic data has greater value relevance than conventional financial data. Similarly, another study finds that the population size and market penetration have great value relevance. This research examines the value relevance of web sales growth rates and conversion rates on firm valuations. Specifically, we will examine the question whether the market incorporates web sales change data into stock valuations. It has been noted that the e-commerce marketplace has been volatile since its initiation. Starting from the dotcom bubble burst to the recent COVID-19 pandemic, e-commerce firms have experienced greater variations. So, this study aims to account for these volatilities by using longitudinal data of web sales and conversion rates.

The data for this research is obtained from three proprietary databases: Compustat and CRSP for financial information, and Digital commerce 360 for e-commerce performance measures. The robustness of these databases has been widely recognized by prior research. More importantly, this study will apply direct measures i.e., actual web sales and conversion rates instead of proxies. The goal is to examine the relationship between web sales data and stock returns. At present, data mapping is in progress. This research has several potential implications. The requirement to expense marketing and advertising costs may diminish the relationship between company growth and financial measures such as earnings which highlights the decrease in value relevance of financial information. This calls for a more balanced approach to evaluating firms, where marketing initiatives and their effects, and other factors receive adequate consideration. In addition to effects on sales and profit, marketing activities create marketing assets such as customer relationships, customer and brand loyalty, and brand equity. Such assets have long-term positive effects on firm value. A significant relation between web sales growth and conversion rate, and firm valuation can suggest improvement in financial disclosures to better communicate the sources of firm value. Disclosure of SG&A costs can be improved by separately reporting costs that have longer-term impacts on firm value. Further, a significant positive relation between web sales growth and conversion, and firm valuation has implications for managers. For instance, they can channel more efforts into marketing and other initiatives that create greater growth in web sales and conversions.

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WHEN SHOULD YOU BEGIN RECEIVING SOCIAL SECURITY PAYMENTS? INCORPORATING TIME VALUE OF MONEY

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ABSTRACT

It is commonly known that you may receive your Social Security benefits as early as age 62. However, the payment will increase by 8% for each year you defer your payments, up to age 70. If you expect to have a long retirement, waiting can be beneficial financially. The decision on when to take your Social Security benefits is influenced by several factors. First and foremost, your death date is uncertain. But there are other factors that complicate this decision. Incorporating basic Time Value of Money (TVM) techniques we should be able to determine an economic breakeven point given an individual's assumptions regarding these other complicating factors. Further work in this space should include incorporating known medical indications related to mortality to further refine the decision.

INTRODUCTION

Brief description of Social Security retirement benefits

As most people are aware, Social Security is a product of President Franklin Roosevelt's New Deal program. Mainly known for its retirement benefits, Social Security also included provisions for unemployment insurance, disability insurance, and aid to dependent children. The benefits are funded by a payroll tax of 12.4%, with half being deducted from the employee's earnings and the other half coming from the employer's contribution. (An additional 2.9% is collected for Medicare, with half, or 1.45%, coming from the employee.) For 2022, income above $147,000 is exempt from Social Security taxes.

Social Security retirement benefits are extremely progressive, providing a significant benefit to lower income workers. If you retired at 65 in 2021 with an average income of nearly $27,000, your retirement benefit would be almost $13,000, nearly 50% of your salary. At a salary of $95,000. Your retirement benefit would be roughly $28,000, only 29% of your salary. At $143,000, the benefits rise to just over $34,000, is approximately 24% of your earnings. [4]

Crossover Age

What factors should be considered by the retiree when deciding on the best age to begin receiving Social Security retirement benefits? It is generally known that you may begin to receive Social Security retirement benefits at age 62. However, if you defer these benefits, the annual payment will increase approximately 8% for each year deferred, up to age 70. For instance, if you turned 62 in 2022, your full retirement age would be 67 but you are eligible to begin receiving Social Security payments immediately. If your annual benefit would be $24000 at 67, then this amount would be reduced to $16,800 at age 62. Waiting until you are 70 would see your benefit rise to $29,760 per year. Thus, your expected longevity is a factor in determining the optimal date to begin receiving your benefits. In addition to this, is the fact that many healthy individuals at age 62 may prefer to continue working. While it is appealing to work and collect one's social security benefit, it doesn't exactly work that way. The social security administration applies an earnings test to individuals below their full retirement age who elect to draw benefits and continue working. The earnings test in 2022 is $1 temporarily withheld for every $2 earned above $19,560. For the

individual mentioned above, retiring at 62 with an annual benefit of $16,800, if they continued to work and earned income greater than $53,160, their SSA benefit would be entirely deferred until they reached full retirement age, and at that point, their benefit will be permanently reduced because of the early election. For the sake of not overcomplicating the present study, we will assume that the individual has reached full retirement age of 67. The full retirement age benefit is simply a scalar, so we will assume a full retirement age benefit of $24,000 which would imply an age 70 retirement benefit of $30,233 (an 8% annual growth rate).

Most studies on when to receive Social Security retirement benefits have focused on the "cross-over age," defined as the age at which lower benefits for more years is just equal to the higher annual payout for fewer years. Using the numbers from the above assumptions, ($24,000 at 67; and $30,233 at 70), waiting to 70 rather than 67 yields a crossover at 80.11 years (11.11 years of receiving the higher payment).

Other Factors to Consider

These "cross-over age" studies have several inherent flaws. Among them are the following:

1. These studies do not account for the fact that, historically, social security benefits are indexed to inflation and consequently increase annually. While the actual cost of living adjustment for SSA benefits is determined annually based on the consumer price index, the average COLA for SSA benefits since 1975 has been 3.785% annually[9]. If an average COLA is applied to the future benefits, other things held constant, then the "cross-over age" extends to 85.03 years.

2. These studies also do not account for the fact that present dollars are worth more than future dollars because present dollars can be invested to earn greater future dollars. This singular focus on the date at which the sum of the payments is equal ignores completely the time value of money (TVM). This oversight is especially ironic when you consider that personal financial advisors are keenly aware of the concept that money now is worth more than an equivalent amount in the future. It is the basic application of time value of money concepts that helps establish the required nest egg needed to support your retirement plans. TVM also determines how much must be saved annually during your work life to accumulate that nest egg. Ignoring the expected COLA adjustments, and only applying a discount factor to the difference in benefits, assuming a 5% rate (which approximates standard annuity accounting), the "cross-over age" moves from age 80.11 to approximately 88 years.

   When both the expected COLA and TVM are considered together, the "cross-over age" moves out to approximately age 97.

3. These studies do not consider that the longer one lives, the greater the likelihood of dying is and consequently the smaller the probability of living for another year. In addition to not considering the expectation of receiving future benefits, they also do not consider the differing survival rates of males vs. females. The actuarial evidence suggests that while the likelihood of dying increases as age increases, it increases at a faster rate for men than for women. Table 1 below shows the actuarial probability of death at various ages used by the social security administration for its calculations[10]. The actual table begins at age 0, but for the purposes of this study, it is truncated below age 67. Also, the probability of life is extrapolated from the probability of death since the outcomes are binary. When the probability of living for a given year is applied to the benefit for that year, then the expected benefit is calculated. When combined with the average COLA, and TVM, this pushes the "cross-over age" out to just over 101 for males and just over 100.

Survivor Benefits

Another factor that crossover analysis ignores concerns married couples. Assume Jane and John are the same age, and their full retirement age is 67. Also assume Jane earned more over the course of her work life and is eligible for $2600 per month in benefits at 67. John is eligible for a monthly benefit of $1000 per month at age 67. He may choose to retire at 62 and receive $700 per month. When Jane retires at 67, he is eligible for a spousal adjustment and can receive 50% of Jane's benefit, or $1300 per month. Jane's deferral increases her benefit as well as John's. [1]

And these social security benefits do not automatically cease when you die. If the retiree is married and the couple's incomes and ages differ, then there are survivor benefits to consider. If the surviving spouse is beyond full retirement age, then they are eligible to receive 100% of the deceased spouse's Social Security benefit. They will opt for this only if it exceeds their own benefit. In the example above, if Jane predeceases john, then his benefit will increase from his $1300 per month to her $2600 per month. This is another benefit of Jane's deferral of benefits. If they are over 60 but less than full retirement age, then they receive a fraction (between 71.5% and 99%) of their spouse's benefit, depending on their age. In any event, the larger you can make your benefit, the more your spouse will receive in the event you die first. This potential continuation of benefits for the surviving spouse makes the benefit stream "live" longer than the actual person. [2]

Health Insurance

But the decision to begin receiving Social Security benefits is not made in a vacuum. For instance, if you retire at age 62 but your health insurance was associated with your job, then you may be required to pay significant health care premiums until you are 65, the year you qualify for Medicare. These premiums could easily exceed the benefit of earlier retirement. If you have health insurance that you can carry into retirement (such as a military retirement) then retiring before age 65 is easier to manage. [4]

Conclusion

While the cross-over age is a useful factor in deciding the best date to begin Social Security benefits, it is certainly not the only factor to consider. Health insurance can be a sizable expense in retirement. It may be wise to synchronize your retirement with Medicare eligibility. In addition, the age (and life expectancy) and the anticipated social Security benefit of your spouse should be considered, as they may assume your benefit upon your death and the time value of money should also be incorporated into the decision. We intuitively know that a dollar today is worth more than the same dollar at any point in the future if we have an investment rate greater than zero. Only by taking such a comprehensive approach can you expect an optimal decision and outcome. This paper provides a more comprehensive, robust, and useful model for determining when an individual should consider taking their social security benefit. It appears that as additional factors are considered, the benefit of waiting diminishes significantly.

Table 1. SSA Mortality Table										
	Male					Female				
age	Death Prob	Life Prob	Number	Life Exp	Death Age	Death Prob	Life Prob	Number	Life Exp	Death Age
67	1.83%	98.17%	77,366	16.67	83.67	1.12%	98.88%	86,065	19.1	86.1
68	1.95%	98.05%	75,950	15.97	83.97	1.22%	98.78%	85,103	18.31	86.31
69	2.08%	97.92%	74,468	15.28	84.28	1.33%	98.67%	84,069	17.52	86.52
70	2.24%	97.76%	72,915	14.59	84.59	1.47%	98.53%	82,950	16.75	86.75
71	2.42%	97.58%	71,283	13.91	84.91	1.62%	98.38%	81,733	16	87
72	2.63%	97.37%	69,559	13.25	85.25	1.79%	98.21%	80,407	15.25	87.25
73	2.87%	97.13%	67,732	12.59	85.59	1.97%	98.03%	78,967	14.52	87.52
74	3.14%	96.86%	65,791	11.95	85.95	2.17%	97.83%	77,410	13.8	87.8
75	3.46%	96.54%	63,725	11.32	86.32	2.41%	97.59%	75,729	13.1	88.1
76	3.83%	96.17%	61,519	10.71	86.71	2.68%	97.32%	73,906	12.41	88.41
77	4.22%	95.78%	59,165	10.11	87.11	2.99%	97.01%	71,923	11.74	88.74
78	4.64%	95.36%	56,669	9.54	87.54	3.32%	96.68%	69,776	11.08	89.08
79	5.09%	94.91%	54,041	8.97	87.97	3.68%	96.32%	67,463	10.45	89.45
80	5.62%	94.38%	51,288	8.43	88.43	4.11%	95.89%	64,978	9.83	89.83
81	6.24%	93.76%	48,404	7.9	88.9	4.61%	95.39%	62,306	9.23	90.23
82	6.92%	93.08%	45,385	7.39	89.39	5.17%	94.83%	59,434	8.65	90.65
83	7.69%	92.31%	42,243	6.91	89.91	5.79%	94.21%	56,362	8.09	91.09
84	8.55%	91.45%	38,996	6.44	90.44	6.49%	93.51%	53,099	7.56	91.56
85	9.51%	90.49%	35,663	6	91	7.27%	92.73%	49,655	7.05	92.05
86	10.58%	89.42%	32,273	5.57	91.57	8.16%	91.84%	46,043	6.56	92.56
87	11.78%	88.22%	28,858	5.17	92.17	9.16%	90.84%	42,285	6.1	93.1
88	13.11%	86.89%	25,457	4.8	92.8	10.28%	89.72%	38,410	5.67	93.67
89	14.58%	85.42%	22,119	4.45	93.45	11.52%	88.48%	34,460	5.26	94.26
90	16.17%	83.83%	18,895	4.12	94.12	12.88%	87.12%	30,489	4.88	94.88
91	17.89%	82.11%	15,840	3.82	94.82	14.36%	85.64%	26,561	4.52	95.52
92	19.74%	80.26%	13,006	3.54	95.54	15.96%	84.04%	22,746	4.2	96.2
93	21.71%	78.29%	10,439	3.29	96.29	17.67%	82.33%	19,115	3.9	96.9
94	23.81%	76.19%	8,172	3.06	97.06	19.50%	80.50%	15,737	3.63	97.63
95	25.88%	74.12%	6,226	2.86	97.86	21.34%	78.66%	12,669	3.39	98.39
96	27.90%	72.10%	4,615	2.69	98.69	23.18%	76.82%	9,965	3.17	99.17
97	29.81%	70.19%	3,327	2.54	99.54	24.97%	75.03%	7,656	2.98	99.98
98	31.58%	68.42%	2,336	2.4	100.4	26.68%	73.32%	5,744	2.81	100.81
99	33.16%	66.85%	1,598	2.28	101.28	28.28%	71.72%	4,212	2.65	101.65
100	34.81%	65.19%	1,068	2.16	102.16	29.98%	70.02%	3,021	2.49	102.49
101	36.55%	63.45%	696	2.05	103.05	31.78%	68.22%	2,115	2.34	103.34
102	38.38%	61.62%	442	1.94	103.94	33.68%	66.32%	1,443	2.2	104.2

Table 1. SSA Mortality Table										
	Male					Female				
age	Death Prob	Life Prob	Number	Life Exp	Death Age	Death Prob	Life Prob	Number	Life Exp	Death Age
103	40.30%	59.70%	272	1.83	104.83	35.70%	64.30%	957	2.07	105.07
104	42.32%	57.68%	163	1.73	105.73	37.85%	62.15%	615	1.94	105.94
105	44.43%	55.57%	94	1.63	106.63	40.12%	59.88%	382	1.82	106.82
106	46.65%	53.35%	52	1.54	107.54	42.52%	57.48%	229	1.7	107.7
107	48.99%	51.01%	28	1.45	108.45	45.08%	54.92%	132	1.59	108.59
108	51.43%	48.57%	14	1.37	109.37	47.78%	52.22%	72	1.48	109.48
109	54.01%	45.99%	7	1.28	110.28	50.65%	49.35%	38	1.38	110.38
110	56.71%	43.29%	3	1.21	111.21	53.69%	46.31%	19	1.28	111.28
111	59.54%	40.46%	1	1.13	112.13	56.91%	43.09%	9	1.19	112.19
112	62.52%	37.48%	1	1.06	113.06	60.32%	39.68%	4	1.1	113.1
113	65.64%	34.36%	0	0.99	113.99	63.94%	36.06%	1	1.02	114.02
114	68.93%	31.07%	0	0.92	114.92	67.78%	32.22%	1	0.94	114.94
115	72.37%	27.63%	0	0.86	115.86	71.84%	28.16%	0	0.87	115.87
116	75.99%	24.01%	0	0.8	116.8	75.99%	24.01%	0	0.8	116.8
117	79.79%	20.21%	0	0.74	117.74	79.79%	20.21%	0	0.74	117.74
118	83.78%	16.22%	0	0.68	118.68	83.78%	16.22%	0	0.68	118.68
119	87.97%	12.03%	0	0.63	119.63	87.97%	12.03%	0	0.63	119.63

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Papers: Sustainability, SCM, Quality Management, Logistics, Hospitality, Recreation and Sports

A META-ANALYSIS OF AIRBNB PRICE FACTORS IN THE SUPPLY CHAIN OF THE SHARING ECONOMY

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ABSTRACT

This paper explores the supply chain of the sharing economy, more specifically, the supply chain of lodging services. There are many factors driving the pricing of lodging-sharing services. We proposed a theoretical model in which characteristics of services are hypothesized to influence the price. To test our hypothesized model, we conducted a Meta-Analysis on 34 papers published in the literature, resulting in 1065 effect sizes. Results show that characteristics such as distance to the city center, lodging amenities, and the number of bedrooms and bathrooms, among other variables, were significantly related to the prices of Airbnb offers.

INTRODUCTION

This paper aims to assess the factors driving lodging service pricing in the sharing economy. The sharing economy is defined as the market of services supplied by individuals to individuals using an electronic platform to match buyers and suppliers or supply and demand. The sharing economy has grown substantially in the last few years because of the rapid pace of technology development, which allowed electronic platforms to enhance their features. There are many companies based on these new technologies in the sharing economy. One contemporary, technology-based sharing economy is Airbnb, which has gained prominence by fostering a digital marketplace for buyers and sellers (i.e., "guests" and "hosts") of tourism, work, and other forms of lodging. Consumer decision-making with regard to tourism lodging is significantly influenced by pricing, both for hotel and Airbnb units [8, 17]. Yet Airbnb differs from hotels because its prices are set by the individual hosts who own the units rather than by the company itself, like in the case of hotels. There is vast heterogeneity amongst Airbnb listings, and myriad studies have examined the various factors that influence Airbnb prices worldwide, typically using hedonic pricing models that rely upon several variables that can affect the price. At times the findings in these studies have been entirely consistent concerning the impact of particular features, and at other times the findings have differed. To date, however, no research has sought to quantitatively synthesize these studies to produce a set of summary findings and their effects on pricing. The present study seeks to fill this gap by undertaking a Meta-Analysis of several existing studies on Airbnb price determinants.

This paper is under development. For this reason, in the next section, we present a brief literature review, followed by a set of hypotheses. Then, we discuss the methods and present the results. Finally, we conclude the paper with a summary of our results and the hypotheses that were supported. We will continue improving this paper for journal submission.

LITERATURE REVIEW

The Service Supply Chain and Sharing Economy

The service supply chain represents the flow of services and information from an interconnected network of suppliers upstream to customers downstream. In contrast with tangible goods, service supply chains are characterized by delivering intangible services [4, 22] and the impossibility of storing them in inventory. The production and consumption of services are simultaneous, making them perishable in the time dimension. That is, if services are not consumed each day, they perish, as they cannot be stored to be sold and consumed the following day. Service supply chains are also characterized by the participation of customers during the production and delivery process [21]. Customer participation creates uncertainty and variability in the production process because customers introduce their idiosyncrasies to the process [7]. Finally, although services are intangible and provide benefits to the consumer, there are tangible elements designed to deliver them.

These general service characteristics fully apply to modern sharing economy services in industries such as transportation and lodging. Sharing economy supply chains likewise provide intangible services that cannot be stored and have customers participating during the production and delivery processes. For example, consumers of sharing services provided by Airbnb consume the lodging service while the service is delivered. That is, there is no separation between the production and delivery of the service and its consumption. Consumers enjoy the benefits of a lodging service, such as a place to rest, shower, eat, and sleep, and part of the consumers' experience is influenced by the diverse tangible elements needed for the service delivery, such as the physical conditions of the apartment or house, the availability of a pool, and the presence of other amenities.

Revenue Management and Hedonic Pricing

The tourism lodging industry has largely embraced the practice of revenue management, which entails optimizing revenue by managing inventory and strategically establishing prices [12]. Prices are impacted by characteristics of the environment, such as seasonal visitation patterns, day-of-week visitation patterns, or the presence of nearby events, together with internal product

attributes, such as the property's location, the quality and cleanliness of the rooms, its amenities, and its guest reviews. Not surprisingly, research has revealed that price is a particularly important factor in selecting tourism lodging [17]. Therefore, if prices are set too high, demand (i.e., occupancy) will decline together with revenues, whereas if prices are set too low, the business will miss out on easy revenue. The arsenal of potential tactics that can be used to boost revenue often features fairly costly undertakings, such as making capital investments to renovate a property or spending large sums on marketing campaigns. In contrast, revenue management can provide a far less expensive path toward improved revenues, as it primarily involves simply wiser decision-making.

The theory of hedonic price modeling, developed by Lancaster [14] and Rosen [19], suggests that products should be understood as representing a collection of different attributes that offer varying degrees of utility to prospective buyers. Therefore, consumer decision-making entails assessing these diverse benefits compared to a product's price, which is therefore determined by forces of market equilibrium. This theory typically uses ordinary least squares regression modeling to measure the degree to which a series of attributes influences a product's price, which is often logarithmically transformed. Hedonic pricing models have been widely applied in a tourism context, examining products including package tours [23], ski lift tickets [6], and cruises [5]. Moreover, hedonic pricing models have commonly been employed to better understand the prices of tourism lodging, such as hotels in Taiwan [24], "green" and non- "green" hotels in Virginia[13], hostels around the world [3], and rural homestays in China [18].

Hypotheses

Based on a review of the existing hedonic pricing studies, the following hypotheses are proposed:

H1: Greater size (number of guests who can be accommodated, number of bedrooms, and number of bathrooms) is associated with higher prices.
H2: The presence of amenities is associated with higher prices.
H3: Entire home units are priced higher than private rooms or shared spaces.
H4: Shorter distances from tourist sites (e.g., attractions) and amenities (e.g., transportation) are associated with higher prices.
H5: Flexible cancellation policies are associated with lower prices.
H6: Superhost status is associated with higher prices.
H7: Instant booking is associated with lower prices.
H8: Higher guest rating scores are associated with higher prices.
H9: Higher numbers of reviews and photos are associated with lower prices.

METHODS

The methodological steps to undertake this research involved identifying relevant research, screening it for eligibility, and analyzing the final sample of included studies (see figure 2). The identification process involved two steps: (i) a definition of keywords and a literature review, and (ii) an identification of records for possible inclusion found via database searches. Registration protocol and eligibility criteria followed the recommendations of Rosenthal and DiMatteo [20]. The initial criteria defined for consumption analysis were scientific papers that deal with the proposed theme of "hedonic pricing" written in English in the form of articles, published or not, in scientific journals. In addition, we considered papers that used the keywords: price per night, room price, Airbnb price, accommodation price, rental room price, and Airbnb property prices. In this stage, only papers that contained quantitative results that provided sufficient statistical information for effect size calculations were considered. The definition of sources of information was obtained using the Web of Science, JSTOR, Scopus, ProQuest, Emerald, EBSCO, and Google Scholar. In addition, the data selected in these databases were required only to contain papers from journals that undergo peer review.

In the screening and eligibility phase, 470 full texts were included. The papers that used meta-analysis conditions were considered. Thus, the following types of studies were excluded: (i) theoretical papers (38), (ii) qualitative studies (23), (iii) descriptive statistics (34), and (iv) duplicate records (316). After applying these procedures, 34 papers were analyzed, resulting in 1065 effect sizes. In the process of coding the information used for this meta-analysis, a spreadsheet containing the following information from each of the extracted articles was developed: (i) article number, (ii) title of the paper, (iii) title of the journal, (iv) country of application of the study, (v) sample number, (vi) indicator of pricing, (vii) name of the Airbnb price determinants, and (viii) regression coefficient.

We performed the meta-analytic calculations according to Hedges and Olkin [9], computing the *d* Cohen effect size by performing conversions following the formulas suggestions by Hunter and Schmidt [11]. Conversions were made from OLS regression results through 296 standardized regression coefficients and 751 unstandardized regression coefficients. The analysis also detected the level of heterogeneity among the studies. We used the Q and I^2 tests [10]. In the Q test, we verified the significance level of heterogeneity ($p < .05$). The I^2 statistic is obtained via the Q statistic and can range from 0 to 100%. Studies with a 25% index show low heterogeneity, studies with a 50% value show moderate heterogeneity, and studies with over 75% show high heterogeneity [10]. The possible moderators of Airbnb price determinants were calculated through three groupings of variables to examine the influence of some variables as the potential drivers of hedonic pricing at the time of choice: methodological, demand for tourism and hospitality, and geolocation information moderators. The moderators selected and coded for this study were: sample size, OLS regression, hotel number, rates averaged, occupancy rate, tourism type, and city size. The moderators' analysis and the direct relationship between product scarcity and consumer preferences help answer the initial hypotheses.

RESULTS

This study has shown data collected in papers published between 2016 and 2022. The short period was determined by the exponential growth of Airbnb within the sharing economy context. The extant body of research included journals primarily related to tourism and hospitality, such as *Tourism Management*, *Journal of Hospitality & Tourism Research*, *International Journal of Tourism Sciences, International Journal of Hospitality Management*, *Journal of Travel & Tourism Marketing*, *European Journal of Tourism Research*, and Marketing Science, among others. In addition, the authors of the papers used as primary data are researchers at 48 different universities and research institutions around the world. Table 1 shows the result.

Table 1
Meta-Analysis Results

Variable	Studies		Effect			Q[6]	I[2 7]
	K[1]	O[2]	Effect r[3]	LCI[4]	HCI[5]		
Flexible cancelation policy	65	909926	0.019	-0.015	0.053	19386.34 ***	99.7%
Distance to a tourist attraction	5	31409	0.014	-0.026	0.055	36.83 ***	89.1%
Distance to the city center	22	534805	-0.270 ***	-0.325	-0.214	8737.17 ***	99.8%
Distance to train station	9	437720	0.003	-0.02	0.027	70.33 ***	88.6%
Distance other	25	794757	-0.006	-0.034	0.022	1490.11 ***	98.4%
Entire room	71	2609477	0.187 ***	0.129	0.243	125440.41 ***	99.9%
Free parking	18	1034932	0.023	-0.026	0.071	9117.64 ***	99.8%
Guest rating	65	1592766	0.064 ***	0.043	0.085	6017.6 ***	98.9%
Gym	7	46537	0.092 ***	0.051	0.133	90.5 ***	93.4%
Instant booking	58	1180441	-0.048 ***	-0.079	-0.018	20084.37 ***	99.7%
Accommodation capacity	59	1587450	0.116 ***	0.098	0.135	25946.75 ***	99.8%
Number of bathrooms	69	1800791	0.161 ***	0.143	0.18	12199.9 ***	99.4%
Number of bedrooms	72	1738151	0.068 ***	0.058	0.077	4090.86 ***	98.3%
Number of photos	12	493718	0.106 **	0.014	0.197	4512.86 ***	99.8%
Number of reviews	83	2308500	-0.001	-0.019	0.017	14114.74 ***	99.4%
Other amenities	59	4809187	0.065 ***	0.029	0.1	35737.37 ***	99.8%
Pool	14	296917	0.059 ***	0.034	0.083	333.39 ***	96.1%
Private room	59	1207204	0.139 ***	0.078	0.2	60245.41 ***	99.9%
Shared room	11	506782	-0.102 **	-0.195	-0.001	23177.54 ***	100.0%
Smoking allowed	5	489037	-0.088 *	-0.19	0.015	7412 ***	99.9%
Superhost	68	1435388	0.091 ***	0.067	0.114	6638.34 ***	99.0%
WI-FI	9	700666	0.081 **	0.016	0.144	5380.21 ***	99.9%
Total	1065	37841495	0.062 ***	0.053	0.072	865612.95 ***	99.9%

Notes: [1]K is the number of studies; [2]O is the number of observations taken from the studies; [3]Effect r is the average effect corrected by the formula $r = \sum_i^k = 1 Z r_j \frac{n_j - 3}{\sum_j^k} = 1(n_j - 3)$; [4]LCI means lower confidence interval; [5]HCI means higher confidence interval; [6]Q is the test of heterogeneity, [7]I[2] is the significance level.

We computed the mean effect of Airbnb price variables based on three groupings of variables to examine the influence of some variables as the potential drivers of Airbnb prices. Q-statistics among the effect sizes were added to the mean effect to understand the heterogeneity of the analyzed samples.

The first category of variables, called "characteristics of listings" had thirteen random-effect models. The random-effects model of hedonic pricing of all observations of *accommodation capacity* found in the primary papers obtained a significant equation of .1186 (k = 59; 95% confidence interval [CI95] 0.0983; 0.1352; *z-value* = 12.30; *p* < 0.001; I^2 = 99.8%; $א^2$(58) = 2594.75; *p* < *.001*).

The variables that assess the direct effect of amenities on Airbnb pricing had four significant relationships and two without statistical significance. The variables that the random-effects model had significant relationships for were *gym* (k = 7; SMD = .0921; 95% confidence interval [CI95] .0511; 0.1327; z-value = 4.40; p < 0.001; I^2 = 93.4%; $א^2$(6) = 90.5; p < .001), *Wi-Fi* (k = 9; SMD = .0806; 95% confidence interval [CI95] 0.0161; 0.1443; z-value = 2.45; p < 0.05; I^2 = 99.9%; $א^2$(8) = 2380.21; p < .001), *pool* (k = 14; SMD = .0585; 95% confidence interval [CI95] 0.0342; 0.0828; z-value = 4.71; p < 0.001; I^2 = 96.1%; $א^2$(13) = 333.39; p < .001) and *others* (k = 59; SMD = .0647; 95% confidence interval [CI95] 0.0293; 0.0999; z-value = 3.58; *p* < 0.01; *I^2* = 99.8%; $א^2$(58) = 35737.37; *p* < *.001*).

The variable that did not have a significant difference was *free parking* (k = 18; SMD = .0227; 95% confidence interval [CI95] -0.0258; 0.0711; z-value = 0.92; p = ns) and *smoking* allowed (k = 5; SMD = -.0884; 95% confidence interval [CI95] -0.1902; 0.0152; z-value = -1.67; p = ns).

The random-effects model representing the *entire room* demonstrated a significant positive equation of .1867 (k = 71; 95% confidence interval [CI95] 0.129; 0.2431; z-value = 6.26; p < 0.01; I^2 = 99.9%; $א^2$(70) = 125440.41; p < .001). In the same vein, the variables *number of bathrooms* (k = 69; SMD = .14; 95% confidence interval [CI95] 0.1386; 0.1414; z-value = 17.01; p < 0.001; I^2 = 99.4%; $א^2$(68) = 12199.9; p < .001) and the *number of bedrooms* (k = 72; SMD = .0676; 95% confidence interval [CI95] 0.0584; 0.0676; z-value = 14.38; p < 0.01; I^2 = 98.3%; $א^2$(71) = 4090.86; p < .001) showed a positive influence on hedonic pricing.

The last two random-effects models evaluated *private* and *shared rooms*. The two variables prove to be predictors of hedonic pricing. For *private room*: k = 59; SMD = .1391; 95% confidence interval [CI95] 0.0777; 0.1995; z-value = 4.42; p < 0.01; I^2 = 99.9%; $א^2$(58) = 60245.41; p < .001; and *shared room*: k = 11; SMD = -.1023; 95% confidence interval [CI95] -.1951; -.0077; z-value = -2.12; p < 0.01; I^2 = 99.1%; $א^2$(10) = 23177.54; p < .001).

The variables associated with locations and neighborhoods on hedonic pricing had one significant relationship and three without statistical significance. The variable that the random-effects model had a significant relationship was the *distance from the city center* (k = 22; SMD = -.2702; 95% confidence interval [CI95] -0.3245; -0.2142; z-value = -9.12; p < 0.01; I^2 = 99.8%; $א^2$(21) = 8737.17; p < .001). The variables that did not have a significant difference were the *distance from the train station* (k = 9; SMD = .0034; 95% confidence interval [CI95] -0.0203; 0.0272; z-value = 0.28; p = ns), *tourism attraction* (k = 5; SMD = .0144; 95% confidence interval [CI95] -0.0261; 0.0547; z-value = 0.7; p = ns), and *others* (k = 25; SMD = -.006; 95% confidence interval [CI95] -0.0339; 0.0219; z-value = -0.42; p = ns).

The last group evaluated the effects of variables associated with attributes of hosts, finding four significant relationships and two without statistical differences. The random-effects model of hedonic pricing of all observations of *guest rating* found in the primary papers obtained a significant equation of .064 (k = 65; 95% confidence interval [CI95] 0.043; 0.085; z-value = 5.95; p < 0.001; I^2 = 99.8%; $א^2$(64) = 6017.6; p < .001). In the same line, the variable *number of photos* obtained positive and significant values (k = 12; SMD = .106; 95% confidence interval [CI95] 0.0131; 0.1965; z-value = 2.25; p < 0.05; I^2 = 99.8%; $א^2$(11) = 4512.86; p < .001). The random-effects model of hedonic pricing of all observations of *Superhost* found in the primary papers obtained a significant equation of .0906 (k = 68; 95% confidence interval [CI95] 0.0669; 0.1142; z-value = 7.47; p < 0.001; I^2 = 99%; $א^2$(67) = 6038.34; p < .001). The *Instant booking* variable also had a significant effect. However, unlike the other effects, this one was negative (k = 58; SMD = -.0483; 95% confidence interval [CI95] -0.0783; -0.0179; z-value = -3.12; p < 0.01; I^2 = 99.7%; $א^2$(57) = 20084.37; p < .001). The variables that did not have a significant difference were the *number of reviews* (k = 83; SMD = -.0008; 95% confidence interval [CI95] -0.0021; 0.0005; z-value = -1.23; p = ns), and *flexible cancelation policy* (k = 65; SMD = .0193; 95% confidence interval [CI95] -0.0193; 0.0534; z-value = 1.11; p = ns).

The random-effects model of Airbnb price determinants across all variables for each observation according to the equation is .0621 (k = 1065; 95% confidence interval [CI95] 0.0526; 0.0717; z-value = 12.69; p < 0.001). The combined studies calculated the mean effect of scarcity show that Airbnb prices fluctuate under various Airbnb price determinants. Several primary studies demonstrate that these effects can act in different ways on Airbnb pricing, such as methodological choices [16], demand for tourism and hospitality [1, 2], and geolocation information [15, 25].

CONCLUSION

This paper aimed to assess the factors driving lodging service pricing in the sharing economy. More specifically, we wanted to evaluate the effect of specific factors affecting Airbnb pricing. We formulated hypotheses about these factors based on previous studies. Then, we collected secondary data from 34 papers published in high-quality journals and conducted a meta-analysis of their effects to test our hypotheses. Table 2 provides a summary of the hypothesis testing for

each hypothesized effect. Most hypotheses are supported and partially supported. The only hypothesis not supported is H5, which hypothesized a negative relationship between flexible cancelation and prices.

Table 2
Hypothesis Testing Summary

Hypothesis		Supported?
H1	Greater size (number of guests who can be accommodated, number of bedrooms, and number of bathrooms) is associated with higher prices.	Supported
H2	The presence of amenities is associated with higher prices.	Partially supported
H3	Entire home units are priced higher than private rooms or shared spaces.	Supported
H4	Shorter distances from tourist sites (e.g., attractions) and amenities (e.g., transportation) are associated with higher prices.	Partially supported
H5	Flexible cancellation policies are associated with lower prices.	Not supported
H6	Superhost status is associated with higher prices.	Supported
H7	Instant booking is associated with lower prices.	Supported
H8	Higher guest rating scores are associated with higher prices.	Supported
H9	Higher numbers of reviews and photos are associated with lower prices.	Partially supported

We will continue working on this paper to expand the introduction, literature review, results, discussion, and conclusion sections. We appreciate the opportunity to present our ideas to reviewers and participants of this conference.

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A PRELIMINARY EMPIRICAL STUDY OF THE IMPACT OF RISK MANAGEMENT MATURITY ON ROBUSTNESS IN SMALL AND MEDIUM BUSINESSES AND ENTERPRISES

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ABSTRACT

This preliminary study explores the relationships among multiple dimensions of supply chain risk management maturity (SCRMM) and supply chain robustness (SCR) in small and medium businesses and enterprises (SMBs/SMEs) from the United States. SCRMM is characterized by factors of continuous systematic improvement/learning of risk management processes (CSI), supply chain (SC) risk management collaboration (RMC), SC risk mitigation (MIT), and organization internal risk management (IRM).

A structural equation model is proposed and empirically tested based on the participation of more than 60 SC professionals from SMBs/SMEs spanning various industry sectors. The proposed model suggests that SC risk management collaboration efforts and improved internal risk management performance precede the effective mitigation of risk events. In the proposed theoretical model, the continuous development and improvement of risk management processes is included as a mediator between RMC and MIT as well as between IRM and MIT. Finally, the implementation of improved mitigation efforts is predicted to have a positive effect on overall SC robustness.

Preliminary empirical results indicate that in the case of SMBs/SMEs, CSI fully mediates the relationship between RMC and MIT while a partial mediation effect is found in the link

between IRM and MIT. Finally, the effective mitigation of risk events is found to have a positive impact on robustness. Overall, the preliminary findings indicate that the model constructs help predict SC robustness, suggesting that SMBs/SMEs in the United States can benefit from a culture of continuous improvement of risk management processes.

KEYWORDS: small and medium businesses, small and medium enterprises, supply chain management, supply chain risk, supply chain risk management maturity, supply chain robustness

A VISUAL ANALYSIS OF THE RELATIONSHIPS BETWEEN TEAM FINANCES, SALARY CAPS, AND COMPETITIVE BALANCE IN SPORTS LEAGUES

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ABSTRACT

Competitive balance among teams within a sports league is considered important as it keeps players and fans engaged every season. Various policies like salary caps, revenue sharing, drafts, and player free agency have been instituted in North American sports leagues to encourage parity among teams. Most European sports leagues, however, have not established such measures, leading to the dominance of a few teams. In this paper, we use data visualization techniques to examine the relationships between competitive balance, team success, and team finances across multiple North American and European sports leagues.

BACKGROUND AND MOTIVATION

Competitive balance among teams within any sports league has long been considered a positive in sports. The idea that every team has a reasonable chance to do well every season is appealing to many audiences including league commissioners, players, and fans. When a few teams dominate any league, there is disengagement among fanbases, talk of "unfairness" and "superpower teams" all of which ultimately have an impact on ticket sales and revenue.

Recognizing this, major sports leagues in North America including the NFL, NBA, MLB, NHL, and MLS have all come up with various measures to combat a lack of parity, both at the player level and at the team level. Some of these measures include draft lotteries, free agency, salary caps on teams, and revenue sharing. Without these measures, small market teams with limited revenue would get outspent and out recruited by large market teams [7].

In contrast to North American leagues, it is well known that European soccer leagues lack parity, and there is increasing worry that the game is becoming more and more unequal [9]. In many major European soccer leagues, there are clear "super teams" which have access to huge payrolls including international investments and larger television revenues, which in turn leads to the acquisition of better talent, winning more games, and attracting more supporters leading to further increase in revenue to continue the cycle.

A factor that impact the lack of competitive balance in European soccer leagues could be the lack of salary caps. There have been concerns expressed about the decline in parity and also calls to remedy the transfer system and implement some form of salary cap [6]. Among the North

American leagues, there are differences in the measures taken to increase parity. In particular, while salary caps are a tool used by various leagues, there are many different forms of salary caps. Salary caps are not limits on team or player salaries but set a band for both the upper and lower salary limits to payrolls for each team within a league [4]. They can be categorized as soft or hard salary caps, depending on how strict they are.

The NFL and the NHL have hard salary caps – that is, the salary cap sets firm limits with no material exemption. The MLS and NBA have soft salary caps -that is, there are some exemptions to the salary cap. In the MLS the exemption is that an MLS team can sign up to three players that will be considered outside the team's salary cap. In the NBA, the exemption is that a team can sign one player at the league's average salary even if it's above the salary cap limit. While the MLB does not have a salary cap, it does have a luxury tax, that is a tax that a team must pay when it exceeds a certain cap.

Salary caps have indeed had an impact in the various leagues by not allowing teams to "collect" superstars [4]. Leagues with hard salary caps like the NFL and NHL have arguably greater parity than leagues with soft salary caps or no regulation at all. Also, the MLB with its lack of salary cap, is the one that has had dominant teams like the New York Yankees.

To what extent this perception is true is what we will explore in this paper. We seek to use data visualization techniques to understand the relationships between team performance and team finances across leagues with different salary caps. We will not only focus on the championship-winning teams, but a range of teams in the league to understand the impact of team salary expenses and salary caps on standings. We also examine the historical changes in salary expenses and the impact of these changes on team performance over time.

DATA

The data for this study comes from multiple sources and had to be cleaned and merged into a few files suitable for analysis. Various websites all over the internet display detailed results of all leagues and competitions around the world. However, there are no files that combine all the results together in one table in a way that we wanted it for our analysis. That is why we decided to create a suitable dataset like this ourselves.

The various data files are separated by sports and contain the results of the current and previous seasons. Thus, the soccer file contains the results of the soccer leagues from Europe and the U.S., while the basketball file contains only the results from basketball, and so on.
This was the first component of the dataset and the one that was relatively easy to obtain. We had to import the data from the different websites into one file and then do some cleanup. Finally, we added the countries, years and ranks of the teams to the dataset manually.

The second component of our data is the financial information of the clubs that we have added to the results. This focuses on the expenses for player salaries of each team. But unlike sports results, most financial information and contracts are not publicly available, and it is difficult to find the salaries and expenditures of the teams. This only applies to the clubs from Europe and not to those from North America. While athletes' salaries are published in the U.S., they do not have to be published in Europe because of the way the leagues are structured. Therefore, we must work with estimates most of the time if we want to work with European sports data.

However, since this applies to all teams and players in the same way and the estimates are very accurate from prior experience, we decided that we can use these values for the analysis. Yet, these estimates only go back to the year 2013 and we could not find any other data regarding salaries from previous years, which is the reason why the analysis mainly refers to the last ten years.

ANALYSIS

There have been prior studies on parity in sports that have used existing statistical measures like the Gini coefficient [5], relative standard deviation [10], Herfindahl-Hirschman Index [12] etc. to compare teams and leagues with regards to competitive balance. This study will focus on a visual approach to understanding parity and how competitive balance has changed over time and across leagues in Europe and the US and how team salaries play into it. We believe that exploratory visualization techniques will provide the ability to deeply understand the patterns and relationships both within and across leagues. These leagues were specifically chosen for study because they represent a very wide range of sports and salary cap parameters, and have publicly available data.

The analysis for this study is multifold and includes

1) Exploratory visualizations: This phase involves creating visualizations with the goal of getting key insights into the data [2] [3]. This phase of analysis typically starts with simple, generic, default charts [13]. As preliminary insights are gained, the visualizations get deeper and more complex to reveal a deeper understanding of patterns and relationships within the data. With each successive visualization, more questions and more potential directions can emerge and lead to key insights [3].

2) Creating a metric: One of the goals of this analysis is to understand how final rankings of teams in each league has changed over time and to correlate this to the team revenue / salary caps that have been implemented and also changed over time. To achieve this goal, we realize that we need to create a measure that will easily capture changes in team ranking over time. This measure will also take into consideration the extent to which it was possible for the team to move up or down in rankings. This measure will then be used to compare the extent of mobility in rankings over time across the three leagues in this study.

RELEVANCE TO DECISION SCIENCE

The field of decision science focuses on making data-informed decisions. Data visualization and data storytelling have both emerged as important techniques in decision making. Decision makers are expected to make the best possible decisions for resource allocation and planning considering the constraints they have. They do this based on their understanding of what factors influence the question in hand and how these factors can potentially be manipulated. In recent years, many studies from various fields, especially computer science and information science, have developed data visualization tools and described the utility and usability of these tools in their field [8]. Visualization techniques are also getting more popular in sports analytics and

within team sports management [13]. This study seeks to explore ways in which visualization techniques can be used at a broader level to study historical changes and comparisons across leagues using not only rankings data but also team financial data with the goal of adding deeper insight into the long-standing issue of competitive balance in sports.

RESULTS

In our exploratory analysis of the data, we created visualizations that reveal some interesting insights into each of these three questions:

1) How do team rankings vary in leagues with and without salary caps over the years?
2) How do financial resources among teams vary in leagues with and without salary caps, particularly between championship winning teams and teams that have not won championships?
3) What is the relationship between team finances and team success in leagues with and without salary caps?

Exploratory Analysis
Part 1: Fluctuation of Team Rankings within Leagues with and without Salary Caps

We first created a series of bump charts to examine the changes in team rankings among teams within European soccer leagues that have no salary caps, Major League Soccer which has a soft salary cap, Major League Baseball which only has luxury taxes, the National Basketball Association which has a soft salary cap too, and the National Football League which has a hard salary cap. We chose various leagues to represent the different types of salary caps, as well as different types of sports. Bump charts are variations of line charts that are used for plotting changes in relative ranks over time rather than absolute values [11]. In all of our bump charts, teams that have won championships are highlighted in blue.

From figures 1 and 2, it is clear that the top European soccer leagues are dominated by a few teams for years. A different situation can be discovered when examining North American leagues with salary caps. Figures 3 compares the European soccer leagues to Major League Soccer, and Figure 4 examines this distribution for the MLB which has the softest salary cap among North American Leagues. It can be see that there were more different winners. In addition, the rankings of the winners also fluctuated more. There is greater mobility within these leagues, and it is easier for teams who do not do well one year to move up in rankings the following year, and this is even more so for leagues with harder salary caps. The preattentive attribute of color used with bump charts made these patterns easier to detect in the presence of multiple lines.

FIGURE 1: Team Rankings Over Time in the German Bundesliga

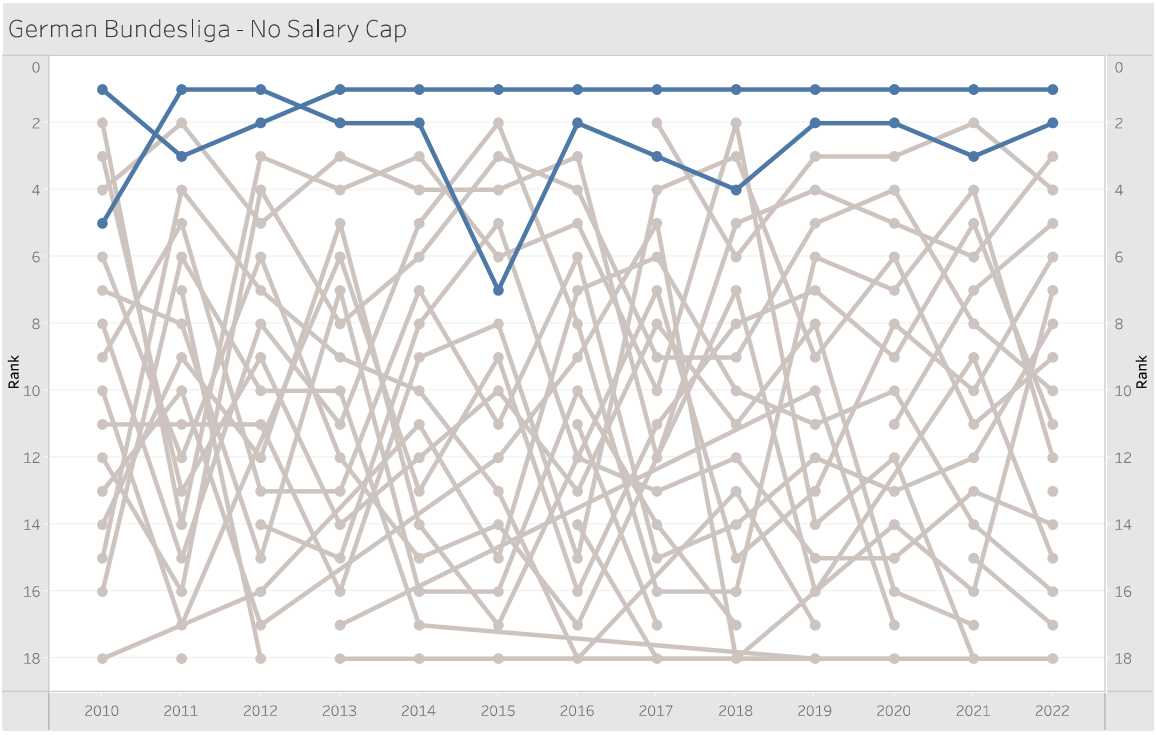


FIGURE 2: Team Rankings Over Time in the Spanish La Liga

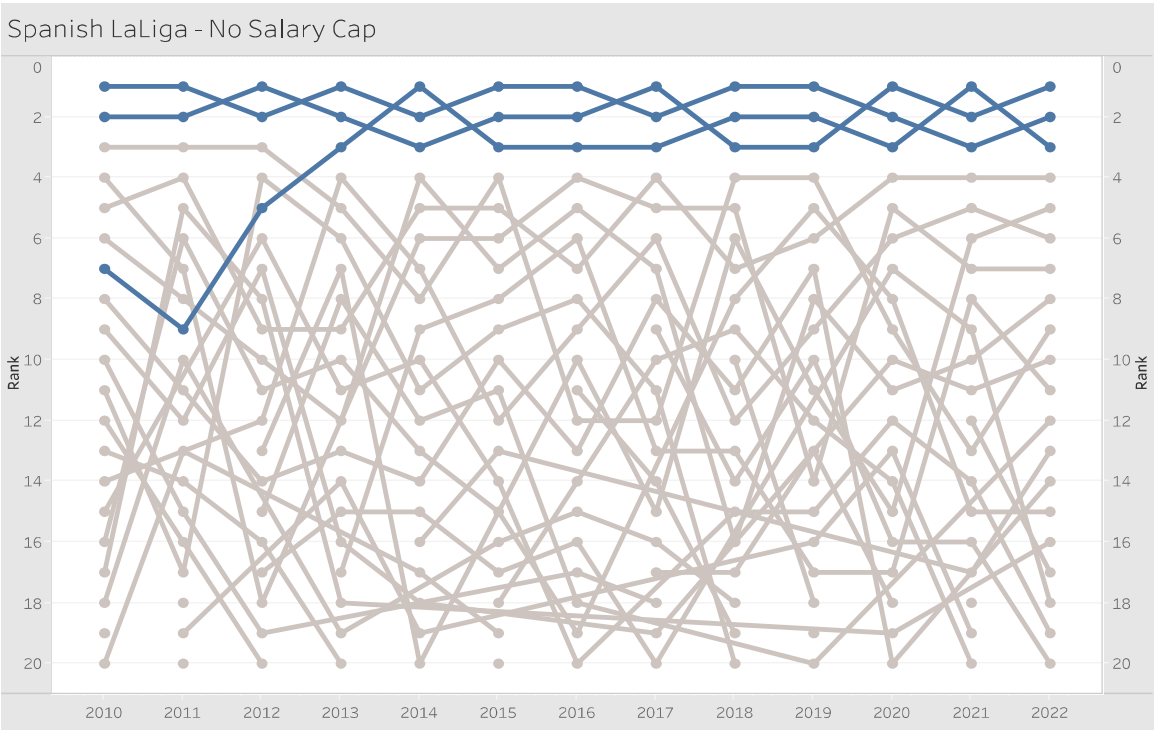


FIGURE 3: Team Rankings Over Time in Major League Soccer (Soft Salary Cap) compared to previous European soccer leagues

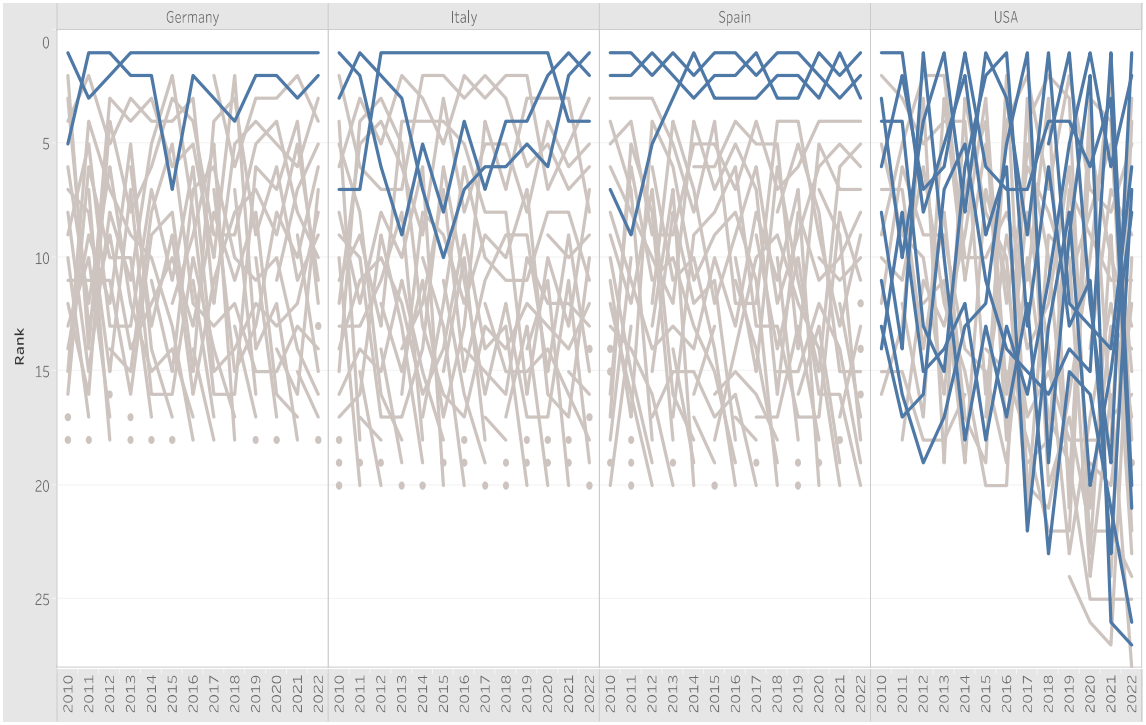
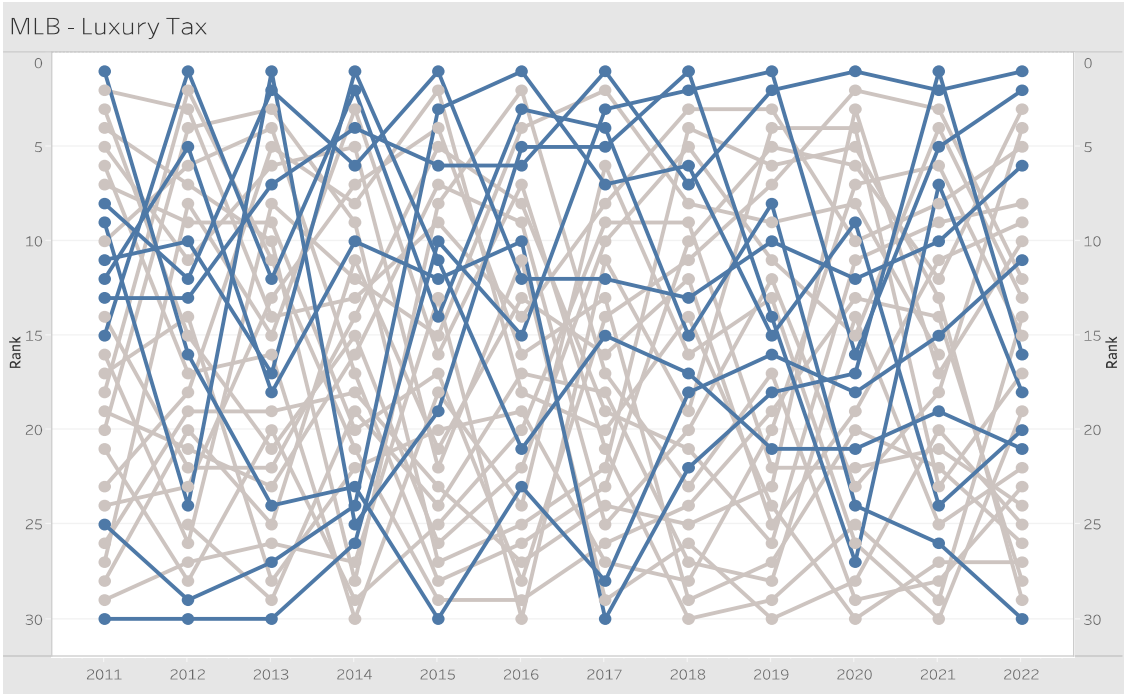


FIGURE 4: Team Rankings Over Time in the Major League Baseball (Luxury Tax)



Fluctuation Metric

To deeper understand the extent of mobility within leagues with and without a salary cap, we created a measure to capture changes in team ranking over time for each team. This metric, Rank Fluctuation, is the absolute value of the difference of the final ranking of a team in two consecutive years. A larger number thus indicates that a team moves up or down considerably from one year to the next, and small number indicates that a team moves little up or down rankings in consecutive years.

We next examined the average fluctuation in final rankings for several European soccer leagues as well as for Major League Soccer using this measure with side-by-side box plots. Box plots give compact summaries of data distributions including outliers and other interesting data points and are particularly useful to compare multiple data distributions [11].

The box plots (Figure 5) show a greater range on Rank Fluctuation for Major League Soccer compared to any of the European soccer leagues, confirming that team ranks vary more from year to year within the MLS than within any European league, and that it is possible for teams to move up or down to a larger extent in the MLS. MLS Rank Fluctuation ranged over 8.95 ranks on average, while the European league Rank Fluctuations from the five biggest leagues ranged between a low of 4.471 in the English Premier League to a high of 6.615 in the German Bundesliga on average.

Figure 6 is an alternative visualization of the fluctuation that points out the same finding in a different way. The horizontal line marks the average fluctuation with a value of 4.02 across all leagues. It shows that almost all teams from the MLS are above this line and thus have an above-average fluctuation. Additionally, Figure 5 highlights an apparent correlation between rank and fluctuation. Accordingly, the teams with the highest and lowest rankings fluctuate less than teams that on average, finish in a mid-ranking position.

The scatterplot in Figure 6 also supports the finding of dominant teams in Europe but not in the MLS. The best average rank of an MLS team is 6.1. In comparison, there are many European teams that have significantly better average rankings, which highlights the presence of league dominant teams. These observations are already indicated in the bump charts in Figures 1-4, but they become far more evident when a different kind of visualization like the scatterplot is utilized. This underlines how essential it is to pick an appropriate form of visualization to obtain the intended insights from available data.

In summary, based on the results of the last 13 seasons, the competitive balance in leagues without a salary cap is lower than in leagues with a salary cap. The European competitions without a salary cap are dominated by a few teams, and it is difficult for other teams to advance to the top rankings in the league. As the visualizations indicate, this is not the case in leagues with some sort of salary cap. In addition, it can be observed that team rankings fluctuate less in Europe than in the US in two consecutive seasons which further supports the findings about competitive balance within the leagues.

FIGURE 5: Comparison of Rank Fluctuation between European Soccer Leagues and Major League Soccer (USA)

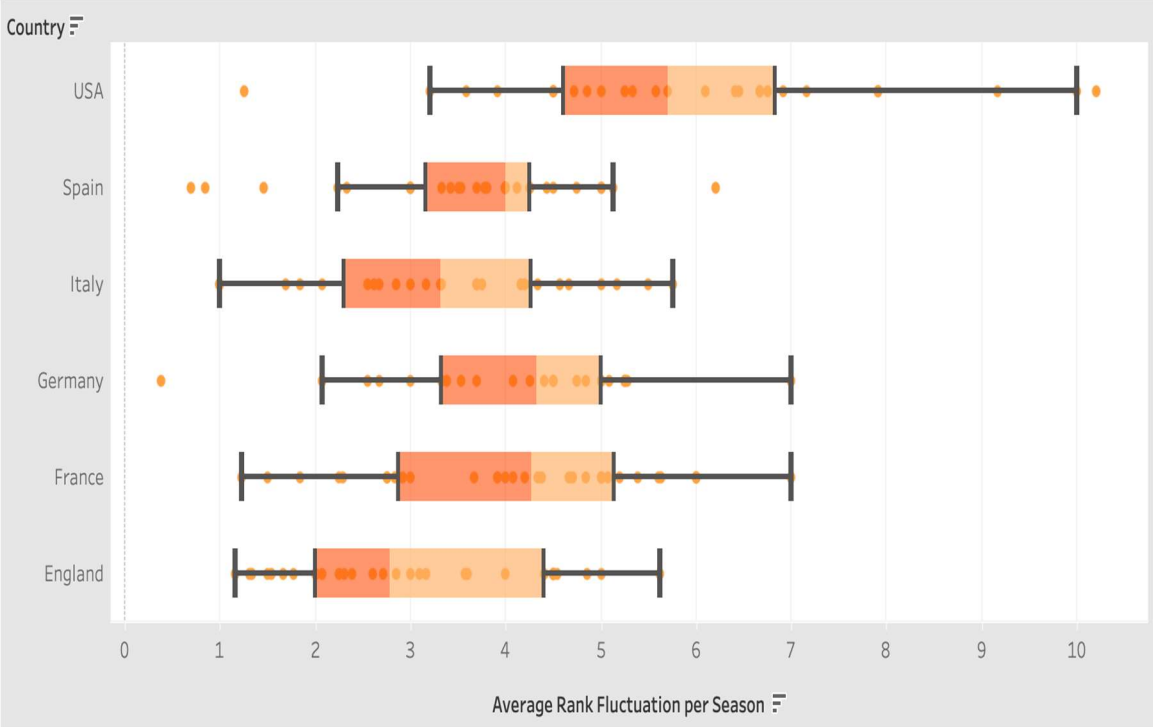
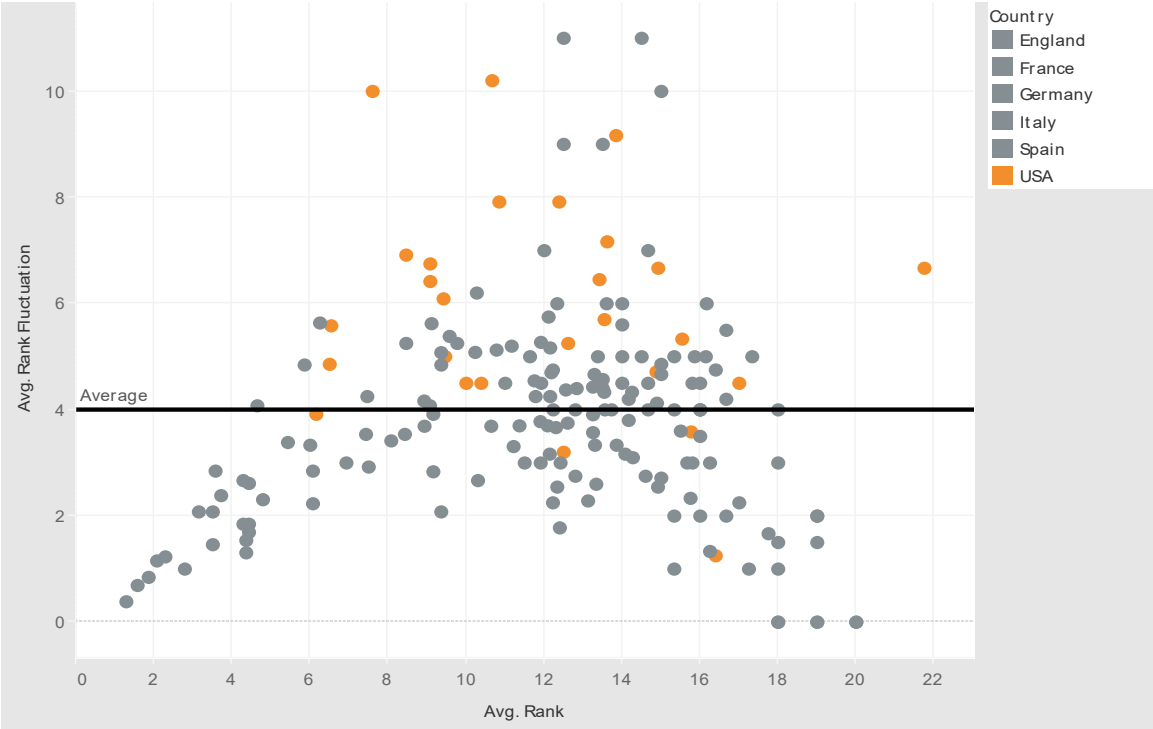


FIGURE 6: Comparison of Rank Fluctuation and Ranks between European Soccer Leagues (No Salary Cap) and Major League Soccer (Soft Salary Cap)



Part 2: Financial Resources of Teams within Leagues with and without Salary Caps

The next part of our analysis seeks to compare financial resources available to teams within leagues with and without a salary cap. In particular, we would like to examine how financial resources of teams that have won championships differ from teams that have not won.

To visually explore this question, we created a series of box plots that examine the average spending money available to teams over the time period examined. Figure 7 shows the distribution of average spending money available to teams within five European soccer leagues. Teams that have won championships are shown in blue. Figure 8 shows the average money available to American sports teams in four major North American sports leagues.

Our visualizations reveal clearly that championship-winning teams in the European leagues have far more spending money available at their disposal when compared to teams that have never won a championship within those leagues. In fact, almost all of the championship winning teams (in blue) were outliers in their respective distributions (Figure 10).

This is not so in the North American leagues that have either soft or hard salary caps. Figures 11 shows the average finances available to all MLB, MLS, NBA and NFL teams respectively. In American leagues, not all champions invest above-average amounts of money on player salaries, as is the case in Europe. They are more evenly distributed across the league. Only the MLB, seems to be an exception, as in that league, the champions are also the biggest spenders in the league.

Furthermore, spending among the teams does not differ to the same extent that it does in Europe. However, further examination shows that there is a difference between the leagues based on salary cap type. A value that reflects this observation very well is how much more the team with the highest salary expenditures spent compared to the team with the lowest expenditures. Figure 9 represents and compares the values for each league visually in one bar chart. This is yet another advantage of visualizations, as they have the ability to display differences between numbers compacted in one chart.

FIGURE 7: Distributions of Average Financial Resources Available for Teams within European Soccer Leagues (Championship-Winning Teams Shown in Blue)

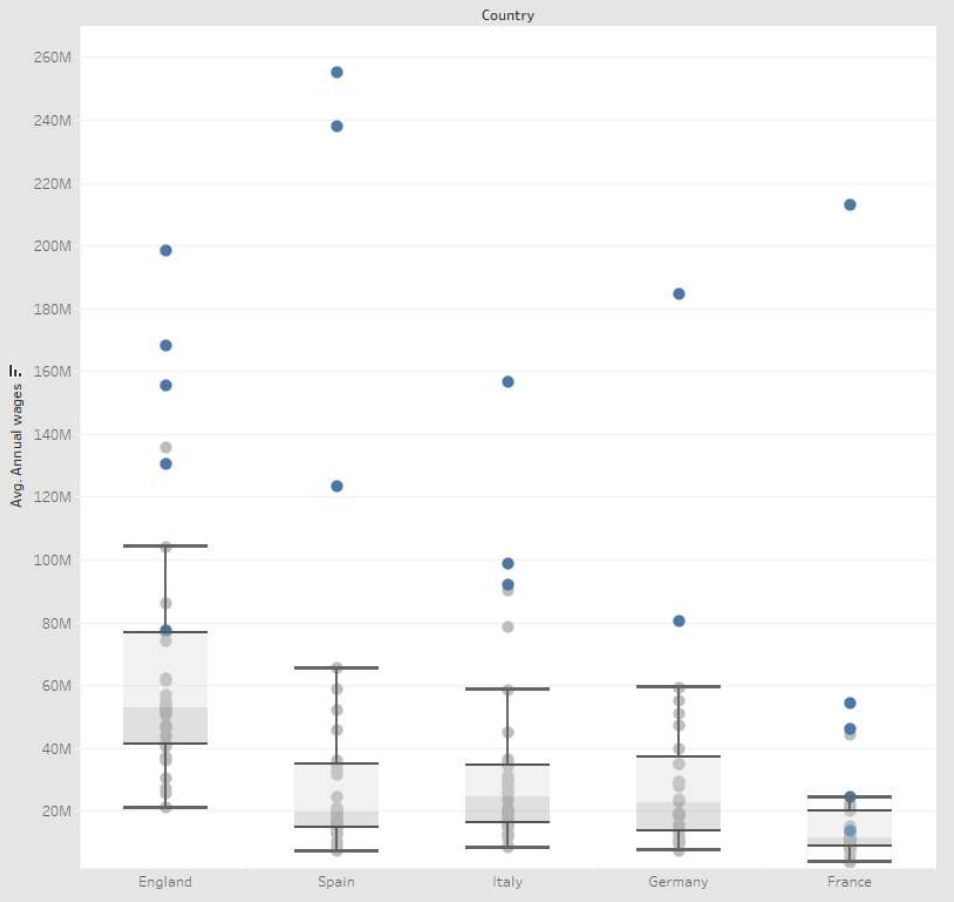


FIGURE 8: Distributions of Average Financial Resources Available for Teams within American Sport Leagues

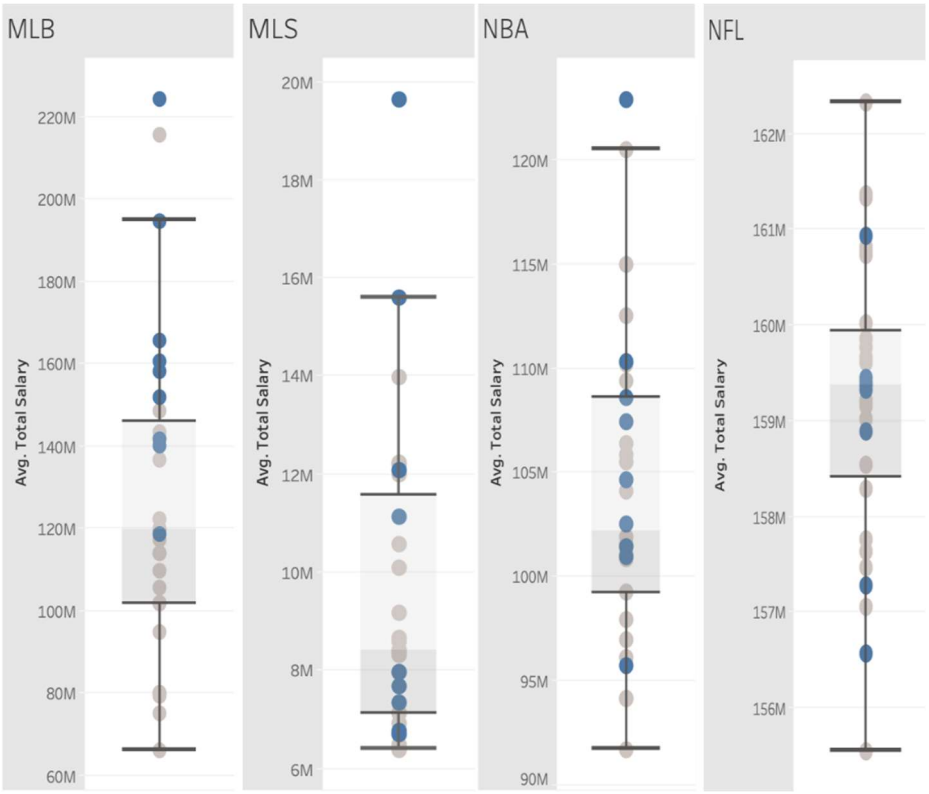
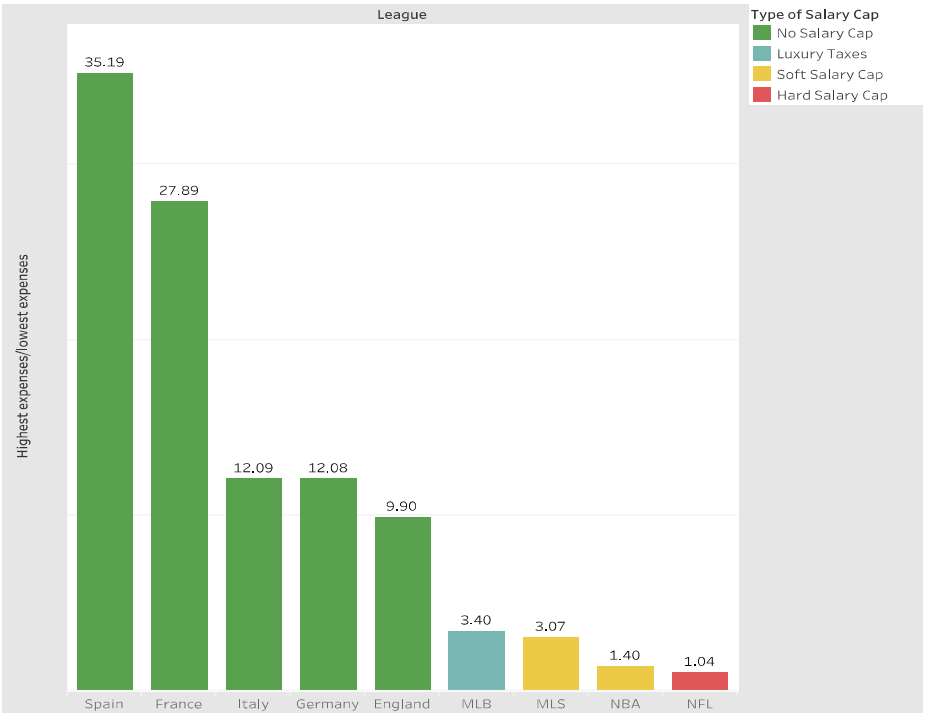


FIGURE 9: Comparison of Financial Gap between Team with largest and smallest Salary Expenses across all Leagues and Salary Caps



Part 3: Relationships between Team Finances and Team Success in Leagues with and without Salary Caps

In the first two steps, we were able to see noticeable disparities between the leagues in terms of both results and financial resources. In the next step in our exploratory analysis, we examined if there is a correlation between salary expenses by teams and team success as measured by the number of wins in a season. To investigate this question, we created scatterplots showing the relationships between the team finances and average number of wins the team has across the seasons examined.

The analysis revealed a strong correlation between salaries and wins across all the major European soccer leagues, an example of which (the German Bundesliga) is given in Figure 10, while the correlation became weaker in the North American leagues. Figure 11 shows the relationship for the MLS, and Figure 12 shows the relationship for the NFL which has the strictest salary cap. The NFL had the least correlation between finances and wins while the other North American leagues with softer salary caps also had weaker correlations than the European leagues. All the R-square values from a linear model are summarized in Table 1.

We further investigated the relationships by creating lines that represented 50% and 150% of the average league money and examining the proportion of the teams within each league that fell within and outside of this range. All the teams in the NFL (Figure 12) fall within the 50% and 150% of average league money distribution lines, whereas in all the European leagues, the teams with the most wins have more than 150% of the average financial resources of teams in the league. In the MLS, while there are two teams that have more than 150% of the average league money, these teams do not have the highest number of wins (Figure 11).

In summary, there is a strong statistical correlation between salaries and team success in European sports leagues without a salary cap. The implementation of regulations that restrict player salary expenses decreases this correlation. The stricter these rules get, the weaker the correlation becomes, up to the point where there is no correlation between expenditure and success at all.

FIGURE 10: Relationship Between Average Finances and Wins in The German Bundesliga

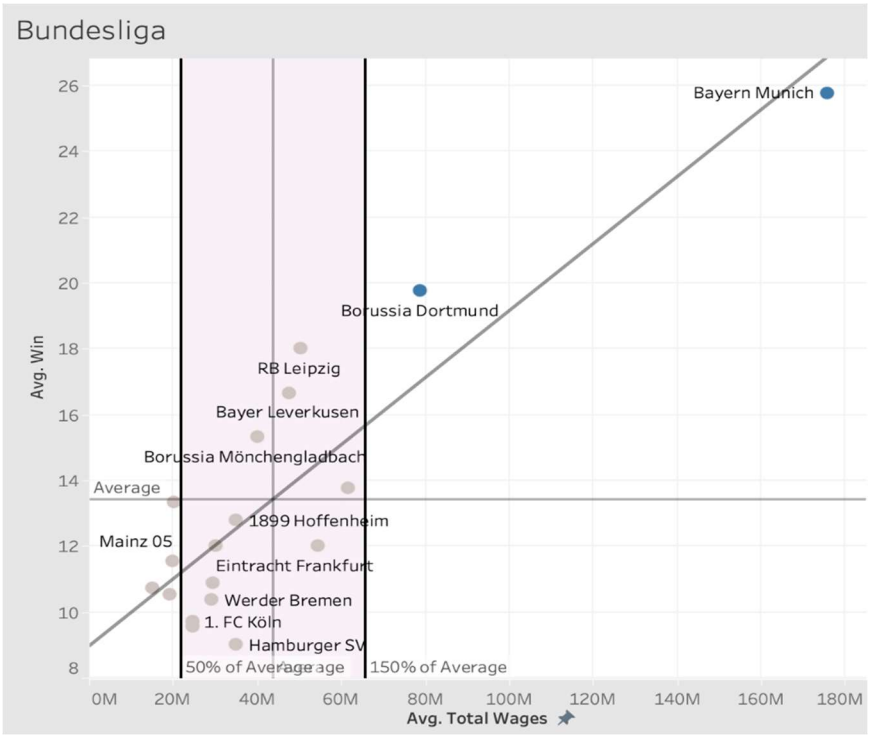


FIGURE 11: Relationship Between Avg. Total Salaries and Wins in Major League Soccer

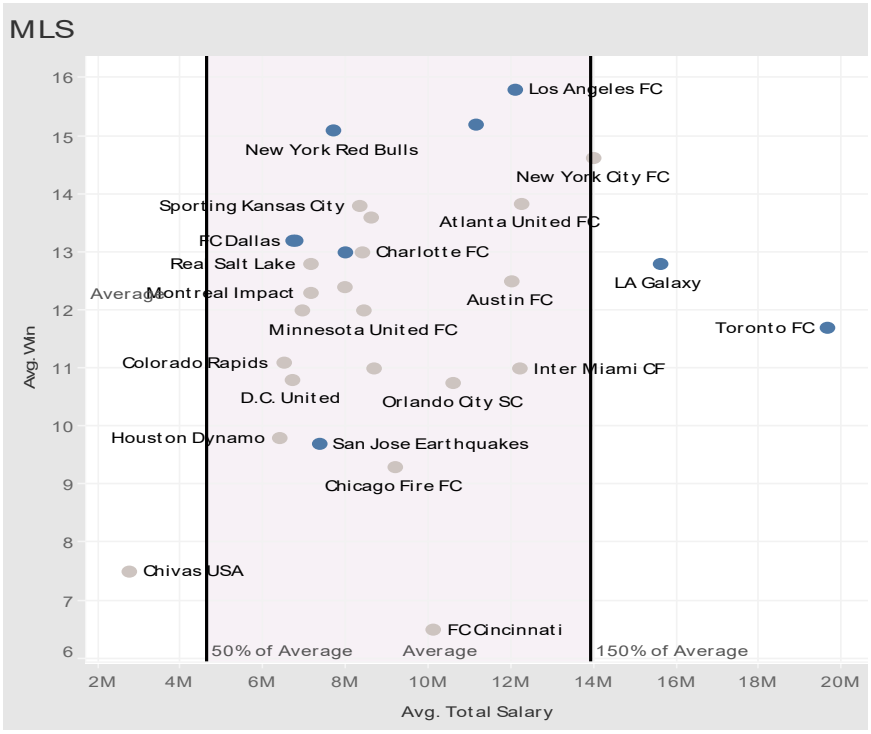


FIGURE 12: Relationship Between Average Total Salaries and Wins in the NFL

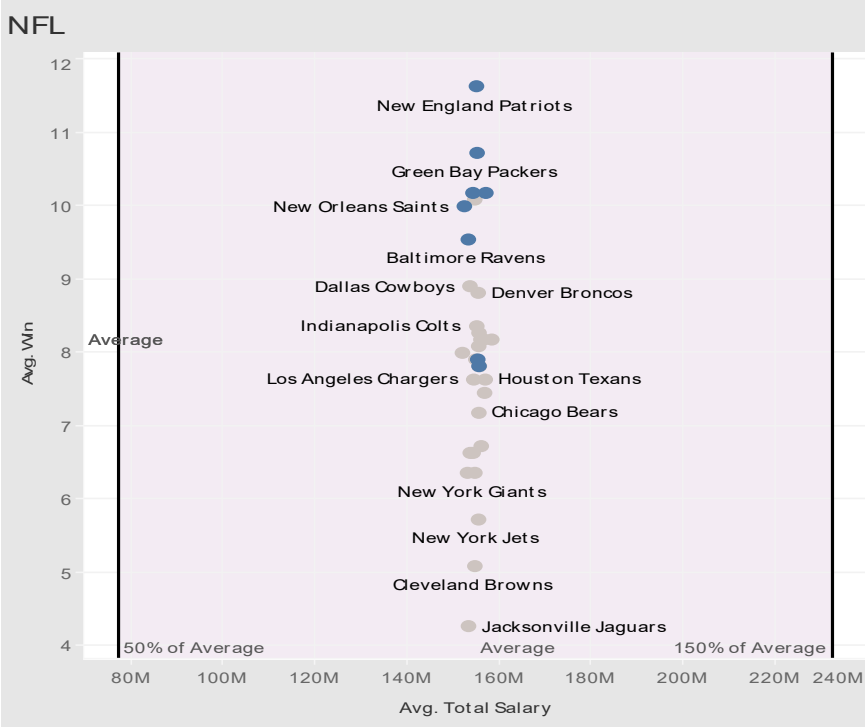


Table 1: A summary of relationships between average finances and wins in various leagues

League	Salary Cap Type	R^2	*P-value*
Bundesliga	None	0.7637	< 0.0001***
Premier League	None	0.7041	< 0.0001***
La Liga	None	0.7829	< 0.0001***
Serie A	None	0.7939	< 0.0001***
Ligue 1	None	0.6596	< 0.0001***
MLB	Luxury Tax	0.3179	0.0011**
NBA	Soft	0.1789	0.0198*
MLS	Soft	0.0776	> 0.05
NFL	Hard	0.0008	> 0.05

*$p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

DISCUSSION

Our visual analysis reveals three key findings

1. European soccer leagues without salary caps in general have a few consistently dominant teams. These teams either win championships or place very highly year after year. Mobility is limited within these leagues, and it is very hard for a team that is not in this elite group to win a championship. North American leagues in comparison do not have

teams that dominate and have much better mobility. It is possible for teams that do not perform well in one season to come back and perform well and even win a championship in the next season.

2. In leagues with no salary caps, there is great inequality in financial resources between teams that win championships and teams that do not. In leagues with salary caps, whether hard or soft, there is not much difference between the financial resources of winning teams and teams that do not win.
3. There is a strong correlation between financial resources and the number of wins a team has in leagues with no salary caps. This is not so in leagues with salary caps, and leagues with hard salary caps like the NFL have an even smaller correlation than leagues with soft salary caps like the MLS and the NBA. In all European leagues, most teams with a high number of wins have over 150% of the average financial resources of teams in the league.

Our analysis reveals the strong effect of salary caps on competitive balance and parity within leagues. Teams with greater financial resources typically spend more money on coach and player salaries and facilities. This results in more championship wins which in turn leads to more allowing for “collecting” more star players which results in more wins. This cycle is difficult to break without some form of regulation.

CONCLUSION AND FUTURE RESEARCH

A correlation between salaries and wins indicates that teams with more money are more successful. This means that the easiest way for a team to become or stay successful is to spend more money than their competition. This is a development which opposes the original idea of competitive sports and should be viewed critically. Especially considering that mechanisms such as performance-based revenue sharing or additional revenue streams like the ones existing in European soccer further reinforce the effect that the rich get richer. Without regulation, it will be very difficult for other teams to break this cycle and end the dominance. From the league's point of view dominance in this case must be considered as a bad thing, as it makes the league more predictable and less interesting for a large part of fans and players, and thus there is a diminishing interest in the league. However, it would be very valuable in a further study to examine what measurable impact competitive balance has on fan behavior and league revenues.

Due to the lack of availability of data, it was not possible to look further into the past in this study, but it would be very interesting to see what the situation in the leagues was like in the previous years. Do the same correlations emerge or has something changed over time? For example, the salary cap in the NFL was not introduced until 1994, and it would be interesting to see what the league's situation was like before that. The same applies to the European soccer competitions and the introduction of the Champions League in 1992.

Another suggestion for future work is to investigate the influence of the luxury tax in more detail, as this study showed large differences in salaries and a correlation between salary and wins. Nevertheless, in recent years there have been no dominant teams like it was the case in European Leagues and the fluctuation within the league has mirrored the fluctuation in other American leagues.

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FACTORS INFLUENCING THE VALUE OF PRIMARY SPONSORSHIP FOR NASCAR CUP SERIES TEAMS

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The importance of sports sponsorship cannot be overstated. In the area of motorsports, sponsorship for every aspect of the sport is imperative. Racetracks must have sponsors for events to support prize purses. Sanctioning bodies such as NASCAR must have sponsors to provide championship prizes. Teams must secure sponsors to fund every aspect of the business including construction of racing vehicles, travel to events, and maintenance of their facilities. Prior research has concentrated on the development of sponsorship partnerships and the maintenance of those relationships. However, little research covers the valuation of sponsorship opportunities.

The NASCAR Cup Series is the highest level of stock car racing in the United States. Although it is the most popular type of American motorsports, teams have struggled to secure sponsorships. At NASCAR's peak of popularity, teams could rely on a single primary sponsor for the entire season. However, as the popularity declined and economic conditions changed, teams have had to rely on multiple primary sponsors, which might change from race to race. The number of primary sponsors for a team might be dependent on the team's structure and longevity. Only three of the 36 full-time teams in the NASCAR Cup Series retained single-entity sponsorships for the entire season. For example, in 2022 Hendrick Motorsports maintained Ally Financial as the primary sponsor for one of its four racecars. The 2022 NASCAR Cup Series Champion Joey Logano's Team Penske car featured four primary sponsors during the season. Live Fast Motorsports relied upon 23 different brands as primary sponsors, most of all full-time teams.

Primary sponsors are those with their branding on the hood of the car and on the driver's uniform. Typically, these sponsors garner the most exposure during the race broadcast. As a result, the primary sponsor of the car will pay the highest rate for that sponsorship. For those teams requiring multiple sponsors, they will do so for a set number of races for each sponsor. Sponsors determine the races that they will act as primary sponsor based on the opportunities to leverage the sponsorship and maximize the returns on investment. Thus, there is an assumption that certain tracks and races garner greater price than others.

There are several factors in addition to those mentioned that might influence the asking price of primary sponsorship. The goal of the current study is to determine what factors are most important to NASCAR Cup Series sponsorship managers. This presentation reports the findings of an ongoing Delphi study involving a questionnaire to determine factors influencing the valuation of primary sponsorship with follow-up surveys requesting rankings of the most influential factors. At least two rounds of rankings are being implemented to ascertain consensus among the participants.

Hybrid GA and Enhanced Jaya Algorithm for Supply Chain Network Model with Disruption Risk

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ABSTRACT

Design and optimization of logistics and *supply chain management* (SCM) network is very important issue, which plans, implements and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the origin and customers. A multistage-based logistics or SCM network can be modeled by means of a sequence of stages, each consisting of a set of functions, *i.e.* the existing or potential facilities located in several countries or regions of the world where goods are transformed or manufactured or stocked and delivered: suppliers, plants, distribution centers (DCs) and customers together. At the same time, we have to consider a disruption which is one of the major risks that can be occurred in the SCN model in the real world. Among the various risks the disruption as one of the categories which is occurred by natural disasters, terrorist attacks, war, etc.

In this paper we propose a *hybridized genetic algorithm* (HGA) combined the enhanced *Jaya algorithm*, HGA-EJA. In overall view, the HGA-EJA algorithm has better convergence behaviors than the others for effectively solving the SCN network models with disruption risk. We implement various metaheuristics such as GA, JAYA, TLBO, PSO, GA-TLBO, and GA-PSO for quantitatively evaluating the proposed HGA-EJA algorithm with different scenarios by using the performance measures: the best solution (BS), average solution (AS), and average CPU time (unit: sec.). Finally, we demonstrate the performance of the HGA-EJA algorithm is effectively superior to those of all single metaheuristic algorithms (GA, JAYA, TLBO, and PSO).
For the CPU time, GA, JAYA, TLBO, and PSO are short than all GA-TLBO and GA-PSO including the HGA-EJA algorithm. In overall view, the HGA-EJA algorithm proposed has better convergence behaviors than the others.

1. Introduction

As the development of economic globalization and extension of global electronic marketing, global enterprise services supported by universal supply chain and worldwide logistics and *supply chain management* (SCM) network design become imperative for business world. How to manage logistics system efficiently thus has become a key issue for many companies to control their costs. That is also why an elaborately designed logistics network under the help today's fully-fledged information technology is catching more and more attentions of business entities, especially that of many multinational companies [1] (Chopra & Meindl, 2010). *Supply chain network* (SCN) design is to provide an optimal platform for efficient and effective SCM. This is an important and strategic operations management problem in SCM. The design task involves the choice of facilities (plants and

distribution centers (DCs)) to be opened and the distribution network design to satisfy the customer demand with minimum cost. It belongs to a production-distribution and facility location-allocation problem. When the facilities have a certain capacity, the problem is referred as a *capacitated location-allocation problem* (CLAP). Since the multi-stage design problem is difficult to solve optimally, especially if capacity constraints are imposed on both plants and DCs, researchers have utilized metaheuristic approaches to solve this problem [2] (Altiparmak, Gen, Lin, & Karaoglan, 2009). Jayaraman and Pirkul (2001) have developed a heuristic approach based on Lagrangean relaxation for the single-source, multi-product, multi-stage SCN design problem [3]. Another heuristic approach based on Lagrangean relaxation and simulated annealing has been developed by Syam (2002) for a multi-source, multi-product, multi-location framework [4]. Jang, Jang, Chang, & Park (2002) presented a combined model of network design and production/distribution planning for a SCN [5]. While they have used a Lagrangean heuristic for the design of SCN.

As one of the *evolutionary computations* (EC), the *genetic algorithm* (GA) has been receiving great attention and successfully applied for combinatorial optimization problems ([6] Goldberg 1989, [7~8] Gen & Cheng 1997, Gen & Cheng 2000), many researchers have proposed for solving various integrated production and distribution planning problems including logistics and SCM network design models.

Roghanian and Pazhoheshfar (2014) [9] proposed a priority-based GA for the integrated closed-loop logistics network design with fuzzy-random programming, Jamrus, Chien, Gen, and Sethanan (2015) proposed discrete particle swarm optimization (PSO) approaches and extended priority-based *hybrid GA* (HGA) for multistage production distribution under uncertainty demands [10]. Pasandideh, Niaki, and Asadi (2015) proposed *nondominated ranking GA* (NRGA) for solving bi-objective optimization of a multi-product multi-period three-echelon supply chain problem under uncertain environments [11]. Lee, Chung, Lee, and Gen (2015) proposed a multi-objective hybrid genetic algorithm to minimize the total cost and delivery tardiness in a reverse logistics [12], Mehrdad, Xue, Miao, and Lin (2015) proposed a straight priority-based GA for a logistics network [13], Tari and Hashemi (2016) proposed a priority-based GA for nonlinear transportation costs problems [14], Pasandideh and Asadi (2016) proposed NRGA for solving bi-objective optimization of a multi-product multi-period three-echelon supply chain problem under uncertain environments [15], and Cho, Lee, Cho, and Gen (2016) proposed logistics network optimization considering balanced allocation and vehicle routing [16].

Shi, et al (2017) proposed multi-objective optimization method by improved genetic algorithm for solving the closed-loop network design problem in which the three objective functions consisting of the overall costs, all carbon emissions and the responsiveness of the network [17]. An improved genetic algorithm based on the framework of NSGA II developed to solve the problem and obtain superior Pareto-optimal solutions in which the priority-based encoding method proposed by [8] Gen and Cheng (2000) shown a better performance for solving network design problems and successfully applied in forward supply chain networks [18] (Altiparmak, et al 2006). Gen, Lin, Yun and Inoue (2018) reported advances in hybrid priority-based genetic algorithms for logistics and SCM network design in which the following multistage based logistics or SCM network models introduced [19]: 1) the sugarcane SCM network model, 2) multiobjective supply chain network model, 3) flexible multistage logistics network model, and 4) multiobjective reverse logistics network model.

Yun, Anudari and Gen (2020) proposed hybrid genetic algorithm, the pro-HGA for solving a *sustainable closed-loop supply chain* (SCLSC) design problem in which they considered 1) minimizing the total cost, 2) minimizing the total amount of CO_2 emission during production and transportation of products, 3) maximizing the social influence. They demonstrated that the pro-HGA approach outperforms its competitors and that the SCLSC design problem with three types of distribution channels is more efficient than that with a single distribution channel [20].

Recently, Pak, Nahavandi, & Bagheri (2022) proposed an improved metaheuristic for solving multiobjective green SCN design problem in the automotive company using company [21]. They combined the Taguchi method to set the parameters of these two NSGA II and SPEA2, respectively and moreover, the priority-based method is applied to encode the bi-objective mo del. Anudari, Yun and Gen (2022) proposed a supply chain network (SCN) model which simultaneously considers the disruption risks of facility and route by using GA and *variable neighborhood search* (VNS) algorithm [22]. Disruption is one of the major risks that can be occurred in the SCN model and has been considered by many literatures [22] in which it classified various risks into nine categories and suggested that disruption as one of the categories is occurred by natural disasters, terrorist attacks, war, etc. The disruption is also consisting of two main risks (natural disasters and human-made disasters). The first risk is mainly caused by earthquakes, floods, or hurricanes, and the second one by terrorist or cyber-attack.

In this paper we propose a *hybridized genetic algorithm* (HGA) and *Enhanced Jaya algorithm* (HGA-EJA) for effectively solving the SCM network models with disruption risk. We implemented various metaheuristics such as GA, JAYA, TLBO (*Teaching-Learning based Optimization*), PSO, GA-TLBO, GA-PSO, and HGA-EJA for effectively evaluating the proposed HGA-JA algorithm with different scenarios by the best solution (BS) in all trials, average solution (AS) through all trials, and average CPU time (CPU) through all trials (unit: sec.). Finally, we get the following experimental results:

- In terms of BS and AS respectively, the performance of the HGA-EJA algorithm is superior to those of all single metaheuristic algorithms (GA, JAYA, TLBO, and PSO).
- In terms of CPU, all hybrid metaheuristic algorithms (GA-TLBO, and GA-PSO) including the HGA-EJA algorithm do not show any merit when compared with all single metaheuristic algorithms (GA, JAYA, TLBO, and PSO)
- In overall view, the HGA-EJA algorithm has better convergence behaviors than the others.

The remainder of this paper is organized as follows: In Section 2, a brief literature review of supply chain network models by variant GAs and recent metaheuristics including *teaching learning -based optimization* (TLBO) and Jaya algorithms is presented. Section 3 outlines the supply chain network model and mathematical formulation of SC network with disruption. In Section 4, Hybrid GA and enhancing Jaya Algorithms (HGA-EJA) for solving supply chain network model with disruption risk. Computational results are discussed in Section 5. Finally, Conclusions and future research direction are discussed in the last section.

2. Literature Review

2.1 Supply Chain Network Models

Gen and Li (1999) proposed a *spanning tree-based genetic algorithm* (STGA) for solving the bicriteria fixed charge transportation problem [23] and Gen, Cheng, and Oren (2001)

proposed an adapted GA for solving various network design problems [24]. Syarif, Yun, and Gen (2002) have applied the STGA approach for solving the multi-source and multistage SCN design problem [25]. Zhou, Min, and Gen (2002) proposed a GA approach for treating the balanced allocation of customers to multiple distribution centers in the supply chain network [26]. Gen and Syarif (2003) proposed HGAs with fuzzy logic controller for designing a multistage supply chain network problem [27]. Zhou, Min, and Gen (2003) proposed a GA approach to the bi-criteria allocation of customers to warehouses [28]. Syarif and Gen (2003) proposed a HGA for production/distribution system in supply chain [29]. Gen, Kumar, and Kim (2005) surveyed recent network design techniques using evolutionary algorithms [30]. Min, Zhou, Gen, and Cao (2005) proposed a GA approach to the balanced allocation of customers to multiple warehouses with varying capacities [31]. Gen and Lin (2005) proposed a multiobjective HGA for solving bicriteria network design problem [32]. Gen and Syalif (2005) proposed a HGA with Prufer number encoding for solving multi-time period production/distribution planning problem [33]. Hwang, Park, and Gen (2006) proposed a priority-based GA for solving a variant of orienteering problem [34]. Yeh (2006) has also proposed a *memetic algorithm* (MA) which is a combination of GA, greedy heuristic, and local search methods for the SCN design problem [35]. The author has extensively investigated the performance of the MA on the randomly generated problems. Altiparmak, Gen, Lin, and Paksoy (2006) applied a priority-based GA approach for solving multiobjective optimization of SCN design problem [36]. Ko, Altiparmak, and Evans (2007) proposed a GA-based heuristic for the dynamic integrated forward/reverse logistics network for 3PLs [37]. Wang, Lin, Gen, and Shiota (2007) proposed a priority-based GA for a case study on optimal routing in logistics network [38]. Jo, Li, and Gen (2007) proposed a STGA for solving nonlinear fixed charge transportation problem [39]. Gen, Cheng, and Lin (2008) proposed a GA based approach to cope with multiobjective network design problems [40].

Jawahar and Balaji (2009) proposed a GA for the two-stage SCN problem associated with a fixed charge [41]. Altiparmak et al. (2009) proposed a *steady-state genetic algorithm* (SSGA) using priority-based encoding and integer encoding for the single-source, multi-product, multistage SCN design problem [42]. Sourirajan, Ozsen, and Uzsoy (2009) proposed a GA for solving a single product network design model with lead time and safety stock considerations [43]. Yun, Moon, and Kim (2009) proposed a HGA with adaptive local search scheme for solving multistage-based supply chain problems [44]. Pishvaee, Farahani, and Dullaert (2010) proposed a memetic algorithm for solving bi-objective integrated forward/reverse logistics network design [45]. Ataka, Kim, and Gen (2010) proposed a Boltzmann random key-based GA for optimal design of two-stage logistics network considered inventory [46]. Inoue and Gen (2012) proposed a HGA for solving multistage logistics system design problem with inventory considering demand change [47]. Yun, Gen, and Hwang (2012) proposed an adaptive GA to multi-stage reverse logistics network design for product resale [48]. Neungnatcha, et al (2013) proposed an adaptive GA with fuzzy logic controller for solving sugarcane loading stations with multifacility services problem [49]. Roghanian and Pazhoheshfar (2014) applied the priority-based GA for the integrated closed-loop logistics network design with fuzzy-random programming [9], Jamrus, et al (2015) proposed discrete PSO approaches and extended priority-based HGA for multistage production distribution under uncertainty demands [10]. Pasandideh, Niaki, and Asadi (2015) proposed *non-dominated ranking genetic algorithm* (NRGA) for solving bi-objective optimization of a multi-product multi-period three-echelon supply chain problem under

uncertain environments [11]. Lee, et al (2015) proposed a multi-objective HGA to minimize the total cost and delivery tardiness in a reverse logistics network [12].

We summarized in the list of the papers until 2016 for the various SC network models by variant genetic algorithms in Table 1 and also list of the recent papers for the various reverse logistic models and closed-loop SC models by variant Genetic algorithms, respectively.

TABLE 1: Various SC Network models by Genetic Algorithms

Authors (year)	Mathematical or Problem models	Objectives	Methodology	Journal or Proceedings
Gen, Li (1999)	bicriteria fixed charge transportation problem	makespan	Spanning tree-based genetic algorithm	*Proc. of IEEE- Congress on Evolutionary Comp.*
Syarif, Yun, Gen (2002)	Multi-stage logistics chain network	total costs	spanning tree-based genetic algorithm	*Computers & Industrial Engineering*
Zhou, Min, Gen (2002)	Balanced allocation of customers	total costs	genetic algorithm	*Computers & Industrial Engineering*
Syarif, Gen (2003)	production/distribution model in SCM	makespan	hybrid GA	*Inter. J. Smart Eng. System Design*
Gen, Syarif (2003)	Multistage supply chain network	makespan, total tardiness	Genetic algorithm with fuzzy logic controller	*Fuzzy Sets based heuristics for optimiz.*
Zhou, Min, Gen (2003)	Bicriteria allocation of customers	makespan	Bi-objective genetic algorithm	*Inter. J. Production Economics*
Min, Zhou, Gen, Cao (2005)	Balanced allocation of customers	total costs	Genetic algorithm	*Inter. J. Logistics Research & Appl.*
Gen, Syalif (2005)	multi-time period production/distribution	total costs	hybrid genetic algorithm	*Computers & Industrial Engineering*
Altiparmak, Gen, Lin, Paksoy (2006)	multiobjective SC networks	total costs	Multiobjective genetic algorithm	*Computers & Industrial Engineering*
Yeh (2006)	multi-stage SCN model	Makespan	memetic algorithm	*Inter. J. Advanced Manufacturing Tech.*
Hwang, Park, Gen (2006)	variant of orienteering problem	total costs	priority-based genetic algorithm	*Inter. J. Logistics and SCM Systems*
Wang, Lin, Gen, Shiota (2007)	Case study of logistics network mlodel	total costs	priority-based genetic algorithm	*IEEJ Trans. on Electro., Info. & Systems*
Gen, Cheng, Lin (2008)	*Network models and optimization*	various object. functions	Multiple objective GA approach	Springer-Verlag
Altiparmak, Gen, Lin, Karaoglan (2009)	multiproduct supply chain network design	total costs	steady-state genetic algorithm	*Computers & Industrial Engineering*
Yun, Moon, Kim (2009)	multistage-based supply chain model	total costs	Hybrid GA with adaptive local search	*Computers & Industrial Engineering*
Pishvaee, Farahani, Dullaert (2010)	bi-objective forward/ reverse logistics model	total costs	memetic algorithm	*Fuzzy Sets and Systems*
Ataka, Kim, Gen (2010)	two-stage logistics network with inventory	total costs	Boltzmann random key-based GA	*IEEJ Trans. on Elect. & Electronic Eng.*
Yun, Gen, Hwang (2012)	multi-stage reverse logistics network	total costs	adaptive genetic algorithm	*Information*
Inoue, Gen (2012)	multistage logistics system with inventory	total costs	hybrid genetic algorithm	*Electronics and Communicat. in Japan*
Yun, Gen, Hwang (2012)	multi-stage reverse logistics network	total costs	adaptive genetic algorithm	*Information*
Neungnatcha, Sethanan, Gen, Theerakulpisut (2013)	biobjective sugarcane SC network	total cost	priority-based modified encoding–decoding GA	*Computers and Electronics in Agricult.*
Roghanian, Pazhoheshfar (2014)	stochastic reverse logistics network	total costs	genetic algorithm	*Journal of Manufacturing Systems*
Jamrus, Chien, Gen, Sethanan (2015)	uncertain multistage production distribution	total cost	discrete PSO and priority-based HGA	*Fuzzy Optimization and Decision Making*
Pasandideh, Asadi (2015)	uncertain bi-objective SC network model	mean & variance of total cost	priority-based modified encoding–decoding	*Inter. J. Management Sci. & Eng. Management*
Cho, Lee, Cho, Gen (2016)	Logi. network balanced allocation & routing	Total cost & travel distance	Microsoft Excel Solver hybrid GA	*Maritime Economics & Logistics*

TABLE 2: Reverse Logistic models and Closed-loop SC models by variant GAs

Authors (year)	Mathematical or Problem models	Objectives	Methodology	Journal or Proceedings
Ko, Altiparmak, Evans (2007)	integrated forward/ reverse logistics	Makespan	genetic algorithm-based heuristic	*Computers & Operations Research*
Lee, Dong (2009)	reverse logistics under uncertainty	two-stage stochastic programming model	hybrid genetic algorithm	*Transportation Research Part E*
Lee, Gen, Rhee (2009)	reverse logistics	# disassembly & process centers	hybrid genetic algorithm	*Computers & Industrial Engineering*
Lee, Chung, Lee, Gen (2015)	Multiobjective reverse logistics	total cost, delivery tardiness	multi-objective hybrid GA	*Multimedia Tools and Applications*
Cho, Lee, Cho, Gen (2016)	Bicriteria SCM network model	balanced allocation and vehicle routing	hybrid genetic algorithm	*Maritime Economics & Logistics*
Shi, Liu, Tang, Xiong (2017)	MO-CLSC network design	cost functions, CO_2 emissions	improved genetic algorithm	*Applied Mathematical Model*
Gen, Lin, Yun, Inoue (2018)	MoSCM and reverse logistics design	flexible m-stage logistics, MoSC	hybrid priority-based GAs	*Computers & Industrial Engineering*
Guo, He, Gen (2019)	CLSC with disruption	return rate, buyback cost, remanuf. cost	genetic algorithm, particle swarm opt.	*Computers & Industrial Engineering*
Yun, Anudari, Gen (2020)	Sustainable closed-loop supply chain	3 cost functions, CO_2 emissions	Hybrid genetic algorithm	*Mathematics*
Guo, Yu, Gen (2020)	Green CLSC in e-commerce	Manuf. costs, remanuf. costs	genetic algorithm, particle swarm opt.	*Computers & Industrial Engineering*
Pak, Nahavandi, Bagheri (2022)	MO-green SCN for automotive Co. Ltd	cost functions, CO_2 emissions	improved meta-heuristic algorithm	*Inter. J. Environmental Sci. and Tech.*
Guo, Wang, Gen (2022)	Uncertain Green CLSC with CER	New product costs, Remanufactur. costs	genetic algorithm, particle swarm opt.	*Mathematical Biosciences & Eng.,*
Anudari, Yun, Gen (2022)	SC network with facility & disruption	Three cost functions	genetic algorithm variable neighborh.	*Inter. J. Management Sci. & Eng. Management*

2.2 Recent Metaheuristics: TLBO and Jaya

Teaching-learning based optimization (TLBO) is also a stochastic algorithm which was first proposed for solving multimodal unconstrained optimization problems in 2011 [56, 57]. It is population based and nature-inspired metaheuristic that imitates teaching learning process in which it has teacher phase and learner phase. Recently Zou, *et al.* (2019) reported a comprehensive survey of TLBO which is one of population-based heuristic stochastic swarm intelligent algorithms [58]. Learners and teacher are two main factors of a class and the TLBO explains two modes of learning via teacher (known as the teacher phase) and discussion among the follower students (known as the learner phase). Gen, *et al* (2021) proposed hybridized TLBO with GA and PSO for solving a SCN model [59] and Yun, *et al* (2022) also proposed a hybrid metaheuristic approach consisting of GA, PSO & TLBO for solving various engineering optimization problems [60].

As shown in the paper title of Jaya by Rao (2016), it is really a simple and new optimization algorithm for solving constrained and unconstrained optimization problems [61]. A simple yet powerful optimization algorithm is proposed in this paper for solving the constrained and unconstrained optimization problems. This algorithm is based on the concept that the solution obtained for a given problem should move towards the best solution and should avoid the worst solution. The performance of the proposed algorithm is investigated by implementing it on 24 constrained benchmark functions and the performance is compared with that of other well-known optimization algorithms such as PSO, *differential evolution* (DE), *artificial bee colony* (ABC), *biogeography-based optimization* (BBO), *heat transfer search* (HTS) and TLBO with Jaya [62, 63]. The performance of the Jaya algorithm is tested

further on 30 unconstrained benchmark functions well documented in the optimization literature. It compared with the results obtained by the other optimization algorithms such as GA, PSO, DE, ABC and TLBO. The proposed Jaya algorithm has obtained better results in terms of "best', 'mean' and 'worst' values of each objective function and 'standard deviation'. Furthermore, it can be observed that the performance of the Jaya algorithm is found either equal or better than all other algorithms in all the 30 unconstrained benchmark functions. Caldeira & Gnanavelbabu (2019) proposed an improved Jaya algorithm for solving the *flexible jobshop scheduling problem* (FJSP) [64]. Dokeroglu, et al (22019) reported a survey on new generation metaheuristic algorithms including Jaya algorithm [65] and recently Gen, et al (2022) reported a hybrid GA and Jaya algorithm for solving the nonlinear least-squares problems [66].

3. SCN MODEL AND MATHEMATICAL FORMULATION

3.1 SCN MODEL WITH DOUBLE DISRIPTION RISK

The SCN model suggested in this paper is consist of several suppliers at each *supplier group* (SG), one manufacturer, several *distribution centers* (DCs) at each regional *DC groups* (DCG), and retailers at each region. The conceptual network flow of the SCN model is displayed in Fig. 1.

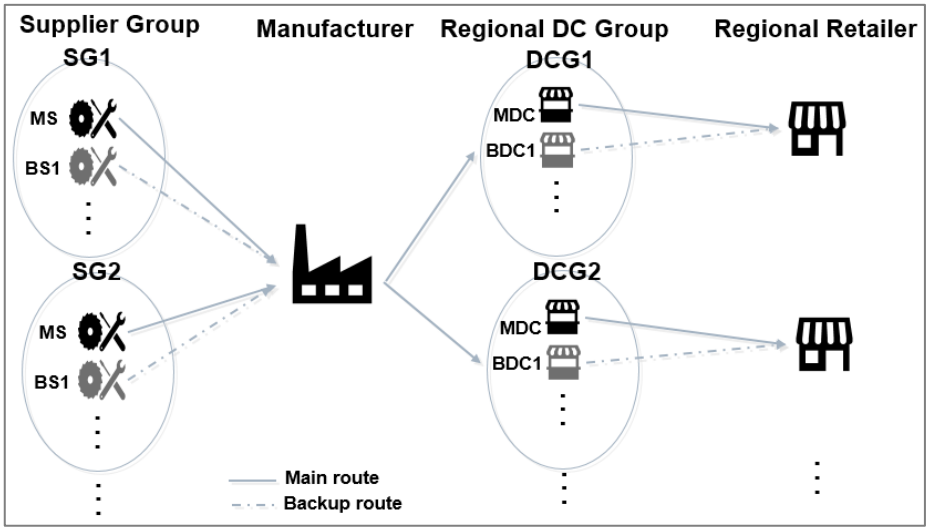

Fig. 1: An conceptual network flow of the SCN model

As seen in Fig. 1, *main supplier* (MS) at each SG is opened and sends parts (or materials) to manufacturer, but if the MS at each SG is disrupted, then the *backup supplier* (BS) at each SG will send parts (or materials) to manufacturer. The same situation is also shown at DCG, that is, *main DC* (MDC) at each regional DCG is opened and sends products to retailer, but if the MDC at each regional DCG is disrupted, then the *backup DC* (BDC) at each regional DCG will send products to retailer. The BS at each SG and the BDC at each regional DCG are randomly selected. Since double disruption risks at each SG and each regional DCG can be occurred, finding optimal network flow at the SCN model is not an easy task. In the following Section, a mathematical formulation is suggested for effectively representing the SCN model with double disruption risks.

3.2 SC Network Model with double disription risk

For formulating the SCN model with double disruption risks, we define sets and indices, parameters, and decision variables as follows:

- **Sets and Indices**

A set of SGs, indexed by a
S set of main suppliers, indexed by s
S' set of backup suppliers, indexed by s'
R set of main routes at main supplier, indexed by r
R' set of backup routes at backup supplier, indexed by r'
M set of manufacturers, indexed by m
U set of main routes at manufacturer, indexed by u
B set of regional DCGs, indexed by b
D set of main DCs, indexed by d
D' set of backup DCs, indexed by d'
O set of main routes at main DC, indexed by o
O' set of backup routes at backup DC, indexed by o'
T set of regional retailers, indexed by t

- **Parameters**

f_{1as} fixed cost at main supplier s of SG a.
$f_{2as'}$ fixed cost at backup supplier $s'$of SG a.
h_{1as} unit handling cost at main supplier s of SG a.
$h_{2as'}$ unit handling cost at backup supplier s' of SG a.
a_{1as} quantity handled at main supplier s of SG a.
$a_{2as'}$ quantity handled at backup supplier s' at SG a.
t_{1masr} unit transportation cost from main supplier s of SG a to manufacturer m using main route r.
$t_{2mas'r'}$ unit transportation cost from backup supplier s' of SG a to manufacturer m using backup route r'.
q_{1masr} quantity transported from main supplier s of SG a to manufacturer m using main route r.
$q_{2mas'r'}$ quantity transported from backup supplier s' of SG a to manufacturer m using backup route r'.
C_{1m} capacity of manufacturer m.
F_m fixed cost at manufacturer m.
H_m unit handling cost at manufacturer m.
A_m quantity handled at manufacturer m.
t_{1bdmu} unit transportation cost from manufacture m to main DC d of regional DCG b using main route u.
$t_{2bd'mu}$ unit transportation cost from manufacture m to backup DC d' of regional DCG b using main route u.
q_{1bdmu} quantity transported from manufacture m to main DC d of regional DCG b using main route u.
$q_{2bd'mu}$ quantity transported from manufacture m to backup DC d' of regional DCG b using main route u.

C_{1bd} capacity of main DC *d* of regional DCG *b.*
$C_{2bd'}$ capacity of backup DC d' of regional DCG *b.*
f_{1bd} fixed cost of main DC *d* of regional DCG *b.*
$f_{2bd'}$ fixed cost at backup DC d' of regional DCG *b.*
h_{1bd} unit handling cost at main DC *d* of regional DCG *b.*
$h_{2bd'}$ unit handling cost at backup DC d' of regional DCG *b.*
a_{1bd} quantity handled at main DC *d* of regional DCG *b.*
$a_{2bd'}$ quantity handled at backup DC d' at regional DCG *b.*
t_{1tbdo} unit transportation cost from main DC *d* of regional DCG *b* to regional retailer *t* using main route *o.*
$t_{2tbd'o'}$ unit transportation cost from backup DC d' of regional DCG *b* to regional retailer *t* using backup route o'.
q_{1tbdo} quantity transported from main DC *d* of regional DCG *b* to regional retailer *t* using main route *o.*
$q_{2tbd'o'}$ quantity transported from backup DC d' of regional DCG *b* to regional retailer *t* using backup route o'.
C_{2t} capacity of regional retailer *t.*

- Decision variables

x_{1as} takes the value 1 if main supplier *s* at SG *a* is available and 0 otherwise.
$x_{2as'}$ takes the value 1 if backup supplier s' at SG *a* is available and 0 otherwise.
y_{1asr} takes the value 1 if main route *r* of main supplier *s* at SG *a* is available and 0 otherwise.
$y_{2as'r'}$ takes the value 1 if backup route r' of backup supplier s' at SG *a* is available and 0 otherwise.
x_{1bd} takes the value 1 if main DC *d* at regional DCG *b* is available and 0 otherwise.
$x_{2bd'}$ takes the value 1 if backup DC d' at regional DCG *b* is available and 0 otherwise.
y_{1bdo} takes the value 1 if main route *o* of main DC *d* at regional DCG *b* is available and 0 otherwise.
$y_{2bd'o'}$ takes the value 1 if backup route o' of backup DC d' at regional DCG *b* is available and 0 otherwise.

Objective function is to minimize the total cost (*TC*), which is consist of total fixed cost (*TF*), total handling costs (*TH*) and total transportation cost (*TT*).

$$\min TC = TF + TH + TT \tag{1}$$

In Equation (1), *TF*, *TH* and *TT* are represented using Equations (2), (3) and (4), respectively.

$$TF = \sum_a \sum_s f_{1as}\, x_{1as} + \sum_a \sum_{s'} f_{2as'}\, x_{2as'} + \sum_m F_m + \sum_b \sum_d f_{1bd}\, x_{1bd} + \sum_b \sum_d f_{2bd'}\, x_{2bd'} \tag{2}$$

$$TH = \sum_a \sum_s h_{1as}\, a_{1as} x_{1as} + \sum_a \sum_{s'} h_{2as'}\, a_{2as'} x_{2as'} + \sum_m H_m A_m + \sum_b \sum_d h_{1bd}\, a_{1bd} x_{1bd} + \sum_b \sum_{d'} h_{2bd'}\, a_{2bd'} x_{2bd'} \tag{3}$$

$$TT = \sum_m \sum_a \sum_s \sum_r t_{1masr} q_{1masr}\, x_{1as}\, y_{1asr} + \sum_m \sum_a \sum_{s'} \sum_{r'} t_{2mas'r'} q_{2mas'r'}\, x_{2as'}\, y_{2as'r'} + \sum_b \sum_d \sum_m \sum_u t_{1bdmu} q_{1bdmu}\, x_{1bd} + \sum_b \sum_{d'} \sum_m \sum_u t_{2bd'mu} q_{2bd'mu}\, x_{2bd'} + \sum_t \sum_b \sum_d \sum_o t_{1tbdo} q_{1tbdo}\, x_{1bd}\, y_{1bdo} + \sum_t \sum_b \sum_{d'} \sum_{o'} t_{2tbd'o'} q_{2tbd'o'}\, x_{2bd'}\, y_{2bd'o'} \quad (4)$$

The objective function in Equation (1) should be optimized under satisfying the following constraints.

subject to

$$\sum_s x_{1as} + \sum_{s'} x_{2as'} = 1, \quad \forall a \quad (5)$$

$$\sum_d x_{1bd} + \sum_{d'} x_{2bd'} = 1, \quad \forall b \quad (6)$$

$$\sum_a \sum_s \sum_r q_{1masr} x_{1as} y_{1asr} \le \sum_a \sum_s a_{1as} x_{1as}\,, \forall m \quad (7)$$

$$\sum_a \sum_{s'} \sum_{r'} q_{2mas'r'} x_{2as'} y_{2as'r'} \le \sum_a \sum_{s'} a_{2as'} x_{2as'}, \ \forall m \quad (8)$$

$$\sum_d \sum_m \sum_u q_{1bdmu} x_{1bd} + \sum_{d'} \sum_m \sum_u q_{2bd'mu} x_{2bd'} \le \sum_m A_m, \quad \forall b \quad (9)$$

$$\sum_b \sum_d \sum_o q_{1tbdo} x_{1bd} y_{1bdo} \le \sum_b \sum_d a_{1bd} x_{1bd}\,, \ \forall t \quad (10)$$

$$\sum_b \sum_{d'} \sum_{o'} q_{2tbd'o'} x_{2bd'} y_{2bd'o'} \le \sum_b \sum_{d'} a_{2bd'} x_{2bd'}, \quad \forall t \quad (11)$$

$$\sum_a \sum_s \sum_r q_{1masr} x_{1as} y_{1asr} + \sum_a \sum_{s'} \sum_{r'} q_{2mas'r'} x_{2as'} y_{2as'r'} \le C_{1m}, \ \forall m \quad (12)$$

$$\sum_d \sum_m \sum_u q_{1bdmu} x_{1bd} + \sum_{d'} \sum_m \sum_u q_{2bd'mu} x_{2bd'} \le \sum_d C_{1bd} x_{1bd} + \sum_{d'} C_{2bd'} x_{2bd'}\,, \forall b \quad (13)$$

$$\sum_b \sum_d \sum_o q_{1tbdo} x_{1bd} y_{1bdo} + \sum_b \sum_{d'} \sum_{o'} q_{2tbd'o'} x_{2bd'} y_{2bd'o'} \le C_{2t}, \ \forall t \quad (14)$$

$$x_{1as}, x_{2as'}, y_{1asr}, \ y_{2as'r'}, x_{1bd}, x_{2bd'}, y_{1bdo}, \ y_{2bd'o'} \in \{0,1\}, \ \forall a, s, s' r, r', b, d', o, o' \quad (15)$$

Equations (5) and (6) mean the opening/closing decision of the main supplier and backup suppliers at each SG and main DC and backup DC at regional DCG. Equations (7) to (11) show that the amounts transported from current stage are restricted in the amount handled at the previous stage. Equations (12) to (14) show that the amount transported from current stage is restricted in the capacity of the next stage. Equation (15) indicates that all decision variables used in Equations (1) to (14) should have 0 or 1 for opening/closing, main route and backup route at each supplier and DC.

The formulated SCN model with double disruption risks is a nonlinear 0-1 integer programming and it is difficult to solve it by the traditional mathematical programming software such as Optimization Toolbox. Here is a reason to develop a fast metaheuristics method.

4. Hybrid GA-Enhanced Jaya Algorithm

For introducing the Jaya algorithms, we consider the following multimodal function $f(\boldsymbol{x})$ in which the decision variables are consisting of n different ones and each variable x_j has a lower and upper bounds ($L_j \le x_j \le U_j$):

$$\min f(\boldsymbol{x})$$

s. t.

$$L_j \le x_j \le U_j \quad \text{for all } j \tag{16}$$

The initial solution is randomly calculated by lower and upper bounds as an initial population and then improved by undergoing two phases: teacher phase and learner phase. A population $\boldsymbol{p}_k(t) = \boldsymbol{x}_k(t)$ at the generation (or iteration) t, is considered as a number of learners (*i.e.*, classes) with the population size, popSz for each decision variable j,

$$\boldsymbol{x}_k(t) = \left[x_{kj}(t)\right] = [x_{k1}, x_{k2}, \dots, x_{kn}], k = 1, \dots, \text{popSz};\ \ j = 1, \dots, n \tag{17}$$

As described in previous section, Jaya algorithm is proposed by Rao (2016). This algorithm is designed on the simple logic that any solution of the given population should always move towards the best solution and move away from the worst solution. The simplify of this algorithm is that it contains only one equation and it does not contain any algorithm-specific parameters to be tuned to get optimal solution, which makes it very easy to understand and uniquely different from any other metaheuristics and Jaya algorithm has only one phase.

The initial solution by the encoding routine is randomly generated by lower and upper bounds as an initial population and then improved by undergoing two phases: teacher phase and learner phase. A population $\boldsymbol{p}(t) = \left[\boldsymbol{x}_1(t)\ \boldsymbol{x}_2(t)\ \dots\ \boldsymbol{x}_{popSz}(t)\right]$ at the generation (or iteration) t, is considered as the solution candidates with the population size, popSz for each decision variable j:

$$\boldsymbol{x}_k(t) = \left[x_{kj}(t)\right] = [x_{k1}(t), x_{k2}(t), \dots, x_{kn}(t)], k = 1, \dots, \text{popSz};\ \ j = 1, \dots, n \tag{18}$$

By using the k-th solution candidate $\boldsymbol{x}_k(t)$, we can calculate the best and worst solutions of the j-th decision variable in the t-th generation, respectively as follows:

$$x_{\text{Best},j}(t) = \text{argmin}\left\{f(x_{kj}(t), k = 1, \dots, \text{popSz}\right\} \tag{19}$$

$$x_{\text{Worst},j}(t) = \text{argmax}\left\{f(x_{kj}(t), k = 1, \dots, \text{popSz}\right\} \tag{20}$$

By using both best and worst solutions, the mathematical description of Jaya algorithm is as follows:

$$x_{kj}(t+1) = x_{kj}(t) + r_1\left\{x_{\text{Best},j}(t) - \left|x_{kj}(t)\right|\right\} - r_2\left\{x_{\text{Worst},j}(t) - \left|x_{kj}(t)\right|\right\} \tag{21}$$

Based on the mathematical equation of Jaya algorithm, we can design a pseudo code for minimizing the multimodal optimization.

However, it is very difficult to get a best solution by Jaya algorithm when solving for large scale problems including high-dimensional variables. For solving this problem, a basic idea is to create new updating operation of the effective solution candidates by combining the Cauchy distribution. The Cauchy distribution has a Gaussian-like peak wing that imply occasional long jumps among local sampling (Yu & Gen 2010; Jamrus, Chien, Gen, & Sethanan 2018):

$$\boldsymbol{u}_k(t+1) = \frac{\boldsymbol{x}_k(t+1)}{\sqrt{x_{k1}(t+1)^2 + x_{k2}(t+1)^2 + \cdots + x_{kN}(t+1)^2}} \tag{22}$$

$$\boldsymbol{s}_k(t+1) = \boldsymbol{u}_k(t+1) \cdot \tan(\pi/2 \cdot \text{rand}[0,1)) \tag{23}$$

$$\boldsymbol{x}_k(t+1) = \boldsymbol{x}_k(t) + \boldsymbol{s}_k(t+1) \tag{24}$$

For enhancing Jaya algorithm with the Cauchy distribution, we can design the enhanced Jaya algorithm with the Hybrid GA (HGA-EJA) as follows in Fig. 2:

Algorithm 1 Hybrid GA and Enhanced Jaya algorithm (HGA-EJA)

input: problem data ($f(\boldsymbol{x})$, n), parameters (t: maxGn, k: popSz, r_1, r_2);
process:
  $t \leftarrow 0$;
  initialize $P(t) = [\boldsymbol{x}_k(t)]$ by encoding; $\boldsymbol{x}_k(t) = [x_{kj}(t)], k=1,...,\text{popSz}\}$;
  evaluate $P(t)$ by decoding & best $\boldsymbol{x}_{\text{Best}}(t) = \text{argmin}\{f(\boldsymbol{x}_k(t)), k=1,...,\text{popSz}\}$;
  while (**not** terminating condition: **not** $t >$ maxGn) **do**
    create $C(t+1)$ from $P(t) = [\boldsymbol{x}_k(t)]$ by crossover; $C(t+1) = [\boldsymbol{x}_k(t+1)]$;
    create offspring $C(t+1)$ from $P(t) = [\boldsymbol{x}_k(t)]$ by mutation routine;
    evaluate $C(t+1)$ & update $\boldsymbol{x}_{\text{Best}}(t+1) = \text{argmin}\{f(\boldsymbol{x}_k(t+1)), f(\boldsymbol{x}_{\text{Best}}(t))\}$;
    for j=1 **to** n
      $x_{\text{Worst},j}(t) = \text{argmax}\ \{f(x_{kj}(t)), k=1, 2, \ldots, \text{popSz}\}$;
      for k=1 **to** popSz
        $x_{kj}(t+1) = x_{kj}(t) + r_1\ \{x_{\text{Best},j}(t) - |x_{kj}(t)|\} - r_2\ \{x_{\text{Worst},j}(t) - |x_{kj}(t)|\}$;
        $u_{kj}(t+1) = x_{kj}(t+1) \,/\, \sqrt{x_{k1}(t+1)^2 + \cdots + x_{kN}(t+1)^2}$;
        $s_{kj}(t+1) = u_{kj}(t+1) \cdot \tan(\pi/2 \cdot \text{rand}[0,1))$;
        update $x_{kj}(t+1)^{\text{new}} = x_{kj}(t+1) + s_{kj}(t+1)$;
        evaluate $x_{kj}(t+1)^{\text{new}}$ & $x_{\text{Best},j}(t+1) = \text{argmin}\ \{\text{eval}(\boldsymbol{x}_k(t+1)), \text{all } k\}$;
        if $(\text{eval}(x_{kj}(t+1)^{\text{new}}) > f(x_{kj}(t)^{\text{new}})$ **then**
          $x_{kj}(t+1)^{\text{new}} = x_{kj}(t)^{\text{new}}$;
      end
    end
    update $\boldsymbol{x}_{\text{Best}}(t+1)^{\text{new}} = \text{argmin}\ \{f(x_{kj}(t+1)), \boldsymbol{x}_{\text{Best}}(t)\}$; $C(t+1)=[\boldsymbol{x}_{\text{Best}}(t+1)^{\text{new}}]$
    t <- t+1;
  end
output: the best solution $\boldsymbol{x}_{\text{Best}}(t+1)^{\text{new}}$;

Fig. 2: Hybrid GA and Enhanced Jaya algorithm

5. Numerical Experiments

For numerical experiment, the following scale of the SCN model is considered:

No. of SGs: 5
No. of suppliers: 5 (= 1 main supplier + 4 backup suppliers)
No. of manufacturers: 1
No. of regionals DCGs: 5
No. of DCs: 5 (= 1main DC + four backup DCs),

No. of regional retailers: 5. Fixed cost

The unit handling cost and unit transportation cost at each stage are randomly generated using uniform distribution shown in Table 3.

TABLE 3: PARAMETER SETTING

	Fixed Cost	Hand. Cost	Transp. Cost
Main supplier	*U*[1,000, 1,500]	*U*[50, 70]	*U*[6, 8]
Backup supplier	*U*[1,500, 1,700]	*U*[70, 100]	*U*[8, 10]
Manufacturer	*U*[2,000, 2,500]	*U*[700, 800]	*U*[10, 15]
Main DC	*U*[1,500, 2,000]	*U*[150, 200]	*U*[6, 9]
Backup DC	*U*[1,700, 2,200]	*U*[200, 300]	*U*[8, 12]

Due to the disruption risk at each stage of the SCN model, we consider following several scenarios for disruption risk.

- Scenario 1 (S1): main supplier at one SG and main DC at one regional DCG are disrupted.
- Scenario 2 (S2): main route of main supplier at one SG and main route of main DC at one regional DCG are disrupted.
- Scenario 3 (S3): main supplier at two SG and main DC at two regional DCG are disrupted.
- Scenario 4 (S4): main route of main supplier at two SGs and main route of main DC at two regional DCGs are disrupted.
- Scenario 5 (S5): main supplier at three SGs and main DC at three regional DCGs are disrupted.
- Scenario 6 (S6): main route of main supplier at three SGs and main route of main DC at three regional DCGs are disrupted.

For performance comparison of the HGA-EJA algorithm, several conventional single and hybrid metaheuristic algorithms are used as shown in Table 4.

TABLE 4: CONVENTIONAL METAHEURISTIC ALGORITHMS FOR COMPARISON

Algorithm	Reference
GA	Gen and Cheng [7]
TLBO	Rao [56]
JAYA	Rao [61]
PSO	Kennedy and Eberhart [67]
GA-TLBO	Güçyetmez and Çam [68]
GA-PSO	Kao and Zahara [69]

All algorithms shown in Table 6 including the HGA-EJA algorithm were programmed and ran under a same computational environment (MATLAB Version 2014b, IBM compatible PC 1.3 GHz processor-Intel core i5-1600 CPU, 4GB RAM, and OS-X EI).

The parameter settings for all algorithms are as follows: Population size is 20 for HGA-EJA, TLBO, PSO, GA-TLBO, and GA-PSO. Crossover rate is 0.5, and mutation rate 0.3 for GA, GA-TLBO, GA-PSO, and HGA-EJA. Total number of iterations is 500 and all computation results are obtained after 10 independent runs. Three measures of performance are used to compare the performances of all algorithms as depicted in Table 5. The experimental results using the all algorithms are summarized in Table 6.

TABLE 5: MEASURES OF PERFORMANCE

Measure	Description
BS	Best solution in all trials
AS	Average solution through all trials
CPU	Average CPU time through all trials (unit: sec.)

The best value shown in each row of Table 6 is bold and underlined for each scenario. In S1 of Table 6, the HGA-EJA algorithm shows the best results in terms of the BS and AS compared with all single metaheuristic algorithms (GA, JAYA, TLBO, and PSO) and all hybrid metaheuristic algorithms (GA-TLBO, and GA-PSO), but the HGA-EJA algorithm shows the slowest search speed and the PSO shows the quickest search speed in terms of the CPU. Similar results are also shown in S3, S4, and S6, that is, the performances of the HGA-EJA algorithm are superior to those of the others in terms of the BS and AS, but in terms of the CPU time, the search speed of the GA is quicker than the others.

In S2 and S5 of Table 6, the HGA-EJA algorithm has better performance than the others in terms of the BS, but the performance of the former is inferior to that of the GA-TLBO algorithm in terms of the AS. Also in terms of the CPU, the GA and TLBO algorithms have best performers.

All results shown in Table 6 mainly depend on how each algorithm finds best value. Therefore, it will be worthwhile to compare the convergence behaviors of each algorithm as iterations (or generations) are proceed. Figs. 3 and 4 show the convergence behaviors of each algorithm in S6 when iterations repeated up to 100 times. In Fig. 3, all algorithms shows various and rapid convergence behaviors at initial iterations, but after iteration numbers are about 28, all algorithms converged to fixed fitness values and show no further convergence behaviors. In Fig. 4, the GA, PSO, JAYA, and GA-TLBO algorithms show various convergence behaviors until iterations proceed to about 30, but the TLBO, GA-PSO, and HGA-EJA algorithms show more various convergence behaviors until iterations proceeds to about 70 or 80. In overall view of convergence behaviors in Figs. 3 and 4, it can be shown that the HGA-EJA algorithm outperforms the others. However, in overall view, the HGA-EJA algorithm has better convergence behaviors than the others.

We can reach the following conclusion using the computational results of Table 6 and the convergence behaviors of Figs. 3 and 4.

- In terms of BS and AS, the performance of the HGA-EJA algorithm is superior to those of all single metaheuristic algorithms (GA, JAYA, TLBO, and PSO) and all hybrid metaheuristic algorithms (GA-TLBO, and GA-PSO), which means that the search scheme used in the HGA-EJA algorithm is more efficient than those used in the others.
- In terms of CPU, all hybrid metaheuristic algorithms (GA-TLBO, and GA-PSO) including the HGA-EJA algorithm do not show any merit when compared with all single metaheuristic algorithms (GA, JAYA, TLBO, and PSO), which implies that since the hybrid metaheuristic algorithms have a combined structure of using each single metaheuristic algorithm, their search routines are more complex than the single metaheuristic algorithms.

TABLE 6: EXPERIMENTAL RESULTS

Scenario	Measure	GA	JAYA	TLBO	PSO	GA-TLBO	GA-PSO	HGA-EJA
S1	BS	826,508	800,182	811,979	806,465	802,422	804,673	**792,877**
	AS	846,661	835,364	838,298	845,336	836,316	834,134	**826,062**
	CPU	3.56	5.67	4.65	**3.11**	5.25	4.33	5.89
S2	BS	804,212	785,762	777,828	784,833	764,081	773,758	**763,309**
	AS	825,520	808,623	818,846	820,824	**805,026**	808,243	823,766
	CPU	**3.48**	4.45	3.69	3.93	4.98	5.04	4.92
S3	BS	897,541	851,994	857,854	859,198	850,872	853,192	**833,482**
	AS	889,202	881,367	881,681	885,650	871,761	878,913	**866,106**
	CPU	**3.41**	4.01	5.31	3.62	5.59	3.84	5.22
S4	BS	814243	790701	807241	803106	789884	796037	**781381**
	AS	839677	821197	820326	840856	822491	827901	**813936**
	CPU	**3.90**	4.28	3.98	4.09	5.52	5.39	6.58
S5	BS	788,448	777,098	786,560	788,197	771,632	783,278	**759,373**
	AS	817,181	815,477	825,454	818,554	**809,245**	812,132	814,285
	CPU	3.37	5.15	**3.19**	3.58	4.55	3.91	7.32
S6	BS	896,680	888,950	895,350	896,495	891,568	892,683	**861,439**
	AS	941,510	929,774	924,621	921,308	920,934	921,358	**913,511**
	CPU	**3.74**	5.07	5.23	5.09	5.75	5.91	6.60

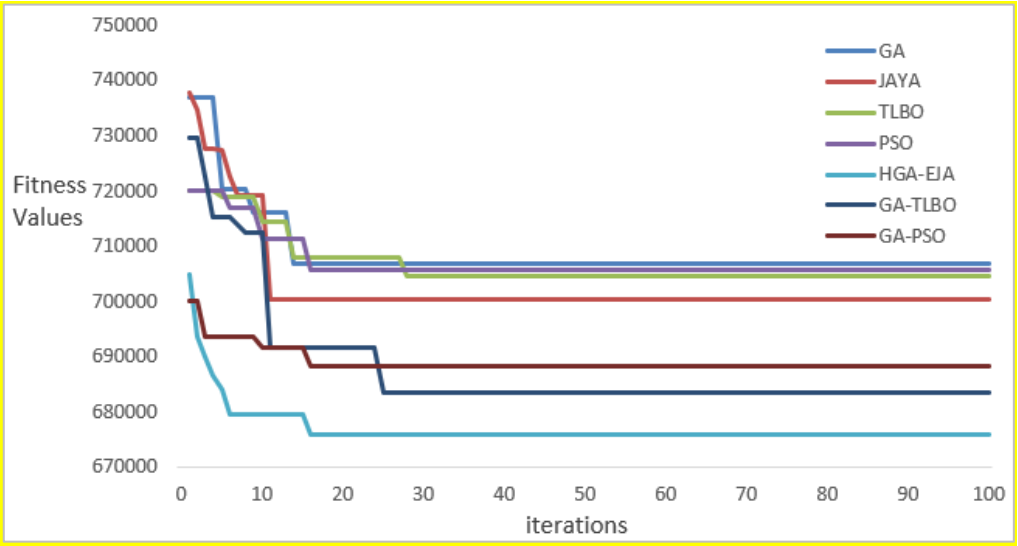

Fig. 3. Convergence Behaviors of Each Algorithm in S4

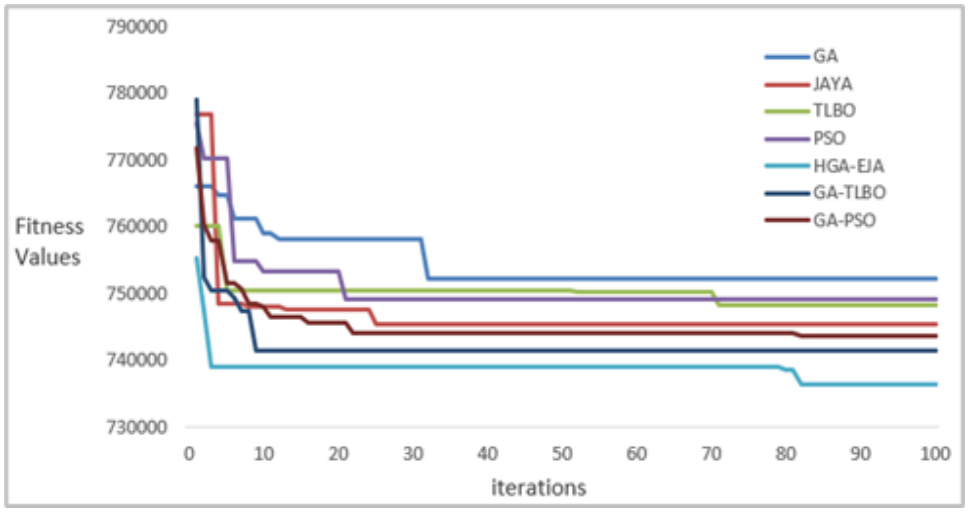

Fig. 4. Convergence Behaviors of Each Algorithm in S6

6. Conclusions

As the development of economic globalization and extension of global electronic marketing, global enterprise services supported by universal supply chain and worldwide logistics and *supply chain management* (SCM) network design become imperative for business world. How to manage logistics system efficiently thus has become a key issue for many companies to control their costs. That is also why an elaborately designed logistics network under the help today's fully-fledged information technology is catching more and more attentions of business entities, especially that of many multinational companies. *Supply chain network* (SCN) design is to provide an optimal platform for efficient and effective SCM. This is an important and strategic operations management problem in SCM. The design task involves the choice of facilities (plants and distribution centers: DCs) to be opened and the distribution network design to satisfy the customer demand with the minimum cost/time. It belongs to a production-distribution and facility location-allocation problem. When the facilities have a certain capacity, the problem is referred as a *capacitated location-allocation problem*. Since the multi-stage design problem is difficult to solve optimally, especially if capacity constraints are imposed on both plants and DCs, researchers have utilized heuristic approaches to solve this problem. At the same time, we have to consider a disruption which is one of the major risks that can be occurred in the SCN model in the real world. Among the various risks the disruption as one of the categories which is occurred by natural disasters, terrorist attacks, war, etc.

In this paper we proposed a *hybridized genetic algorithm* and *enhanced Jaya algorithm* (HGA-EJA) for effectively solving the SCN network models with disruption risk. We implemented various metaheuristics such as GA, JAYA, TLBO (Teaching-Learning based Optimization), PSO (Particle Swarm Optimization), GA-TLBO, GA-PSO, and HGA-EJA for quantitatively evaluating the proposed HGA-EJA algorithm with different scenarios by using the performance measures: the best solution (BS) in all trials, average solution (AS) through all trials, and average CPU time (CPU) through all trials (unit: sec.). Finally, we demonstrated the following experimental results:

- In terms of BS and AS respectively, the performance of the HGA-EJA algorithm is effectively superior to those of all single metaheuristic algorithms (GA, JAYA, TLBO,

and PSO).

- In terms of CPU, all hybrid metaheuristic algorithms (GA-TLBO, and GA-PSO) including the HGA-EJA algorithm do not show any merit when compared with all single metaheuristic algorithms (GA, JAYA, TLBO, and PSO)
- In overall view, the HGA-EJA algorithm has better convergence behaviors than the others.

A future research topic will be expanding the HGA-EJA to the multiple objective functions conflicting each other in the SCN network models with disruption risk and also be applying to sustainable closed-loop SCN design problems [20, 22, 40]. Another topic will be combining the hybrid GA and Jaya algorithm with a machine learning [70] or a hybrid cooperative co-evolution algorithm with Jaya algorithm for solving SCN design problem with disruption risk [71].

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ON INEQUALITY CONSTRAINTS IN WELL-KNOWN OPTIMIZATION PROBLEMS

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ABSTRACT

This work studies some of the well-known optimization problems such as transportation problems, assignment problems, shortest path problems, transshipment problems, and dynamic lot sizing problems. Particularly, it is shown that the core constraints of these problems can be derived using the conservation of flow principle. This principle can lead to an alternative inequality expression of the core constraints. These inequality constraints, then, provide alternative formulations for these problems. It is shown that the resulting alternative formulations return the same optimal solution as the ones returned by the original problems. Finally, some of the applications of alternative formulations are explored.

KEYWORDS: Optimization problems, Constraints, Conservation of flow, Transportation problems, Assignment problems, Shortest path problems, Transshipment problems, Dynamic lot sizing problems

OPTIMAL COAL MINE ALLOCATION AND DELIVERY SCHEDULE FOR A POWER COMPANY

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ABSTRACT

A Power company uses high moisture and ash with low calorific content coal. The company needs to improve upon the present grade of coal being used through a network of coal suppliers from all over the world within time and budget constraints. A linear programming formulation is used to determine the optimal supply of coal from different mines in various countries depending on several technical and chemical specifications of the coal. Consequently, and to co-ordinate all activities, a delivery schedule is developed and monitored. A case of a real company is studied, and the results are analyzed and discussed.

INTRODUCTION AND LITERATURE REVIEW

The problem of delivering Fuel Management Solutions to a spectrum of industrial consumers (power plants, fertilizer plants, cement plants, synthetic fiber plants and paper plants) is crucial especially in times of crisis [5]. Once the most suitable fuel is identified, shipping is arranged either on groups' own vessels or on chartered ships to designated ports.

India has imported approximately 8 million tons of coal and there will be an explosive growth to 20-25 million tons. A need powered by the ever-increasing switch over to imported low ash coal and a burgeoning gap between domestic production and demand [7].

A company can choose to maintain stocks of various grades of coal from Indonesia, Chain, Russia, Australia and South Africa at Chennai, Cochin, New Mangalore, Goa and Kandla. In fact, the fuel is sourced from large companies like Anglocoal (Indonesia) and Total (South Africa), CNCIECC (China), PT Bukit Baiduri (Russia) and PT Kideco (Korea), Bonoco (Australia), Emarat and Adnoc(UAE), and transported in dry bulk vessels belonging to companies such as West Asia Maritime and others like Maersk Line (Denmark), Transocean Grab Bulk (Singapore) and Western Bulk(Norway).

Coal can be considered as consisting of moisture, mineral matter and 'pure coal'. The moisture consists of inherent moisture, within the coal structure and free moisture, which tends to be surface moisture, which can be removed by air-drying. The mineral matter comprises the inorganic components, which give rise to ash when the coal is burned [4]. The 'pure coal' comprises the combustible material, i.e. the hydrocarbons, plus organically bonded sulfur, nitrogen and chlorine.

The proximate analysis of the coal is the measure of moisture, ash, volatile matter and fixed carbon [1]. The first three are measured and the fixed carbon is obtained by subtracting the percentage totals of the other three:

100% Fixed carbon = 100 - % ash - % moisture - % volatile matter

An error in the measurement of one or more of the ash, moisture and volatile matter content immediately gives an error in the fixed carbon percentage.

Proximate analysis of coal can be expressed in four different ways:

- *As received basis* which is the analysis of the coal as it is received.
- *Air-dried basis* in which the coal is analyzed after being subject to grinding to a given size in the laboratory, followed by air drying at a given temperature for a given time. This basis measures inherent moisture.
- *Dry basis* is the analysis of the coal without any moisture
- *Dry, ash free basis* is the analysis, as the name implies, without the presence of ash or moisture.

Analyses on the dry ash free basis are often used for comparing different coals. A more precise comparison results from analyses on dry mineral-matter-free bases, but the mineral matter content is often not determined [3].

Ash is the residue remaining after the coal is completely combusted. Mineral matter contains all the minerals, which form the ash plus water of hydration of the minerals and other components such as carbon dioxide and sulphur oxides, which are released from mineral compounds. Water of hydration, carbon dioxide and sulphur oxides are difficult to measure, but are the reason the mineral matter content is often different from the ash content of the coal.

The ultimate analysis gives the carbon, hydrogen, sulphur, nitrogen, chlorine and oxygen content of the coal. The first five elements are measured and recorded, ash percentages and the oxygen content is given by the difference, i.e. 100 minus the sum of the rest. This analysis is important in determining the efficiency of the combustion in a plant. Boiler efficiency depends on other factors as well, such as heat transfer. Combustion efficiency does not equate with boiler efficiency [2].

Ash analysis is important in three ways:

- In boilers for determining the behavior of ash within the equipment i.e. its effects on fouling, slagging and ash collection;
- On disposal and/or use in other equipment;
- On the process as it becomes part of the product i.e. in cement production;

Calorific values are quoted at two levels, *gross* and *net*, which are occasionally called *upper heating value* and *lower heating value* respectively. In the laboratory the gross calorific value at constant volume is the figure determined by experiment. The net calorific value, however, is a more realistic indication of the actual energy of the coal, which can be used during combustion. The difference between the two figures is mainly the latent heat of evaporation of the moisture in the coal together with that of the moisture created during the combustion of hydrogen in the coal.

PROBLEM STATEMENT

The Power company uses at present high moisture and ash with low calorific content coal. The company needs to improve upon the present grade of coal that is being used. Coal is to be procured from different coal suppliers from all over the world within budget, time and cost. The problem is therefore to optimize the supply of coal from different mines in various countries to improve on the quality of the coal presently being used by the power company [6]. Subsequently, a realistic schedule to co-ordinate all activities and monitor the progress must be developed.
The power company needs to minimize the total supply cost subject to desired technical specifications of the coal. Let X_j be the number of tons of coal received from supplier j, and C_j the cost per ton. The company has upper and lower limits on the following coal specifications: total moisture (TM), inherent moisture (IM), calorific value (CV), volatile matter (VM), Hardgrove Grindability Index (HGI), sulfur (Sul), ash content (A) and size (S). The reader is referred to appendix A for a glossary of these terms. A general form of the problem can therefore be written as follows:

$$Min \sum_j C_j X_j$$

$$st.$$

$$\sum_i \sum_j TM_{ij} X_j \le TM_i$$

$$\sum_i \sum_j IM_{ij} X_j \le IM_i$$

$$\sum_i \sum_j H_{ij} X_j \le H_i$$

$$\sum_i \sum_j CVGAR_{ij} X_j \ge CVGAR_i$$

$$\sum_i \sum_j CVNAR_{ij} X_j \ge CVNAR_i$$

$$\sum_i \sum_j CVGAD_{ij} X_j \ge CVGAD_i$$

$$\sum_i \sum_j A_{ij} X_j \le A_i$$

$$\sum_i \sum_j VM_{ij} X_j \le VM_i$$

$$\sum_i \sum_j Sul_{ij} X_j \le Sul_i$$

$$\sum_i \sum_j HGI_{ij} X_j \le HGI_i \qquad \textbf{(1)}$$

$$\sum_i \sum_j S_{ij} X_j \le S_i$$

$$X_j \ge 0$$

The problem is a standard linear program and can be solved with any LP solver. The case study presented is fairly manageable and is solved using Excel Solver®.

CASE STUDY

Table 1 summarizes the key parameters and the corresponding customer requirements (upper and lower limits) for the case study.

	Supplier								
Spec	***Anglo Coal***	***Total***	***CNCIECC***	***KIDECO***	***SEBUKU***	***BUKIT***	***BONOCO***	***JORONG***	***SHENHUA***
TM	22.0	22.0	30.0	25.0	12.0	16.0	12.0	8.5	11.5
IM	14.0	15.0	17.0	16.0	8.0	11.0	6.0	3.0	3.5
H	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
CV - NAR	**5,100.0**	**5,050.0**	**4,100.0**	**4,700.0**	**4,650.0**	**5,800.0**	**5,813.0**	**6,000.0**	**6,000.0**
CV - GAR	5,431.1	5,381.1	4,477.9	5,048.7	4,922.6	6,096.0	6,085.6	6,252.1	6,269.7
CV - GAD	5,988.1	5,864.0	5,309.5	5,654.5	5,146.4	6,458.9	6,500.5	6,627.9	6,836.4
Ash	**5.0**	**5.0**	**5.0**	**5.0**	**12.0**	**5.0**	**15.0**	**15.5**	**8.0**
VM	41.0	41.0	41.0	41.0	33.0	41.0	40.0	24.0	31.0
Sul	0.20	0.60	0.92	0.10	0.70	1.00	0.80	0.50	0.87
HGI	36.0	48.0	41.0	45.0	48.0	47.0	38.0	40.0	43.0
Size	49	50	48	59	54	57	61	56	52
C&F Costing $									
FOBT	19.00	17.25	13.50	16.00	15.30	22.00	23.00	25.00	27.00
Freight	10.20	10.20	10.20	10.20	10.20	10.20	10.20	12.30	10.25
C&F Price	***29.20***	***27.45***	***23.70***	***26.20***	***25.50***	***32.20***	***33.20***	***37.30***	***37.25***

CONCLUSION

Applying Linear Programming and the ensuing Sensitivity Analysis in overcoming the constraints and choosing the best source of coal, the CNCIECC

company has a high calorific value when compared to coal from other mines and minimizes the metric ton cost, transportation cost and other overheads. To improve on the current schedule, the company needs to consider increasing the database of the mines and reducing the processing time taken by the various departments in effecting the contract.

APPENDIX

The table below indicates the typical specifications of each category of coal under the American Society for Testing and Materials Standard.

Specification in ASTM Standard		Low Calorific Value	Medium Calorific Value	High Calorific Value
Gross Calorific Value	GAR	4,200 Kcal/kg	5,000 Kcal/kg	5,800 Kcal/kg
Net Calorific Value	NAR	3,800 Kcal/kg	4,700 Kcal/kg	5,500 Kcal/kg
Total Moisture	ARB	36%	26%	14%
Inherent Moisture	ADB	Approximately 24%	18%	9%
Ash Content	ADB	8%	5%	15%
Volatile Matter	ADB	Approximately 40%	40%	41%
Ash Fusion Temperature	T1	1,150 Degree Celsius	1,150 Degree Celsius	1,300 Degree Celsius
Total Sulfur	ADB	0.8%	0.9%	0.6%
HGI	-	Minimum 45%	40%	40%
Size 0-50mm	-	Approximately 90%	90%	90%

GAR - Gross As Received
NAR (Net As Received)
CV calorific value
VM volatile matter
TM total moisture
IM inherent moisture
ADB - Air-Dried Basis. In coal sample analysis, ADB neglects the presence of moistures other than inherent moisture while DB (dry-basis) leaves out all moistures, including surface moisture, inherent moisture, and other moistures.

ARB - As-Received Basis. In coal sample analysis, ARB puts all variables into consideration and uses the total weight as the basis of measurement. ARB is the most widely used basis in industrial applications.

Ash content - Ash content is the non-combustible residue that remains after coal is burnt. Ash reduces handling and burning capacity, affects combustion efficiency and boiler efficiency and therefore increases handling costs.

ASTM - American Society for Testing and Materials

GAR - Gross As Received. Thermal coal is quoted on a GAR basis, except for Europe/ARA, Richards Bay 6,000 kcal/kg, and Japan and Korea West CIF, which are quoted on a NAR (Net As Received) basis.

Fixed carbon - Fixed carbon is the solid combustible residue that remains in the furnace after volatile matter is distilled off, comprised mostly of carbon but also containing some hydrogen, oxygen, sulphur and nitrogen not driven off with the gases. It provides a rough estimate of the heating value of coal.

HGI - The relative ease with which coal can be pulverised depends on the strength of the coal and is measured by the Hardgrove Grindability Index (HGI). This empirical test indicates how difficult it would be to grind a specific coal to the particle size necessary for effective combustion in a pulverized coal fired boiler

Inherent moisture - Inherent moisture (or bed moisture) means moisture that exists as an integral part of the coal seam in its natural state, including water in pores, but excluding that present in macroscopically visible fractures.

Sulphur - Sulphur content in coal presents problems with utilization and resultant pollution, as it causes corrosion and fouling of boiler tubes, and atmospheric pollution when released in flue gases.

Total moisture - Total moisture in coal is represented by measuring weight loss from aggressive drying in an air atmosphere under rigidly controlled conditions of temperature, time and air flow. The presence of moisture is an important factor in both the storage and the utilization of coal, as it adds unnecessary weight during transportation, reduces the calorific value, and poses some handling problems.

Volatile matter - Volatile matter is the material that is driven off when coal is heated to 950 °C in the absence of air under specified conditions. It consists of a mixture of gases, low-boiling-point organic compounds that condense into oils upon cooling, and tars. In general, coals with high volatile-matter content ignite easily and are highly reactive in combustion applications.

Cost and Freight (C & F) — one of several standard terms of sale for exports and imports. C and F indicates that the buyer must obtain transit insurance on the newly purchased goods, since the price paid by the buyer includes the cost of goods and all freight charges but not insurance.

FOBT in relation to price means the price per Metric Ton delivered free on board and spout trimmed in vessel loaded at Port of loading and in relation to delivery means coal so delivered.

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REINTRODUCING TRANSPORTATION FUNDAMENTALS WITHIN THE MODERN SUPPLY CHAIN CURRICULUM USING SIMULATION

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Abstract

Over the past thirty years, transportation programs and degrees have evolved first into logistics programs and then supply chain management (SCM). While there are clear arguments for the positive effects of these types of changes, one of the unintended consequences of this shift is an ever-decreasing amount of time and structure spent educating students on transportation fundamentals. All programs are faced with a limited number of contact hours to help prepare students for jobs within the SCM industry. While transportation remains a trillion-dollar industry in its own right, most programs are reducing the specific content. Therefore, an alternative method of incorporating transportation pragmatics is needed to help prepare students. One solution is the use of transportation specific simulation(s) as a class project to educate students. This article presents an argument for both the need to improve transportation education and a possible solution that can be applied. Furthermore, it presents results from multiple semesters of use of a transportation simulation and the impact on student learning. Finally, it concludes with some opportunities and limitations developed from this study of today's SCM students.

Keywords: transportation, supply chain management, simulation, pedagogy

RESHORING BOOM IN SUPPLY CHAIN: IS IT WORTH IT FOR FIRMS FINANCIALLY?

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ABSTRACT

In recent years, most companies have faced supply chain disruptions from the demand and supply sides. The reshoring of manufacturing or service activities to the U.S. has gained significant attention from practitioners and scholars. The reshoring is considered one of the potential solutions to fix the ongoing supply chain crisis and also helps create jobs in the U.S. However, there are limited studies investigating the implications of reshoring decisions on the stock market performance of firms doing reshoring. We attempt to fill these gaps in the literature by conducting an event study to analyze the impact of reshoring announcements on firms' stock market performance. The results offer help to policymakers understand the reasons for reshoring decisions and their financial implications.

Keywords: Reshoring, supply chain, stock performance, event study

1. INTRODUCTION

In the past few decades, many U.S. and European companies transferred their traditional manufacturing operations to low-cost countries, such as China, India, and other Southeast Asian countries, to maximize their profit by optimizing their global supply chain. One of the major factors of this trend has been cheaper labor costs in emerging economies. As a result, millions of manufacturing jobs were lost from 1980 to 2010 [1]. However, labor wages in developing economies like China and India have been increasing by 10%–20% annually, thus highlighting the shortcomings of offshoring, including shipping costs and lead times, lost manufacturing expertise, and political pressure [2]. Nevertheless, after the 2008 financial crisis, the U.S. government started providing tax incentives to companies to encourage them to relocate their business operations back to the local country to create more manufacturing jobs. Retaining all or part of valuable business operations performed overseas to the company's home country is known as reshoring [3]. In times of global crisis, policymakers in several Western countries even started considering reshoring as a partial solution to rising unemployment rates [3-4].

Interest in reshoring rose initially among practitioners. In the past decade, due to rising wage rates in emerging countries, many large U.S. multinational companies (MNCs) (e.g., General Electric, Caterpillar, Ford, and Apple), as well as numerous small enterprises operating across industries have announced to partially or fully move their business operations back home [5]. The business press and the government have termed these announcements as back-shoring, homeshoring, on-shoring, reshoring, near-shoring, and back-reshoring ([1], [3], [6-7]). In academic literature, it is referred to as reshoring. Despite the recent reshoring boom, practitioners share different views on whether reshoring is viable and scalable [8].

The interest in the reshoring topic has been further fueled by the COVID-19 outbreak, which not only hit the world economy but also utterly exposed the existing global supply chain networks [9]. During the COVID-19 period, several companies have announced to reshore their manufacturing operations to home countries during COVID-19 [1] to simplify their supply chains. For example, in May 2021, GAF Energy announced relocating its solar operations from Asia to California [10]; Peloton announced opening a new factory in the U.S. with an investment of $400 million to produce treadmill machines [11]. Ford Motor, along with S.K. innovation (its alliance company), confirmed to open a manufacturing plant in the U.S. to produce battery cells for its electric cars [12]. These reshoring efforts have also created several thousand jobs [13].

Apart from traditional supply chain risk management strategies (e.g., multiple sourcing [8], flexibility and redundancy [14], backup supplier [15], and information sharing via the latest technologies like blockchain [16]—the reshoring is being considered one of the effective strategies ([9], [17]) to deal with supply chain disruption risks.

The literature makes some attempts to investigate why firms are reshoring and analyze what drives firms to repatriate ([1], [5], [18-20]). The reshoring topic has received much attention from academicians in the past two years, especially during COVID-19 ([9], [15-16], [22]). Most of

these studies investigate reshoring and insourcing decision drivers and discuss the external and organizational challenges for U.S. and European firms. Contrary to the offshoring literature, reshoring studies lack a clear theory-grounded interpretation of the motivations and are often descriptive in nature. Thus, there is a need for more comprehensive research to identify the factors motivating U.S. firms to reshoring decisions.

On the other hand, reshoring decision increases the labor cost and other expenses. The labor wage gap is shrinking between developed and low-cost counties, but the salary gap is still significant ([4], [16]). However, one can argue that the high productivity of U.S. labor can compensate for it. Surprisingly, the higher labor cost in the U.S. is still a big concern for firms in reshoring decisions [23]. Although in recent years, the U.S. government has provided several subsidies and tax breaks to the firms that are reshoring. The taxation system is still unlikely to favor the U.S. as a manufacturing location ([4], [24]). Together, these costs may result in negative incremental cash flows for the focal firm [25].

Most erstwhile literature has focused on determinants of reshoring [13]. Still, little work investigates the effects of reshoring decisions on shareholders' value. Given the recent reshoring boom, investigating its effect on stock prices is very important. Overall, the impact of reshoring decisions on shareholder wealth cannot be determined independently. It depends on the relative magnitude of the predicted positive and negative cash flow implications of reshoring. This study fills this gap in the literature by analyzing the impact of firms' decisions regarding relocating overseas business operations back to the U.S. on shareholders' stock wealth. Specifically, this paper investigates: (i) what are the determinants of reshoring decisions? and (ii) how do reshoring decisions affect firms' stock market performance?

2. RESEARCH METHODOLOGY AND DATA COLLECTION

This study plans to use the event study methodology to address the research issues as it produces reliable results. The event study method is designed to investigate the effect of an event on metrics [26-27]. It is a widely used technique in the finance and accounting research area and has been traditionally effective in estimating stock price reactions to events such as the announcements of earnings, dividends, or mergers [28]. This technique assumes that inefficient markets, the shareholder wealth impact of an event will be reflected in stock prices as soon as the market learns about the event. Therefore, it is an appropriate technique to investigate the immediate financial impact of reshoring on the firm's value. It also helps differentiate between normal and abnormal returns observed under reshoring announcements [29]. Eventually, this methodology will help determine whether the reshoring announcements produce a "significant" stock price reaction around the announcement time.

We aim to utilize secondary data to address the research questions listed in the above section. The first data is related to the reshoring announcements, which is manually collected mainly from the historical archives (January 01, 2010 to December 31, 2019) of business newspapers and magazines, such as Wall Street Journal, Financial Times, white papers of consulting companies, and the LexisNexis news database. Each new article was manually analyzed to determine what

reasons and motivations are cited by companies for reshoring decisions. Second, after gathering the reshoring announcements data along with dates, historical daily stock returns are collected around each company's announcements date and time from the yahoofinance database in different markets. For example, a USA firm announcing reshoring might be listed globally in different stock markets. Therefore, we have considered multiple stock markets for the analysis to see how many markets the announcement impacts the stock performance.

We selected the date of announcement of reshoring by companies as the date of a significant event for investors. If the information is made public during the weekends, we consider the next working day as an event day. The common method to assess the impact of an event is, first, to regress stock returns on the market returns that provide parameters to estimate stock returns. The period over which these parameters are estimated is known as the estimation period. We use an estimated period of 120 days. Abnormal stock return (AR) is then assessed by calculating the actual stock return (R) minus the expected return (E(R)). To understand AR over the period t_1 and t_2, we compute the cumulative abnormal return (CAR) of firm i as

$$CAR_{i(t_1,t_2)} = \sum_{t=t_1}^{t_2} AR_{it} \quad (1)$$

We considered three relatively narrow event windows: [0,0], [-1,+1], and [-5,+5]. The day of announcement is considered day 0 and [-1,+1] represents one day before the event day, i.e., -1, and one day after the event day, i.e., +1.

3. RESULTS AND ANALYSES

From the analysis of reshoring announcement data, we have found a total of 1555 reshoring announcements by US firms between 2010 and 2019. These cases also include multiple announcements made by the same company on different dates. In Europe alone, a total of 132 reshoring cases are found, which include reshoring announcements from outside and within European countries. The results of the European reshoring announcement are presented in Table 1. The US reshoring cases are presented due to its size.

The results show that maximum reshoring has happened from China and India. The top countries where most manufacturing or service activities are reshored or brought back are the United Kingdom, Italy, and France. The analysis of the European data shows that the major factors for reshoring decisions are: labor cost, lack of skilled labor availability, high energy cost, currency exchange rate risk, tax structure, shipping time, proximity to customers, the extent of automation, and infrastructure.

Table 1: Total reshoring cases in European countries

		Austria	Belgium	Croatia	Denmark	Estonia	Finland	France	Germany	Greece	Hungary	Ireland	Italy	Netherlands	Norway	Poland	Portugal	Romania	Slovakia	Spain	Sweden	UK	Total
Reshored from	Australia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2
	Austria	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
	Belgium	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	Bulgaria	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
	Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	China	0	0	0	0	0	1	6	2	0	1	0	10	0	1	0	2	1	0	4	0	12	40
	Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	Czech Republic	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
	Denmark	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	2
	Finland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
	France	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	3
	Germany	0	0	1	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	3	7
	India	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	4	7
	Italy	1	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	1	5
	Japan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	Latvia	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Moldova	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
	Netherlands	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	4
	Norway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
	Poland	0	0	0	2	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	7
	Romania	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4
	Singapore	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Slovakia	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	3
	South Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	Spain	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
	Sweden	0	1	0	0	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	5
	Switzerland	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	1	0	5
	Taiwan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
	Thailand	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Turkey	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	UAE	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	UK	0	0	0	0	0	0	3	1	0	0	1	0	0	0	0	0	0	0	0	0	0	5
	USA	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	5
Total cases		1	2	2	5	2	3	21	6	1	1	2	28	2	4	4	3	1	1	8	5	30	**132**

The event study results are shown in Figure 1. We can observe a noticeable stock market reaction on and after the announcement of reshoring for the US and European counties. Overall, reshoring announcements positively impact stock performance in different markets.

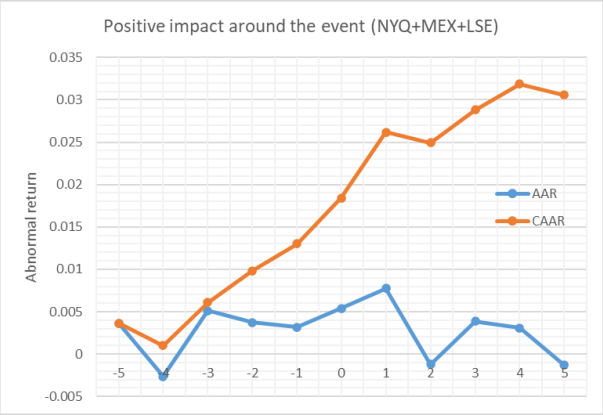

Figure 1: Results of stock market reactions

4. CONCLUSIONS

In recent years, there has been much emphasis on making supply chains more robust and resilient. However, today’s supply chains are more globally dispersed and complex than ever. With the global spread and lean philosophy adoption, supply chains have been exposed to constant disruptions. To minimize these risks and have greater control over supply chains, firms in Europe and the US have started reshoring some of their overseas operations to their home countries. This paper first investigates what factors affect the reshoring decisions of the US and European firms. To address this objective, we have collected secondary data about the reshoring announcements done by companies using different internet sources and the LexisNexis news database. After manually analyzing the reshoring announcements news data, we identified the major factors behind reshoring: labor cost, lack of skilled labor availability, high energy cost, currency exchange rate risk, tax structure, shipping time, proximity to customers, and the extent of automation and infrastructure.

Further, an event study was conducted to analyze how the reshoring announcements affect the stock market performance of the case company. We have collected the announcement date and stock prices around the announcements from yahoo finance. The event study results show a positive abnormal return around the reshoring announcement for European and US companies. It shows that customers perceive the reshoring decision as good. These are encouraging results for the manager.

Like any other study, this paper also has certain limitations on which the authors are already working. There has been more emphasis and increased reshoring activities due to COVID-19. Therefore, it would be interesting to compare the reshoring data before and after COVID-19 and analyze any difference in shareholders' reactions.

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STRUCTURE OF JIT-BASED SUPPLIER INTEGRATION: ITS ANTECEDENTS AND CONSEQUENT

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ABSTRACT

The recent global supply chain disruptions and crises shed light on the importance of supply chain management again, particularly supply chain integration and risk/crisis management, for most business enterprises. This paper picks up the integration with upstream suppliers in the JIT-based supply chains. It focuses on the antecedents and consequent of JIT-based supplier integration. Supplier integration can be promoted by JIT delivery by suppliers, which depends on top management support, IT use with suppliers, and geographical proximity. On the other hand, supplier integration is expected to improve the performance of suppliers. Based on the review of the existing literature, a research model for the structure of JIT-based supplier integration and six research hypotheses are developed. With survey data collected from manufacturing companies, valid and reliable multi-item constructs are established and used to test the hypotheses by SEM. All the hypotheses are supported, which proves the positive sequence from IT use with suppliers and geographical proximity to supplier performance.

Keywords: supply chain management, supplier Integration, JIT delivery by suppliers, empirical research, SEM

INTRODUCTION

Background

Supply chain management (SCM) and supply chain integration (SCI) are critical factors for manufacturing plants to survive, especially in turbulent environments. Today, the COVID-19 pandemic, the Ukraine-Russia military conflict, and the US-China geopolitical conflict broke the global supply chain of many manufacturers. [17] calls it a "global supply chain crisis." Many manufacturing companies suffer from them, and they feel the criticality of SCM and SCI. Many plants must stop production because of a supply shortage of key materials and parts [28].

Researchers have studied the effects of SCM, SCI, and supplier performance on buyer/manufacturer performance and found a tight link among supply management orientation, supplier performance, and buyer performance [37]. Both academic people and practitioners realize that supplier performance determines buyer performance. The supplier's risk is the buyer's risk [42]. Supplier performance affects buyer performance because of SCI or supplier integration. A typical impact pattern comes from JIT (Just-In-Time) delivery of materials and parts by suppliers. Many plants must have stopped

operations because of a supply shortage. "The situation has been especially difficult for businesses with complex supply chains, as their production is vulnerable to disruption due to shortages of inputs from other businesses" [11].

Research Motivation

Researchers revealed that many factors, such as top management support, geographic proximity, information systems (IT communication), and communication with suppliers, affect JIT (Just-In-Time) delivery by suppliers and supplier integration. However, we need more reflections and empirical studies of these complex relationships. Because of many related factors, the relational patterns that past studies could cover are limited. We need to accumulate more empirical evidence to confirm the complex relationships and factors. It is our motivation to conduct this study.

We try to find and conceptualize some related factors through a literature review and hypothesize the relationships between these factors and set a research model in the next section. The third section explains the data that we employed to conduct this study and multiple question items to construct measurement scales for the key factors. Then, we conduct some preliminary data analyses to check the reliability and validity of the constructs and move to SEM model analysis to test our hypotheses and research model in the fourth section. Finally, the last section concludes and sums up with academic and practical contributions and research limitations of this study.

LITERATURE REVIEW

Geographic Proximity

JIT delivery by suppliers needs speedy and constant communication between suppliers and buyers [23] [26]. "Industrial district theory regards spatial proximity as the basic success factor of regional cluster as it facilitates personal interaction. Personal interaction in various circumstances and settings form a social embeddedness that in turn facilitates a development of trustful relationships" [16, p. 1]. Geographic proximity improves supplier integration and involvement. It makes communication easy and speedy, especially for tacit knowledge and information exchange [22]. Supplier integration "leads to a better understanding of product technologies and brings about design improvements early in the design process" [25]. JIT delivery by supplier needs real-time and frequent information exchange. Therefore,
H1: If geographic proximity as a supplier selection criterion is important, JIT delivery becomes easier for suppliers.

IT Use with Suppliers

JIT delivery by suppliers needs speedy and constant communication between suppliers and buyers [23] [26]. IT and information systems make communication with suppliers speedy and precise, especially for exchanging formal data and information. "Businesses must invest in the implementation of information technology to enable automatic notification to suppliers when orders are received" [39]. "Implementation of IT in SCM can integrate and

coordinate the flow of materials, information, and finances among suppliers, manufacturers, wholesalers, retailers, and end-consumers" [24]. Information sharing benefits suppliers, too [45] [20]. Therefore,
H2: If buyers use IT with suppliers, JIT delivery by supplier becomes easier.

Top Management Support

Suppliers are one of important sources of external information and knowledge for product and process innovation, and top management conceives product and process innovation as a strategic issue [40]. [31] wrote that "top management involvement in collaboration with a supplier is important for increasing collaborative efforts." Therefore, top management understands the importance of supplier integration and involvement. The introduction of JIT delivery by suppliers needs top management support for supplier orientation, which is a critical part of supplier integration, too. Therefore,
H3: Top management support for supplier orientation is necessary for JIT delivery by suppliers.
H5: Top management support for supplier orientation improves supplier integration.

JIT Delivery by Suppliers

Production system coupling with suppliers includes some forms, such as Vendor Managed Inventory (VMI) and JIT [4]. [30] showed that supplier management is one of three critical factors of JIT. "JIT supply chain can be articulated as the right items arriving at each supply chain partner when needed in the right quantity, at the right place, and with the right quality" [44]. It depends on "the degree to which vendors are integrated into the production system by a pull system making frequent deliveries as needed" [1]. Although frequent delivery includes some drawbacks to suppliers [5], "pull type links with suppliers and customers enable a plant to be agile and responsive and, enhance delivery reliability" [1]. Pull system is a typical pattern of supplier integration, but it is not the sole ingredient of supplier integration. Some other researchers insist on the importance of JIT pull system, too [9]. From the discussion above, we can argue that supplier integration improves if JIT delivery by suppliers is implemented. Therefore,
H4: If JIT delivery by suppliers increases, supplier integration will improve.

Supplier Integration

[32] wrote that "supplier integration involves coordination and information sharing activities with key suppliers that provide the firm with insights into suppliers' processes, capabilities and constraints." Although supplier integration has some risks, such as lock-in [5] [43] and some researchers found even negative relationships to some performance indices [38], it has many benefits and improves supply chain performance [24]. [32] admitted that "researchers have linked supplier integration to better product development performance." Therefore, buyers evaluate the performance of integrated suppliers better than those not integrated. As integrated suppliers communicate with buyers more frequently, these suppliers are evaluated as friendly and better. Therefore,
H6: If supplier integration improves, buyers evaluate supplier performance better.

Based on the above hypotheses, we set a research model in the following sub-section.

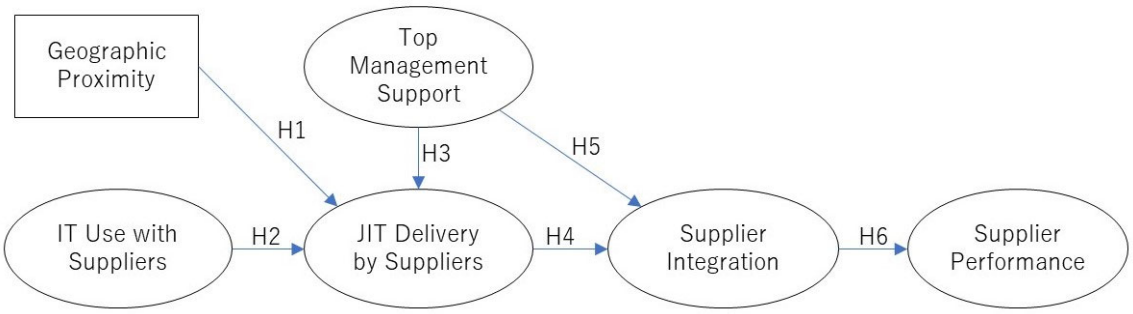

FIGURE 1: Research Model

Research Model

Figure 1 shows our research model for this study, based on the above hypotheses. At first, JIT delivery by suppliers depend on geographic proximity, IT use with suppliers, and top management support for supplier orientation. JIT delivery by suppliers and top management support for supplier orientation have positive impact on supplier integration, which leads to higher supplier performance.

We scrutinize this research model with data in hand. We explain the data in the next section.

DATA

Data Collection

The data we employed for this study is the fourth-round dataset of the High-Performance Manufacturing (HPM) research project [33] [36]. The project collected data from plants in three manufacturing industries in thirteen industrialized countries/regions. The fourth round of the HPM project data collection started in 2014. It is the latest version available. Table 1 and Table 2 show the demographics of respondents in terms of industry and country/region, respectively. The dataset includes 306 plants in thirteen countries/regions.

TABLE 1: Data Distribution by Industry

Industry	Count	%
Electric/Electronics	114	37.3
Machinery	110	35.9
Transportation	80	26.1
Missing	2	0.7
Total	306	100.0

In each country/region, a regional team of researchers visited the representatives of companies and plants and asked them to respond to 12 standardized questionnaires. Each plants nominated two persons as appropriate respondents to each questionnaire. If a company had multiple plants, the company selected one of them for the data collection.

TABLE 2: Data Distribution by Country and Region

Country/Region	Count	%	Country/Region	Count	%
Brazil	24	7.8	Japan	22	7.2
China	30	9.8	Korea	26	8.5
Spain	25	8.2	Sweden	9	2.9
Finland	17	5.6	Taiwan	30	9.8
Germany	28	9.2	United Kingdom	13	4.2
Israel	26	8.5	Vietnam	25	8.2
Italy	29	9.5	Missing	2	0.7
			Total	306	100

The original questionnaires had been made in English, and regional team members in each country/region translated them into their language before the distribution. To mitigate translation bias, the questionnaires were translated back into English by other professors and checked against the original English version for accuracy in most of countries/regions. Experienced bilingual professors edited the questionnaires for each country/region. We also requested a pilot test with local manufacturers and experts to refine the questionnaires further.

Questionnaire Items

Table 3 shows questions for supplier performance, which are measured by supplier evaluation and performance assessment by plant buyers. These questions are measured on a Likert scale, rated as 1=strongly disagree to 5=strongly agree. Upstream supply chain management in each plant answered the questions.

TABLE 3: Supplier Evaluation and Performance Assessment (Supplier Performance)

We are satisfied with the performance of our key suppliers on the following criteria: (Likert scale, 1=strongly disagree, 5=strongly agree)	
SEPA01	Price
SEPA02	Product liability
SEPA03	Quality certification, such as ISO 9000
SEPA04	Quick response on short notice

Table 4 shows the questions for supplier integration. They are measured on a Likert scale, rated as 1=not at all to 5=extensively. Upstream supply chain management in each plant answered the questions.

Table 5 shows the question items for JIT delivery by suppliers. Upstream supply chain management in each plant answered the questions.

TABLE 4: Supplier Integration

We have processes to ensure that … (Likert scale, 1=not at all, 5=extensively)	
SUPIN01	Our manufacturing plans/solutions are supply chain aligned
SUPIN02	Supply chain partner input is used in developing manufacturing plans and solutions
SUPIN03	Our supply chain partners' plans /solutions are manufacturing aligned
SUPIN04	Manufacturing inputs is used in developing our supply chain partners' plans and solutions

TABLE 5: JIT Delivery by Suppliers

We have processes to ensure that … (Likert scale, 1=not at all, 5=extensively)	
JITDS01	Our suppliers deliver to us on a just-in-time basis.
JITDS02	We receive daily shipments from most suppliers.
JITDS03	Our suppliers are linked with us by a pull system.

Table 6 shows the questions about IT use with suppliers. Upstream supply chain management in each plant answered the questions.

TABLE 6: IT Use with Suppliers

Please indicate the extent to which you use IT to communicate with your primary suppliers for the following: We have processes to ensure that … (Likert scale, 1=not at all, 5=extensively)	
ITUWS01	Managing warehouse stock and inventories
ITUWS02	Understanding trends in sales and customer preferences
ITUWS03	Integrating your design and manufacturing functions
ITUWS04	Leveraging your plant's expertise to create new business opportunities

Table 7 shows the questions for top management support to supplier orientation. Upstream supply chain management in each plant answered the questions.

TABLE 7: Top Management Support for Supplier Orientation

TMSSO01	Relationships with our suppliers are considered to be of critical importance to our plant's top managers.
TMSSO02	Sharing valuable information with our suppliers is considered critical by our top managers.
TMSSO03	Our top managers repeatedly tell us that sharing supply chain risks and rewards with our suppliers is critical to our plant's success.
TMSSO04	Our top managers support us in resolving conflicts with our suppliers, when they occur.

Table 8 includes a single question about the importance of geographic proximity as the supplier selection criterion. It is measured on a Likert scale, rated as 1=unimportant to 5=very important. Upstream supply chain management in each plant answered this question.

TABLE 8: Geographic Proximity

How important is each of the following criteria in the selection of key suppliers for this plant? (Likert scale, 1=unimportant, 2=less important, 3=neutral, 4=somewhat important, 5=very important)	
SSCGP	Geographic proximity

RESEARCH RESULT

Preliminary Analysis

All descriptive analyses shown below are conducted using SPSS version 28. First, we conducted an Exploratory Factor Analysis (EFA) with all question items (Table 9). EFA explores "the underlying factor structure without prior specifications of the number of factors and their loadings" [41]. We employed the maximum likelihood method with Promax rotation with Kaiser Normalization. We found five potent factors, as we expected. All loadings in the yellow cells are greater than 0.5. Overall, the five factors explained 68.55% of the total variance.

TABLE 9: Exploratory Factor Analysis (EFA)

	Top Management Support	IT Use with Suppliers	JIT Delivery by Suppliers	Supplier Integration	Supplier Performance
TMSSO01	0.677	0.068	-0.075	0.021	-0.034
TMSSO02	0.75	-0.041	0.068	-0.054	0.063
TMSSO03	0.657	-0.02	0.129	0.008	-0.027
TMSSO04	0.622	0	-0.061	0.054	0.017
ITUWS01	-0.047	0.664	0.076	0.03	0.061
ITUWS02	0.037	0.901	0.015	-0.038	-0.095
ITUWS03	-0.002	0.855	-0.062	-0.027	0.075
ITUWS04	0.017	0.788	0.011	0.089	-0.044
JITDS01	0.03	0.045	0.695	-0.008	0.041
JITDS02	0.061	-0.085	0.69	0.015	-0.043
JITDS03	-0.069	0.113	0.668	-0.009	0.049
SUPIN01	-0.05	0.023	-0.062	0.81	0.062
SUPIN02	0.027	0.043	0.052	0.855	-0.103
SUPIN03	0.039	-0.054	0.026	0.876	-0.014
SUPIN04	0.017	0.044	-0.013	0.765	0.092
SEPA01	-0.046	-0.061	0.096	0.049	0.556
SEPA02	0.02	0.022	-0.146	0.039	0.801
SEPA03	0.132	0.026	-0.065	-0.055	0.653
SEPA04	-0.086	-0.001	0.188	-0.014	0.634

We employed the HPM dataset, a single source of data (upstream supply chain management in each plant), and it is the self-report measure (Likert-type scale). The result might suffer from common method variance or common method bias [19]. Therefore, we

made Harman's one-factor test. If the total variance extracted by the largest factor exceeds 50%, common method bias may be present in our study. We found it loads only 31.34%, and it suggests that common method bias is not a serious problem [29].

We checked the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity. The result of the KMO test of sample adequacy was .882, where >.9 is marvelous, >.8 is meritorious, >.7 is middling >.6 is mediocre [18]. Bartlett's Test of Sphericity had an Approximate Chi-Square of 2347.006 (p= 0.000). "A significance value < .05 shows that the data is approximately multivariate normal and suitable" for factor analysis" [15].

TABLE 10: Confirmatory Factor Analysis (CFA)

	Top Management Support	IT Use with Suppliers	JIT Delivery by Suppliers	Supplier Integration	Supplier Performance
TMSSO01	0.668				
TMSSO02	0.744				
TMSSO03	0.702				
TMSSO04	0.641				
ITUWS01		0.709			
ITUWS02		0.854			
ITUWS03		0.831			
ITUWS04		0.838			
JITDS01			0.762		
JITDS02			0.623		
JITDS03			0.697		
SUPIN01				0.785	
SUPIN02				0.864	
SUPIN03				0.862	
SUPIN04				0.843	
SEPA01					0.562
SEPA02					0.796
SEPA03					0.685
SEPA04					0.644
Cronbach's alpha	0.783	0.882	0.739	0.905	0.751
AVE	0.587	0.767	0.597	0.798	0.567
CR	0.850	0.929	0.817	0.940	0.838
Square root of AVE	0.766	0.876	0.773	0.893	0.753

Secondly, we conducted Confirmatory Factor Analysis (CFA) with AMOS version 25 (Table 10). We also computed the Average Variance Extracted (AVE), Composite Reliability (CR), and then the square root of AVE. The CR values of all the factors are greater than the threshold value of 0.70 [6]. Therefore, we deemed that the internal consistency of each construct was adequate [10]. All AVEs exceeded the minimum criterion (above 0.5) [2]

[34]. All CRs and Cronbach's alpha values exceeded 0.7 [8] [27]. They ensured convergent validity, too.

We confirm the discriminant validity by comparing the square root of AVEs to the inter-construct correlations (Table 11). All the square roots of AVEs are higher than the inter-construct correlations. It provides the evidence of discriminant validity [10] [21].

TABLE 11: Inter-Construct Correlation Coefficients

Factors	IT Use with Suppliers	JIT Delivery by Suppliers	Top Management Support	Supplier Integration	Supplier Performance
IT Use with Suppliers	0.876*				
JIT Delivery by Suppliers	0.531	0.773*			
Top Management Support	0.311	0.454	0.766*		
Supplier Integration	0.587	0.416	0.522	0.893*	
Supplier Performance	0.257	0.335	0.476	0.478	0.753*

*The value in the diagonal cells is the square root of AVE of each construct.

Result of SEM

Because we had set six hypotheses and a model based on our literature review, we employed covariance-based SEM (AMOS version 25) rather than PLS-SEM for the analysis. Covariance-based SEM is recommended for confirmatory model analysis [3] [14] [35]. This research intends to be a confirmatory study rather than an exploratory study.

Figure 2 shows the result of the covariance-based SEM analysis. All coefficients in the figure are highly significant ($p<0.001$) except H4 ($p=0.001$), which strongly supports all the six hypotheses we proposed. Model adaptability is good enough as χ^2(CMIN)=245.126, d.f.=162, CMIN/d.f.=1.513. However, the estimated model is evaluated to be significantly different from the hypothesized research model ($p=0.000$). This is a common phenomenon to SEM analysis with large degree of freedom. We understood that it comes from the data size that we employed in this empirical study. [12] wrote that "because the Chi-Square statistic is, in essence, a statistical significance test, it is sensitive to sample size, which means that the Chi-Square statistic nearly always rejects the model when large samples are used."

On the other hand, the model fit is good. Normed-fit index (NFI) = 0.904, IFI = 0.965, Tucker-Lewis index (TLI) = 0.954, Comparative fit index (CFI) = 0.965, RMSEA = 0.041, AIC = 381.126. TLI and CFI need to be greater than 0.95 as a good fit [12] [13]. "Browne and

Cudeck recommend that an absolute RMSEA value of less than 0.05 indicates a close-fit" [37]. As a result, the model fit can be regarded as good enough.

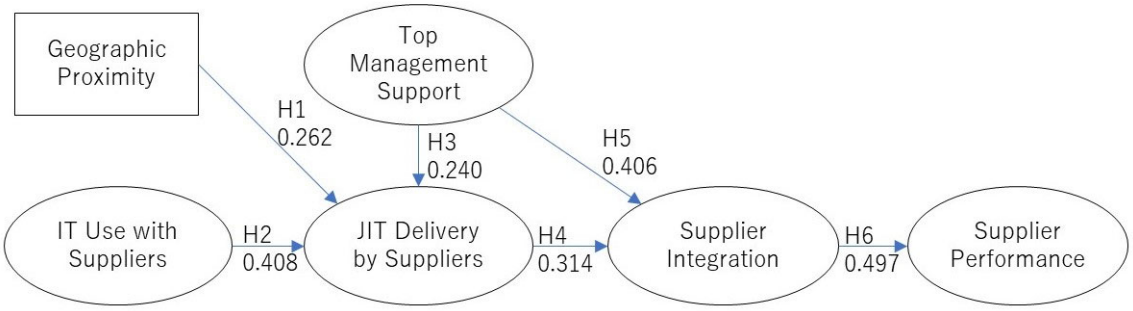

FIGURE 2: Result of SEM

DISCUSSION AND CONCLUSIONS

Research Summary

Supplier integration is critical for the supplier and buyer performance of plants along supply chains. Integration of the JIT delivery system into a production system is a popular mechanism for supplier integration. The existing literature suggests that some factors, such as IT use with suppliers and top management support, affect the introduction of JIT delivery by suppliers. Many practitioners suggest that geographic proximity is a key factor for introducing JIT delivery by suppliers. Although the above suggestions are known facts, we do not know the cause-effect relationships among these factors. We need to infer these cause-and-effect relationships with more empirical studies. It is our research motivation in this study.

We tried it with data from an international collaboration named HPM research project. In other words, we applied the data to a hypothesized cause-effect relationship model. Based on the literature review, we set six hypotheses about the relationships among factors. Based on the empirical data analysis, we find significant and well-fit results, and this paper reports them. The academic contribution of this study is that we added empirical evidence of cause-and-effect relationships. We set six hypotheses:
H1: If geographic proximity as a supplier selection criterion is important, JIT delivery becomes easier for suppliers.
H2: If buyers use IT with suppliers, JIT delivery by supplier becomes easier.
H3: Top management support for supplier orientation is necessary for JIT delivery by suppliers.
H4: If JIT delivery by suppliers increases, supplier integration will improve.
H5: Top management support for supplier orientation improves supplier integration.
H6: If supplier integration improves, buyers evaluate supplier performance better.

The main conclusions from the analysis are as follows:

First, geographic proximity (H1), IT use with suppliers (H2), and support or leadership of top management (H3) are key factors for JIT delivery by suppliers. Second, JIT delivery by suppliers (H4) and top management support (H5) are critical determinants for supplier integration. Finally, successful supplier integration results in better supplier evaluation (H6). We can recommend practitioners to promote above principles, and it is our practical contribution.

Research limitations

There are some research limitations in this study. First, our sample size is limited to around 300 plants, and we need more. Because of missing values in the dataset, the real sample size must be less than 300, depending on the analysis. Second, data are not new. As data are collected in the period of 2014-2018, we need newer data to repeat and confirm our results in this study. Third, our literature review is relatively limited because of resource limitations. As we noted earlier, there are many studies about this theme and related factors. We need a more extensive literature review.

Finally, as every case differs depending on the contingency, we can imagine different patterns and results on SCI. We must repeat more empirical tests to find these missing factors and relationships. However, because of time limitations, they are left for future study.

ACKNOWLEDGMENTS

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Papers: Student Papers (Undergraduate, Master and Ph.D Students)

1998-2018 MAJOR LEAGUE BASEBALL PAYROLL EFFICIENCY

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ABSTRACT

Major League Baseball (MLB) has differentiated itself from the other two major American sports league (National Basketball Association and the National Football League) by designing the player salary system so that there is no official salary cap that a team can't go past to spend on players. However, not all 30 Major League teams are built equally and the payrolls vary widely among the teams. The MLB allows the big market teams to remain dominant through investing as much money as they want into talent while many small market teams are allowed to consistently spend significantly less while they bring in enough money to easily clear their bottom line due to their low investment in talent. Through data visualizations in Tableau and explanations of the way in which MLB operates, this paper examines how and why money is invested in talent and what this typically results in in regards to attendance, wins, and playoff success.

INTRODUCTION

The CBA and the differences from the NFL and the NBA

The collection bargaining agreement (CBA) is negotiated by the Major League Baseball Player's Association (MLBPA) and the owners of the teams every few years to come up with an agreed upon contract under which the MLB can operate. Since 2003, the [1] CBA has included a collective bargaining tax (CBT) which makes teams pay a luxury tax on every dollar they spend on their 40-man payroll over a certain threshold. This is different than the NBA and NFL which have a hard salary cap that cannot be exceeded by teams. The luxury tax is collected by the league and redistributed among teams not spending over the set threshold. To give an idea of the numbers being discussed, the threshold for the luxury tax to hit was set at $197 million and every dollar $20 million over that would be taxed at a rate while every dollar $40 million over the threshold would be taxed at a greater rate, and so on. This rate also changes depending on the amount of consecutive seasons a team has been in violation of it. However, it is interesting to note here that of the 2 teams which were forced to pay the luxury tax in 2018, the Red Sox won the 2018 World Series and the Nationals won the 2019 World Series [2]. A tax was paid but both teams were rewarded with something of much more value shortly after.

It is also interesting to note the difference between the valuation teams put on MLB players as opposed to NFL and NBA players. Baseball is unique in the fact that the environment in which a player is graded is much more controlled due to it lacking the typical qualities of a team sport. The vast majority of most players' value in today's MLB relies on their hitting at the plate or their pitching on the mound. Scouts and data analysts working in front offices across the MLB

can place a lot of trust on data such as a player's batting average, on-base percentage, slugging percentage, earned run average, pitch velocity, or wins-above-replacement when determining the value of that player. They can have much more trust in the statistics and numbers than the NFL and NBA because it comes down to a player's individual level of pitching or hitting more than anything else. The NFL and NBA are much more fluid sports where the statistics don't come out as cleanly and individualized. On every football play, there are 10 other guys of varying talent levels helping out each player on the field and 11 other guys of varying talent levels trying to stop them. The NBA has a similar problem but not as bad with there only being 10 players total affecting any given play, but it comes nowhere close to replicating the relative vacuum that MLB players are evaluated in. Collecting statistics from a sport which involves so many variables which are hard to control for leads to a more inaccurate valuation of players. There is also the fact that the sample size of plate appearances and innings pitched accumulated in an MLB 162 game regular season is unlike any other in sports with the NFL having 17 game seasons and the NBA having 82 game seasons.

The main way teams are able to go on impressive runs in the present-day MLB without spending money like a big market team that can afford to is by scouting and drafting talent at a young age successfully and finding quick use for them while they are still on their small rookie contract. MLB again is able to collect more valuable statistics than football and basketball here as well due to the MLB's uniqueness of having the large minor league system which allows scouts and analysts to evaluate players without them even playing on the major league level. Every bit of the MLB's talent is quantified to a much finer degree than the NBA or NFL could ever hope to achieve due to these processes which makes it all the more harder for MLB teams that don't spend as much to have break out seasons better than the big spenders because it's much harder to get a contract that is one of those "diamonds in the rough" in a league where the talent is valued much more accurately by the teams offering contracts.

The Data

The data chosen to work with is from 1998-2018 because 1998 was the last year new franchises were added into the league (Tampa Bay Rays & Arizona Diamondbacks) so the same 30 teams will be the only ones present in the dataset across the 21 years (with the exception of the Montreal Expos moving to Washington to rebrand as the Nationals but still remaining as the same franchise). The data originates from Baseball Reference and was downloaded into an Excel file with modifications made to import into Tableau properly in order to make the figures used in this paper. This data's timeline also ensures that it all takes place in the "Wild Card Era" (1995-Present) so teams may be reliably distinguished across the timeline on playoff success along the five possible outcomes of: "No Playoffs," "Wild Card," "Won Division," "Won Pennant," or "Won World Series."

The data also includes each team's opening day estimated 40-man payroll at the start of each season in an attempt to see how much each team spends on their talent. This payroll only represents the salaries of players eligible to play on the major league team and does not include any investments made into minor leaguers, managerial staff, or other departments within the organization. Another value included in the data for each MLB season is each team's average attendance per home game to gauge each team's relative level of revenue as well as their market size and fanbase size. The amount of wins accumulated by each team each season is also in the

data. All of the data mentioned so far is different for each team each season dependent upon their performance, investment in talent, and attendance levels.

The data also includes the park factors for singles, doubles, triples, home runs, and runs and is different values by team but does not change by year since it is a value calculated over a multiple season stretch from the ballpark a team plays in and is meant to represent a value that should remain consistent regardless of the year. The park factors are meant to measure how much each ballpark differentiates from the mean in allowing a certain type of hit or overall runs with the value of 1 being average while having a park factor on singles for 1.15 would mean that 15% more singles are hit in that ballpark on average than the rest of the league. The longitude and latitude for each team's ballpark is also in the data in order to create a map (WSN represents the Washington Nationals and the Montreal Expos) and the New York Mets, Los Angeles Angels, Chicago White Sox and Oakland A's have been moved slightly from their actual location to avoid overlapping graphically with the New York Yankees, Los Angeles Dodgers, Chicago Cubs and San Francisco Giants respectively which appear almost on top of them on a map. Each team's division and league is also included in the data (the Houston Astros are shown as the AL West throughout the data even though they switched from the NL Central to the AL West in 2013).

ANALYSIS

Data Visualizations

Figure 1 shows a map which is analyzing each team's market size through average attendance per game with a color scale where the degree of orange represents smaller market size with not as many ticketholders while the degree of blue represents the bigger market teams with more people in attendance. The increasing size of the bubbles on this map correspond to more average wins per season across this dataset. As mentioned earlier in the paper, the longitudes and latitudes are slightly inaccurate for the Mets, Angels, White Sox, and A's in order to reduce graphical overlapping on the map with other teams that reside in the same metropolitan area. This is a very cursory glance looking into the relation between the average attendance per games and the average wins per season across these 21 years, but it definitely shows a trend towards the bigger market teams tending to have more wins per season with a few outliers. This graphic is made to show the actual location of where the bigger market teams as opposed to the smaller market teams regionally in the United States.

FIGURE 1

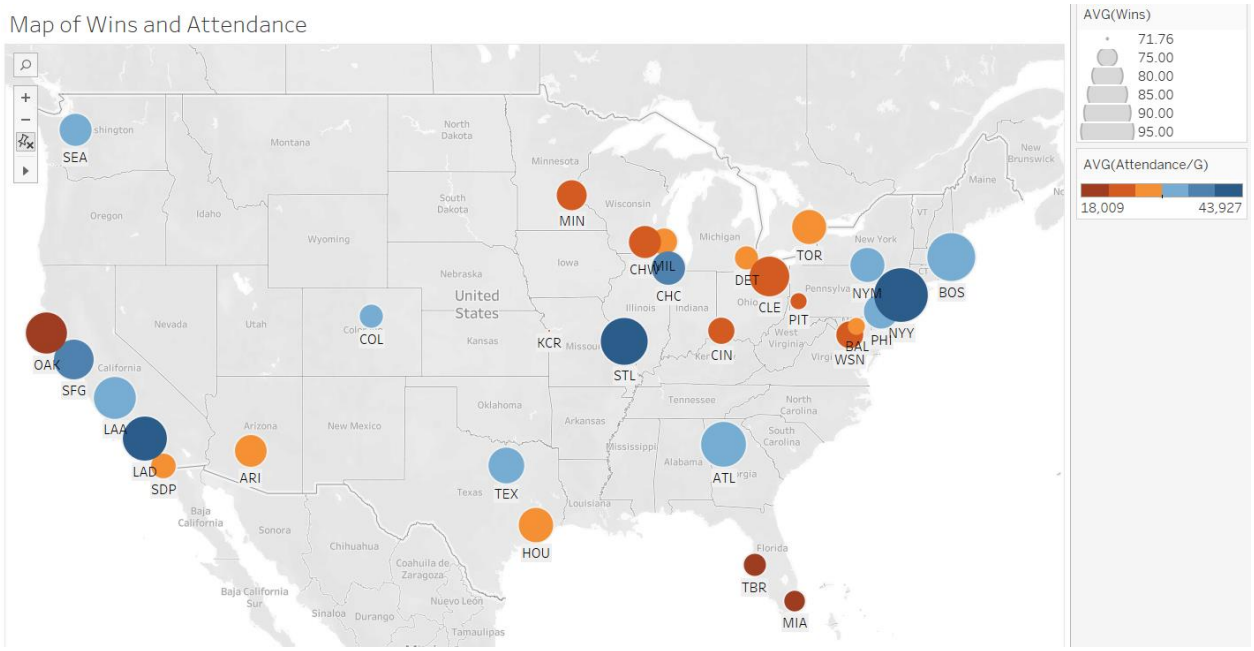


Figure 2 supports this idea by plotting the idea of Figure 1 on a scatterplot with a p-value and r-squared calculated between the 2 variables' correlation to see the true relationship associated with the two variables of attendance and wins. The p-value comes out to less than .0001 showing a very statistically significant relationship while the r-squared does show a fair amount of variance not being accounted for at a .468291. The As may be pointed out as an outlier in both of these first 2 figures and we'll address that shortly.

FIGURE 2

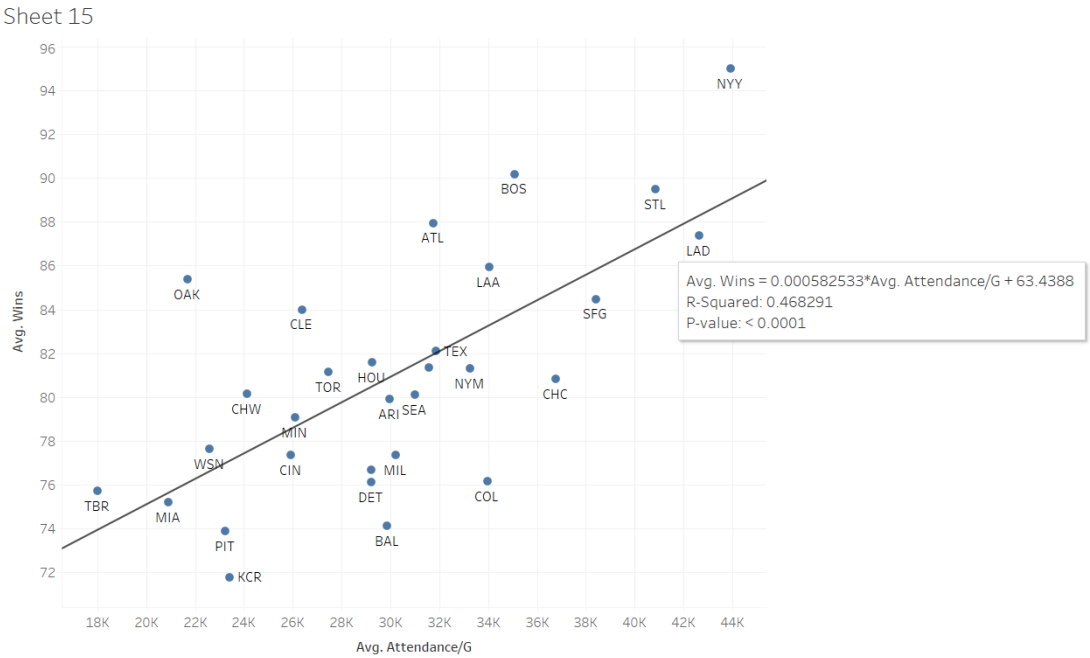


Figure 3 plots where each team ranks in average attendance per game on the y-axis while showing where each team ranks in average payroll per year on the x-axis. In some ways, this scatterplot shows the revenues and the costs of the teams generally but of course this is only specifically looking at tickets sold and investment in talent so it gives a good general idea of a team’s cost and revenues relative to each other. Here again, there is an exceptional p-value of less than .0001 and a much better r-squared of .689694 when looking at their relationship. It’s also important to note those eight teams that seem to be in their own little space up in the top right corner dominating the league in attendance and payroll and the Rockies seemingly be further off the line of best fit than any other team.

FIGURE 3

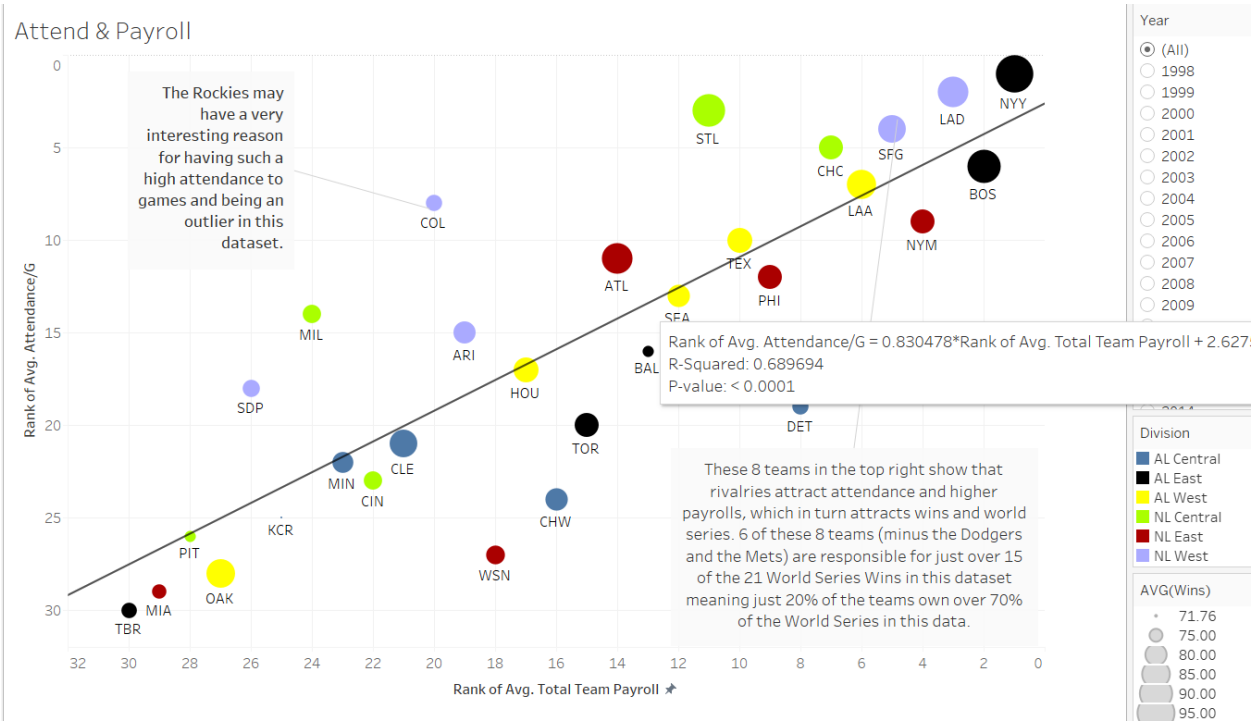


Figure 4 looks at park factor which clearly shows one thing: when you play in Colorado, there’s a lot of runs scored. This abundance of runs and exciting baseball might explain why the Rockies naturally have so many people attending their games. It’s also interesting to note that the physical reason for this discrepancy in runs comes from the fact that Coors Field (where the Rockies play in Colorado) is located a mile above sea level and the ball has less air resistance which causes it to fly further leading to baseballs being hit further.

FIGURE 4

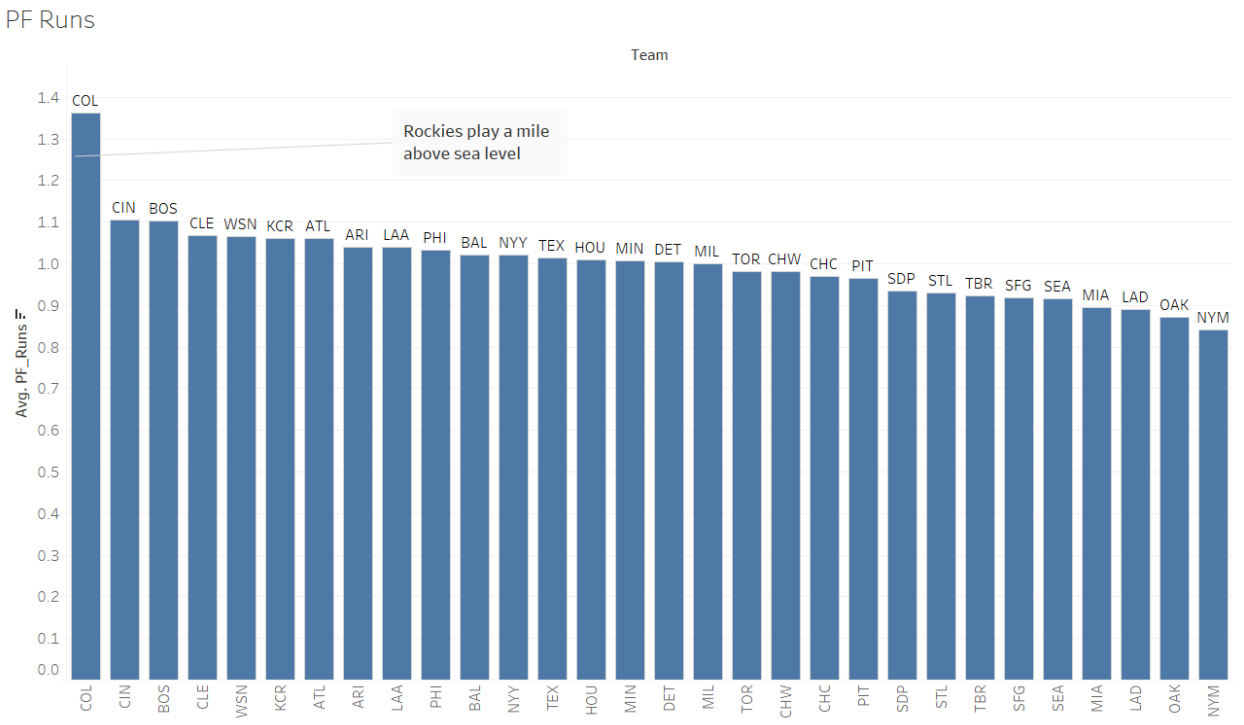


Figure 5 looks at six of those eight teams discussed with Figure 3 and depicts a treemap which shows just how dominant the Red Sox, Yankees, Angels, Giants, Cardinals, and Cubs have been over this 21 year stretch in comparison to the other 24 teams in the league.

FIGURE 5

Figures 6-8 look at the relation between a team's rank in payroll per year and their rank in average wins to determine the correlation between the two variables attempting to bring a general answer to the question of, "can money buy wins?" Figure 6 shows a good trend line with a p-value of less than .0001 and a r-squared value of .427176. However, there is a couple of obvious outliers when going year by year through the data and filtering for stretches where some teams were efficient in getting more wins with less payroll. Figure 7 shows the Oakland A's run from 1998-2006 where they ranked 23rd in payroll while ranking 3rd in wins across that same stretch. This stretch was actually historic enough to get a movie made based on it called "Moneyball." The other noticeable outlier in this data are the Tampa Bay Rays from 2008-2013 where they were even more efficient than the A's during their stretch (albeit a shorter stretch of years) by ranking 26th in payroll spending per year while ranking 2nd in wins per year. Neither of these teams were able to acquire any World Series titles during their stretches but they are definitely outliers in regular season baseball.

FIGURE 6

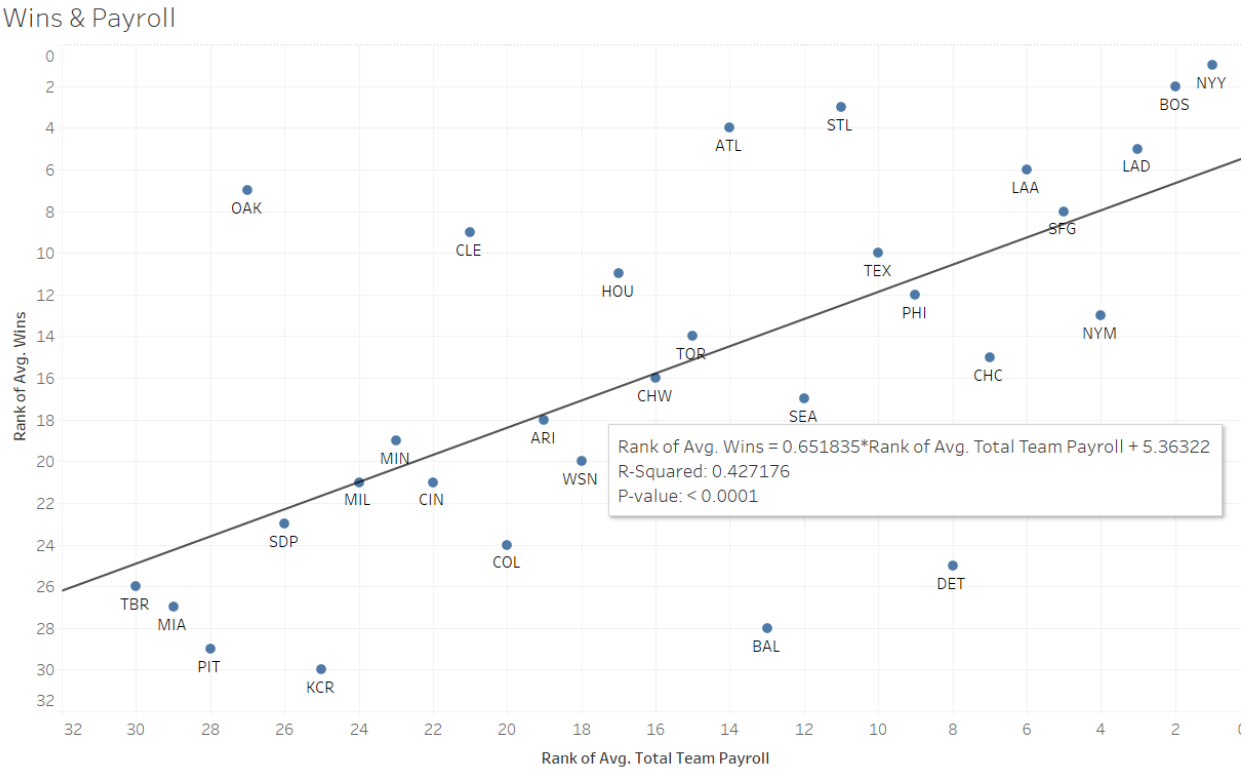


FIGURE 7

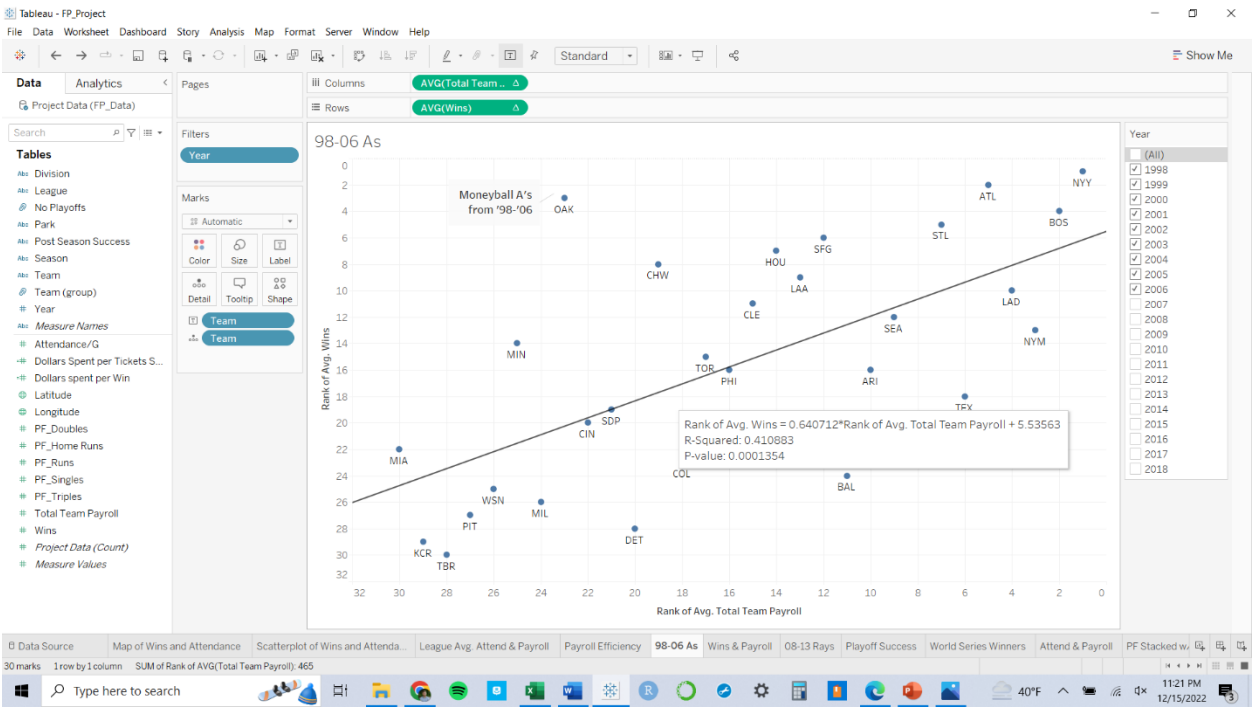
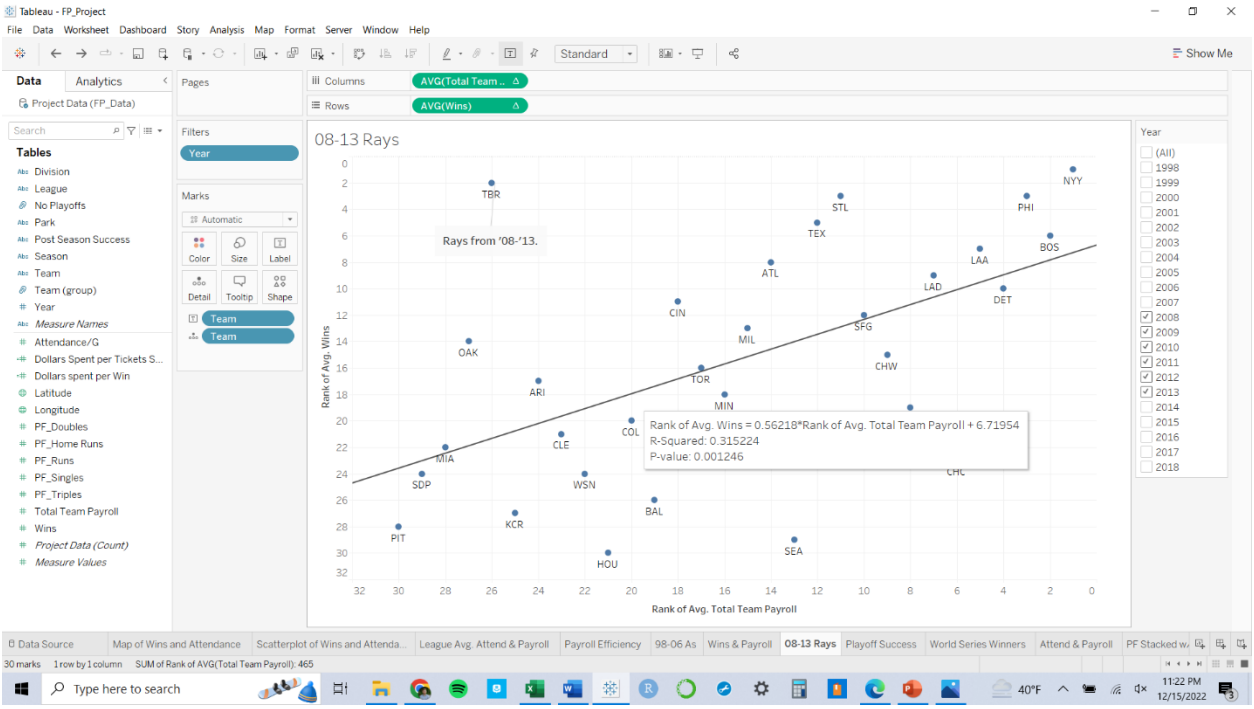


FIGURE 8



Figures 9 and 10 take a look at teams which were lower third and upper third teams by payroll in their respective seasons. Figure 9 shows the teams with lower third payrolls, and while not all of the teams from every year are visualized, the median and upper/lower quartiles give us a good idea of what can be expected from a lower third team as far as wins go across the 21 years in the dataset. The lower quartile is 68, the median is 75, and the upper quartile is 83 which shows that

lower third payroll teams can expect a season below a .500 winning percentage typically (81 wins would be .500). Figure 10 shows the upper third payroll teams and their numbers are quite different. The lower quartile is 79, the median is 88, and the upper quartile is 94.75. This means that a team in the upper third of payrolls can most definitely expect to win most of their games normally.

FIGURE 9

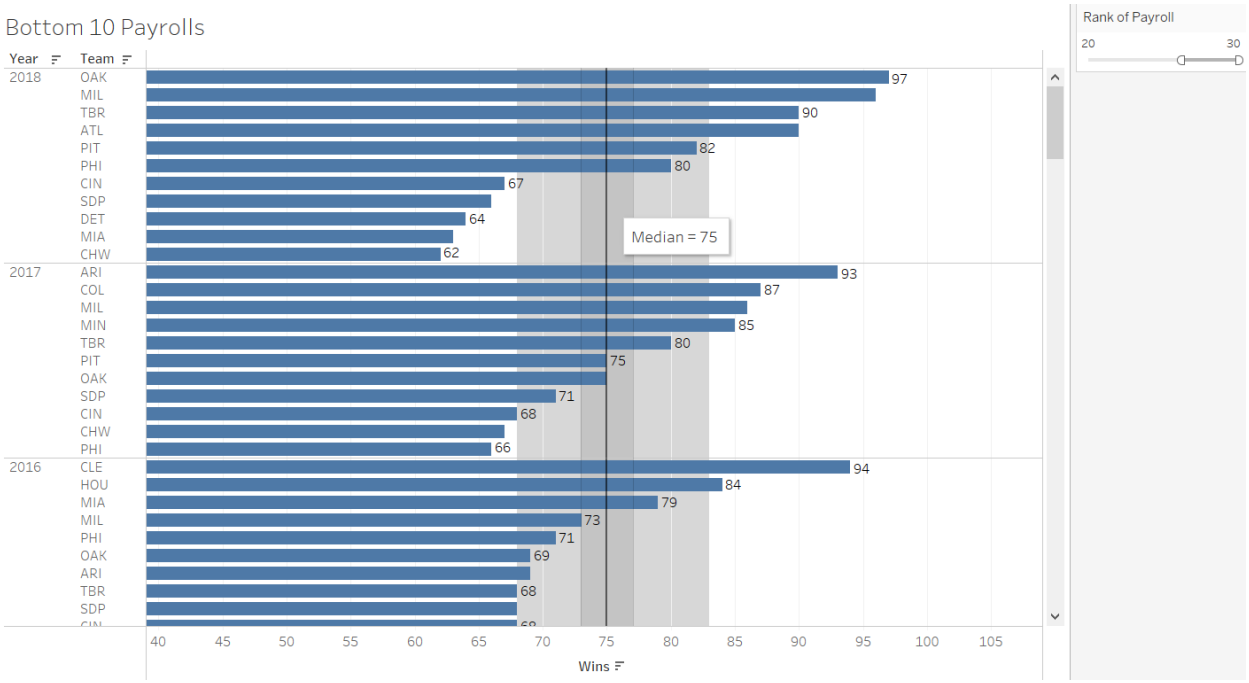


FIGURE 10

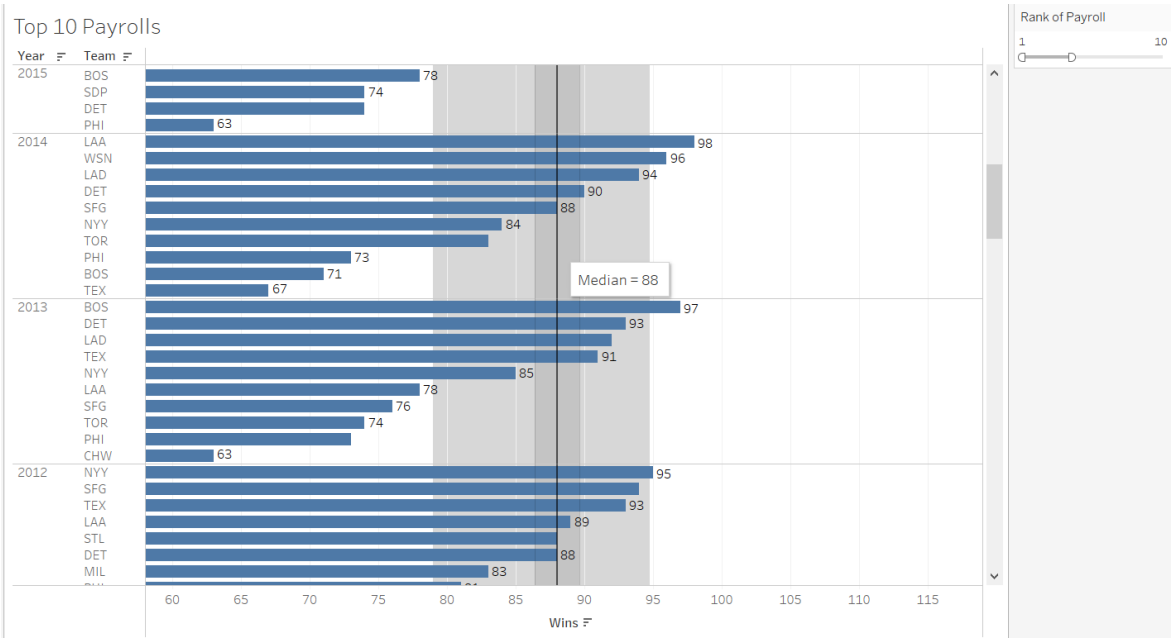
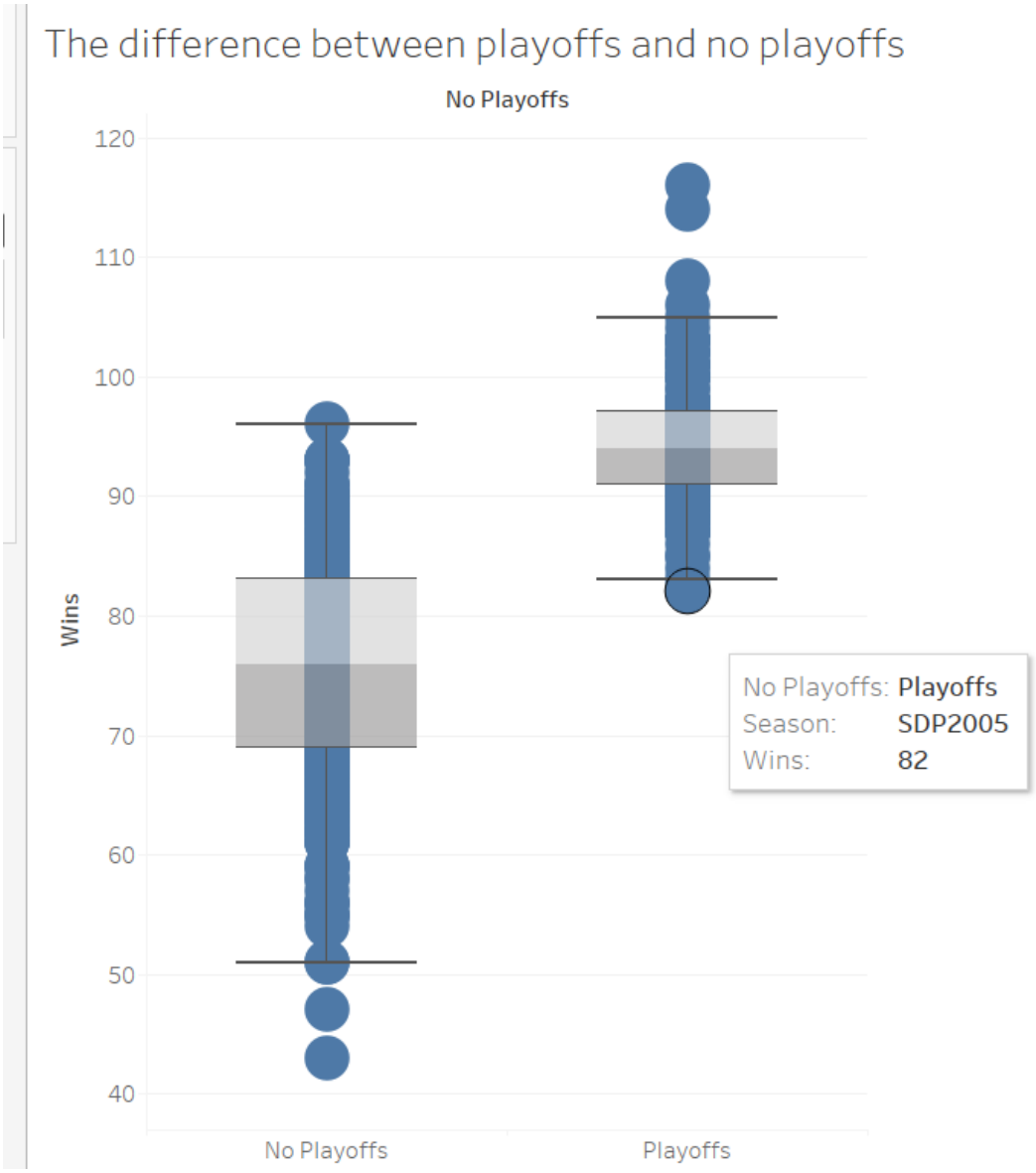


Figure 11 shows the typical amount of wins needed to make the playoffs in a given season in order to give Figures 9 and 10 some more meaning. The median value for a team that doesn't make the playoffs is 76 while it is 94 for a team that does make the playoffs. No team in this dataset has ever made the playoffs winning less than 82 games and it's generally uncommon that they would make the playoffs winning less than 90 games.

FIGURE 11



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AN ENVIRONMENTAL AND ECONOMIC IMPACT ASSESSMENT OF POTENTIAL SPILLS IN THE GALVESTON BAY AREA

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ABSTRACT

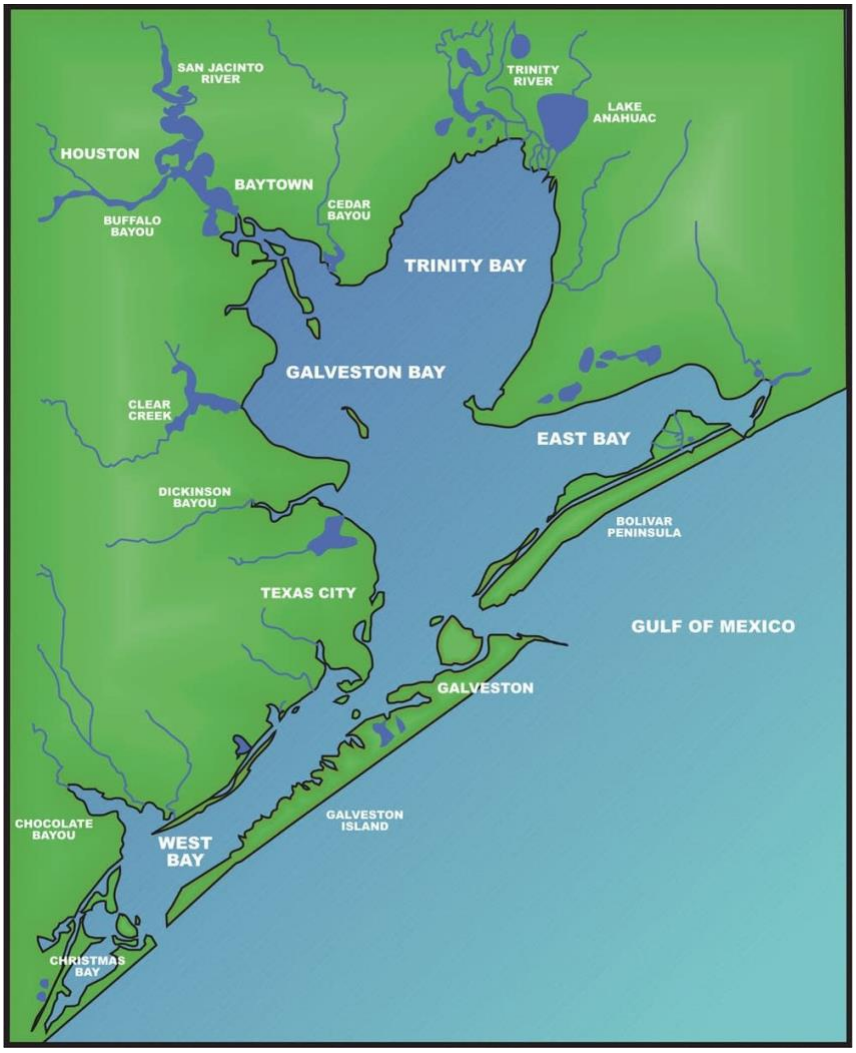
Maritime businesses in Galveston Bay are at risk from environmental and economic damages caused by potential chemical/oil spills. Spills disrupt shipping lanes/ports, damage surrounding ecosystems, and can require expensive and laborious cleanup efforts. Despite improvements in technology and increased regulations that seek to mitigate the occurrence and risks of spills, they will continue to happen and cause damages. As such, it is vital that new, sustainable, and proactive approaches to solving the spill problem are created. We studied the risk-related factors involved with spills in Galveston Bay and the resulting environmental and economic impacts. To assess these factors, the extant literature was reviewed, and qualitative and quantitative questionnaires were distributed to eight experts on spills in the Galveston Bay area. The factors solicited from the literature and questionnaires were used to construct an Environmental and Economic Impact Model (EEIM) using the Bayesian theory. Important risk- related factors were found to be spill location, spill type, environmental conditions, seasonality, and the specific cleanup/recovery methods deployed. In addition, costs of the environmental and economic impacts were quantified for several potential spill scenarios. The information obtained in this study can be used to develop transferrable tools, guidelines, and frameworks to support decision-making in the Galveston Bay area and elsewhere. Further, the paper underscores the need for a holistic and proactive evaluation of the different dimensions of a spill (policy, economic, health, social, remediation mechanisms, etc.) for effective outcomes.

INTRODUCTION AND BACKGROUND

Galveston Bay is an inlet of the Gulf of Mexico located on the southeastern shore of Texas. It is 35 miles long and up to 19 miles wide with an average depth of 7 feet, making it the largest estuary in Texas [9]. The Bay is surrounded by several waterways including the Trinity and San Jacinto Rivers and is home to the Houston Ship Channel. The major cities and waterways surrounding Galveston Bay are shown in Figure 1. Galveston Bay comprises complex and interconnected biological, hydrological, and geological systems, and houses two main ports. The smaller Port of Galveston and the larger Port of Houston. Each port is highly valuable economically, and are the main centers for maritime business and shipping in Texas. These

factors combine to make Galveston Bay a critical environmental and economic asset to Texas and the rest of the U.S.

FIGURE 1



A map of Galveston Bay and the surrounding cities and waterways. Source: Photo courtesy: https://www.tshaonline.org/images/handbook/entries/GG/galveston_bay_map.jpg.

Galveston Bay is a bar-built estuary formed from the sediment deposits of the Trinity and San Jacinto rivers. The Bay exhibits high variability in salinity with values that range from 15-35 psu at Bolivar Peninsula inlet and 0-30 psu in Trinity Bay [17]. As such, the plants and animals that permanently inhabit the Bay can tolerate fluctuating salinities. However, as salinity changes, the diversity of species present in the Bay also changes as lower salinities lead to a higher abundance of freshwater species and higher salinities lead to a higher abundance of marine species. Furthermore, seasonality is a critical component in species distribution as species migrate in and out of the Bay depending on the season. The southern flounder population is an example of this, as they migrate annually into the Bay during the spring and back to the Gulf in late fall. Estuaries

such as Galveston Bay exhibit high variability because they are constantly responding to changes in tidal cycles, weather patterns, and seasonal events such as hurricanes. While the Bay is well-suited for adjusting to these natural cycles and changes in the environment, external factors such as spills can permanently disrupt its biological, hydrological, and geological systems. Depending on the type, size, and timing of a spill, the natural systems present in the Bay can suffer from significant and costly damages.

The Port of Galveston is located at the entrance of Galveston Bay along the Galveston Channel which has an authorized minimum depth of 45 feet and a width of 1,200 feet at its narrowest point [20]. Its facilities include RoLo (roll-on/roll-off) terminals on the east and west ends, and two cruise ship terminals [14]. It is the only port in Texas that accommodates cruise ships, and in 2015 had over 1.67 million cruise passenger movements and generated over 74 million USD in local revenue. This has led the Port of Galveston to become the fourth-busiest cruise ship homeport in North America and the seventh busiest in the world [15]. In addition, the port ranks 52nd in the nation for cargo tonnage at 5.6 million tons moved and accounted for 5.5 billion USD in international trade in 2015 [18]. It's primary imports include machinery, vehicles, fertilizers, and produce while its primary exports include machinery, bulk grains, mineral oils, and liquid chemicals.

The Port of Houston is located at the end of the Houston Ship Channel, a 52-mile-long shipping channel that hosts more than 8,300 large ships and 231,000 smaller commercial vessels carrying a total of 230 million tons of cargo annually [20]. These numbers have made the Houston Ship Channel the busiest waterway in the U.S. The port has more than 150 public and private terminals, including the nation's largest petrochemical complex [16]. As a result, the Port of Houston is the largest importer and exporter of petroleum and petroleum products in the U.S. In 2015, a total of 24.7 billion USD in revenue was generated from imports and exports of petroleum which accounted for 18% of its total trade that year [19]. The large amount of petroleum being moved in and out of the Port of Houston greatly increases the risk of a spill occurring, and poses the greatest threat to the environment.

As a result of its high environmental and economic value, a spill event in Galveston Bay could to lead to costly and long-lasting impacts. While the probability of a large spilling event is low, the chance of it occurring is always a possibility despite the best efforts of local government and industry. Natural disasters such as hurricanes greatly increase the likelihood of a large spill occurring in Galveston Bay. Hurricanes are expected to occur more frequently and with greater magnitude as it is vital that businesses and agencies plan and prepare accordingly so potential major spills can be avoided. To help businesses and agencies prepare for this scenario, this research project seeks to be a source of information for the costs of a potential spill in Galveston Bay. As such, the objectives of this research project are to: 1) Understand the factors that contribute to potential spills in Galveston Bay; 2) Develop an Environmental and Economic Impact Model (EEIM) for spills in Galveston Bay; 3) Quantify the cost in dollars of the environmental and economic consequences when a spill occurs in Galveston Bay; 4) Develop transferrable tools, guidelines, and frameworks to support decision-making.

LITERATURE REVIEW

Previous works have studied the use of Bayesian Networks, as well as environmental and economic impacts of spills. A Bayesian Network shows the relationships between related factors and links them together [22]. They are a widely used tool for risk-modeling and have been applied in many fields including maritime risk analysis [11]. Applications of Bayesian Networks within maritime risk analysis include updating information for decision-making, assessing environmental pollution issues such as spills, and providing solutions to the aforementioned problems. Liu and Callies used a Bayesian Network to improve decision-making in response to an oil spill in the German Bight [10]. In this case, a Bayesian Network provides a reliable model for making decisions when under situations of high uncertainty and high risk [1]. Furthermore, Bayesian Networks have already been used to evaluate the impacts and costs of spills. Lecklin, Ryömä, and Kuikka evaluated the short-term and long-term impact of an oil spill in the Gulf of Finland and Afenyo et al. assessed the socioeconomic impacts of oil spills in the Arctic [8] [2]. In both studies, a Bayesian Network was applied and is effective in estimating the impacts and costs of a spill. As such, Bayesian Networks are a tested and valuable tool for improving decision-making and finding solutions to the spill problem.

Spills create short-term and long-term impacts to the environment that are costly and potentially irreparable. Afenyo, Ng, and Jiang found that ecosystem damages increase with time as waves and wind push oil slicks away from the area of release [3]. The longer a spill remains without being cleaned up, the greater the environmental damages. These damages are exemplified by the Mauritius oil spill where two UNESCO wetlands and other marine protected areas were contaminated and suffered irreparable consequences as a result [13]. In addition, spills can heavily damage commercial/recreational fish stocks and after a single spill in Alaska it was estimated that 25.5 billion Pacific herring eggs were killed [6]. Damages to fish stocks can be costly as it was estimated that a total of 3.5 billion dollars were lost in the recreational fishing industry alone between 2010 and 2017 as a result of the Deepwater Horizon oil spill [7]. While the short-term impacts of spills to ecosystems and fish stocks are well-studied, the long-term impacts require further research and evaluation. Many of the long-term impacts of the Deepwater Horizon oil spill are currently unknown as much of the oil was lost to the environment and could take decades to centuries to be removed from the system.

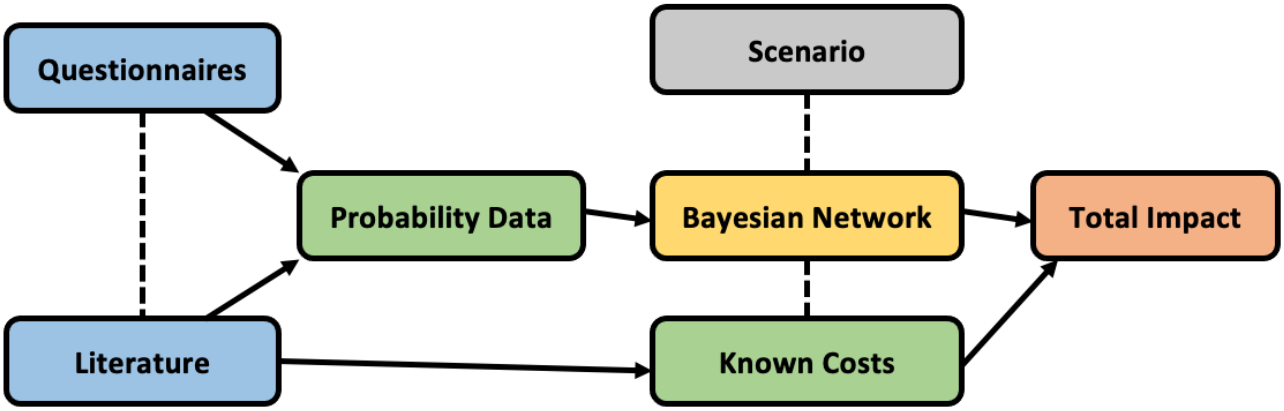
The economic consequences of a spill are wide-reaching and costly to communities, industries, and governments. Cohen estimated that the average spill in the U.S. costs approximately $18 per gallon in cleanup and damages, excluding litigation costs [5]. This estimate is useful for calculating the economic costs of most spills such as the Dalian, China oil spill. On July 16, 2010 approximately 45 million gallons of oil were spilled over a period of seven days resulting in economic losses of 750 million USD [12]. Using the estimation from Cohen, the cost of the Dalian, China oil spill can be approximated at 810 million USD [5]. When comparing the measured and approximated costs in USD, it can be seen that this estimation proves to be highly accurate in assessing economic costs of spills. For the purposes of this study, spill cost estimates were calculated using Cohen and probability inputs from risk-related factors associated with spills in Galveston Bay [5]. Furthermore, spills are costly to surrounding communities as increased levels of General Anxiety Disorder (GAD) have been observed in areas affected by the Deepwater Horizon oil spill [21]. Increased levels of GAD cause a high economic burden on

primary care services, leading to further economic impacts that result from a spill. While many of the economic impacts of spills can be measured and estimated, more research is required to determine the true size and magnitude of these impacts on communities, industries, and governments.

METHODOLOGY AND MODEL

The methodology is illustrated in Figure 2. It was comprised of a literature review, and the creation and distribution of qualitative and quantitative questionnaires to experts on spills in the Galveston Bay area. These methods were used to gather risk-related factors involved with spills, and obtain probability data and known costs. Utilizing the risk factors and probability data, an Environmental and Economic Impact Model (EEIM) was designed using a Bayesian Network (BN). From this model, total environmental and economic impacts were calculated for various scenarios using conditional probability and known costs.

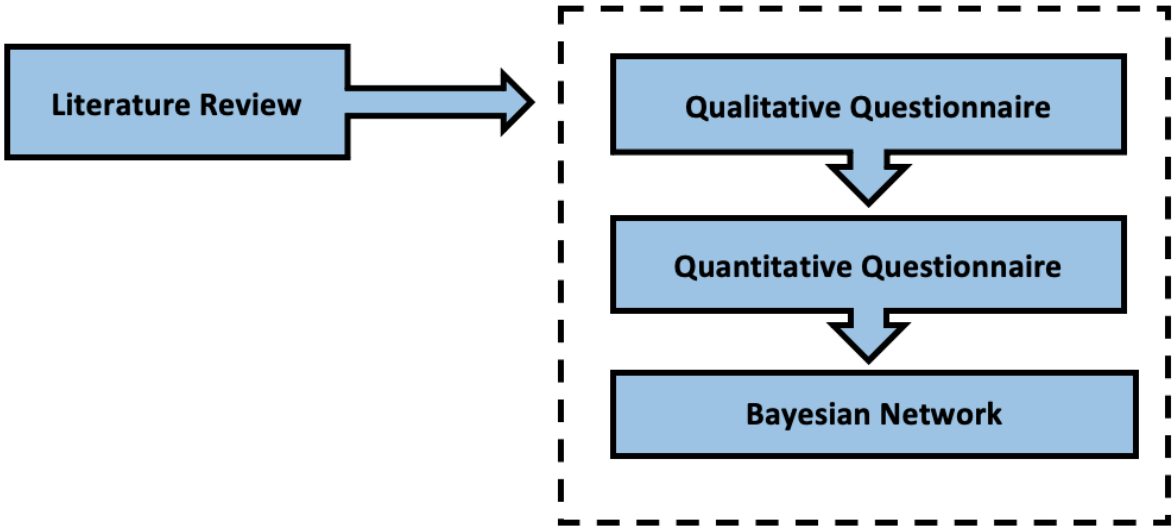
FIGURE 2



Methodology used for developing the model. This figure shows that the first step is to conduct a literature review, which can be done alongside the questionnaires. The information gathered from both the literature review and questionnaires are used in constructing the Bayesian Network. Once complete, the Bayesian Network can be used to run various scenarios to estimate the environmental and economic impacts. This figure is adapted from Afenyo, Ng, & Jiang [3].

Current literature was evaluated on the use of Bayesian Networks, and the known environmental and economic impacts and costs of spills. Risk factors and probability data was obtained and used to supplement and fine-tune the questionnaires. Known environmental and economic costs were strictly assessed using the current literature. The connections between the literature review, questionnaires, and Bayesian Network are shown in Figure 3.

FIGURE 3



Connection between the literature review, qualitative and quantitative questionnaires, and the Bayesian Network used for making the EEIM. The information gathered from the literature helps refine the qualitative questionnaire, which in turn, helps refine the quantitative questionnaire. This then allows for the construction of the Bayesian Network. This figure is adapted from Afenyo, Ng, & Jiang [3].

Qualitative And Quantitative Questionnaires

To gather additional risk-related factors involved with spills, a qualitative questionnaire was designed and distributed to experts on spills in the Galveston Bay area (See Appendix A). Questionnaire responses were anonymized and collected using email and zoom interviews. For ensuring the credibility of the respondents and their responses, the expertise and years of experience with spills for each respondent was obtained. A code was then assigned to each respondent so they can be identified if needed while still ensuring their anonymity. The characteristics and experience for all of the respondents are listed in Table 1. For the factors to be included and to avoid bias at least one of the following criteria had to be met: 1) factor must be identified by at least three respondents 2) factor must be identified as important/significant by at least one respondent 3) factor appeared in at least two scientific literary works. The obtained factors were then used to create the quantitative questionnaire and to construct the parameters for the model. Both questionnaires can be modified for future studies to account for differences between Galveston Bay and other maritime regions.

The quantitative questionnaire was designed to gather probability data that could not be acquired using the literature (See Appendix B). Questionnaires were distributed to previous respondents using the same procedures as before. All the probability data obtained was averaged and outliers were thrown away to ensure an accurate distribution. The data was then uploaded into a computer software called GeNIe to create a Bayesian Network.

TABLE 1

Characteristics and experience of questionnaire participants in the study.

Description	Code	Expertise	Experience
U.S. Coast Guard	USCG-1RA	Spill Response/Management	25 years
	USCG-2C	Spill Response/Recovery	30 years
	USCG-3CE	Spill Response/Management	34 years
U.S. Northern Command	USNC-1LO	Spill Response/Management	30 years
Texas General Land Office	TGLO-1SC	Spill Research/Response	17 years
Response/Emergency Management	REM-1MC	Spill Management	20 years
	REM-1P	Spill Response/Management	30 years
Crisis Consultant	CC-1ML	Spill Response/Management	35 years

Environmental And Economic Impact Model

The Bayesian Network was constructed using the risk-related factors obtained from the literature and qualitative questionnaire. These factors are presented in Tables 2-7. Within the network, obtained probability data and known costs were inputted to calculate total environmental and economic impacts in USD. Total impacts were calculated for several different scenarios using the law of conditional probability and known costs. The law of conditional probability is shown in Equation 1 and the calculation of total costs is shown in Equation 2:

$$P(A|B) = (P(B|A)\times P(A))/P(B), \quad (1)$$

where A and B are events, P(B|A) is the probability of an event B given A. P(A) and P(B) are the probabilities of A and B, respectively.

$$\text{Total costs} = \text{Environmental costs} + \text{Economic costs}, \quad (2)$$

where total, environmental, and economic costs are expressed in USD.

There are important parts within the Bayesian Network that include probability (oval-shaped), decision (rectangle-shaped), and utility nodes (hexagon-shaped). Figure 4 shows the different nodes, each is represented by their aforementioned shape. Probability nodes are where probabilities for each factor can be inputted, decision nodes indicate a specific choice made by an individual or group, and utility nodes are used for calculating designated impacts. In the case of this network, probability nodes were used for inputting the probability of each factor occurring in the event of a potential spill. Decision nodes represent the cleanup and recovery methods deployed as a result of the spill, and the utility nodes are used for calculating the environmental and economic impacts. Each of these nodes can be modified to account for changes in data or geographical region by adjusting the factors, decisions, probabilities, and costs. As such, this network serves as a functional and adaptive Environmental and Economic Impact Model for spills that can be updated with new data and modified for different regions.

TABLE 2

Environmental and seasonal variable information for EEIM.

Variable	Description	Range	Unit
Currents	Subordinate	Current type	[-]
	Harmonic	Current type	[-]
Depth	Shallow	0-25	[ft]
	Deep	26-50	[ft]
Wind	Light	8.1-9.5	[mph]
	Gentle	9.6-11	[mph]
	Moderate	11.1-12.5	[mph]
Environmental Conditions	Good	Type of conditions	[-]
	Bad	Type of conditions	[-]
Weather	Hurricane	Hurricanes in a month	[hurricanes/mo]
	Thunderstorm	Thunderstorms in a month	[thunderstorms/mo]
	Rainstorm	Rainstorms in a month	[rainstorms/mo]
	Other	Other weather in a month	[other weather/mo]
Temperature	Cool	51-60	[°F]
	Mild	61-70	[°F]
	Warm	71-80	[°F]
	Hot	81-90	[°F]
Season	Fall	September-November	[mo]
	Winter	December-February	[mo]
	Spring	March-May	[mo]
	Summer	June-August	[mo]

TABLE 3

Accident variable information for EEIM.

Variable	Description	Range	Unit
Operator Training	Extensive	Effectiveness of training	[-]
	Minimal	Effectiveness of training	[-]
Operator Competence	High	Operator experience	[-]
	Low	Operator experience	[-]
Operator Compliance	High	Operator compliance	[-]
	Low	Operator compliance	[-]
Traffic Density	High	21-60 days per ship at port	[days/ship]
	Low	0-20 days per ship at port	[days/ship]
Accident	Severe	Type of Accident	[-]
	Minor	Type of Accident	[-]

TABLE 4

Release variable information for EEIM.

Variable	Description	Range	Unit
Cargo Type	Tanker	% of Liquid Cargo	[%]
	Container	% of Container Cargo	[%]
	General	% of General Cargo	[%]
Cargo Quantity	Large	10,000-21,000+ TEU	[TEU]
	Small	0-9,999 TEU	[TEU]
Spill Type	Heavy Oil	Medium/Heavy Crude Oils	[-]
	Light Oil	Gasoline/Light Crude Oils	[-]
	Chemical	Non-Oil/Chemical Products	[-]
Spill Source	Vessel	Source of spill	[-]
	Pipeline	Source of spill	[-]
	Facility	Source of spill	[-]
Spill Quantity	Large	1,000+ gallons of oil spilled	[gal]
	Small	0-999 gallons of oil spilled	[gal]
Spill Location	Channel	Location of spill	[-]
	Wetland	Location of spill	[-]
	Beach	Location of spill	[-]
Release	Large	Size of spill	[-]
	Small	Size of spill	[-]

TABLE 5

Response variable information for EEIM.

Variable	Description	Range	Unit
Response Time	Fast	0-24 hours	[hr]
	Slow	24+ hours	[hr]
Response Quality	Good	Quality of response	[-]
	Bad	Quality of response	[-]
Resources	Available	Probability from survey	[-]
	Unavailable	Probability from survey	[-]
Interopobility	Good	Probability from survey	[-]
	Bad	Probability from survey	[-]
Protocols	Followed	Probability from survey	[-]
	Not Followed	Probability from survey	[-]
Response	Good	Type of response	[-]
	Bad	Type of response	[-]

TABLE 6

Cleanup and recovery variable information for EEIM.

Variable	Description	Range	Unit
Spill Containment	Booms	Containment efficiency	[%]
	Burning	Containment efficiency	[%]
	Dispersants	Containment efficiency	[%]
	Natural	Containment efficiency	[%]
Cleanup Time	Fast	0-24 hours	[hr]
	Slow	24+ hours	[hr]
Cleanup Quality	Good	Quality of spill cleanup	[-]
	Bad	Quality of spill cleanup	[-]
Recovery Rate	Skimmers	Amount of oil recovered	[%]
	Sorbents	Amount of oil recovered	[%]
	Manual	Amount of oil recovered	[%]

TABLE 7

Economic areas variable information for EEIM.

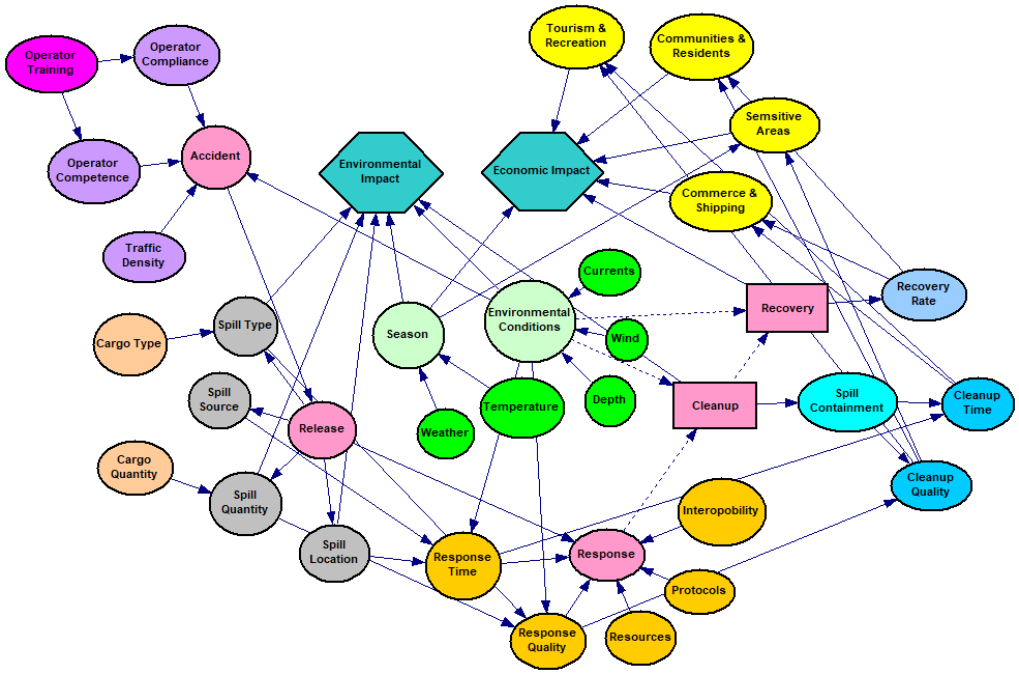
Variable	Description	Range	Unit
Commerce & Shipping	Significant	Type of impact	[-]
	Insignificant	Type of impact	[-]
Communities & Residents	Significant	Type of impact	[-]
	Insignificant	Type of impact	[-]
Tourism & Recreation	Significant	Type of impact	[-]
	Insignificant	Type of impact	[-]
Sensitive Areas	Significant	Type of impact	[-]
	Insignificant	Type of impact	[-]

RESULTS AND DISCUSSION

The responses from the qualitative questionnaire show that many of the participants identified similar factors that contribute to spills in Galveston Bay. These factors closely aligned with those gathered through the literature review, indicating that spill experts and the scientific community have a general consensus regarding important risk-related factors. The factors involved with a potential spill in Galveston Bay and their relationships are displayed in Figure 4. The majority of respondents agree that the procedures and regulations in place for Galveston Bay do an effective job of mitigating the impacts of most spills. However, each respondent noted that a large spilling event could lead to devastating consequences as it would exacerbate the minor problems with current procedures and protocols. The most commonly stated problems were improper notification and communication, and inadequate and untimely response. In this regard, real life lessons could be learned from past cases of large spills and how communication plus notification was executed. A thorough understanding of things that worked could prove useful for key stakeholders within the Galveston Bay area in the event of a spill. The most significant problem is a delay in reporting the spill to appropriate authorities as this greatly increases a spill's total

impact. To reduce the likelihood of these problems arising, the majority of respondents suggested thorough and frequent training exercises and a more efficient and easier method of reporting a spill to authorities. It is vital that the methods of reporting a spill are improved so common problems such as responsibility and the time it takes to reach authorities can be mitigated or avoided altogether. For accomplishing this, it is suggested that a phone number is created so any individual can anonymously report a spill. This "spill reporting" phone number can be used through call and text, and will notify appropriate authorities immediately without having to reveal a responsible party, unless done so willingly.

FIGURE 4



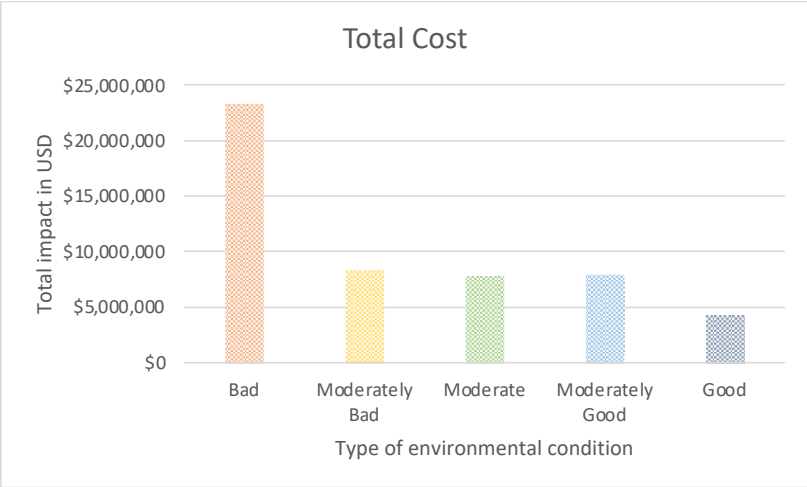
Environmental and Economic Impact Model (EEIM) for a spill in Galveston Bay.

Furthermore, the methodology presented offers a tool that could help address this issue in Galveston Bay and elsewhere. The results of this study show that there is a significant increase in the environmental and economic impacts. Bad environmental conditions such as wind, currents, and water depth make the cleanup of a spill more challenging and ineffective (see Figure 5). Additionally, this study shows that seasonality causes a significant increase in total impacts due to the presence of hurricanes during the late summer through late fall (see Figure 6). Estimations of the environmental and economic impacts used in Figure 5 and Figure 6 are derived from the Texas City Y spill. This spill occurred on March 22, 2014 and resulted in a release of 168,000 gallons of oil, making it the largest spill to date in Galveston Bay. The specific information used for the estimates in Figure 5 and Figure 6 are listed below:

- A spill of 168,000 U.S. gallons of oil
- Estimate of $18 per gallon USD in cleanup and damages
- Probabilities calculated for each type of condition

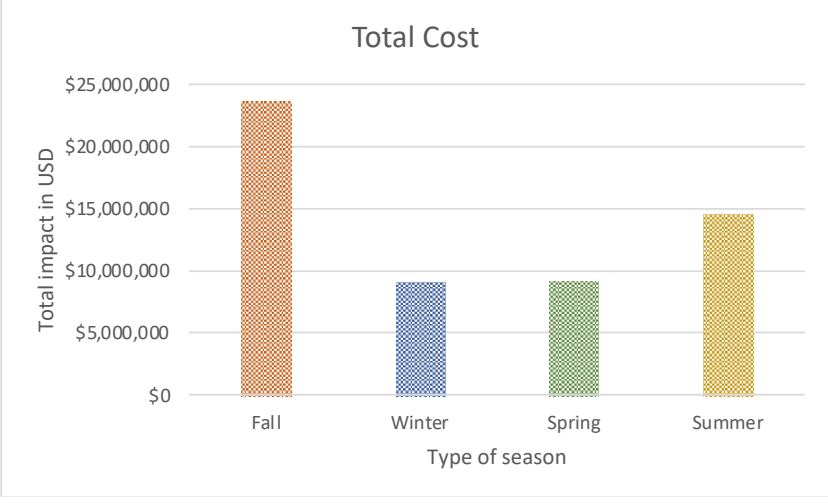
However, while the Texas City Y spill is considered the largest spill thus far in Galveston Bay at 168,000 gallons of oil released, it must be noted that a potential spill could result in a release of up to 50 million gallons. This estimate is based upon the current vessel, pipeline, and facility infrastructures present in Galveston Bay and the likely amount of oil/chemicals released in the event of a worst-case scenario spill.

FIGURE 5



Estimated total cost of the environmental and economic impacts for a spill in Galveston Bay. This figure shows the difference in total costs based on the type of environmental conditions present at the time of the spill.

FIGURE 6



Estimated total cost of the environmental and economic impacts for a spill in Galveston Bay. This figure shows the difference in total costs based on the type of season present at the time of the spill.

CONCLUSION

A potential spill in Galveston Bay could create costly and long-lasting impacts to the environment and economy. These impacts affect key ecosystems such as estuaries, which compose the majority of Galveston Bay, making them high risk for damages resulting from a potential spill. They are a vital habitat for developing marine species, many of which are economically important for commercial/recreational fishing. It has been estimated that estuaries bring in a yearly revenue of 1.4 billion dollars to Galveston's economy [4]. Estuaries and other ecosystems are critical assets to the natural world, but also to local economies around the globe. The economic value these ecosystems generate must be further studied. While the possibility of a large spill occurring is small, they can still happen. With much oil and gas investment in the Galveston Bay and Texas City enclave, it is expedient that future studies could consider the impact that a large spill might have on the stock price of companies operating refineries, etc within these catchment areas. In Galveston Bay, hurricanes have the greatest likelihood of causing a major spilling event. With hurricanes expected to occur more frequently and with greater magnitude due to anthropogenic climate change, it is vital that businesses and agencies plan and prepare accordingly so potential major spills can be mitigated and avoided. The findings of this research can be applied to any maritime region where spills occur, and the Environmental and Economic Impact Model can be modified accordingly. Areas of interest for future research involve better assessments of environmental and economic costs, further analysis of spill impacts, and economic assessments of ecosystems and their biodiversity. There are also implications for the insurance industry when one considers the multiplicity and complexity of interactions between the economic and environmental impact during such oil spills. Whereas insurers have the proclivity to ascertain the economic impact of such spills, future studies could perhaps explore their perception and conceptualization of environmental impact.

ACKNOWLEDGEMENT

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APPENDIX A

Questionnaire For Qualitative Interview

Answer the following questions to the best of your ability and knowledge.

Introduction:

1. Where do you currently work?
2. How many years of experience do you have with spills?
3. What is your experience with spills in Galveston Bay?

Part A: Regulations and Response

1. What procedures and guidelines are currently in place to respond to spills in Galveston Bay or elsewhere?
2. In your opinion, what procedures and guidelines can delay the response to a spill in Galveston Bay?
3. Based off your previous response, how can those procedures and guidelines be improved to reduce the risks related to a spill in Galveston Bay?

Part B: Environmental Risk Related Factors

1. In your opinion, what are the factors that could cause an impact on the environment when a spill occurs in Galveston Bay?
2. Of the factors you mentioned, which are the most important in terms of probability and consequence?
3. How do you think the above factors are related? Do some of the factors depend on each other. If so, which factors and how?

Part C: Economic Risk Related Factors

1. In your opinion, what are the factors that could cause an impact on the economy when a spill occurs in Galveston Bay?
2. Of the factors you mentioned, which are the most important in terms of probability and consequence?
3. How do you think the above factors are related? Do some of the factors depend on each other. If so, which factors and how?

APPENDIX B

Questionnaire For Quantitative Interview

The purpose of this questionnaire is to gather probabilities for various scenarios that occur during a spill. All responses will remain anonymous. Unless otherwise specified, answer each question to the best of your knowledge using a scale of 0-10 where; 10 = completely likely & 0 = completely unlikely.

Part A: Accident

1. What is the likelihood that a ship operator with extensive training will demonstrate low competence?
2. What is the likelihood that a ship operator with minimal training will demonstrate low competence?
3. What is the likelihood that a ship operator with extensive training will demonstrate low compliance?
4. What is the likelihood that a ship operator with minimal training will demonstrate low compliance?

Part B: Release

1. What is the likelihood of a severe accident causing a large spill?
2. What is the likelihood of a minor accident causing a large spill?
3. What is the likelihood of a large spill originating from a vessel?
4. What is the likelihood of a large spill originating from a pipeline?
5. What is the likelihood of a small spill originating from a vessel?
6. What is the likelihood of a small spill originating from a pipeline?
7. What is the likelihood of a large spill occurring near a wetland?
8. What is the likelihood of a large spill occurring near a beach?
9. What is the likelihood of a small spill occurring near a wetland?
10. What is the likelihood of a small spill occurring near a beach?

Part C: Response

1. What is the likelihood of response resources being available when a spill occurs?
2. What is the likelihood of response protocols being followed when a spill occurs?
3. What is the likelihood of responder interoperability being good when a spill occurs?

Part D: Cleanup & Recovery

1. Using a percentage, how effective are natural methods when containing a spill?
2. Using a percentage, how effective are booms when containing a spill?
3. Using a percentage, what is the recovery rate when using manual recovery?

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ANALYZING THE IMPACT OF SOCIAL MEDIA MARKETING ON REVENUE | FORECASTING TOMMY HILFIGER'S REVENUE USING TWITTER SENTIMENTS & MARKETING-CUSTOMER INTERACTION

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ABSTRACT

This paper aims to study the impact of customer engagement with marketing events and their associated sentiments on the sales revenue of an organization. To achieve the same, financial datasets of Tommy Hilfiger was considered to predict the revenue. Furthermore, to study the impact of customer engagement and sentiments, twitter data of Tommy Hilfiger's page was extracted from the year 2009 to 2021. Sentiment as well as emotion analysis was performed on this twitter data to get positive, negative, neutral sentiment score. Along with that Happy, Sad, Fear, Surprise and Anger emotion score was generated for each event (tweet) posted by the company. The marketing trends and customer engagements were studied using visualization made in Tableau. The results showed that the sentiment scores, emotion scores as well as the number of likes improved the model's R^2 by 8%.

Keywords: Tommy Hilfiger, Forecasting Model, Sentiment Analysis, Emotion Analysis.

INTRODUCTION

Tommy Hilfiger is America's premium clothing brand that offers multiple products including apparels, footwear, accessories, fragrances and home furnishing. The company had a total of 9.1 Billion Dollar revenue in the year 2021. Such premium companies use various strategies and tactics to increase brand loyalty as well as revenue generated. One of the booming marketing industry is social media marketing. Tweeting trending events and content, companies manage to capture consumer's attention and interests in order to establish brand interaction.
In this paper we analyzed the impact of social media marketing campaigns on the Tommy Hilfiger's revenue. To extract the sentiments and emotions of consumers for the brand, we extracted Twitter data that included tweets, likes, comments, and retweets. The extracted sentiments from twitter data was than implemented in the predictive and forecasting model to deduce actionable insights.

We chose Tommy Hilfiger because no such study has been performed in the apparel industry. With over 2000 stores across 100 countries, Tommy Hilfiger is not just a premium brand but also

has high brand value. Not only that, after observing various brands, we found out that Tommy Hilfiger's marketing campaigns were quite active on multiple social media platforms specially twitter. Thus, Tommy Hilfiger turned out to be the best fit to perform this analysis and to comprehend the role of marketing campaigns and customers'' sentiments in predicting as well as forecasting company's revenue.

Research Questions

1. Does marketing campaigns impact the sales revenue of the company?
2. What role does customer engagement play in predicting/forecasting the company's revenue?
3. What sentiment variables can be incorporated in the model to accurately predict/ forecast company's revenue?
4. How many such variables can be included in the model to increase the accuracy of the model?

DATA DESCRIPTION

- **Financial Dataset:** Tommy Hilfiger's yearly and quarterly total revenue was used from the year 2004-2021. The last decade is the known era of social media marketing boom. With time, we can observe the growth in company's revenue, which is an indicating factor of incorporation of various sales and marketing strategies by the company. We can observe an obvious downward trend in the revenue from end of 2019 due to Covid-19. Furthermore, an upward trend can be observed from mid-2020 (countries started to reopen from lockdown)

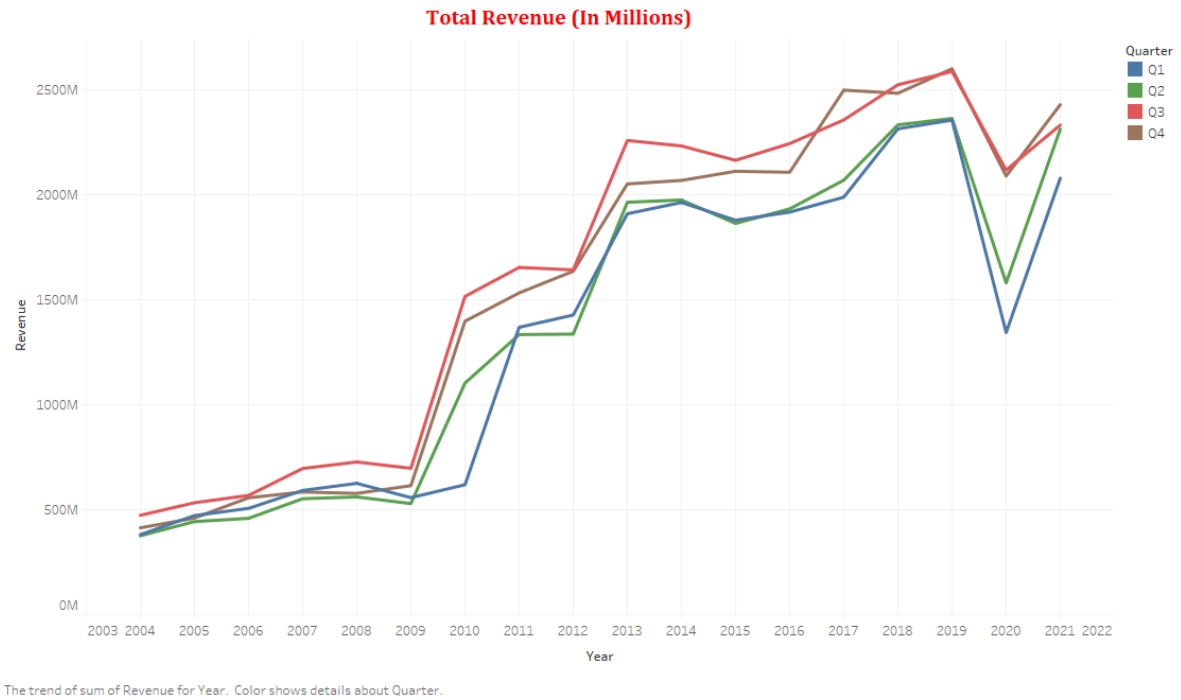


Figure 1

- **Twitter Data:** Tweets along with number of likes, comments, retweets were scraped from the twitter data from the years 2009-2021. 2009 was the year Tommy Hilfiger’s twitter page was started. Over the years we can observe that customers engagement has been increasing. We can observe a downward trend in comments from 2020, which could be the result of type of tweet and the type of engagement it demanded.

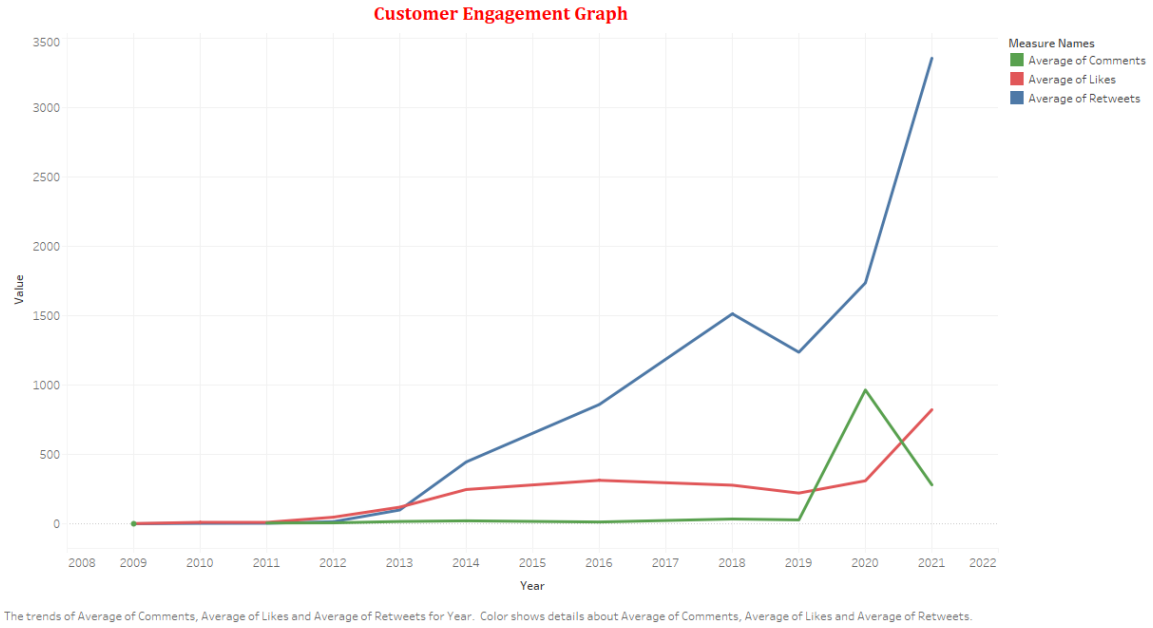


Figure 2

- **Google Trends:** Google Trends is a time series index (real-time daily and weekly indexes) of the volume of queries that users search for at Google. The index is based on the total volume of the queries for the search term and geographic area in question, divided by the total number of queries for the same period and region (H. Choi and Varian 2012).

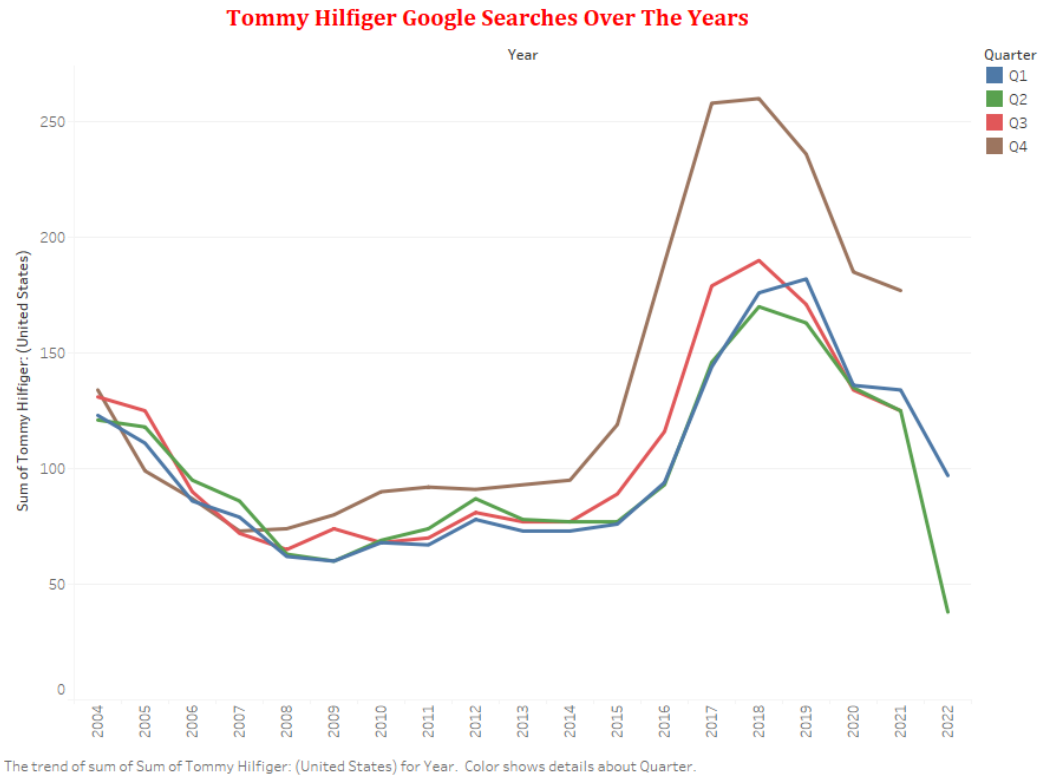
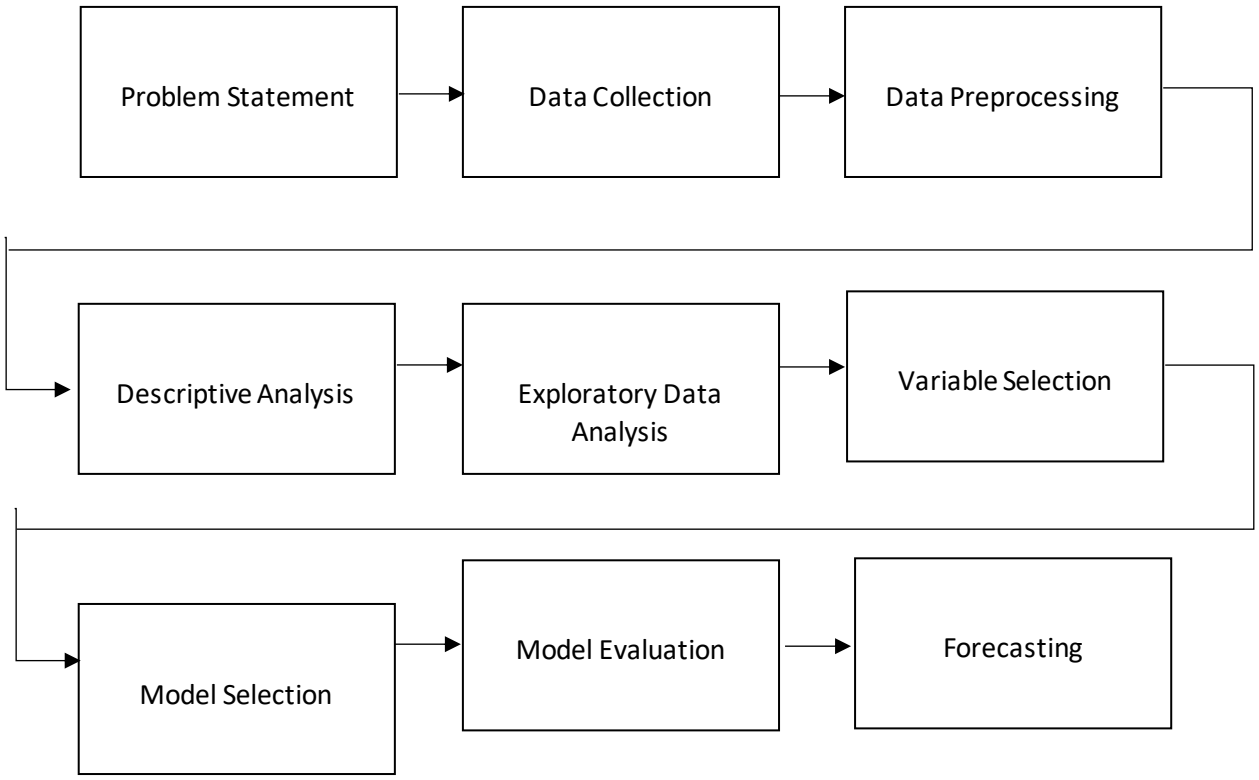


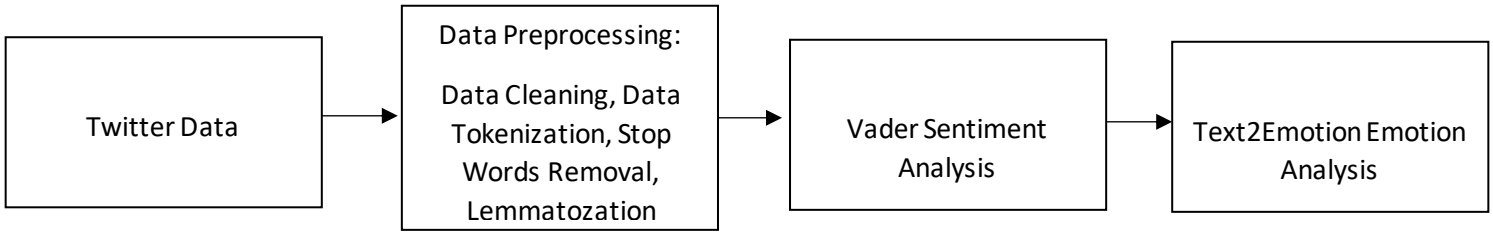
Figure 3

RESEARCH AND ANALYSIS PROCESS



For this project, we first defined the problem statement and the aim of the study. The second step was to collect reliable financial data of Tommy Hilfiger, followed by scraping of twitter data of Tommy Hilfiger's page. Furthermore, twitter data was cleaned to performed sentiment and emotion analysis. The results of sentiment analysis along with financial data was used to explore trends and patterns in the data. The next step of the project was to build plain predictive model using the financial data of the company. The choice of model was XGBoost. The next step involved improvising the model and selecting significant variables amongst available potential variables such as sentiment score, emotion score, number likes, number of comments, number of retweets. Accuracy and R^2 of the model were the parameters chosen for optimum model selection. At last, the selected model was used to forecast the revenue for next two quarters.

I. Data Analysis: Sentiment & Emotion Analysis



The first step performed on the twitter data was to pre-process the tweets column. Below are the data preprocessing steps performed on the tweets:

- Data Cleaning: All the white spaces, alphanumerical and numerical values are eradicated from the column.
- Data Tokenization: The content in the tweets columns were converted into tokens.
- Stop Word Removal: Irrelevant English stop words were removed from the column.
- Lemmatization: The token were converted into root words(lemma) to proceed for sentiment analysis.

The next was to perform sentiment analysis on the tweets column. Vader tool was used to do the same. We chose Vader as it is lexicon-based and rule-based tool which has been trained on various social media datasets. Hence, it was the first choice. Furthermore, Vader capitalizes on the punctuation marks, word capitalization, etc. while performing sentiment scoring. For instance, if the sentence contains the word amazing, the sentiment score will be lower than if the word AMAZING was capitalized or had punctuation marks AMAZING!!!

After sentiment analysis, we used text2emotions to bifurcate the sentiments into Happy, Sad, Anger, Fear, and Surprise emotion. For instance if we consider the tweet "VOICES SPEAK VOLUMES. We all have the power to affect the world with our voice. #TommyHilfiger", the emotion scoring for it was as follows: {'Happy': 0.0, 'Angry': 0.2, 'Surprise': 0.0, 'Sad': 0.2, 'Fear': 0.6}

Below is the top 10 output of the sentiment and emotion analysis:

Table 1

Tweet Cleaned	Negative Score	Positive Score	Neutral Score	VADER Score	Vader Overall Sentiment	Happy	Angry	Surprise	Sad	Fear
VOICES SPEAK VOLUMES We power affect world voice TommyHilfiger	0	0	1	0	Neutral	0	0.2	0	0.2	0.6
Speak Stand Light world YaraShahidi ARamosofficial jackharlow KimSooHyun DJCassidy wizkidayo lighting world voice wordsand passing mic What say TommyHilfiger PassTheMic	0	0	1	0	Neutral	0	0	0.25	0	0.75
So happened We teamed Roblox talented creator make capsule musthave piece rock virtual world THXRoblox PolarcubArt RynityRift Zealocity MiracleDropsRBX Blizzei missmudmaammmm	0	0.142	0.858	0.5106	Positive	0	0	0.5	0.5	0
Your favorite style Roblox Big shout PolarcubArt RynityRift Zealocity MiracleDropsRBX Blizzei missmudmaammmm httpsrobloxcomusers3127895510profile	0	0.2	0.8	0.4588	Positive	0.5	0	0.5	0	0
Time start twinning Tommy Jeans style Roblox Who would match outfit Tag BSF belowTHXRoblox	0	0	1	0	Neutral	0	0	0	0	1
Because TommyXFlags leg warmer Leave 80 past cozy limited edition rerelease archive gone httptommyNewArrivalsWomen	0.19	0.135	0.675	0.0258	Positive	0	0	0.33	0.33	0.33
Get winter state mind TommyXFlags collection Checl spirited throwback TH httptommyColorblockedParka	0	0.187	0.813	0.3182	Positive	0	0	0.33	0.67	0
This jacket translates flag semaphore looking good TommyXFlags favorite color httptommyNauticalHoodedZipThru	0	0.396	0.604	0.7096	Positive	0.67	0	0	0.33	0
Tees wont want take And good news dont Stock TommyXFlags color theyre gone httptommySignatureStripedTee	0.076	0.18	0.744	0.3975	Positive	0.25	0	0	0.25	0.5
Mix match primary look pop Signal style updated classic TommyXFlags httptommyNewArrivalsMens	0	0	1	0	Neutral	0	0	0	0	1

II. Data Analysis: Model Selection

Forecasting: The forecasting models are built to understand the trends of the revenue and answer the research questions.

Simple regressions: Simple regressions are developed to see how each variable can predict the target variable i.e., the total revenue of the company. These variables include the customer engagement with the brand over social media platforms, sentiments of the marketing campaigns done by the organization on social media like twitter. This analysis also provides insights into the different explanatory power oof variables on the different trends involved in the data.

Our source of data for analyzing marketing campaigns of Tommy Hilfiger is Twitter. Other sources like Facebook can also be used to understand the online marketing campaigns of different organizations. Another main source of information that we considered is the Google Trends Index. This google Trends index is developed using phrases that were searched on Google News Search, Google Web Search and the Google Shopping, calculate the frequency grouped by location and time. We considered just the United States of America for our analysis and the time period between 2009-2021. This index is important as this shows the engagement of the customers with the brand and a direct derivative of un-pushing engagement.

Multiple regressions: Multiple linear regressions are performed to combine multiple variables and calculate the affect of the combination of variables on the target variable i.e., the total revenue. This methods determines a regression equation that determines the importance of each predictor variable in predicting the Total Revenue. The different variables explaining the forecast like lags were included in the model to properly understand the delay between the implementation of the marketing campaign and the impact it can show on the total revenue of

that company. Other than that, we also tried to see how the marketing campaigns are affecting the revenue. As this paper is on the usefulness of social media data we are not looking at other variables that could also be influencing sales. Our model focuses on the twitter variables, sentiment analysis of the tweets and the google search index.

Extreme Gradient Boosting Regression: The XGBoost regressor is also a multiple regression model. XGBoost is an open-source library that is effective to boost the existing regression algorithms. The objective function has a loss function and a regularization term that would tell about the difference between actual and predicted values, to understand how the model is performing. The most common loss functions in XGBoost for regression problems is reg:linear, and that for binary classification is reg:logistics. The variables that are included in the XGBoost are the twitter variables like likes, retweets and comments. As the revenue data is available in terms of Quarters of the year, we have aggregated the events of twitter into average retweets, average likes and average comments for that particular quarter.

III. Data Analysis: Modeling & Variable Selection

Our analysis is an iterative process of adding and removing different variables to the best performing base model.

A. Base Model: To perform the basic modelling the variables that we considered to train are the total revenue of the company along with the lags in 4 intervals. As Tommy Hilfiger is a fast fashion brand, the lag between the marketing and the revenue would almost be immediate, mostly within the next quarter. We considered four lags in the training as our data has a frequency of four quarters.

We considered the Linear Regression, Random Forest Regressor and XGBoost to train with the dataset. To test the performance of models, we divided the dataset into test and train sets with 20% of the data into test set. Our main metric to compare the models is R2 score. The predicted sales are calculated based on the intercept and coefficient of the regression output and the actual value of the explanatory variable in the Quarter. We realized that XGBoost outperformed all the other models and we chose this as the final base model. The variables will next be iteratively added to the base model to understand the affect of other factors on the forecast of total revenue.

Table 2

Model	**Linear Regression**	**Random Forest Regressor**	**XGBoost Regressor**
R2 Score	0.32	0.77	0.84

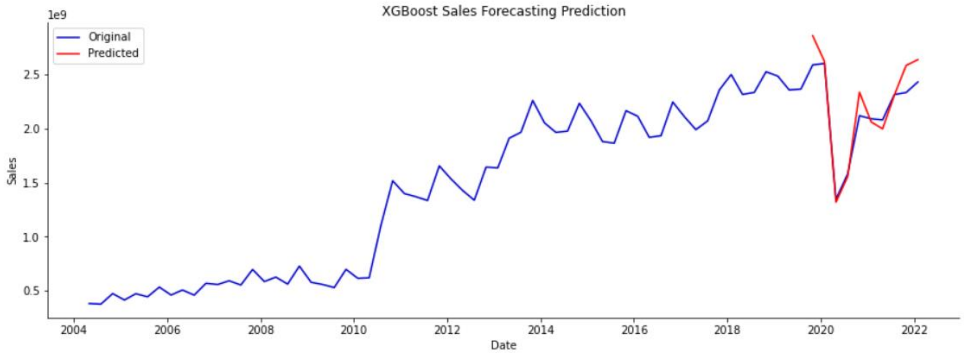


Figure 4

B. Iterative Modeling: The base model is XGBoost Regressor and will be used to iteratively add variables to the model. After feeding in the variables, we performed Hyper Parameter tuning on the XGBoost model. Hyperparameter tuning is choosing a set of optimal hyper-parameters for a learning algorithm i.e., XGBoost regressor. In recent times, the key to machine learning algorithms is hyperparameter tuning. The hyperparameter that we tuned for our models are 'max_depth', 'learning_rate', 'n_estimators', 'colsample_bytree'.

The following are the iterations that were involved in developing the final model.

a. Iteration 1: Along with the lags and the total revenue, we added the average google search index per Quarter of every year. The model was tuned using GridSearchCV and the final parameters were tuned for this model. The R2 value is 0.85. The following describes the forecasting. The forecasting was done from 2019 to 2022 and compared with the actual revenue of tommy Hilfiger during those years.

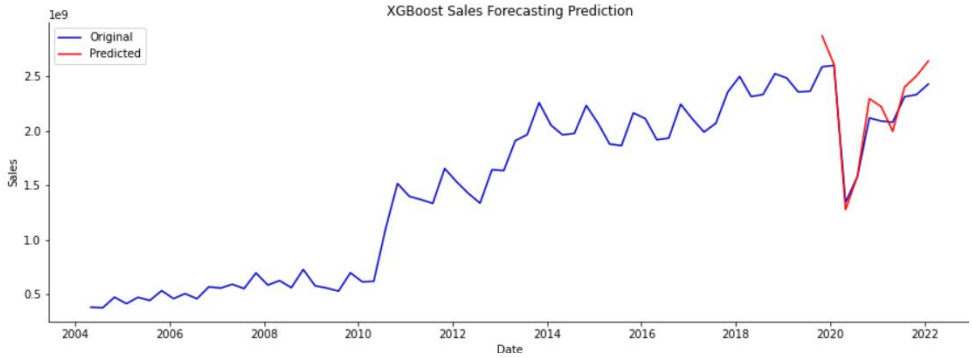


Figure 5

b. **Iteration 2:** Along with the lags and the total revenue, we added the average likes of tweets per Quarter of every year. The model was tuned using GridSearchCV

and the final parameters were tuned for this model. The R2 value is 0.84. The following figure describes the forecasting. The forecasting was done from 2019 to 2022 and compared with the actual revenue of tommy Hilfiger during those years.

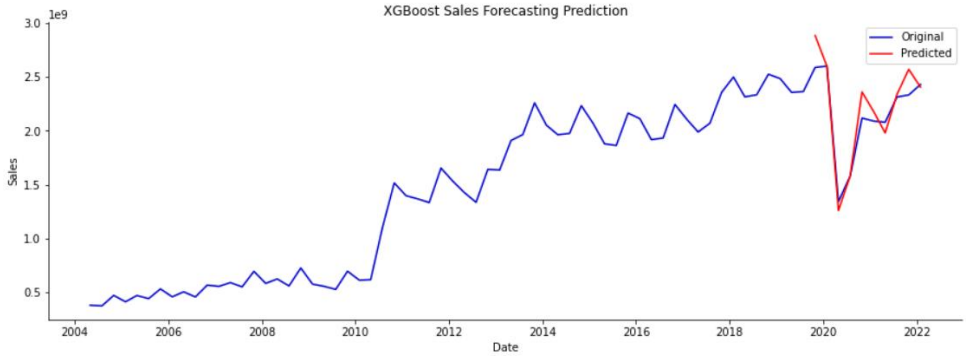


Figure 6

c. **Iteration 3:** Now we try to analyze the effect of retweets along with the lags and total revenue is performing. The model was again fine-tuned and the R2 score was decreased to 0.838. The following figure shows the forecast of 2019 to 2022 compared with the actual revenue of the Tommy Hilfiger.

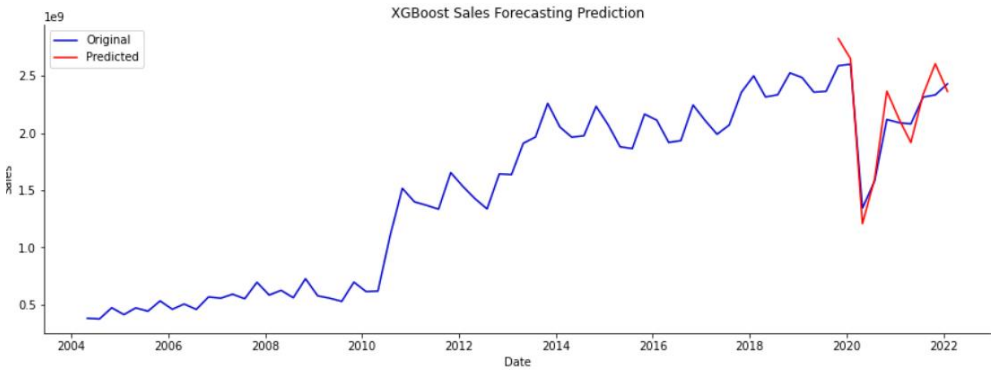


Figure 6

d. **Iteration 4:** We now try to analyze the effect of comments on each tweet, by average of a quarter in a year along with the lags and total revenue is performing. The model was again fine-tuned and the R2 score was decreased to 0.82. The following figure shows the forecast of 2019 to 2022 compared with the actual revenue of the Tommy Hilfiger.

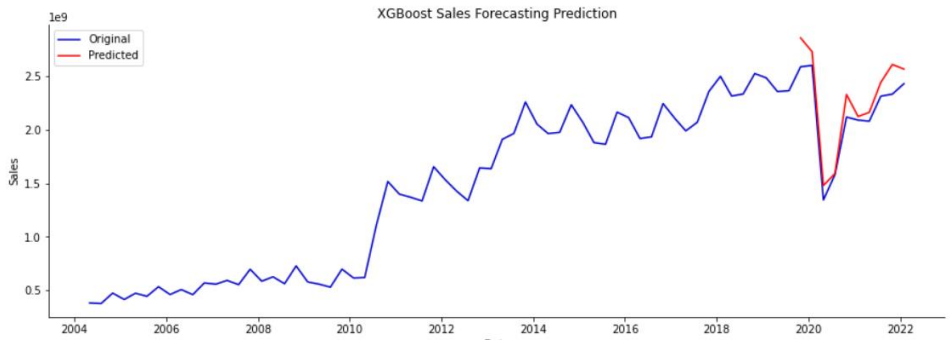


Figure 7

e. Iteration 5: Vader Score is a composite score of a sentiment for a particular text. This sentiment was derived by assigning the text i.e., the tweet with negative, positive, and neutral scores. The words involved in the text are initially classified into these sentiments and the frequency of each of these classified words lead to the increase of wither positive, negative or neutral score of the text. These three scores are combined to form a composite score that would help us understand the sentiment of the text.

This Vader score was added to the base model to understand its effect on the forecasting of total revenue. This analysis would help us understand if the type of marketing makes any sense in terms of revenue generation. The model was again fine-tuned and the R2 score was decreased to 0.72. The following figure shows the forecast of 2019 to 2022 compared with the actual revenue of the Tommy Hilfiger.

The below forecast shows that the average score is not a good predictor for forecasting the total revenue. Therefore, we shall take the individual sentiments of the tweets aggregated by the quarter by every year.

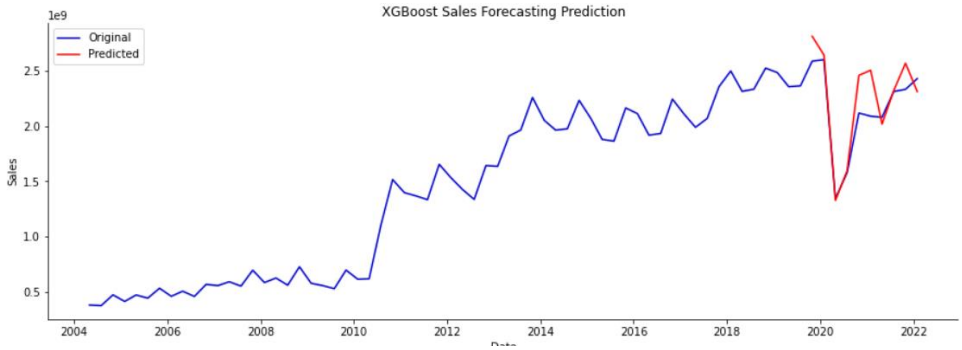


Figure 8

f. **Iteration 6:** Apart from the composite score, we have also generated the sentiments of the tweets done by the official tommy Hilfiger page. We considered the actual tweets of the page and excluded the retweets, and comments done by the official tommy Hilfiger page. We used Vader and Text2Emotion to generate the sentiments of the tweets. These scores were aggregated into averages per Quarter and fed into the model. The emotions that we considered were Happy, Sadness, Anger, Surprise and Fear.

These sentiment scores were added to the base model to understand its effect on the forecasting of total revenue. This analysis would help us understand if the type of marketing makes any sense in terms of revenue generation. The model was again fine-tuned and the R2 score was decreased to 0.88. The following figure shows the forecast of 2019 to 2022 compared with the actual revenue of the Tommy Hilfiger.

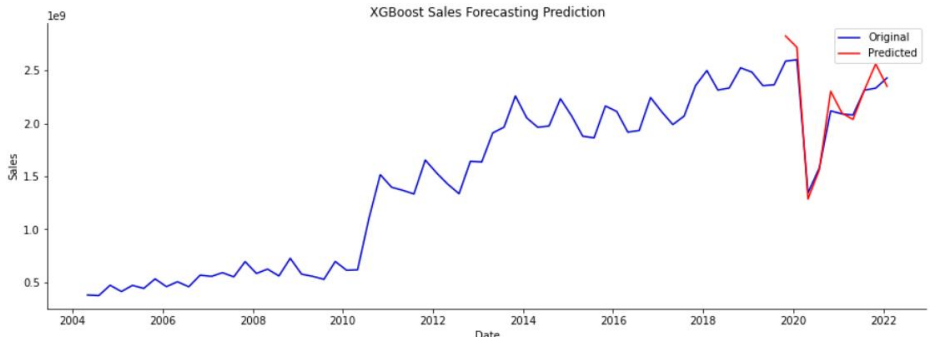


Figure 9

g. **Final Iteration:** The individual sentiments model and the model with likes were the better performing models in terms of Forecasting the trend in the data. The model with likes was accurately able to predict the increase from 2020 to 2022 better than all the previous models. The individual sentiments model outperformed all the other models in terms of R2 score and in accurately predicting the dip occurred from 2019 to 2020. We combined both these models along with the base model to get the final model. We tried combinations of all the other models as well; this combination outperformed all the other combinations.

The combined model is tuned using Hyper Parameter tuning and this is used to decide the parameters of the final model. The final R2 score is 0.91 and the below figure represents the forecast of the model from 2019 to 2022 compared to the actual values during that period.

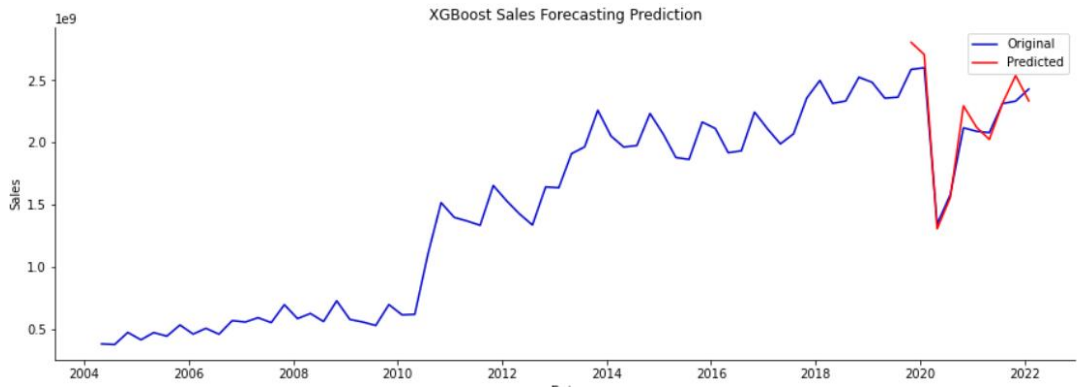


Figure 10

FINDINGS AND DISCUSSIONS

The analysis of data gave a clear idea of the metrics that we can use in analyzing the marketing aspect of an organization. The variables likes, retweets, comments are all used for the regression analysis and likes of the tweets affected the forecasting compared to retweets and the comments. The accuracy of the forecasting model improved when we introduced the average number of likes per quarter in the model. This supports the use of social media interaction with the people to forecast the future sales of any organization.

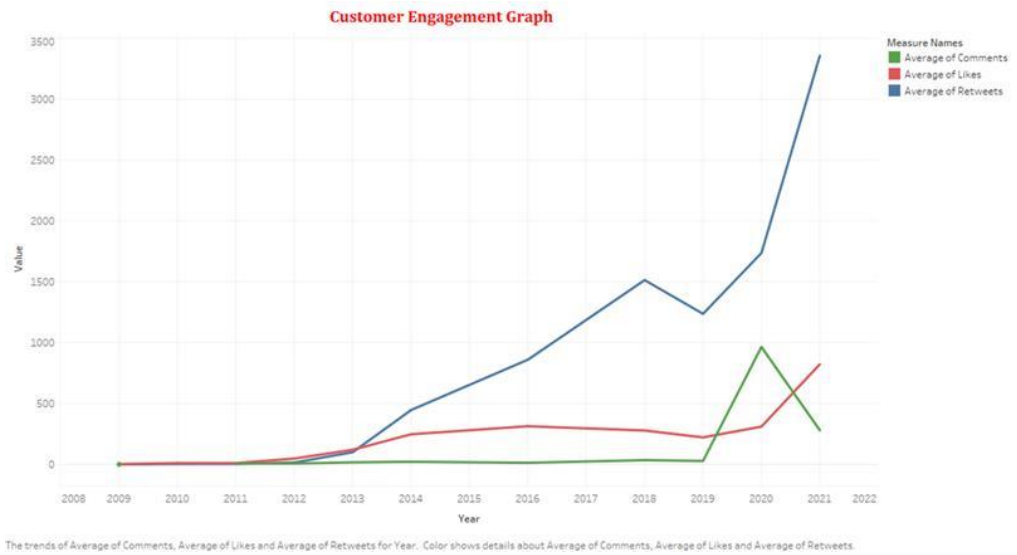


Figure 11

This figure shows the increase number of retweets over time, this might show that the brand reach kept growing during the years. The comments remained constant over years, with a spike during 2020. This could be attributed to the increase number of online interactions during Covid-19.

The sentiments involved in the marketing of Tommy Hilfiger campaigns were mainly Happy, Sadness, Anger, Fear and Surprise. The marketing strategy in the initial days of the campaign began with Happy tweets. But it quickly changed to the emotion the fear. This might show that the marketing is being fear inducing to the customers, either in terms of creating an urgency to buy the products or in any fear generating sense.

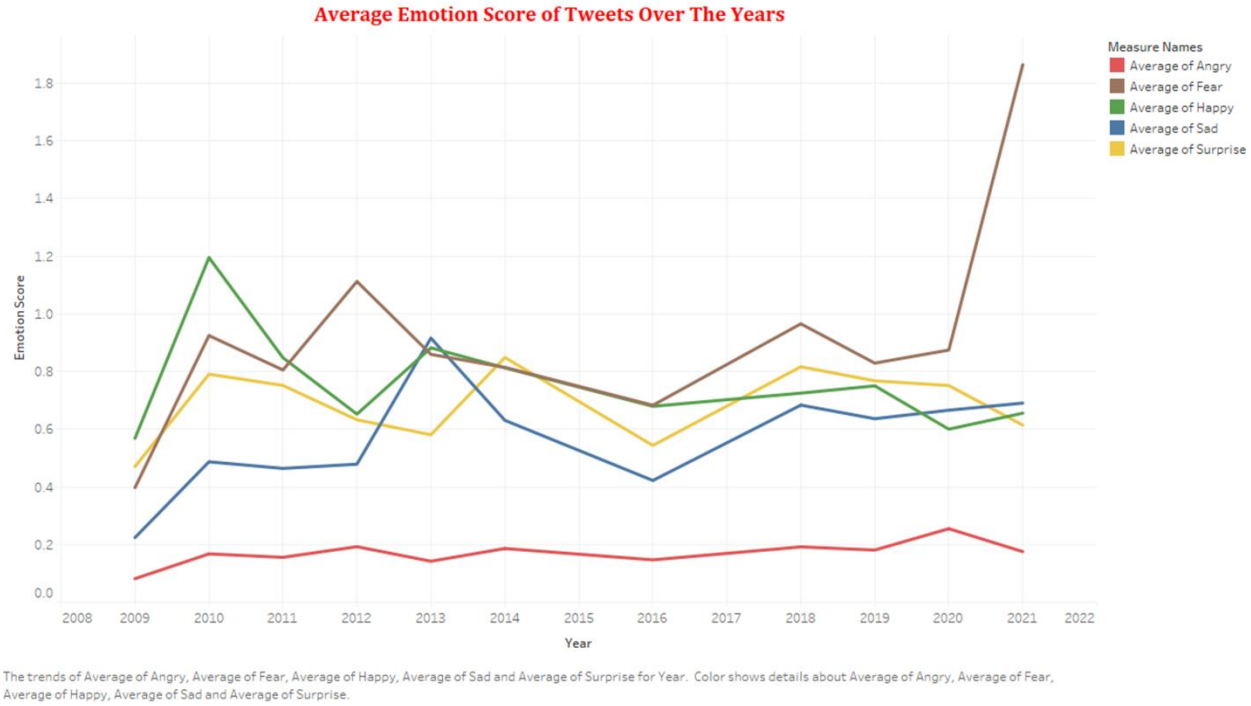


Figure 12

Followed by Fear, Happy and Surprise tweets stayed constant during the years in the marketing campaigns of Tommy Hilfiger. The emotions of Sad and Anger stayed the same through the years and they were the least existent in the marketing, which makes sense.
As our data is strictly pertaining to the textual tweets, the customer engagement could also have come from the images and videos that were posted along with the tweet. But the images are inline with the textual tweet, so the sentiments extracted from the texts are assumed to be consistent.

LIMITATIONS

It is well known that social media data can be used as a representative of the population world-wide. We are trying to forecast global sales, but not all the data is majorly divided equally geographically. This will introduce a bias into the data. As the revenue published online is for the entire organization, there is no way for us to understand which part of the organization gave the highest revenue. This aggregation will also not provide enough information for the model to understand this aspect.

Along with the textual tweets, Tommy Hilfiger often posts images and videos related to the campaign. After manually checking, we can safely assume that the sentiments are consistent with the textual tweet that went along with every image or video. But there are a few tweets that gained more than expected traction, and this was the result of the video, or the photo posted rather than the textual tweet itself.

Lastly, the brands have multiple events going on at the same time on social media and it very hard to distinguish which marketing campaign resulted in an increase of revenue for the Quarter. Tommy Hilfiger being a fast fashion company, there is a chance that there was a spike in sales during a particular month, but due to the Quarterly frequency of reporting, we might attribute the revenue to the entire quarter, which is not the ideal case.

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AUGMENTING COLLABORATIVE FILTERING MODEL BASED APPROACH LEVERAGING RFM METHODOLOGY TO INCREASE CUSTOMER ENGAGEMENT

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ABSTRACT

The success of any online retail business hinges on the efficacy of its three fundamental pillars: understanding customer's shopping patterns, mapping the demands created by it to its product base and efficiently managing the supply chain from procurement to delivery. While most businesses have developed an efficient process around each of these three pillars, a cross-functional strategy that allows businesses to build customized recommendations has been elusive. This paper explores solutions through a novel idea that segregates customers based on clustering indices from Recency-Frequency-Monetary (RFM) analysis. The customers groups are analyzed through a combination of descriptive and preceptive analytics to decipher inherent problems and propose business solutions on how to overcome these issues.

KEYWORDS

Recommender system, clustering, machine learning, unsupervised learning, collaborative filtering, Recency-Frequency-Monetary Value (RFM) Analysis, Alternating Least Squares (ALS) Recommender System

INTRODUCTION

Personalized content has been an evolving topic in the marketing realm for quite some time. With the increasing potency of data in today's world, we are at a time when even small changes to a tried and tested methodology might be the difference between a company's success or mediocrity. In light of providing personalized content, recommender systems have had an ever-increasing prevalence in the online retail sector. They have been found to be pivotal in increasing click-rates, improving quality of service, maintaining customer satisfaction, and retaining customers in the

online e-commerce industry. Typically, Singular Value Decomposition (SVD) algorithms, content-based filtering algorithms and hybrid filtering algorithms have widely been used as collaborative filtering methods in most recommendation systems. In this paper, we explore an alternative approach by clustering RFM analysis values into four segments: loyal, promising, needing attention and lost. We then analyze issues within these four segments and look to propose a recommendation principle that does not hinge merely on a machine learning algorithm but also encompasses a fundamental analytics approach to provide better services to all customer classes. This study explores a technique through which intricacies can be added to the way product recommendations can be made to an online retail customer. This approach leverages the Recency-Frequency-Monetary (RFM) Analysis technique to assign values to the customer and then cluster similar customers based on their Recency (R) value and a mean of their Frequency (F) and Monetary (M) values. A major advantage of the solution provided in this paper is its ability to provide effective recommendations based on considerably smaller pool of data points. Recommender systems have historically been plagued by an issue of requiring massive amounts of data to train. However, owing to our RFM approach, we can propose equally effective recommendations with lesser processing power and lesser data points.

Clustering Filtering

It is a system that predicts what products are to be recommended to target customers based on ratings made by users that are similar to those target customers. The fundamental idea behind the process is that an early grouping of similar customers into the same cluster will lead to an increase in forecasting accuracy.

Recency-Frequency-Monetary Analysis

RFM (Recency, Frequency, Monetary) analysis is a marketing technique that identifies a firms best clients based on their shopping patterns. A score is calculated based on the Recency, Frequency and Monetary value of the customers shipping pattern. Finally, the scores of all three variables are consolidated as RFM score ranging from 555 to 111 (Haiying and Yu, 2010) which is used to predict the future patterns by analyzing the present and past histories of the customer. [13]

Recommender Systems

Recommender systems are tools for interacting with large and complex information spaces. They provide a personalized view of such spaces, prioritizing items likely to be of interest to the user [4]. They act as information filtering tools that offers users suitable and personalized content or information. They have been widely adopted in areas of product recommendations in ecommerce,

content recommendations in social media and streaming services and service recommendations in banking and insurance.

Types of Recommender Systems

Recommender Systems can be broadly classified into content-based filtering systems, collaborative filtering systems and hybrid filtering systems.

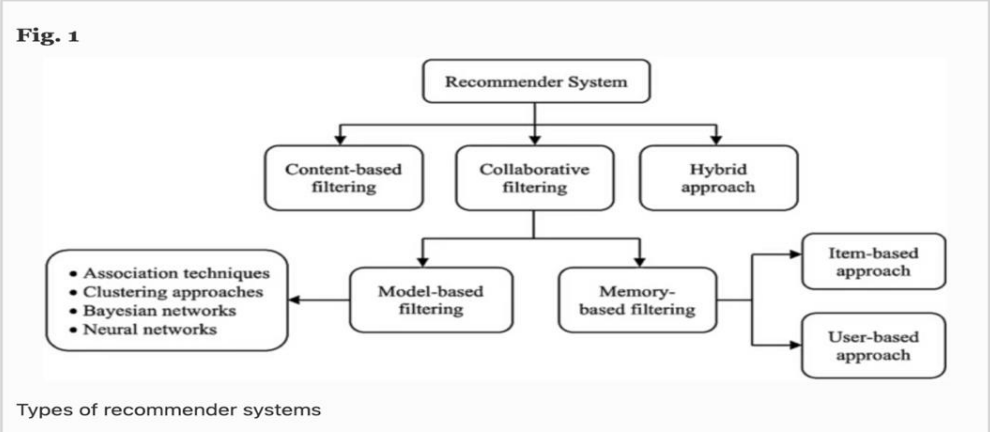

Figure 1: Types of Recommender Systems [7]

Content-based filtering approach

In content-based recommender systems, based on an items descriptions or features, they are collected into different item profiles. As for instance, in the case of a movie, the features will be genre, actor, director, language, theme etc. When a user gives a positive rating to a particular movie, all the other items present in that movie's profile are aggregated together to build a user profile. This user profile combines all the item profiles whose items are rated positively by the user. Items present in this user profile are then recommended to the user. The major disadvantage of this approach is the need for a lot of datapoints on items for accurate recommendations. In-depth information for all items might not always be available. In addition to this, the approach also has limited in its capacity to recommend something outside the users existing interests or choices. However, this approach can dynamically adjust to changing user preferences and does not require the profile details of other users ensuring the security and privacy of user data. It also does not suffer from the cold-start problem i.e., it can recommend items even when that item has not been previously rated by any user. Content-based filtering recommender systems are widely used in areas like news recommendations and web page recommendation systems.

Collaborative filtering approach

Collaborative filtering-based recommender systems make use of the measure of similarity between users. It finds a group of users whose preferences, likes and dislikes are similar. Items which are liked by say user X are then recommended to another user A which is in the same group. X is termed the neighbor of A. The efficacy of the system hinges on how effectively a model can find the neighborhood of the target user. This approach does not require any knowledge on an item feature for generating a recommendation in addition to its capacity to expand a user's existing interests by discovering new items. However, it is prone to the cold-start problem. Collaborative filtering approaches are divided into two types: model-based approaches and memory-based approaches. We have adopted the model-based ALS collaborative filtering recommender system in this paper.

Problems with ALS Recommender Systems

We have leveraged the Alternating Least Square (ALS) Matrix Factorization collaborative filtering recommender system for the purpose of this paper. The utility matrix used in this method often contains many missing values. Since users generally tend to rate only a small number of items, the initial matrix is usually very sparse and as a result, the recommender system is mainly focused on finding the values which are missing in the utility matrix. On top of this, we are usually only interested in the products having high user ratings since only these would be recommended back to the users. As a result, the efficacy of a recommendation system is highly contingent on the type of algorithm used and the nature of the data source, which again may vary.

DATASET DESCRIPTION

In this project, we have utilized a dataset from Kaggle [5] which is provided by a Brazilian e-commerce company, Olist Store. This firm facilitates the sale of products from a variety of small businesses to prospective customers. In the dataset, there are details about 100k orders placed across multiple marketplaces between 2016 and 2018. In addition to order status, price, payment, and freight performance, it also provides access to product attributes and customer reviews. The data was provided in eight different tables and was joined using following relationships:

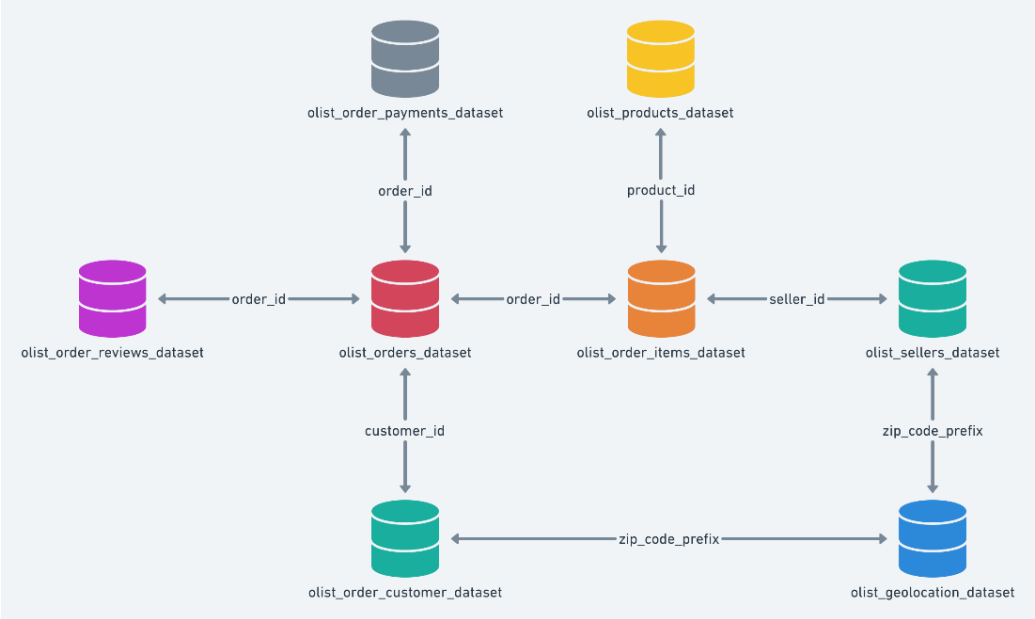

Figure 2: Data Schema [6]

- olist_customers_dataset - Information about the customers and their location.
- olist_geolocation_dataset – Maps the Brazilian zipcodes to its latitude/longitude coordinates.
- olist_order_items_dataset - Data about the items purchased within each order.
- olist_order_payments_dataset - Includes data about the orders payment options.
- olist_order_reviews_dataset – Includes the reviews made by the customers.
- olist_orders_dataset – Information about each order
- olist_products_dataset - Includes data about the products sold by Olist.
- olist_sellers_dataset - Includes data about the sellers that fulfilled orders made at Olist.

As part of our understanding and further work, we translated the customer reviews and product categories into the english language.

LITERATURE REVIEW

Recommender Systems is a fast-growing and emerging research field. The research hit its peak in the 1990s when Amazon launched Collaborative Filtering, which was highly successful in increasing its sales. The success of Amazon encouraged other companies to develop and employ different approaches to identify and recommend products from a potentially overwhelming array of choices.

The first paper [11] that appeared in 1994 discussed the idea of using Collaborative Filtering (CF) to develop a system that helped people find the articles they will like. As CF was known for its sparsity and scalability issues, several researchers employed a variety of algorithms to address those issues [1,2]. Authors further discussed Content-Based Filtering (CB) that analyzed a set of documents rated by an individual user to determine user profiles and used it to recommend additional items of interest based on the document content and rating [3]. In addition, there were research studies that addressed the overspecialization problem of CB, i.e., recommending items that are excessively similar to those already known to the user [9]. Due to the limitations of both methods, researchers in recent decades have studied and developed new approaches to solve these problems. Specific hybrid approaches including collaborative, content-based, knowledge-based, and other techniques have been proposed that improve recommendations for real-world implementation. On the other hand, RFM methodology has mainly been used for customer segmentation problems for estimating Customer Lifetime Value [10], for performing Market Basket Analysis [12], building inventory management systems [8], etc. However, none of the studies have considered both the approaches to build a personalized recommendation system that offers product recommendations based on customer segmentation.

METHODOLOGY

The goal of this paper is to propose a strategy for an e-commerce company that generates tailored solutions for each customer segment group, thereby increasing customer loyalty and revenue for the company. We started by clustering customers based on the Recency Frequency Monetary (RFM) metrics. Recency value was calculated as the number of days between the last purchase made by the customer and the maximum purchase date in the whole dataset. The frequency was calculated by adding the number of purchases made by each customer while the monetary value was calculated by adding up the total price of products bought by each customer. As an alternative to simple binning, which is the conventional choice for RFM methodologies, we implemented K-Means clustering to segment similar customers by each attribute to form five bucket categories per attribute. Since Frequency and Monetary bucket values should be analyzed together, we took the mean of both frequency and monetary bucket values and combined them with the recency bucket in order to form four customer segments:

1. Loyal Customers – The customers having high recency, frequency, and monetary values. These customers are the most valuable ones on the site.

2. Promising Customers – The customers that have high recency value but low frequency and monetary average value. These customers should be targeted so that they spend more money more often.

3. Customers Needing Attention – The customers that have low recency value but high frequency and monetary average value. This group of customers suggests the ones that were highly active in the past but have not shopped recently. We categorize these customers as the ones that may churn and require more attention.

4. Customers Lost – The customers with low recency, frequency and monetary value.

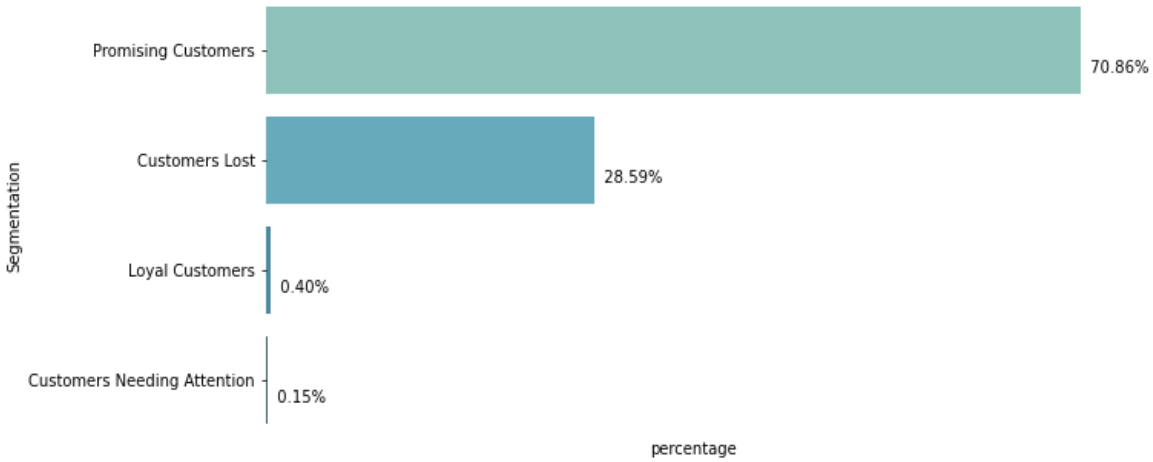

Figure 3: Customer Segmentation Overview

With the customers placed in 4 clusters based on their respective RFM bucket values, the next step was to calculate a comprehensive rating value for each of the products and derive a sentiment value metric from the comments of each of the products. These score metrics were then standardized and added together to get a final product rating value. This final product rating by every customer for each product will be used as a rating column in the recommendation system. The calculation of the product score was done through a three-step process:

I. A Rating Score is generated for each of the products bought and reviewed by the customers. To calculate this metric, the average of all ratings received by the product is multiplied by the ratio of number of reviews by the average number of reviews. The multiplication ensures that a product with very few ratings does not receive a high score. Customers tend to trust those products where there are many reviews positive or negative rather than 1 or 2 positive ones.

*Rating Score = Average of all ratings of product * (Number of reviews received by product / average number of reviews generated)*

II. Sentiment Score Values are calculated from the comments of each of the products. For the unsupervised method, the prediction of sentiment of a review is based on a-priori knowledgebases, lexicons and ontologies. The lexicon used for this score calculation is AFINN. If the score is positive, then the sentiment is positive and if score is negative then sentiment is negative. If the score is 0 then it is neutral. Grouped on Product_ID, the scores and sentiment Score Values are aggregated.

III. An Aggregated Score Value is calculated from the Rating Score and the Sentiment Score Values. The approach this study has taken for this is by normalizing each of the two scores and calculating the sum of the two metrics. The Aggregated Score Value along with the Product_ID and Unique_Customer_ID were fed into the recommender system.

The method undertaken has approached customer shopping pattern as a clustering problem, looking to find patterns in the rating values and customer reviews. Ultimately, the study looks at the possibility to feed these metrics to a recommender system which recommends products to customers on the basis of the popularity of the products.

To prepare the dataset for the recommendation system, for user information table dataset, unique customer ids were taken along with the unique product ids and the sentiment score and rating given by that user for that product. For product information, unique product ids were taken, and the aggregated average of sentiment scores and ratings given by all the customers was used. Final dataset had unique customer index, product index, sentiment score, rating and aggregated total of both the prior standardized scores. The data was then split into training and test data in 70:30 ratio and ALS recommender system was trained in Python. We used Root Mean Squared Error (RMSE) as a metric to assess the efficiency of the recommender system. Three recommender systems were developed as follows:

1. Model 1: Sentiment Score value was used as the rating column used for training the recommender system. This was done to test if only customer review sentiments are sufficient to recommend new products.

2. Model 2: Next system was trained on the aggregated standardized value of Sentiment Score and Rating.

3. Model 3: Lastly, we only took a subset of data having customers that belonged to 'Loyal Customer' segment and 'Promising Customer' segment. This was done to recommend products to promising customers that performed well and had high rating for loyal customers.

RESULTS

From experimental evaluation, we had some important observations.

Model Name	RMSE
Model 1	2.69
Model 2	1.66
Model 3	1.05

- We also wanted to analyze the 'Customers Lost' and 'Customers Needing Attention' subset to understand what might have gone wrong for them.

- As a first step, we examined the delivery performance and shipping details of the orders made by these customers. We found that 4.23% of the orders were delivered late while 8.73% of orders exceeded the shipping limit set by the carrier. There is a possibility that customers stopped shopping here because of the unsatisfactory delivery experience, therefore, it is recommended that all orders placed by customers in this subset receive priority shipping.

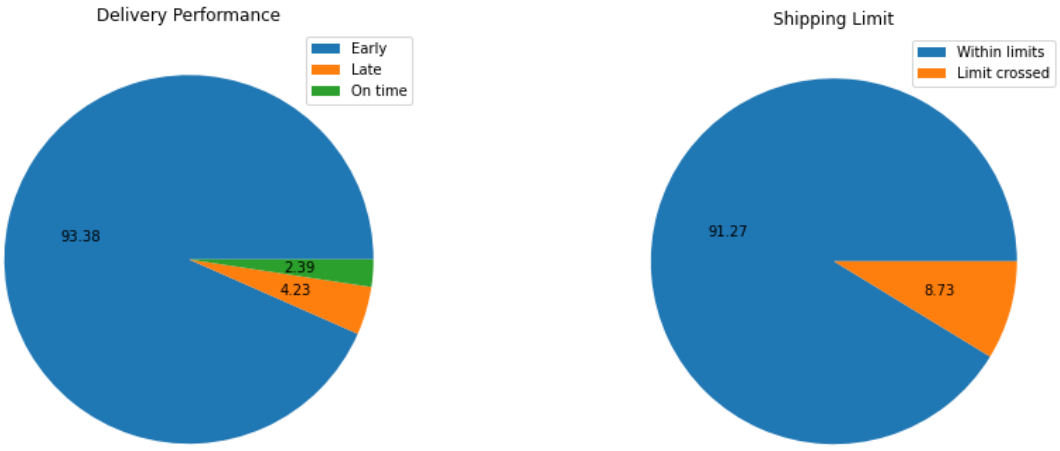

Figure 4: Overview of Delivery Performance and Shipping Limit

- Next, we undertook a subset of customers who received their orders 'Early' or 'On Time' but were still in the 'Customers Lost' or 'Customers Needing Attention' groups. Upon

reflection, we realized that this may have been caused by their review of the products they ordered.

- We found that 11.7% of those customers had a 'Negative' sentiment towards the products that they bought. Since the product experience was terrible, we suggest using the same recommendation system as above (*Model 3)* to recommend products liked by Loyal Customers. Assessing one step further, we found three categories that received the maximum number of negative sentiments from this customer subset. To ensure quality, we recommend that the e-commerce company thoroughly investigates items in the categories of 'Bed Bath Table', 'Health Beauty' and 'Furniture Décor'.

- In the case of the customer subset with 'Neutral' (31%) or 'Positive' sentiments (57%), we believe that either they found another better website or have forgotten about it. Sending them special offers tailored to their needs is a good way to further engage these customers.

The suggested workflow is shown in Figure 5:

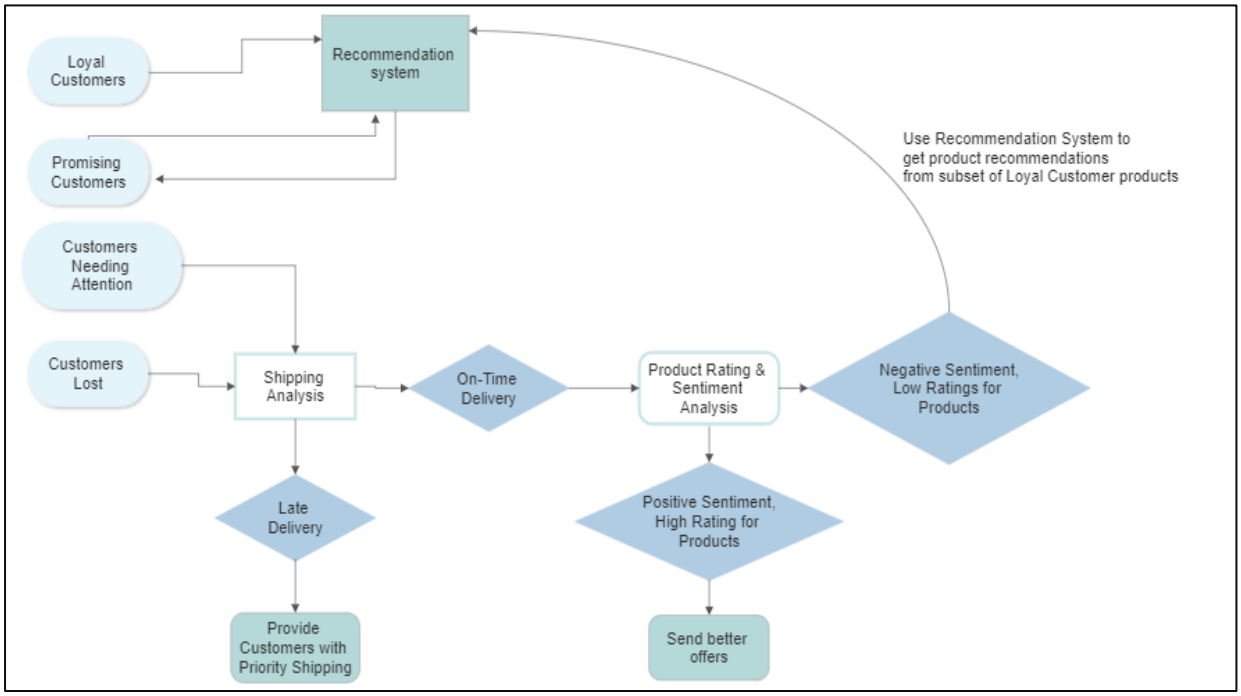

Figure 5: Workflow Overview

CONCLUSIONS

This paper had looked to explore solutions through a novel idea that segregates customers based on clustering indices from Recency-Frequency-Monetary (RFM) analysis. The customers groups have been analyzed through a combination of descriptive and preceptive analytics to decipher inherent problems and propose business solutions on how to overcome these issues. The study leverages a clustering methodology to create classes of customers, establishing a product rating value based on its average rating and sentiment scores and adopting a cross-functional strategy to recommend products popular among one class of customer to similar customers of another class. It also looks to address issues found in all customer groups and proposes solutions on how to overcome them. Overall, this paper has looked to find a way around the dichotomy of customer-profile and product-profile recommendation systems and propose a solution by amalgamating both concepts to build a more robust recommendation principle.

We have presented a process for recommending best-suited products to customers in order to increase their satisfaction thereby retaining them on the website. Our results corroborated our initial assumption that an aggregated metric of rating and sentiment values will improve the ALS recommender system, as compared to the product order count metric usually taken. Furthermore, taking a subset of higher-value customers and their product orders and feeding it to the model resulted in more precise recommendations of products to customers in the ‘Promising Customer’ Segment. Additionally, we suggested ways to re-engage customers belonging to the 'Customers Lost' segment by analyzing their past data, as well as steps necessary to assist customers belonging to the 'Customers Needing Attention' segment. By implementing the proposed workflow, we believe that the e-commerce company will achieve customer loyalty while the customers will receive the products and services they want.

DISCUSSIONS AND RECOMENDATIONS

Our study has looked to find a new solution to the collaborative filtering model-based approach by leveraging the RFM methodology to segment customers while also adding business analytic approaches to improve customer loyalty. While our study did show marked improvements through the adaptation of our suggested process, there are still a few areas that can help enhance this study. One major issue was the inability of our system to segment new customers through the RFM process since they have no history. Our suggestion for this would be to group new customers through an alternative process such as profiles based on sign-up forms. Another area of concern for us, primarily owing to the lack of data points in our dataset was that the segments ‘Lost Customers’ and ‘Customers needing attention’ are based on delivery performance and their sentiments. However, there might be a host of different factors that might lead to customers not being drawn to that particular ecommerce website including cheaper prices elsewhere, better

shopping experience or better product selections. Our study was limited in this regard due to the shortcomings in the features pertaining to this in our dataset. A more comprehensive study can be done regarding this.

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BIG DATA ANALYTICS CAPABILITIES AND ORGANAIZATIONAL CULTURE IMPACT ON FIRMS' PERFORMANCE: EMPIRICAL STUDY

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ABSTRACT

The potential of Big Data Analytics Capabilities (BDAC) to provide firms competitive advantage has been a topic of interest to practitioners and academicians. This interest is reflected in the large number of studies that have examined the relationship between big data analytics capabilities and firms' performance. Currently, efforts are focused on enhancing methods for the analysis and treatment of large amounts of data, with the goal of improving the decision-making process and generating more value for the company.

To examine the impact of big data analytics capabilities and organizational culture on firms' performance, this study will draw from the resource-based view (RBV) which connects firms 'performance to firm-specific, rare, and difficult-to-replicate or substitute resources and skills. Adopting a resource-based perspective of information systems, firms can leverage their investments to create unique resources and skills that determine a firm's overall effectiveness. This study will adopt a formative construct measurement from which is made up of two first-order reflecting constructs: operational performance and market performance. This performance indicator will provide how well a firm is performing relative to direct competitors.

Introduction

The potential of Big Data Analytics Capabilities (BDAC) to provide firms competitive advantage has been a topic of interest to practitioners and academicians. This interest is reflected in the large number of studies that have examined the relationship between big data analytics capabilities and firms' performance. Currently, efforts are focused on enhancing methods for the analysis and treatment of large amounts of data, with the goal of improving the decision-making process and generating more value for the company [2, 11, 16]. There is a significant need to have analytical capabilities to use large bulks of unstructured data in various formats [9]. IBM appears to have recognized this when it decided to shift its strategic focus away from hardware manufacturing toward the provision of services related to information system management [2]. Big data is becoming increasingly important to businesses of all sizes, not only in terms of driving profitability but also in terms of ensuring long-term suitability [18, 23].

In light of this new reality, analyzing the impact of big data has become a top priority for both executives and academia, who want to understand the phenomenon, its implications, and even its future direction and scope [12, 16, 23, 25]. It is safe to say that big data is viewed as a phenomenon that will be used to leverage a company's competitive advantage in the future, owing

to its importance and the need to comprehend its current relationship with another competitive advantage [1, 23, 26].

To expect a positive outcome, firms must pay close attention to issues such as organizational culture (CL) and business process alignment, among others. (Gupta & George, 2016) the study examined the resources required to build a BDA capability, which is defined as a company's ability to assemble, integrate, and deploy big data-specific resources. Moreover, their study emphasizes that relying exclusively on BDAC is ineffective until the company has developed a supportive organizational culture that allows it to capitalize on the prospects identified through BDAC [12].

To examine the impact of big data analytics capabilities and organizational culture on firms' performance, this study will draw from the resource-based view (RBV) which connects firms 'performance to firm-specific, rare, and difficult-to-replicate or substitute resources and skills [3, 4]. The resource-based view, which focuses on a firm's costly-to-copy attributes that are seen as the fundamental drivers of performance, is currently the dominant theoretical perspective in strategic management literature [3, 5, 24]. Adopting a resource-based perspective of information systems, firms can leverage their investments to create unique resources and skills that determine a firm's overall effectiveness [1, 18].

In this context, the main purpose of this study focuses on analyzing the affect of big data analytics capabilities and organizational culture on firms' performance. This study will contribute to the existing literature by developing empirical evidence that confirms the relationship and significance of BDAC and CL in improving firms' performance. Moreover, this study will instruct and draw the attention of managers on the importance of BDAC development besides organization culture, and how their sufficient management results in a direct and positive relationship with firms' performance and thus in a competitive advantage for the firms.

The outline of the paper is divided into three sections. The remaining of the paper is organized as follows. Section 2 is discussing the literature review. Section 3 is the research methodology.

Literature Review

The review of the literature formerly covers the three significant constructs of the study, namely BDAC, CL, and FP.

Big Data

The use of 'Big Data 'etymology has been traced to the mid-1990, when John Mashey, retired former Chief Scientist at Silicon Graphics, refer this term to handling and analysis of massive datasets [7]. In 2001, Laney presented the three most common attributes of big data, which have been widely cited and adopted. According to Lani, the concept of big data refers to enormous quantities of data (high volume), that exist in structured, semi-structured and unstructured forms (high variety), and that are collected fast (high velocity). IBM added another attribute or "V" for "Veracity" on the top of Douglas Laney's 3Vs notation, which is so called as Four Vs of Big Data. (Diebold, 2012) discussed data definition from five V's perspective. The following table summers the 5vs per Hoffer:

Volume	The amount of data collected and processed are much larger than those stored in typical rational data bases

Variety	Big data consists of a rich variety of data types (structured, semi-structured, and unstructured)
Velocity	Big data arrives to the organization at high speeds and from multiple sources simultaneously.
Veracity	Data quality issues are particularly challenging in big data context
Value	Big data meaningless if it does not provide value toward some meaningful goal

Table 1. (Diebold, 2012; Hoffer, 2020)

Big Data Analytics Capabilities (BDAC)

Management scholars argue that BDA, as an organizational capability, can help businesses acquire comparative benefits [1, 8, 12, 14,16, 23, 25]. Big data analytics capability (BDAC) is broadly defined as the capacity to give business insights through data management, infrastructure (technology), and talent (people) capability to transform the business into a competitive force [1, 14. (Srinivasan & Swink, 2018) defined big data analytics as "*an organizational facility with tools, techniques, and processes that enable a firm to process, organize, visualize, and analyze data, thereby producing insights that enable data-driven operational planning, decision making, and execution*" [21].

(Ravichandran et al., 2005) investigated how the resources and capabilities of information systems can provide a competitive advantage [18]. (Kiron & Shockley, 2011) highlight creating an analytics environment where strategy and capability (e.g., data management, technology, and talent) are well aligned to achieve sustainable competitive advantages [14]. (Wamba et al., 2017) investigated the relationship between big data analytics capabilities and firms' performance, as well as the mediating effects of process-oriented dynamic capabilities (PODC) on the relationship between BDAC and FP [25]. (Dubey et al., 2019) emphasized how big data analytics capability (BDAC) as an organizational culture can enhance *trust* and *collaborative performance* between civil and military organizations engaged in disaster relief operations [9].

Three resource classes that account for the BDAC capability are identified in the literature.

The first resource category, tangible resources, and infrastructure, emphasizes the significance of data as a vital resource, considering characteristics such as its origin, capture, and type, as well as technical and physical infrastructure needs that enable effective data utilization [1, 8, 12, 14,16, 23, 25].

The second category is human resources, which are divided into two groups: the first group those with technical skills for big data – programming, machine learning, artificial intelligence, statistical analysis, data cleaning and extraction – as well as the ability to learn and understand new technological trends; the second group of people those with managerial skills for big data management and are in responsible of planning, implementing, and controlling big data-related processes and resources, as well as, more crucially, understanding how big data knowledge may be applied to various areas of the firm [1, 8, 12, 14,16, 23].

The third category deals with intangible resources, which reflect the importance of two aspects: the first is a data-driven culture, which empowers managers at all levels of the organization to make decisions based on facts provided by data rather than intuition based on past experiences; the second intangible resource is organizational learning which recommends firms that have built

capacities to explore, gather, share, and transform knowledge have a significant inventory of valuable knowledge, very useful for validating and contextualizing big data outcomes, i.e., high levels of organizational learning enable the combining and validation of big data information, allowing for an educated decision-making process in the corporation [1, 8, 12, 14,16, 23, 25]

Organizational Culture (CL)

Organizational Culture (CL) is defined as the expectations and norms that govern how people behave and how things are done in a company. This includes implicit conventions, values, shared behavioral expectations, and assumptions that guide the behaviors of the members of a firm. CL refers to a company's core beliefs, services, or goods, as well as how employees and groups within the company treat and interact with one another [10, 19]. (Deshpande & Webster, 1989) define organizational culture as a "set of shared assumptions and understanding about organization functioning." [6].CL provides employees with a shared frame of reference for changes in a company. When organizations have different cultures, members have diverse views and interpretations of organizational changes, which affects employees' willingness to embrace change [6, 13]. As a result, it is well known that organizational culture is critical to the success of any initiative requiring organizational transformation. (Ke & Wei, 2008) emphasize the ability to build CL is a key driver in executing the learned capabilities. Good culture in the organization supports better utilization of learned capabilities. It is necessary to embed the BDAC into the CL to leverage the capabilities for better FP [13].

To measure organizations' culture, different instruments are available framed with a focus on various dimensions of organizational culture. This study will use the organizational culture review [10]. which focused on six empirical factors: teamwork and conflict, climate and morale, information flow, involvement, supervision, and meetings.

Firms' Performance (FP)

An organization's ability to learn is stated to improve financial performance (i.e., profitability, ROI). Companies can learn about their consumers, rivals, and regulators have a higher chance of detecting and responding on market events and trends [20, 22]. Learning firms also have a better understanding of how to engage with consumers and rivals, which should lead to increased profitability. Another performance metric that is thought to be aided by a company's capacity to learn is sales growth [20, 22]. A company that actively learns about its clients is better able to provide items that are more relevant and precisely targeted.

This study will adopt a formative construct measurement from [12, 18, 26]. which is made up of two first-order reflecting constructs: operational performance and market performance. This performance indicator will provide how well a firm is performing relative to direct competitors [12, 18, 26].

Theoretical Background and Research Questions

The Resource-based view (RBV) States that company resources are the most important factor in determining business performance [1, 4, 5,12, 18, 23, 24, 26].

The resources required to develop, choose, and implement strategies are likely to be distributed differently between organizations, which is thought to explain disparities in firm performance [3]. A firm's resources are inventories of readily available production elements that it owns or controls. In contrast, capabilities refer to a company's ability to deploy resources through organizational procedures [3, 5, 24]. Capabilities are defined as a group's ability to accomplish a task or activity, and they are frequently built in functional and sub-functional areas by integrating physical, human, and technology resources [3, 5]. Furthermore, resources that are precious and unique, and whose advantages may be acquired by the controlling business, provide it a temporary competitive advantage. That advantage can be sustained over longer time periods to the extent that the firm is able to protect against resource imitation, transfer, or substitution [24]. RBV essential parts are resources and capabilities. 'Resources' refers to the firm's tangible and intangible assets (e.g., technological, human, and organizational), whereas 'capabilities' are non-transferable subsets of the firm's resources that strive to improve the productivity of other resources [17].

From a resource-based perspective, BDACs (parallel computing, cloud-based services, and data visualization) can be seen as valuable technology assets which can provide a firm with competitive advantage [12]. As BDAC is one of the key organizational capabilities identified as the building blocks of competitive advantage in the big data environment, the traits of value, rarity, and organization may become a source of superior firm performance [1].

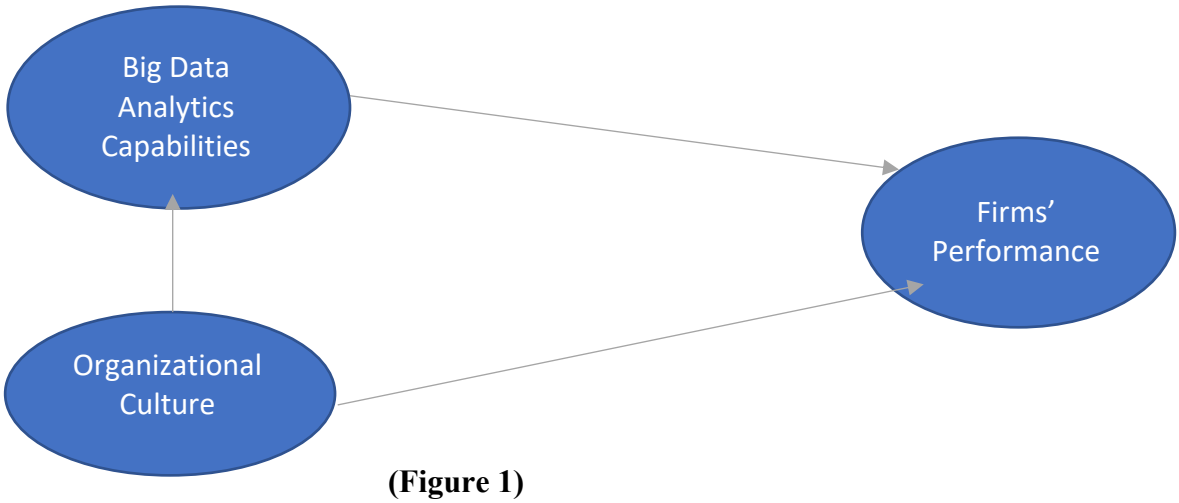
This study suggests RBV as a persuasive framework for integrating different BDAC constructs, their cooperative effects on firms' performance and organizational culture alignment associated with this overall capabilities' performance relationship.

This paper answers the following research question:

- How do big data analytics capabilities and organizational culture impact firms' performance?
- To what extent does organizational culture influence big data analytics capabilities adaption within organizations?

Research Conceptual Framework

I Propose a research model that interrelates Big Data Analytics Capabilities, Organizational Culture, and Firms' Performance variables as shown in (Figure 1)



(Figure 1)

Research Hypotheses

This current study examines

H1: *Big Data Analytics Capabilities will be associated with significantly higher Firms' Performance*

H2: *Organizational Culture will be associated with significantly higher Firms' Performance*

H3: *Organizational Culture will be associated with significantly higher Big Data analytics Capabilities*

Methodology

Context of The Study

Data for this study will be collected though a mail survey.

Measures

Big Data Analytics Capabilities (BDAC)

To measure big data analytics capability, this study will use the (Gupta & George, 2016) scale, which is a construct composed of other constructs: tangibles, human skills, and Intangibles. In turn, the tangibles construct is composed of three formative constructs: Data, technology, and basic Resources; and the intangibles construct is made up of two reflective constructs: data-driven culture and Intensity of Organizational Learning. A 5-items Likert scale is going to be used from totally disagree (1) to totally agree (5). [Appendix 1]

Organizational Culture (CL)

This study will use the scale given by (Glaser et al., 1987) to measure CL, which can adequately show the required traits. The instrument has 31 items which are listed in the (Appendix 2). Theis scale has six components of CL teamwork & conflict, climate morale, information flow, involvement, supervision, and meetings (Glaser et al., 1987). A 5-items Likert scale is going to be used from totally disagree (1) to totally agree (5). [Appendix 2]

Firms' Performance (FP)

Firm performance will be measured by the respondent's assessment of the firm's performance on two dimensions: (1) operating performance and (2) market-based performance. *Operating performance will be* measured using a four- item scale that assessed the extent to which the profitability, productivity, and financial performance exceeded those of their competitors. *Market-based performance* will be measured using a three-item scale that assessed the success of the firm in entering new markets and in bringing new products and services to the market. [Appendix 3]

APPENDIX

(Appendix 1) Big Data Analytics Capabilities.

Item Code	Dimensions	Items
BDACD1	Data	We have access to very large, unstructured, or fast-moving data for analysis
BDACD2		We integrate data from multiple internal sources into a data warehouse or mart for easy access
BDACD3		We integrate external data with internal to facilitate high-value analysis of our business environment
BDACT1	Technology	We have explored or adopted parallel computing approaches (e.g., Hadoop) to big data processing
BDACT2		We have explored or adopted different data visualization tools
BDACT3		We have explored or adopted cloud-based services for processing data and performing analytics
BDACT4		We have explored or adopted open-source software for big data analytics
BDACT5		We have explored or adopted new forms of databases such as Not Only SQL (NoSQL) for storing data.
BDACB1	Basic Resources	Our big data analytics projects are adequately funded
BDACB2		Our big data analytics projects are given enough time to achieve their objectives
BDACT1	Technical Skills	We provide big data analytics training to our own employees
BDACT2		We hire new employees that already have the big data analytics skills
BDACT3		Our big data analytics staff has the right skills to accomplish their jobs successfully
BDACT4		Our big data analytics staff has suitable education to fulfill their jobs
BDACT5		Our big data analytics staff holds suitable work experience to accomplish their jobs successfully
BDACT6		Our big data analytics staff is well trained
BDACM1	Managerial Skills	Our big data analytics managers understand and appreciate the business needs of other functional managers, suppliers, and customers.
BDACM2		Our big data analytics managers are able to work with functional managers, suppliers, and customers to determine opportunities that big data might bring to our business
BDACM3		Our big data analytics managers are able to coordinate big data-related activities in ways that support other functional managers, suppliers, and customers
BDACM4		Our big data analytics managers are able to anticipate the future business needs of functional managers, suppliers, and customers

BDACM5		Our big data analytics managers have a good sense of where to apply big data
BDACM6		Our big data analytics managers are able to understand and evaluate the output extracted from big data
BDACD1	Data-driven Culture	We consider data a tangible asset
BDACD2		We base our decisions on data rather than on instinct
BDACD3		We are willing to override our own intuition when data contradict our viewpoints
BDACD4		We continuously assess and improve the business rules in response to insights extracted from data
BDACD5		We continuously coach our employees to make decisions based on data
BDACI1	Intensity of Organizational Learning	We are able to search for new and relevant knowledge
BDACI2		We are able to acquire new and relevant knowledge
BDACI3		We are able to assimilate relevant knowledge
BDACI4		We are able to apply relevant knowledge
BDACI5		We have made concerted efforts for the exploitation of existing competencies and exploration of new knowledge

(Appendix 2) Organizational Culture.

Item Code	**Dimensions**	**Items**
CL1	Teamwork & conflict	I work with are direct and honest with each other.
CL2		I work with accept criticism without becoming defensive
CL3		I work with Function as a team
CL4		I work with constructively confront problems
CL5		I work with good are good listeners
CL6		Labor and Management have a productive working relationship
CL7	Climate and Morale	This organization motivates me to put out my best efforts
CL8		This organization respects its workers
CL9		This organization treats people in a consistent and fair manner
CL10		There is an atmosphere of trust in this organization

CL11		This organization motivates people to be efficient and productive
CL12	Information Flow	I get enough information to understand the big picture here
CL13		When changes are made, the reasons why are made clear.
CL13		I know what < s happening in work sections outside of my own.
CL15		I get the information I need to do my job well.
CL16	Involvement	I have a say in decisions that affect my work
CL17		I am asked to make suggestions about how to do my job better
CL18		This organization values the ideas of workers at every level.
CL19		My opinions count in this organization.
CL20	Supervision	Job requirements are made clear by my supervisor.
CL21		When I do a good job, my supervisor greets me
CL22		My supervisor takes criticism well.
CL23		My supervisor delegates responsibility.
CL24		My supervisor gives me criticism in a positive manner.
CL25		My supervisor is a good listener.
CL26		My supervisor tells me how I am doing.
CL27	Meetings	Decisions made at meetings get put into action.
CL28		Everyone takes part in discussions at meetings
CL29		Our discussions in meetings stay on track.
CL30		Time in meetings is time well spent
CL31		Meetings tap the creative potential of the people present there

(Appendix 3) Firm Performance.

Item Code	**Dimensions**	**Items**
FPMP1	Market Performance	We have entered new markets more quickly than our competitors
FPMP2		We have introduced new products or services into market faster than our competitors
FPMP3		Our success rate of new products or services has been higher than our competitors
FPMP4		Our market share has exceeded that of our competitors
FPOP1	Operational Performance	Our productivity has exceeded that of our competitors
FPOP2		Our profit rate has exceeded that of our competitors
FPOP3		Our return rate has exceeded that of our competitors
FPOP4		Our sales revenue rate has exceeded that of our competitors

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This is a blank abstract to make Ex Ordo happy.

Do Respect for Safety and Neutralization Influence Distracted Driving Behavior Among Young Adults: The Moderating Role of Polychronicity

Abstract

This study explores how respect for safety, neutralization, and polychronicity contribute to safety–transportation research through engagement in distracted driving behavior. The study harnesses a sample (N = 309) of young drivers' data collected through a survey and vignette-based approach. From a methodological standpoint, structural equation modeling analysis was used to investigate the research outcome, followed by a post-hoc analysis to obtain a driver's profile. The framework is analyzed through the cognitive dissonance theory lens to explore the cognitive human factor variables that increase or decrease engagement in the behavior. Results indicate that drivers' predetermined respect for safety significantly reduces distracted driving behavior. Nonetheless, driver polychronic tendencies or preference to engaging in more than one activity at a time weakens the relationship increasing their engagement in the behavior. Similarly, young drivers that employ neutralization techniques to justify their actions as a precursor of the behavior are associated with increased distracted driving regarding traffic laws violations. Based on the findings, academic and practical implications are discussed, which can lead to proactive and tailor education content in distracted driving behavior.

Keywords: Distracted driving behavior, respect for safety, neutralization, polychronicity, structural equation modeling

EXAMINATION OF THE EFFECTS OF FACULTY COMPENSATION AND LEVEL OF EXPERIENCE ON STUDENT OUTCOMES AT 4-YEAR SOUTHERN COLLEGES AND UNIVERSITIES

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ABSTRACT

Literature has shown that compensation and work experience are linked to improved employee performance [18] [23]. Four-year institution faculty are essential determinants of student outcomes; thus, their performance is essential to the institution's success. Retention, graduation rates, and graduate earnings are outcome metrics used by institutions to benchmark effectiveness. Due to the COVID-19 pandemic, institutions are falling short in these areas [22]. Through regression techniques, this research determines that instructional staff experience and compensation significantly impacts each of these metrics. Therefore, through optimized human resources policies, institutions could indirectly influence student outcomes thus improving their ability to meet desired benchmark figures.

INTRODUCTION

Introduction

Proactive colleges and universities in the United States are continuously looking for ways to improve and innovate their practices to meet benchmark figures. Due to the COVID-19 pandemic, which has negatively impacted students and their willingness to stay enrolled in these institutions, many institutions are beginning to fall short in some of these areas [22]. The fundamental purpose of higher education institutions is to maximize positive outcomes for students. Previous research has examined how institutional characteristics, which often also include instructional staff variables, affect student retention [1] [6] [26], graduation [7] [8] [16], and labor market success [4]. It was hypothesized that since instructional staff directly interact with students, they are perhaps the most influential part of a student's undergraduate experience. While some research does look more closely at instructional staff's effect on these, no research could be found that combines these staff characteristics to examine the three aforementioned outcome metrics.

It is imperative that institutions allocate their resources appropriately so that they are positioned to promote student success. Financially, staff expenses, especially salaries, are the largest, regular, component of instructional expenditures at four-year schools. Thus, by knowing what instructional staff characteristics are most influential in promoting a positive outcome, schools can better distribute their resources to help promote a more efficient staff which is an essential strategic commitment if they wish to provide the best outcome for students. Furthermore, with staff expenses being so significant, these freed resources could be utilized in other areas to promote strategies that would further improve the student experience such as improved facilities or providing more financial support.

It was determined that the instructional staff experience and compensation should be examined as these are metrics that can be influenced through appropriate human resource policies and procedures are four-year institutions. Within these two categories were multiple independent variables that were available for nearly all the institutions represented in the data set, thus providing fair metrics for comparison between the institutions. These two categories of variables will be subjected to both univariate and multivariate regressions, the results of which will be extensively analyzed, to determine their relationship with one another and their impact on student retention, six-year graduation rate, and earnings after college.

Starting with univariate linear regression models, each of the 14 variables of interest were explored individually to examine the relationships that existed between student outcomes and instructional staff characteristics. This was important to the study as it provided justification to create larger models to explore which variables created the "best" environment for student success. Ultimately, there were multiple independent variables that seemed to exhibit a significant relationship with student retention, graduation, and earnings after graduation. This information was then used to perform a backward stepwise regression analysis which provided the final model which could be used to provide prescriptive recommendations to four-year institutions on how they could potentially improve the student outcome metrics examined by making strategic changes to their current and future staff through human resource policies and hiring criteria. This model, after some manually removals were made due to variable insignificance and multicollinearity, showed that institutional expenditure on instructional wages and the level of experience among full-time faculty members make a significant, positive, contribution towards student outcomes and are thus areas that institutions may consider allocating more time to improve upon should they wish to meet desired benchmarks.

Literature Review

The theory that student outcomes, specifically graduation rates, are influenced by characteristics of the institution's faculty was not simply developed based on presumptions. One study, conducted by Mehta et. al. (2021), examined the use of genetic algorithm assisted regression techniques to predict graduation rate and included independent variables that were tied to the institution's faculty [16]. Genetic algorithms are used to optimize the performance of a model and do so by following a process like that of humans: selection, crossover, and mutation [16]. Genetic algorithms were not used in this study, however the structure of their model and which variables they found to be the most significant were used during the formation of the hypothesis of what would impact graduation rates the most. They found that the two most significant classes of variables were institute characteristics, which accounted for 80% of their final model, and human resource characteristics, which accounted for 12% of their final model [16, p. 2275]. While they do not provide details on the 142 independent variables within these categories, they gathered their data from IPEDS [16, p. 2271]. The variables that describe the faculty characteristics of interest to this study (compensation and experience indicators) are all included in the human resources section of IPEDS. Since Mehta et. al. used the human

resource variables from IPEDS, it can safely be assumed that 12% of an effective model predicting graduation would use variables from that same category. This indicates that faculty characteristics do have a significant impact on graduation rate, and therefore it is possible that they may also affect other student outcomes such as retention and earnings after college.

When evaluating the overall performance of a higher-ed institution it is essential to look at more than one metric. In the literature examined, the primary indicators of institutional success have been graduation rates, retention rates, and success in the labor market [11] [15] [16] [27] [29]. However, many studies tend to focus on retention or graduation. It was hypothesized that the most successful institutions would have faculty that encouraged and indirectly contributed towards not only above-average graduation and retention rates, but also higher median earnings after graduation. In this study all three of these factors and the chosen faculty characteristics, the independent variables, will be examined in an attempt to determine how they affect one another. While it has been shown that student characteristics, such as GPA and standardized test scores, certainly influences all these factors, especially retention rates, existing literature also expresses that institution-level variables, including faculty characteristics, have a large impact as well [3] [16]. Graduation rates have also been found to be positively correlated with faculty characteristics such as number full-time faculty members, faculty-to-student ratios, and others that will be examined further in this study [8].

This study will use regression techniques to evaluate the effect of different categories of faculty characteristics. While there is little literature that discusses the application of regression techniques on the College Scorecard Dataset, there are numerous studies that have been conducted using the National Center for Education Statistics' (NCES) Integrated Postsecondary Education Data System (IPEDS). To justify the use of this technique, the study done by Horn and Lee (2015) was examined in which they determined whether regression residuals are a legitimate way to measure student outcome, specifically they sought to assign an effectiveness score that reflected how effectively institutions were promoting degree completion [12, p. 491]. In their discussion, they concluded that their regression results could be reproduced and were therefore consistent, furthermore they state that the results seemed to be consistent over consecutive years [12, p. 491]. Their work implies that regression is a reliable method of examining institutional effectiveness at influencing student outcomes.

Aside from determining the reliability and validity of regression, there are studies that employ this method to determine the effectiveness of specific variables in promoting a positive student outcome [6] [11] [15] [21]. These studies tend to use hierarchical regression which creates multiple regression models using different variables of interest to improve the overall performance of the model. This is a helpful technique when evaluating variables that can fit into different categories which was how Marsh (2014) implemented this. As more levels are added to the regression, more variance is typically explained and thus it is possible to infer the total impact of each variable in the overall model. Hobson et. al. (2022) utilized regression to examine the differences between white and Hispanic college student six-year graduation rates that they retrieved from IPEDS. This shows that

regression not only is a viable method, but also that IPEDS data is compatible with the technique as are a variety of the variables that it contains.

The work of Dahlvig et. al. (2020) helps readers understand the relationship between different types of institutional expenditure and how they impact student retention and graduation. They found that institutional expenditure on instruction per full-time equivalent (FTE) student was positively correlated with graduation [6, p. 361]. It is well known that the largest part of instructional expenditures is faculty salary, so knowing that instructional spending is positively correlated with student graduation could imply that faculty salary would reflect these results. However, this goes against the findings of Aaron (2013) who found that there was no correlation, negative or positive, between instructional spending or faculty salaries and student retention [1, p. 73]. They did, however, state that as the regional normalized wages increased student retention increased slightly [1, p. 73].

To determine if faculty salary really would have an impact on student outcomes, one would need to examine whether student success and teaching are incentivized monetarily in high education institutions. Some research has been done in this area [17]. Melguizo and Strober (2007) found in their study that most faculty were compensated more because of their contribution to the institution's overall prestige as it was perceived by those outside of the college [17]. Additionally, they concluded that there was a negative, though very small, correlation between time spent instructing students and salaries [17, p. 662]. This would imply that there are no significant financial incentives for instructors who choose to focus on instruction alone. This is an important conclusion as it could provide an explanation for the low impact salaries had on student outcomes described by Aaron (2014). In this study, the relationship between faculty compensation and student outcomes will be reexamined to determine if a correlation exists between them. Unlike previous studies, however, outcomes other than graduation will be examined such as retention and graduate earnings after graduation.

Zong and Davis (2022) conducted a similar study to this one where they examined the retention and graduation rates of 706 public institutions in the United States. Their focus was on testing and potentially improving upon an existing theoretical model developed by Fung (2010) [7] [29]. One of the key takeaways from this model is its use of categories of variables to further break down the different factors affecting retention and graduation. In the study, they ultimately developed a model that included variables that could be categorized within institutional performance, student commitments, student background, student finance, academic environment, and social environment [29, p. 6-7]. Contained within their academic environment variables was student-to-faculty ratio, which was examined in other literature examined [15]. This is a common theme in previous research, faculty characteristics are typically either combined with institutional influences or it is summarized by using student-to-faculty ratios. However, there are many other characteristics of faculty that could influence student outcomes when they are examined individually before being placed in a model.

Studies such as Marsh (2014), include faculty qualities as a part of the overall characteristics of the institution and attempt to determine a relationship between these measures and student retention. Marsh emphasizes the importance of retention especially in the growing age of data transparency [15]. Using hierarchical regression techniques, they found that the faculty characteristics included in the model, percentage of full-time faculty and student-to-faculty ratio, had a relatively low impact on the overall R^2 of their model [15, p. 139]. They go on, however, to say that these lower figures may be due to previous stages of the model accounting for variance that could also be explained by faculty characteristics [15, p. 144]. Furthermore, they reference previous studies such as Tinto (2006) that argued many larger institutions use part-time or less experienced faculty in their first-year courses which could lead to students not getting the same quality of instruction as upper-level students [15, p. 144] [26].

The theory that part-time faculty may have an impact on student outcomes is not a new one and has been examined by Thirolf and Woods (2018) who explored the role of contingent faculty at community colleges and the importance of providing them adequate support. Adequate support for part-time faculty, in this instance, means better compensation and access to groups and training workshops on campus. Compensation for contingent faculty in four-year schools has historically been a concern as full-time faculty salaries decrease which has also led to a decrease in the already low salary of adjuncts and lectures [13]. While this study aims to examine faculty's impact at four-year institutions, one could argue that community and technical schools are a good source of information when examining the effects of part-time faculty members on students since historically contingent faculty have been a majority at these types of schools [25]. They concluded that part-time faculty ultimately are a valuable resource to students and should be provided resources such as professional development and opportunities to engage with other faculty members [25]. They also briefly discuss the findings of Yu, Campell, and Mendoza (2015) who found that there was not a negative correlation between the percentage of part-time faculty and student's ability to graduate [28].

A study by Xu and Ran (2020), sought to find the relationship between the type of faculty members a student interacted with and their outcomes in the labor market [27]. Their analysis was based on the idea that in recent years, higher education institutions have become increasingly reliant on adjunct and non-tenured track faculty members due to the higher cost of full-time instructors. They found that while at two-year colleges there was a negative impact on student performance when exposed to more part-time instructors, there was no such effect on students at four-year institutions [27, p. 252]. However, it could be possible that this lack of an effect at four-year institutions is a result of the disproportionate number of adjuncts and faculty present at two-year institutions. If this is the case, the argument could be made that the percentage of instructors that are adjuncts or temporary lecturers is still an important metric to examine in a study relating faculty characteristics to student outcome for if an institution is more reliant on part-time instructors, for their first-year students especially, there could be a negative impact on outcome. In addition to adjunct faculty lacking motivation due to their lower compensation and lack of available resources [13] [25], there are concerns surrounding their level of interaction with students outside of the classroom which has recently been a focus among

higher education institutions as it has been tied to higher retention and graduation rates [19].

While there certainly appears to be validity to the claim that student exposure to different types of faculty members can influence their outcome, it appears as though the primary dependent variable affected by part-time faculty ratios is student retention [25] [27]. In fact, according to existing literature, the level of exposure a student has to adjuncts has no effect on labor market outcomes [27]. This is supported by other literature that suggests that there is a minimal effect on labor market effectiveness influenced by instructor characteristics and that even instructors that are effective in the classroom may not lead to increased success in the job market [4]. In this study instructional staff characteristics will be broken down further and the effectiveness of not just part-time staff, but also the ranks of those staff members such as lecturers and adjuncts as well as the different ranks of full-time faculty members including professors, assistant professors, and associate professors will be examined. While there may not have been an impact on earnings when looking at just part-time instructors, it is possible that more experienced faculty could lead to increased earnings. Additionally, based on the findings of Xu and Ran (2020), it was hypothesized that when retention and graduation rates are examined, the institutions with the highest proportion of senior faculty members will show higher levels of successful student outcomes than those with more junior or part-time instructors.

METHODOLOGY

The Data

In this study, data was gathered from two locations, the College Scorecard Dataset, which is provided by the U.S. Department of Education, and the Integrated Post-Secondary Education Data System (IPEDS), maintained by the National Center for Education Statistics' (NCES). The IPEDS data was the primary source for all independent variables examined (faculty characteristics) while the College Scorecard was the source of the dependent variables (student outcome).

Both data sets are updated annually, typically a few months apart from one another, and include information on all institutions in the United States that are eligible for Title IV funding. All data collected was from the 2020-2021 academic year which is the most recent year for which data was available for download. Any variable that examined faculty characteristics that are subject to change (academic rank, salary, etc.) are from the start of the fall semester at each institution. This means that if an instructional staff member were to receive an increase in compensation or a new title during the academic year examined it would not be reflected in the data.

All variables extracted from the IPEDS data came from the Human Resources category which includes salary outlays, tenure status, academic rank, and other characteristics for all full and part-time staff at an institution. Independent variables were selected from the dataset based on the belief that they may impact student outcomes. The independent variables selected fit into two categories: (1) instructional staff compensation and (2)

instructional staff rank, experience, and status. Once the data had been extracted, numerous aggregations, summarized in Appendix I, were completed to provide more normalized values which allows for a more accurate and fair comparison between institutions.

College Scorecard was used as the source for student outcome variables. Both retention and graduation rates are available through the IPEDS website, however College Scorecard includes graduate earnings after college, gathered from documents filed by alumni to the Internal Revenue Service, which was an outcome of interest in this study.

The final data set contained 401 institutions in the United States. They were all 4-year colleges and universities according to their Carnegie Classification that predominantly grant bachelor's degrees. Additionally, they were all accredited by the Southern Association of Colleges and Schools Commission on Colleges (SACSCOC). Once the sample had been reduced to this smaller subset, any columns that were suppressed for privacy reasons or any columns that were missing data for 15% or more of the institutions included were removed.

During the early stages of this preliminary analysis, it was acknowledged that faculty salaries may be skewed due to graduate instructors at some institutions. A potential limitation with this data is that the IPEDS data does not differentiate between graduate and undergraduate instructor salaries; This could cause issues when examining undergraduate outcomes as graduate instructors tend to receive higher compensation. To alleviate this issue, total spending variables were used rather than the average salary outlays for instructional staff. The three spending variables examined were: 1) total spending on instructional wages, 2) total spending on academic support wages, and 3) total spending on auxiliary service wages. All these variables were then divided by the entire student population, not just undergraduates, to provide a better figure for comparison between institutions. Support and auxiliary wages were included to ensure that tutors, athletic academic staff, and other instructional staff were included that may not be represented in instructional staff wages. Using spending on instructional wages also ensures that part-time salaries are included in the model, which would not be a guarantee if average faculty salary had been examined.

Preliminary Analysis

Prior to building the final model, the relationship between each independent variable and the three dependent variables was examined. During the exploratory phase, the relationship between each predictor variable and the three dependent variables of interest were examined, starting with retention. This relationship was examined by conducting 13 univariate regression models for each of the dependent variables where the dependent variable remained the same and each independent variable was used as the sole predictor. Univariate regression would not be sufficient when trying to explain the primary driver for any single student outcome in this case as there is a great deal of variance to be explained and no single faculty characteristic can account of all of it. However, these simple regression models helped to determine which predictors were the most statistically

significant and find their correlations to the dependent variables. This would help form hypotheses around which variables would most likely be used in the final model. Additionally, it led to conclusions regarding the validity of the research question, as if there were no significant predictors, then there would be little evidence to support further examination of faculty characteristics and their impact on student outcomes.

For each univariate regression, a confidence interval of 95% was specified. Meaning a p-value below 0.05 would indicate a statistically significant relationship in the model - that is to say, the null hypothesis can be rejected due to the relationship between the independent and dependent variables. Furthermore, the f-statistic was included in the model results to further support the significance of the independent variables. All the models had a single degree of freedom due to them having only a single predictor, however each model had at least 380 residual degrees of freedom. Using f-tables, the critical f-value necessary to reject the null hypothesis was found to be 3.8415 meaning that any model with an f-statistic exceeding this critical value is statistically significant and the null hypothesis can be rejected.

Constructing the Final Models

After conducting the preliminary analysis, the final models were constructed. The best possible subset of variables that influenced the outcome measure of each model was desired, so various subset selection techniques were evaluated. Ultimately, stepwise regression was selected as the best method for this study. Stepwise regression allows the researcher to evaluate different model combinations without having to manually compute each one and produces a set of independent variables that have the highest degree of influence on the dependent variable. Traditionally, stepwise regression utilized the f-statistic as the selection criteria for the model where a critical value was used and any independent variable that failed to be greater than the critical value would not be included in the model. However, as Hastie et al point out, this method is dated and fails to take into account the problem of multiple testing [10]. Instead, the Akaike information criterion (AIC) was utilized which uses the log-likelihood to determine the fit of the model and penalizes the model for being overly complex. Equation 1 shows the equation used for calculating AIC.

$$\boldsymbol{AIC = -2\,ln(\hat{\beta}) + 2k} \qquad \textbf{(1)}$$

When applied to regression, the procedure is to search for the set of independent variables that will minimize the AIC value of the overall model while also trying to simplify the model as much as possible. In this instance, this is helpful because it will, in theory, find the most significant subset of independent variables that are associated with student outcomes thus creating a smaller model as opposed to having a larger model with many variables that may have a miniscule contribution to the explanation of the variance in the dependent variable.

There are two separate ways to approach a stepwise model. Forward stepwise models start with the most significant independent variable and then sequentially attempts to add one

variable at each step. If the added variable hurts overall performance, it is not included. Once the variable is added, the model is reevaluated to ensure all variables are still significant and any that are deemed insignificant are dropped. Backward stepwise regression starts with a single, large, model that contains all independent variables. It then goes through and removes the least significant variable, based on the z-score of the variable, at each step. This is helpful because the "kitchen sink" model can be examined which is simply a model that contains all independent variables as predictors, something that is very unlikely to happen in a forward selection process. This allows the researcher to see how all their variables interact together and how effectively the predictors explain the variance of the dependent variable. It should be noted that these so called "kitchen sink" models are often never used as they contain numerous insignificant variables and typically fall victim to high levels of multicollinearity.

Once the models were constructed, a variety of tests were selected to examine their goodness of fit and attempt to detect any multicollinearity which may negatively affect their performance. Using variance inflation factors, the effect collinearity had on variance in the model could be examined. It was deemed that any VIF coefficient between four and nine was worthy of investigation and any variable with a coefficient greater than nine was removed from the model immediately. If a variable had a VIF coefficient below four, it was concluded that collinearity had little impact on that variable's effectiveness in the model. Equation 2 shows the equation that can be used to calculate the variance inflation factor of a variable. In addition to the VIF coefficients, the condition indices for each model were examined and if any independent variable had a condition index value over 30 it was removed from the model as it was likely highly collinear with another variable.

$$\boldsymbol{VIF = \frac{1}{1 - R^2}} \qquad \textbf{(2)}$$

Coefficient sign flips are also an indicator of collinearity. In instances where a sign flipped, the variable was removed from the model and it was reexamined.

Goodness of fit was tested by examining the models' residual plots and R^2 values. Adjusted R^2 was the preferred measure as it considers the number of independent variables that are entered into the model and only increases as more variance is explained.

RESULTS

Preliminary Analysis Results

Table 1 shows the results of the first set of regressions that were conducted on retention. Using the R package *purrr*, the 13 univariate regressions could be run rather quickly, and the results could be mapped into a table for analysis. When paired with the *dplyr* and *broom* packages, *purrr* makes running multiple regression models with the same dependent variable quick and provides an easy to interpret output that allows summary statistics of interest to be specified, thus simplifying outputs for reporting. Furthermore, by

utilizing R and other computer software, replication is more feasible in the future as there will be fewer hand calculations necessary to reach similar findings.

TABLE 1

Retention Univariate Regression Results

PREDICTOR	COEFFICIENT	R^2	P-VALUE	F-STATISTIC
TOTAL SPENT ON INSTRUCTIONAL WAGES PER STUDENT	1.40E-05	0.2085	6.82E-22	104.3096
TOTAL SPENT ON ACADEMIC SUPPORT WAGES PER STUDENT	8.67E-06	0.0521	4.23E-06	21.7616
TOTAL SPENT ON STUDENT SERVICES AND AUX. SERVICES PER STUDENT	2.27E-05	0.0744	3.19E-08	31.8447
% FULL-TIME INSTRUCTIONAL STAFF	0.26013	1.71E-01	7.88E-18	81.4570
% FULL-TIME TENURED FACULTY	0.31784	0.17581	2.23E-18	84.4745
% FULL-TIME TENURE TRACKED FACULTY	0.00311	7.60E-06	9.56E-01	0.0030
% FULL-TIME NON-TENURED FACULTY	0.01775	0.00064	0.61616	0.2517
% FACULTY - PROFESSOR	0.41089	0.10832	1.65E-11	48.1066
% FACULTY - ASSOCIATE PROFESSOR	0.19025	0.01702	0.00917	6.8561
% FACULTY - ASSISTANT PROFESSOR	-0.16448	0.02094	3.82E-03	8.4690
% FACULTY - INSTRUCTOR	-0.19012	0.01237	0.02647	4.9619
% FACULTY - LECTURER	0.36968	0.05069	5.73E-06	21.1462
% FACULTY - NO ACADEMIC RANK	-0.08903	0.00152	0.43821	0.6022

These models show there are numerous predictor variables with p-values less than 0.05 meaning that they are statistically significant and could be used to disprove the null hypothesis. Furthermore, expenditure on instructional salary per student, the percentage of instructional staff holding professor ranks, the percentage of full-time staff, and the percentage of full-time instructional staff that holds tenure each had R^2 values of 0.10 or greater indicating that they may explain more than 10% of the variance in student retention. This indicates that experienced faculty likely have a positive impact on student retention. There was concern regarding collinearity between salaries and instructional staff experience, however by using the slightly broader variable of instructional salary expenditure per student, part-time staff salaries are included. Additionally, the wage spending variables were normalized based on class size which further helps eliminate some of this error.

After examining retention, six-year graduation rate was examined using the same methodology. Six-year graduation rate was chosen over four-year due to the greater number of students that would be captured by this variable. Should a student require additional semesters of coursework due to factors such as inability to meet major requirements or athletics, they would not be included in the four-year graduation rate of an institution. By using the six-year rate, which is often not caused by institutional factors, this issue is mostly eliminated, and thus the variable is more likely to showcase institutional effectiveness in helping students reach their desired outcomes. Table 2 shows the output from the regression models built for six-year graduation.

TABLE 2

Six-Year Graduation Rate Univariate Regressions

PREDICTOR	COEFFICIENT	R^2	P-VALUE	F-STATISTIC
TOTAL SPENT ON INSTRUCTIONAL WAGES PER STUDENT	2.59E-05	0.3362	6.11E-37	199.5089
TOTAL SPENT ON ACADEMIC SUPPORT WAGES PER STUDENT	0.000015	0.0702	8.72E-08	29.7455
TOTAL SPENT ON STUDENT SERVICES AND AUX. SERVICES PER STUDENT	0.000053	0.1927	4.44E-20	94.0229
% FULL-TIME INSTRUCTIONAL STAFF	0.3177	1.17E-01	2.57E-12	52.2367
% FULL-TIME TENURED FACULTY	0.4538	0.1675	2.01E-17	79.2627
% FULL-TIME TENURE TRACKED FACULTY	-0.0441	7.15E-04	5.96E-01	0.2817
% FULL-TIME NON-TENURED FACULTY	-0.0229	0.0005	0.6584	0.1958
% FACULTY - PROFESSOR	0.6864	0.1407	1.13E-14	64.5016
% FACULTY - ASSOCIATE PROFESSOR	0.3592	0.0284	0.0008	11.5180
% FACULTY - ASSISTANT PROFESSOR	-0.2334	0.0195	5.42E-03	7.8189
% FACULTY - INSTRUCTOR	-0.4032	0.0259	0.0013	10.4796
% FACULTY - LECTURER	0.3118	0.0165	1.06E-02	6.5940
% FACULTY - NO ACADEMIC RANK	-0.1309	0.0015	0.4357	0.6088

Again, the model showed that instructional salary expenditure was significant and had the highest R^2 value, but in addition it appears as though auxiliary support and student services salary expenditure was significant. Additionally, professor ranked instructional staff and full-time staff with tenure were again found to be significant and had R^2 values over 0.10.

These results show that there are faculty characteristics that play a significant role in determining student outcome in four-year institutions. Furthermore, the claim that, depending on the outcome being measured, a different combination of faculty characteristics may be more significant than others can be justified, which in turn also justifies the creation of multiple models to examine different student outcomes to provide more specific areas for improvement to institutions. While prior research discussed in the literature review tends to examine only one outcome measure, such as retention, these results show that there are differences in how the outcomes are influenced, and thus multiple dependent variables should be considered when determining the most effective instructional staff make up at four-year institutions.

Finally, univariate regressions were conducted on independent graduate earnings eight years after entering the institution. College Scorecard includes earnings data for students six, eight, and ten years after entering their undergraduate program. It was determined that eight years would be the most useful for this study because 1) it would include the students that did not graduate within four years and 2) it was soon enough after most students graduate that their experience in an undergraduate program would likely still influence their earnings. This second point would not be true ten years after program entry as this could be as many as six years after graduation, at which point employees are likely compensated more based on experience than education. Table 3 shows the results of the univariate regressions conducted on graduate earnings.

TABLE 3

Earnings Eight Years After Program Entry Univariate Regressions

PREDICTOR	COEFFICIENT	R^2	P-VALUE	F-STATISTIC
TOTAL SPENT ON INSTRUCTIONAL WAGES PER STUDENT	1.46E+00	0.2979	1.67E-32	169.2638
TOTAL SPENT ON ACADEMIC SUPPORT WAGES PER STUDENT	7.62E-01	0.0528	3.34E-06	22.2322
TOTAL SPENT ON STUDENT SERVICES AND AUX. SERVICES PER STUDENT	2.54E+00	0.1235	4.27E-13	56.2027
% FULL-TIME INSTRUCTIONAL STAFF	15454.1599	7.95E-02	9.18E-09	34.4554
% FULL-TIME TENURED FACULTY	22994.2281	0.1218	6.31E-13	55.3257
% FULL-TIME TENURE TRACKED FACULTY	-4673.8427	2.27E-03	3.42E-01	0.9060
% FULL-TIME NON-TENURED FACULTY	-2104.5762	0.0012	0.4928	0.4713
% FACULTY - PROFESSOR	33775.4510	0.0970	1.79E-10	42.8819
% FACULTY - ASSOCIATE PROFESSOR	16052.0723	0.0160	0.0112	6.4955
% FACULTY - ASSISTANT PROFESSOR	-11244.7455	0.0130	2.25E-02	5.2464

% FACULTY - INSTRUCTOR	-29764.2327	0.0400	5.48E-05	16.6318
% FACULTY - LECTURER	14581.7784	0.0104	4.15E-02	4.1828
% FACULTY - NO ACADEMIC RANK	-4083.8758	0.0004	0.6825	0.1676

Fascinatingly, there again was a positive correlation between the salary expenditure variables and the dependent variable. This would indicate that as institutions spend more on the salaries of individuals that directly contribute to student’s academic success, there is an increase in the student’s earnings after college. This could be due to several factors, but it was hypothesized the most reasonable explanation for this relationship is that students experience better academic performance which in turn would increase their likelihood and ability to negotiate higher entry level salaries. Another potential explanation could be that institutions that pay their instructional staff and student services employees better likely compensate their career and professional development staff equally as well leading students to have more resources on campus that would improve their likelihood of a more lucrative job or internship placement.

Another relationship to make note of in these results is tenured faculty. While in the previous models created professor status and the percentage of full-time instructional staff were found to be significant predictors, in this case only tenure status was found to add significant value to the model. The other independent variables had low R^2 values but appeared to have significant F-statistic and p-values leading to the conclusion that they may account for more overall variance in the final model when examined alongside other variables.

Retention Model Results

The retention model consisted of 398 institutions rather than 401 due to three being removed from the data prior to analysis due to them missing the dependent variable. Table 4 shows the shows the variables removed from the model during the stepwise process. Table 4.2 shows any additional variables removed as well as the reason for their removal. The percentage of staff that held the instructor rank being dropped from the model was not entirely surprising since this is a relatively uncommon rank, however associate professor is much more common and was also deemed insignificant. This is likely due to other experience variables such as the percentage of staff holding the professor rank accounted for variance that was partially explained by these less significant predictors. Auxiliary service wages per student also dropped during the backward steps. This variable includes the wages of academic support staff that work with student athletes as well as other academic support staff not directly connected to either a specific degree program or the academic support program of the institution. Some may assume that these programs are instrumental to the success of student athletes, but the initial results from this model indicate that perhaps the wages of their instructors and regular academic support staff may be more influential.

TABLE 4.1 & 4.2

4.1 Variables Removed from the Retention Model During Stepwise Process

VARIABLE REMOVED	AIC (VARIABLE)	AIC (MODEL)
AUXILIARY WAGE SPENDING PER STUDENT	-724.264	-722.544
% FACULTY – INSTRUCTORS	-725.862	-724.264
% FACULTY – ASSOCIATE PROFESSORS	-727.375	-725.862
% FACULTY – TENURED	-728.251	-727.375

4.2 Additional Variables Removed from the Retention Model

VARIABLE REMOVED	REASON	JUSTIFICATION
% FACULTY – TENURE TRACK	Collinearity	Incorrect Coefficient Sign
% FACULTY – NO ACADEMIC RANK	Collinearity	Incorrect Coefficient Sign
% STAFF – NOT TENURED	Insignificance	p = 0.592 > 0.05
INSTRUCTIONAL SUPPORT WAGES PER STUDENT	Insignificance	p = 0.134 > 0.05

Once variables had been removed for collinearity, the model was reconstructed, and variables were dropped due to insignificance. Table 5 contains the independent variables that made up the final model.

TABLE 5

Retention Model Independent Variables

	ESTIMATE	STD.ERROR	P.VALUE
(INTERCEPT)	0.591	0.018	8.27E-114
INSTRUCTIONAL WAGE SPENDING PER STUDENT	9.42E-06	1.37E-06	2.31E-11
% FACULTY – FULL-TIME	0.174	0.032	6.37E-08
% FACULTY - PROFESSOR	0.193	0.056	< 0.001
% FACULTY – ASSISTANT PROFESSOR	-0.260	0.050	2.75E-07
% FACULTY – LECTURERS	0.180	0.070	0.011
% FACULTY – NO ACADEMIC RANK	-0.223	0.094	0.018

The p-value of the independent variables all indicate a high level of significance and the preliminary analysis seemed to indicate that these variables were also correlated with retention, leading to the conclusion that this model is valid and its performance can be examined before proceeding on to making assumptions with these findings.

The statistical software used returned a p-value that was equal to $2.2x10^{-16}$ which is the minimum figure that R will report to indicating a p-value that is extremely close to zero. This means that the p-value is likely smaller than $2.2x10^{16}$ which is far below the threshold required to disprove the model's significance. The f-statistic is the more easily interpreted figure in this case and for this model it was found to be 37.82 which, according to the critical f-value of 2.0096, also shows that the model is statistically significant.
While the model is significant according to both the f-statistic and the p-value, the adjusted R^2 value of 0.358 may be lower than some desire. In this case, however, a lower R^2 value was anticipated, as there are undoubtedly additional variables that contribute to student retention at higher-education institutions aside from those included. With these figures meeting or exceeding the minimum expectations of this study, model fit could then be examined to further prove the validity of the model's ability to guide policies.

FIGURE 1

Retention Model's Plotted Residuals

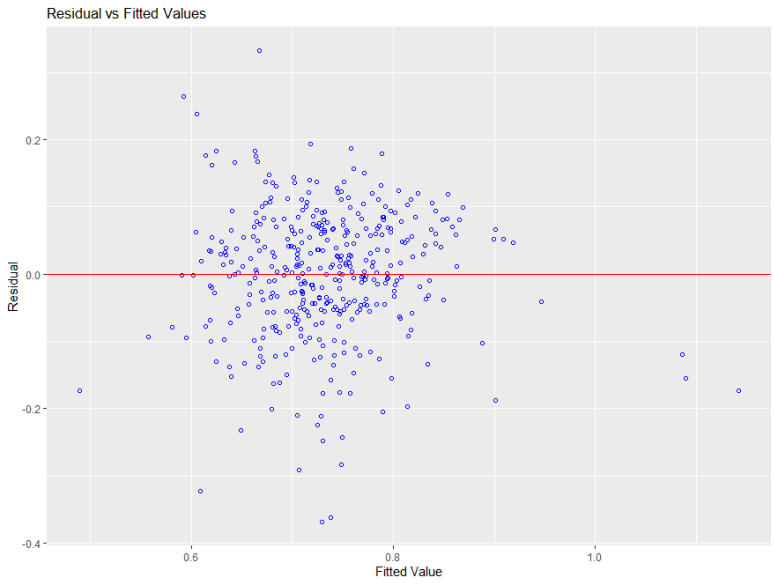
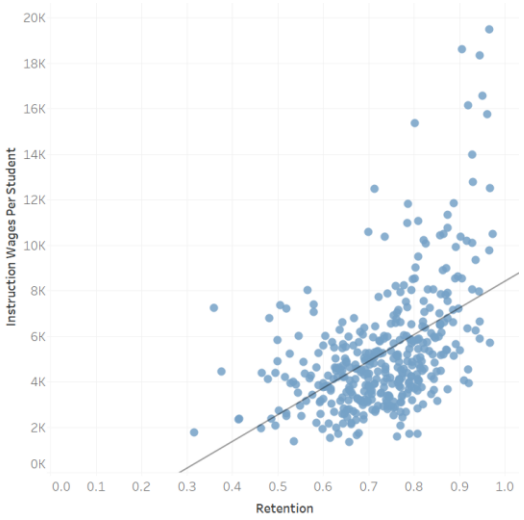


Figure 1 shows the plotted residuals of this model which gives an idea of the model's goodness of fit. Ideally, this plot would show characteristics of a null residual plot, one that shows no apparent relationship between the data points. In this case, while there seems to be a cluster of points on the left of the graph and a slight skew to the right, overall, there does not appear to be a clear relationship between the points which indicates a well-fit model. Once model performance had been evaluated, the relationship between the independent variables and retention could be more carefully examined.

As stated above, each of the variables in the final model had p-values less than 0.05 indicating they were overall statistically significant. Beyond their significance, they all held some level of correlation with the dependent variable. Figure 2 shows the highest correlation in the model which was instructional wage spending per student. Note that 10 institutions were removed from this visualization due to not reporting the instructional wage figures. Furthermore, there were three outliers that, while included in the model, made evaluating the relationship between the variables difficult so they were also removed from this visualization. When removing these outliers, the R^2 of relationship experienced an insignificant change and the p-value remained well below the threshold of 0.05 and thus remained significant, so these removals did not significantly influence the relationship.

FIGURE 2

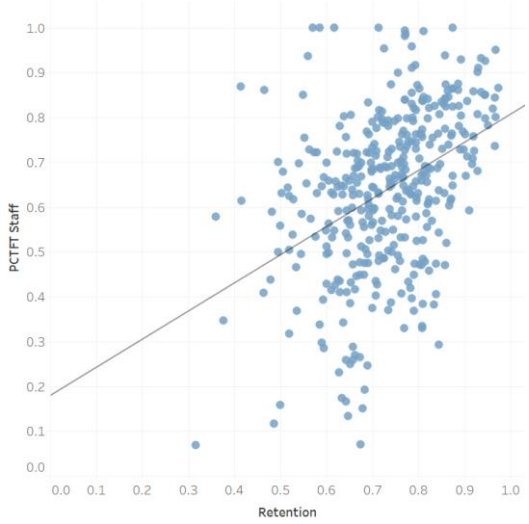
Retention and Instructional Wage Spending per Student



This figure shows a clear, positive, correlation between the two variables indicating that instructional staff salaries in some way influence retention rates at four-year institutions in a positive manner. The same can be said about the relationship between full-time instructional staff and retention as seen in Figure 3.

FIGURE 3

Retention and % of Full-Time Instructional Staff



These results will be discussed further in the discussion portion of this paper, however the positive relationships between these independent variables and retention support the hypothesis that more experienced and more highly compensated staff have a positive impact on student retention. Furthermore, this positive relationship with full-time staff provides and explanation for the collinearity that existed prior to the removal of the tenured faculty variable which would have been closely related to the number of full-time instructional staff.

Graduation Model Results

This model included all 401 institutions. Unlike retention, all the institutions in the data set reported their graduation rates meaning the dependent variable was present for all observations. The graduation model's stepwise process dropped the variables in Table 5.

TABLE 6

Variables Removed from Graduation Model During Stepwise Process

VARIABLE REMOVED	AIC (VARIABLE)	AIC (MODEL)
% FACULTY – LECTURERS	-483.994	-482.186
% FACULTY – TENURED	-485.341	-483.994
ACADEMIC SUPPORT WAGE SPENDING PER STUDENT	-485.492	-485.341

Unlike the retention model, only three variables were dropped due to insignificance during the backwards steps. However, as Table 6 shows, there were additional variables removed for insignificant p-values.

TABLE 7

Additional Variables Removed from Graduation model

VARIABLE REMOVED	REASON	JUSTIFICATION
% FACULTY – ASSOCIATE PROFESSORS	Insignificance	p = 0.093 > 0.05
% FACULTY – INSTRUCTORS	Insignificance	p = 0.155 > 0.05

In this instance two variables were removed from the model for insignificance and no variables were deemed to have collinear relationships that negatively impacted performance. This model included more variables than the retention model and seemingly performed better. Interestingly, it contained many of the same variables as the previous model, however it also added two new variables, both of which had to do with tenure status. While the percentage of faculty who held tenure was removed from the model for insignificance, the percentage of tenure track faculty and those without tenure status were kept. These variables likely explain more overall variance in the model and hold a higher degree of significance. It can also be assumed that tenure track faculty
The graduation model's variables are summarized in Table 8.

TABLE 8

Graduation Model Independent Variables

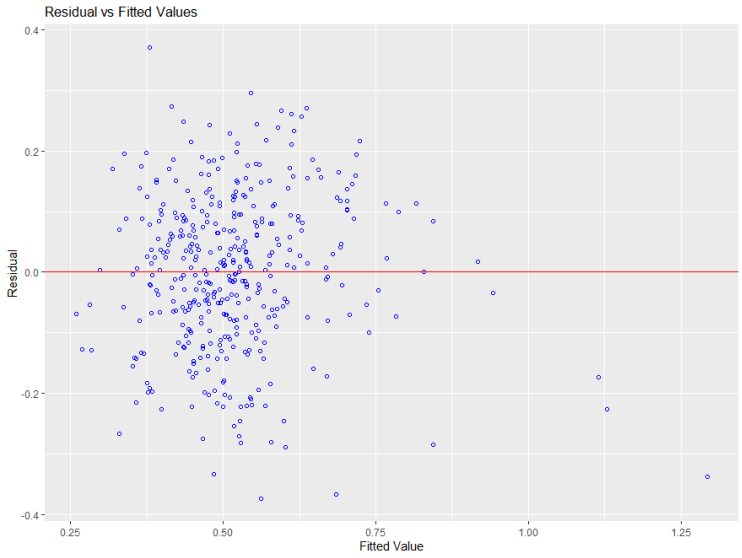
	ESTIMATE	STD.ERROR	P.VALUE
(INTERCEPT)	0.355	0.025	7.14E-37
INSTRUCTIONAL WAGE SPENDING PER STUDENT	1.68E-05	2.20E-06	2.19E-13
AUXILIARY SERVICES WAGE SPENDING PER STUDENT	1.51E-05	5.82E-06	0.010
% FULL-TIME FACULTY	0.253	0.056	7.26E-06
% FACULTY – TENURE TRACK	-0.354	0.106	0.001
% FACULTY - WITHOUT TENURE	-0.209	0.061	0.001
% FACULTY – PROFESSOR	0.270	0.082	0.001
% FACULTY – ASSISTANT PROFESSOR	-0.313	0.072	1.61E-05
% FACULTY – NO ACADEMIC RANK	-0.345	0.126	0.006

This model yielded a higher adjusted R^2 value, 0.4528, and a higher f-statistic, 41.76. These figures indicate the model was statistically significant and that the combination of variables used in the model make a significant contribution to the explanation of variance in the dependent variable, in this case graduation. As the higher adjusted R^2 value would indicate, the goodness of fit of this model was acceptable.

Figure 4 shows the plotted residuals which further support this claim. The apparent randomness of the points supports the hypothesis that the model accurately depicts a relationship between faculty experience and compensation and student graduation rates. There were, once again, outliers that appeared to skew the residuals right, however the overall plot exhibits no relationship among the points.

FIGURE 4

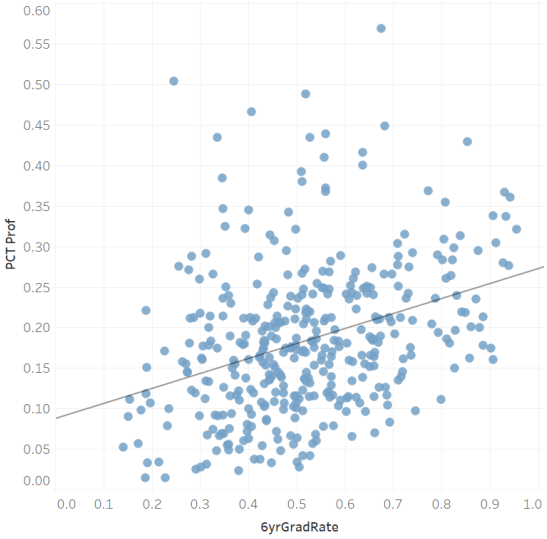
Graduation Rate Model's Plotted Residuals



When examining the relationships in the model more closely, again instructional wages per student appeared to be the most significant variable with a p-value of $2x10^{-16}$. However, the relationship between the percentage of professor ranked faculty was the next most significant variable with a p-value of 0.0001. When plotted, this relationship becomes clear, as seen in Figure 5.

FIGURE 5

Graduation Rate and % Faculty with Rank of Professor



This relationship suggests that while the difference between full-time and part-time faculty is less significant in the overall graduation rate of an institution, the experience level of the faculty is.

Graduate Earnings Model Results

One issue encountered with this model was that some institutions did not have a figure listed for their graduates' earnings, and therefore a zero was inserted as a placeholder. These outliers caused a great deal of interference, so any institution that had a zero listed for the independent variable was removed from the sample. This means that instead of 401 observations the dataset included 395. Since this data comes from the internal revenue service, it certainly exists, so it was likely excluded due to the agency not having enough data to report.

In the early stages of this study, it was hypothesized that earnings would have the least significant model, meaning instructor rank and compensation would have little effect on graduate earnings eight years after program entry. However, with an F-statistic of 70.73 and an adjusted R^2 of 0.415, this model was the second best fit and significant of the three evaluated which implies that faculty experience and compensation are better indicators of graduate earnings than they are of retention.

Table 7 summarizes the variables removed from the model during the backward stepwise regression. Interestingly, both auxiliary wage spending and support wage spending were removed during the stepwise process, unlike the other models where only one of the spending variables was removed. Aside from this oddity, there were no "unusual" removals from the model.

TABLE 9

Variables Removed from Graduate Earnings Model During Stepwise Process

VARIABLE REMOVED	AIC (VARIABLE)	AIC (MODEL)
AUXILIARY SERVICES WAGE SPENDING PER STUDENT	8112.578	8114.448
% FACULTY – ASSOCIATE PROFESSORS	8110.879	8112.578
ACADEMIC SUPPORT WAGE SPENDING PER STUDENT	8109.669	8110.879

Following the stepwise process, the model was evaluated for collinearity and significance and additional variables, listed in table 8, were removed to improve the overall performance of the model. In this instance, the variance inflation factor was sufficient in catching cases of multicollinearity, and no variables were removed for this reason aside from those that failed the VIF test.

TABLE 10

Additional Variables Removed from Graduate Earnings Model

VARIABLE REMOVED	REASON	JUSTIFICATION
% FACULTY –FULL-TIME	Collinearity	VIF = 23.286 > 9
% FACULTY– WITH TENURE	Collinearity	VIF = 17.340 > 9
% FACULTY – NO ACADEMIC RANK	Collinearity	CI = 53.394 > 30
% FACULTY – WITHOUT TENURE	Insignificance	p = 0.132 > 0.05
% FACULTY – ASSISTANT PROFESSOR	Insignificance	p = 0.163 > 0.05
% FACULTY – INSTRUCTORS	Insignificance	p = 0.160 > 0.05

Unlike any of the previous models, both the full-time and tenured variables were removed from the model. This lack of a significant relationship could potentially be linked back to the relationship between students and professors. Students often build relationships with their instructors that can often lead to connections with potential employers. Many part-time staff continue to work in industry while they teach, meaning that they are able to maintain a connection with those in their field and these current industry connections could lead to fruitful connections between students and employers negating some of the benefits of full-time faculty.

The variables for the graduate earnings model are summarized in table 11.

TABLE 11

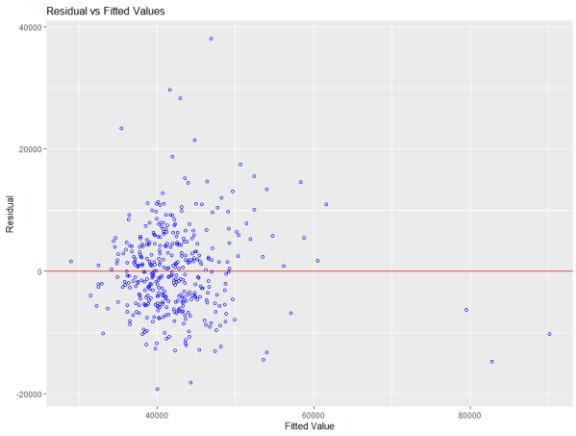
Graduate Earnings Model Independent Variables

	ESTIMATE	STD.ERROR	P.VALUE
(INTERCEPT)	32504.12	925.2541	7.13E-123
INSTRUCTIONAL WAGE SPENDING PER STUDENT	1.226119	0.094427	2.73E-32
% FACULTY – TENURE TRACK	-8503	3337.899	0.011236
% FACULTY – PROFESSOR	18535.57	3925.721	3.27E-06
% FACULTY – LECTURER	22791.09	5047.684	8.39E-06

Figure 6 displays the model's residual plot. As with the other models, the plot exhibits characteristics of a null residual plot, which is desirable. This, coupled with the adjusted R^2 value, indicates a well-fit model, and thus it is safe to say that the model provides a good indication of the relationship between the independent and dependent variables.

FIGURE 6

Graduate Earnings Model's Plotted Residuals

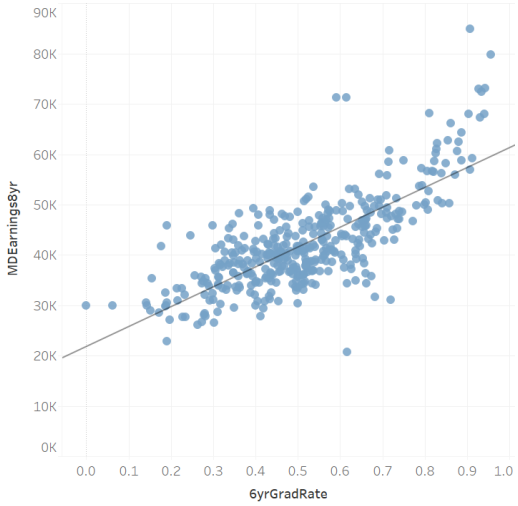


The graduate earnings model's performance, as previously mentioned, was considerably better than anticipated, and, like graduation, the strongest variables were instructional wages per student and the percentage of faculty holding the rank of professor. The similar performance and variable relationships exhibited by both the earnings and graduation models prompted an exploration of the relationship between the dependent variables. If there was a positive relationship between these outcomes it would indicate that the pursuit of one of these outcomes would, by consequence, lead to an increase in the other which turned out to be true as seen in Figure 7. This relationship is, of course, relatively intuitive, however it does provide institutions with the ability to pursue two benchmark figures

simultaneously without having to implement multiple complicated initiatives as the positive influence of one of the outcomes would have influence on the other.

FIGURE 7

Six-Year Graduation Rate and Graduate Earnings Eight Years after Entry



DISCUSSION & CONCLUSION

Discussion

The results from each of these models show that student first-year retention, graduation rates, and earnings eight years after program entry are significantly influenced by the level of experience held by and compensation of the institution's instructional staff. This study both confirms and expands upon some areas of previous work that examined these outcomes and that also seemingly implicated the importance of institutional characteristics, especially the characteristics of instructional staff, to institutional effectiveness at promoting positive student outcomes [1] [4] [6] [16]. Furthermore, it examined three separate outcomes as dependent variables rather than choosing only one, thus providing a clearer indication of how a more robust model can provide indicators of student success. This relationship can be used to help institutions reach their targeted benchmarks through human resource policies and improved hiring criteria.

The positive relationship between staff holding the rank of professor and retention indicated that first-year students are more satisfied with their academic environment when they are exposed to more experienced faculty. This claim is further supported by the apparent negative relationship with negative relationship with the proportion of associate professors, a rank that is commonly held by new or less experienced faculty. Furthermore, there was a negative relationship between non-tenured faculty and retention as seen in Table 5, this could also be used as justification to have a more experienced faculty, as

tenure status is typically acquired only after an instructor has been teaching for several years at the institution.

Faculty experience, therefore, should be a priority of an institution that wishes to maximize retention past the first year. This, coupled with the findings in the graduation model that seem to point towards full-time faculty having a more positive impact on graduation rates, lead to the implication that southern four-year institutions hoping to reduce student attrition should change direction and focus their efforts on trying to retain faculty. This is contrary to the current trend of some institutions that are beginning to fill their vacancies with part-time faculty. This move towards fewer permanent instructors could be due to the lower salaries commanded by adjuncts and part-time lecturers as well as the reduced spending on additional resources that are often not made available to temporary employees [25]. According to the findings of this study, this practice could be undermining attempts to increase retention and graduation rates, factors that play a significant role in the overall performance of institutions.

Regarding the influence of instructor compensation, the most significant and correlated variable across all models was instructional wage spending per student. This is in line with the findings of Syahreza et al who found that employee productivity is higher at firms where they are compensated higher [23]. The idea that compensation is an incentive for performance is not a new claim by any means, however in the scope of this study, the target of which was student outcomes, it shows that instructors are impacting students in a more meaningful and positive way through their interactions as a result of their higher compensation. While no literature could be found specifically examining wage spending per student at institutions, other research examining instructional expenditure has also revealed a relationship between spending and student outcomes, specifically graduation rates, which is significant as wage spending is typically the dominant segment of instructional expenditure [6]. The choice to use instructional wage spending per student over instructional spending per student was essential given that this study sought to examine faculty's influence on student outcomes and the instructional spending variable often includes additional expenses sometimes entirely unrelated to instructional staff such as academic building depreciation.

While institutions will most likely try to reduce expenditure in coming years due to the unfavorable macroeconomic circumstances the United States is currently facing, this study would suggest that in terms of allocating remaining funds to encourage desirable outcome metrics, instructor salaries need to be a higher priority. While the relationship between salary expenditure and graduate earnings may partially be influenced by the cost of living of the region in which the institution is located, the clear correlation between retention and graduation would not experience any interference because of this. In fact, with instructional wage spending being the only independent variable to make the final model for all three dependent variables, it appears that this is the single most influential instructional staff characteristic examined by this study that could be used to correct student outcomes that are falling short of benchmark figures.

As stated above, it is difficult to compare graduate earnings and instructional wage expenditure since they would both be influenced by the cost of living of the area in which the institution is located. However, the experience of faculty was also significant in the graduate earnings model, specifically the percentage of the faculty holding the rank of professor, which was also significant in the retention model. This would imply, once again, that the more experienced the staff, the more likely student success becomes.

Thus, this study confidently asserts that there is a clear positive relationship between the spending on instructional staff compensation and the degree of experience held by faculty members are essential determinants in student success. There is no doubting the fact that there are other influential characteristics of both institutions and students that will impact these outcomes. However, the relationships uncovered by this paper imply that by spending more on instructional wage expenses and by employing experienced faculty that show signs of being a long-term fit, schools will position themselves more efficiently to reach their targeted benchmarks.

Limitations and Areas for Future Study

This study examined the compensation of faculty by looking at institution-level expenditure on instructional wages per student. However, the argument could be made that cost-of-living in some locations may cause a degree of bias in some states. In future studies that plan to explore instructional staff compensation, there should be an attempt to adjust these figures according to the cost-of-living index for the state in which they operate. This may not be possible using expenditure values, however the existing data that looks at the average salaries of instructional staff often overlooks part-time instructors and in many cases, graduate-level instructor salaries cause these values to be inflated. In this study this was overcome by using institution wide expenditure per student which should help, to an extent, provide a more accurate depiction of how an institution compensates their instructors. This did not, however, help in solving issues related to cost-of-living.

Another limitation of this study was that the characteristics beyond those of instructional staff that influence student outcomes, which were not included in any of the models created. It is possible that other institutional characteristics could partially explain the variance of the dependent variables that was also explained in this study. To alleviate this, and to provide a better indication of the importance of the compensation and experience of instructional staff, multiple other models could be created and compared utilizing a method such as AIC to find which is the "best" subset of institutional characteristics.

In addition to the implementation of the above improvements, researchers could examine how instructional staff experience prior to entering academia affects their effectiveness at promoting positive student outcomes. Other studies could examine instructional staff at the institution-level and see if there is a relationship between different characteristics. A final recommended course of study could examine instructional staff in different fields to see if faculty differences exist at the major level, as this could provide more specific hiring criteria depending on the department in which the instructor will be teaching.

Conclusion

This study demonstrates the importance of instructional staff and how their experience and level of compensation influence positive student outcomes. Fortunately, these characteristics can be altered by the institution through the implementation of effective human resource policies, thus creating a faculty body that is more effective. The strategic initiative implied here can be summarized as a "quality over quantity" approach, meaning institutions should focus their efforts on retaining faculty so that they can eventually achieve tenure status. Additionally, institutions should be adequately compensating faculty for their efforts, even at the cost of having fewer instructors overall, as the models created for all three outcome measures showed that instructional wage spending per student was by far the most significant indicator of success. According to the findings of this study, an institution that follows this approach may reach benchmark standards for student outcomes more consistently than those who are relying on solely on adjunct and other part-time instructional staff or are paying their instructional staff at a below average rate.

APPENDIX I

Summary List of Data Aggregations

TOTAL SPENT ON INSTRUCTIONAL WAGES PER STUDENT	The total amount that was spent on instructional wages reported by IPEDS divided by the institution's total enrollment.
TOTAL SPENT ON ACADEMIC SUPPORT WAGES PER STUDENT	The total amount that was spent on academic support wages reported by IPEDS divided by the institution's total enrollment.
TOTAL SPENT ON STUDENT SERVICES AND AUX. SERVICES PER STUDENT	The total amount that was spent on student services and auxiliary support wages reported by IPEDS divided by the institution's total enrollment.
INSTRUCTIONAL STAFF PER UNDERGRAD	Total number of instructional staff (IPEDS) divided by number of undergraduate students.
% FULL-TIME FACULTY	Number of full-time instructional staff divided by total instructional staff.
% FULL-TIME TENURED FACULTY	Number of tenured full-time faculty divided by total instructional staff.
% FULL-TIME TENURE-TRACKED FACULTY	Number of tenure-tracked full-time faculty divided by total instructional staff.
% FULL-TIME NON-TENURED FACULTY	Number of non-tenured full-time faculty divided by total instructional staff.
% FACULTY - PROFESSOR	Number of professor-ranked faculty divided by total instructional staff

% FACULTY - ASSOCIATE PROFESSOR	Number of associate professor-ranked faculty divided by total instructional staff
% FACULTY - ASSISTANT PROFESSOR	Number of assistant professor-ranked faculty divided by total instructional staff
% FACULTY - INSTRUCTOR	Number of instructor-ranked faculty divided by total instructional staff
% FACULTY - LECTURER	Number of lecturer-ranked faculty divided by total instructional staff
% FACULTY - NO ACADEMIC RANK	Number of faculty without an academic rank divided by total instructional staff

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IMPROVING DATA INTEGRITY FOR LONG-TERM RESEARCH REPRODUCTION

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ABSTRACT

Long-term data archives are used in disaster recovery systems to mitigate information loss risks in information systems. In long-term archival, it is common to provide byte-level data integrity checking to detect data corruption. We introduce high-level data integrity tracking for context provenance, meaning metadata that tracks information about the usage processes as well as authorship and other metadata. Related literature in design science is reviewed to survey systems and frameworks that provide different levels of data integrity. We find that the lack of high-level data integrity provision is a gap that our research begins to address. We propose a design called FASTINT that adds semantic and contextual metadata processing using natural language processing artificial intelligence to provide this high-level data integrity tracking and demonstrate a use case in bioinformatics. The FASTINT design also addresses byte-level data integrity. By providing this model that integrates data validation at the byte-level with the higher-level metadata, we can work toward achieving an end-to-end data integrity system that provides greater confidence in data integrity at all levels of data management – from byte-level to application-level, we will provide a model that gives us integrity of the applications, algorithms and context of our data.

INTRODUCTION

Scientific data integrity in long-term storage archives requires methods to provide data integrity. Data integrity often means providing provable output that data has not been altered from its original form. While data integrity auditing provides evidence of corruption, the ability to repair data corruption within an archive is not often provided. File systems often provide advanced features for repair of sectors and blocks. For example, "ZFS provides automatic repairs in mirrored configurations and provides a disk scrubbing facility to detect latent sector errors" [14]. Low-level data integrity such as that for file systems is only part of the picture. In long-term archiving of scientific data we wish to also to capture the provenance of data context. This means we need the processes, software, algorithms, documentation, and other metadata related to the scientific data structured with the data archive itself. The overall goal of our proposal is to improve the ability for scientists and other data consumers to retrieve value from data stored in long-term archives by providing a long-term contextual framework for the data and the research it represents. Providing data integrity will allow future scientists to replicate the results of studies and to re-use data collected now for studies decades or centuries in the future. This research proposes a software system design into which scientific data and related information common to all scientific data entered will be stored. This design will provide and preserve artifacts that describe the identification, context, analysis procedures and software related to the original data. Using the model developed, we will next develop an artifact that uses Artificial Intelligence (AI) methods to investigate research questions. This AI approach allows us to investigate detailed research questions detailed in our

investigations and provide an artifact that extends the state of the art in contextual integrity in data provenance.

Data Integrity Types

Data integrity is any set of algorithms and tools used to maintain the consistency and accuracy of data. It is important to note that data integrity does not refer to data quality or data validation for the purposes and context of this paper. Data corruption can be viewed as an antonym for data integrity. For our purposes data integrity also encompasses the repair of corrupted data. We agree with Imran who says, "data integrity can be briefly defined as a specific state of the data which is expected by a consumer" [7]. To provide data integrity, checksum and error correction codes are used in transmission and storage of data. To provide data integrity of underlying storage systems, many approaches are used such as RAID technologies. Before continuing the discussion of integrity, it is important that we define some terms as we discuss them further in this work, summarized below. Firstly, the term Semantic Integrity has a similar definition to that used in Spatial Information Science related to structured data in engineering and computer aided design models [2][9]. Secondly, Semantic Integrity also includes the definition used in Artificial Intelligence research, where natural language processing is performed to analyze semantic relationships in unstructured data [15]. Lastly, we wish to extend those definitions of Semantic Integrity to include additional terms called Contextual Provenance and Provenance Metadata in Table 1.

Term	Definition
Semantic Integrity [2][9]	The level to which data's semantic meaning is preserved by the metadata describing the data. This value subjective and we propose a real-number scoring from 0 to 1, where the extrema are only hypothetically possible: 0 means 'no meaning' and 1 means 'full meaning'.
Contextual Provenance	The level to which data's Semantic Integrity includes metadata about the data's provenance. We propose a real-number scale from 0 to 1 where 0 represents no contextual provenance information is present or detected, and 1 where full provenance information is present or found.
Provenance Metadata	This metadata includes, but is not limited to, fields that track the origin, date, ownership, and linkage to other data or metadata within or outside the dataset where the metadata resides.

Table 1 - Definition of Terms

STATE OF THE ART

We surveyed a list of technologies that provide low-level or high-level data integrity. The benefits and limitations of these technologies to the current state of the art are summarized in Table 2.

Model	Benefits	Limitations
LOCKSS [10]	Distributed storage, self-auditing and self-repairing.	Limited data types; focused on scholarly publications and web-harvesting such data.
ERDC-SR ([3], 2017)	Defends against repair on the fly attacks in cloud storage replication.	Does not detect corruption. Does not scale to billions of files or PB of data; designed for replication of small (GB) data sizes in S3 cloud storage.
EDC-PDP ([4], 2009)	Stores unique and incomparable replicas of data across network nodes.	Does not provide repair capability for parts of files. Does not audit files for corruption.
HAIL [1]	Uses principles of RAID to distribute and repair data blocks. Uses advanced MAC for ECC in auditing.	Limited to static files; handles updates to files poorly. Files only repaired based on node loss, not local corruption.
OPM [13]	Provides context auditing using Open Provenance Model (OPM), an implementation of OWL RDF.	Does not provide direct data integrity integration with underlying data. Much work to be done here in integrating model with other data integrity components.
RAID [11]	Physical data integrity, protects against disk failure.	Only protects against a local and limited number of simultaneous disk failures. If more than the limit of disks fails, then data corruption occurs.
RAIT - Redundant Array of Independent Tapes [8]	Physical data integrity, protects against tape failure.	Only protects against limited number of tape failures. If more than the limit of disks fails, then data corruption occurs.
ZFS [14]	Triple redundant file metadata and copy on write built into file system.	Does not provide provenance or structured metadata.
Duraspace DSpace [5]	Provides data management, metadata, and provenance.	No auditing or replication of content, integrity separate from management.
iRODS [12]	Provides checksumming, replication, provenance, storage tiering, ingest automation, live auditing, compliance.	Lacks archival auditing and storage-native recovery.
HDF5 Hierarchical Data Format [6]	Provides internal contextual data structures, extensible data typing, tools for manipulation.	Lacks archival auditing, lacks contextual auditing and reporting. Contextual provenance is not emphasized.

Table 2 – State-of-the-Art Technology Benefits and Limitations

MOTIVATING ISSUES – LITERATURE REVIEW

While the state-of-the-art technologies we've reviewed offer different types of data integrity, they do not offer an extensive set of capabilities to show the context of scientific research, algorithms for analysis, or sample results of analyses. Among the issues that data scientists, and scientists in general, confront with data integrity are lack of provenance, version control, descriptive metadata, and search-ability in systems that otherwise provide those features. These issues result in the end-users of data being unable to utilize data that is archived over long periods of time in simple systems such as flat file systems like ZFS or RAID type systems. Conversely, software that provides search, auditing of activities and changes to data and version control, do not provide high-integrity subsystems that audit, archive, and repair. Many pieces of software such as data and document management systems have capabilities to provide provenance and metadata. However, these systems do not provide end-to-end data integrity solutions for long-term storage, or archive, nor do they typically include auditing and error correction.

For example, data management systems such as DSpace and iRODS provide provenance, action auditing, and compliance capabilities, as well as full-text indexing and search, but do not provide recovery and data auditing, especially at the storage system level [12]. Regarding other technologies researched, for example OPM and HAIL, data integrity is provided across networks and other subsystem components – storage arrays, disks, file systems – and recovery is provided in some cases, but higher-level data integrity features such as metadata and searchability are missing. Therefore, we see few places where the high-level data integrity systems that provide auditing and provenance also provide subsystem data integrity as one system. This lack of end-to-end integrity represents a gap in capabilities that could be combined to create an optimal system. Data integrity validation and repair capabilities provided by some lower-level systems are not integrated or reported to higher-level systems like iRODS. This gap means that the onus of data integrity is not borne by the data science application alone, and disparate groups must ensure that data integrity is provided at both high and low levels.

RESEARCH QUESTIONS

In the realm of bioinformatics, I will be looking at FASTA files that contain both metadata and data taken from experimental runs in a laboratory. The metadata includes names of organisms or proteins, for example, and these relate to the data in the files. I'm interested to know if we can develop a semantic similarity detection system that will allow us to parse FASTA files and create an ontology map. This map could help researchers unfamiliar with the particular data set at hand with determining what to do with the data and how it was originally gathered. Combining the research gaps and the goals above in the instance of using FASTA bioinformatics files, I have developed the following research questions. Firstly, how can we develop a semantic similarity detection system for FASTA files to extend data integrity to include contextual semantics of the data and its metadata? Secondly, how can we use ontology mapping to improve contextual data integrity? Thirdly, how can we develop a data format ontology for FASTA files that produces ontologies that indicate relationships between elements of unknown data? Lastly, how can we

evaluate the methods used to create semantic detection system outputs? Based on the gaps described earlier, we map these research questions to each gap and provide goals to address the gap with each research question, in Table 3.

Question	Gap	Goal to Address this Gap
How can we develop a semantic similarity detection system for FASTA files to extend data integrity to include contextual semantics of the data and its metadata?	Data semantic meanings are lost in provenance tracking systems. With unknown data, we cannot deduce or induce easily the contextual or semantic meanings.	Develop NLP (Natural Language Processing) model and instantiate this model to demonstrate the detection and identification of semantic context from unknown data.
How can we use ontology mapping to improve contextual data integrity?	The links between metadata concepts are disjointed and dispersed throughout metadata. It is difficult to identify the components of unknown data that are interrelated without precise definitions of what the data is meant for.	Develop model that includes parts of speech processing that assists in mapping a known set of ontologies – or parts of speech – to correlate different data elements from unknown data.
How can we develop a data format ontology for FASTA files that produces ontologies that indicate relationships between elements of unknown data?	An ontology that describes the interrelated contexts of FASTA data does not exist a priori. Metadata in FASTA files does not directly link the relationship between data elements.	Develop a method to generate ontologies that describe unknown data's metadata in terms of its context. This will involve NLP approach to detecting ontologies from parts of speech.
How can we evaluate the methods used to create semantic detection system outputs?	We do not have a known set of data provenance or correlation contexts defining how data is interrelated.	Develop a method of evaluating the manual review of data against artificial intelligence approaches.

Table 3 – Research Questions

CONTRIBUTIONS AND CONCLUSIONS

In this paper we discuss concepts of semantic data integrity, review the state of the art of systems that provide semantic data integrity to differing levels, and propose research questions into gaps found in the current state of the art. Our goal is to fill the gap where systems like iRODS, LOCKSS, HAIL and HDF5 do not provide service-context and application-context capabilities in the archive and auditing processes. We will extend this research to create a model and create an instantiation of that model using a software artifact, evaluate and validate the model, and test the model's ability to assist in providing semantic integrity.

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ONLINE ARIMA WITH FORGETTING FACTORS FOR TIME SERIES PREDICTION

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ABSTRACT

ARIMA is one of the most popular and fundamental models in time series data analysis and prediction. Simple and flexible, it also supports online model updates for streaming data. However, these online ARIMA models still face some challenges such as stable parameter estimation and regret bound analysis. Thus, in this paper, we improve online ARIMA models by applying the concept of forgetting factors. By combining the two, we propose online ARIMA with forgetting factors which has the ability to assign recent data points more weight compared to data points of the past. We demonstrate our algorithm's performance with promising test results in various, synthetic and real-life, experiments.

INTRODUCTION

Time series is a collection of observations taken sequentially in time, often at equally spaced time points[6]. This includes data such as temperatures and stock prices, to name a few. These kinds of data can be easily found in our everyday lives, and a great number of research on time series models for predicting future data points have been proposed and investigated for the past several decades[11]. In short, one of the major goals of time series models is to discover the underlying relationship in the data and use this relationship to make future predictions.

Starting from classical autoregressive model(AR) and moving average model(MA)[6], such models include ARFIMA(autoregressive fractional integrated moving average), ARCH(autoregressive conditional heteroskedasticity), Kalman filters, NARX(nonlinear autoregressive exogenous model), Prophet, RNN(recurrent neural network), LSTM(long short-term memory), and so on. One noticeable, simple but effective, model is the autoregressive moving average model(ARMA) which is a combination of AR and MA[6]. ARMA can discover hidden properties in the time series data with satisfactory accuracy due to its flexible capabilities and has been used widely since[6].

ARMA, however, has several constraints: major one is that the time series must be stationary[10]. This does not apply to most real-life time series data today. To solve this, autoregressive integrated moving average(ARIMA) has been proposed. ARIMA can deal with nonstationary time series by differencing the data, making it stationary. While ARIMA has proved to be very flexible and also became a fundamental model in time series analysis, it still has some major setbacks. Some of these setbacks are that parameter estimation of ARIMA may be computationally expensive, it may suffer poor performance if the timespan of the data is too long, and that it cannot account for multiple seasonality among several

others[10]. It also relies on strong assumptions with the constant noise terms and loss functions. However, this is not applicable in many real-life data since the data-generating conditions often vary according to time or in a sudden manner, and thus recent observations may require more attention than long-past ones[2,4]. In addition, when ARIMA uses a batch method algorithm such as least-squares to estimate its parameters, it requires access to the entire dataset in advance to build the model and make predictions. This makes such ARIMA methods unviable for online learning of new streaming data inputs.

To solve these issues, online ARIMA has been proposed in the literature[10]. Basically, online ARIMA estimates the parameters using a recursive formulation as in recursive least squares, mostly by either online gradient decent or online Newton's updates, to fit an online learning setting[14]. It receives data observations and updates the parameters simultaneously, making it much more suitable for modern, real-time, time series analyses. It also uses an improper learning principle due to the nature of unpredictable noise[14]. Indeed, the use of forgetting factors, enabling the observations' contribution to the model to gradually decay according to time, appears mainly in the recursive least squares (RLS) filter. With forgetting factors, one can assign larger weights to recent data points, giving them more influence in the model updates[15]. While the least squares method requires all of the data points to make an estimation, the RLS method starts with only a portion of initial data and can update its parameters simultaneously as new data points are received. Showing extremely fast convergence[15], RLS with forgetting factors makes possible real-time parameter estimation with more weights on recent observations than past ones, which is a major advantage especially in the presence of the recently ever-growing amount of data. In fact, the idea of assigning different weights according to time is universal in not only simple models such as exponential smoothing but also complex ones such as RNN, LSTM, and their variants. To the best of our knowledge, no online ARIMA model equipped with a forgetting factor has been proposed in terms of its theoretical attributes and empirical performance. By applying this idea to online ARIMA, we aim to emphasize recent data and lead to better estimation and prediction in the model.

Our Contribution

While existing ARIMA updates using online Newton's steps and online gradient descent theoretically showed convergence and optimal performance and empirically demonstrated satisfactory results, contributing to time series prediction, they fail to reflect time-varying weights for data points, meaning they simply assigned identical weights for all data[7,15]. This is often not the case in real-life data where recent data points have more influence on the current value than data points from the past and may arise from a different condition. To solve this problem, we propose a discounted online ARIMA algorithm, or online ARIMA with forgetting factors, enabling reflection of dynamic situations. We start from recursive least squares algorithms equipped with forgetting factors for ARIMA models to give recent data points more weight compared to older data points and link it with online Newton's steps. We induce its theoretical performance in terms of a regret upper bound. We denote the forgetting factor as λ, with $0 < \lambda \leq 1$. If λ is 1 then all data points have equal weights, and as λ gets smaller the recent points are given more weight. Empirically, many studies use a value between 0.9 to 0.98 for λ. With this factor, our algorithm focuses more on the

recent points when estimating parameters in an online fashion and thus leads to more accurate estimations and predictions.

LITERATURE REVIEW

In a classical time series analysis, in which squared loss and noise, i.i.d normally distributed, were assumed, statistical methods such as least squares or Box-Jenkins[13] have been adopted. Later, with other assumptions such as t-distribution of noise have brought forth much various time series models, such as autoregressive conditional heteroskedasticity(ARCH) and general ARCH(GARCH). ARCH can eliminate the assumption of independence between noise, offering a broader range of modeling. Recently, numerous advanced time series analyses are in practical usage with machine learning and deep learning artificial neural networks such as XGBoost (eXtreme Gradient Boosting)[4], recurrent neural networks[13], GRU[5] and LSTM[8].

In fact, few researches were made in online time-series learning in the research society. In the research on online ARMA models[1], the authors laid the foundation for online ARIMA with its online approach and novel regret bound of $O(q(\log(T)^2)$. Later new research[12] focused on online ARIMA algorithms for prediction, allowing non-stationary datasets as input and removing more assumptions regarding the model parameters. It also proved a lower regret bound of $O(\log(Tq)\log(T))$ than its previous algorithm. Moreover, the online Newton algorithm in the research[3] showed better results than online gradient descent. Other studies[17] incorporated the concept of forgetting factors in their online Newton steps and conducted experiments in several time-series scenarios.

Furthermore, recursive least squares coupled with forgetting factors is also investigated in various situations in the literature. The authors[9] extensively verified RLS, considering signals deterministic rather than stochastic like the least mean squares(LMS) filter does. Some work[2] used RLS with forgetting factors to increase the weight of recent data points. In addition, the coupled method has been utilized in various applications such as prediction of vehicle mass and road grade[16] and system leakage identification[6]. Hence in this study, linking online learning algorithm, that is induced by RLS, with forgetting factors, we propose a discounted online ARIMA algorithm with forgetting factors for better model estimation and data prediction in time series.

PRELIMINARY

ARIMA Model

We denote a time-series measurement as X_t at a discrete time t. Also, ε_t stands for the random zero-mean noise term at time t. The ARMA(k, q) model as a combination of moving average and autoregressive assumes that X_t is generated with the following:

$$X_t = \sum_{i=1}^{q} \beta_i \varepsilon_{t-i} + \sum_{i=1}^{k} \alpha_i X_{t-i} + \varepsilon_t, \quad (1)$$

where β_i is a moving-average coefficient, q is the moving-average order, α_i is a autoregressive coefficient, k is the autoregressive order, and ε_t is a white noise with mean zero and constant variability. To deal with nonstationarity, the auto regressive integrated moving average(ARIMA) model was proposed for nonstationary situations. ARIMA(k, d, q) generates X_t with the following:

$$\nabla^d X_t = \sum_{i=1}^{q} \beta_i \varepsilon_{t-i} + \sum_{i=1}^{k} \alpha_i \nabla^d X_{t-i} + \varepsilon_t, \quad (2)$$

where ∇^d is $(1-L)^d$ for lag operator L. Forecasting the original data points X_t with ARIMA(k, d, q) is a reversion of the differential process and uses the following formula to predict $\tilde{X}_t$ with its past observations $X_{t-i}, i > 0$:

$$\tilde{X}_t = \nabla^d \tilde{X}_t + \sum_{i=0}^{d-1} \nabla^i \tilde{X}_{t-1}. \quad (3)$$

Regret in Online Algorithms

In online learning algorithms, one compares the best possible decision from an entire data with sequential best decisions from incoming data. This difference is the 'regret' bound. In ARIMA models, a decision-maker tries to predict values made from an adversarial ARIMA(k, d, q) model where its coefficient vectors, $\theta = [\alpha, \beta]$, are not disclosed for given d at any time to the decision-maker. For a loss $\ell_t(X_t, \tilde{X}_t)$ caused by prediction $\tilde{X}_t$ for true value X_t, the regret can be defined as

$$R_t = \sum_{t=1}^{T} \ell_t(X_t, \tilde{X}_t) - \min_{\alpha,\beta} \sum_{t=1}^{T} \ell_t(X_t, \tilde{X}_t(\theta)). \quad (4)$$

Sublinear online algorithm has its regret growing sublinearly, $R_T \leq o(T)$. It means that per-round regret will disappear as T infinitely increases[17].

Two online learning algorithms, online gradient descent[3] and online Newton steps[3,18], have been introduced. Online gradient descent is one of the most general settings of convex optimization. In each iteration the algorithms take a constant step to the gradient of the previous cost. Regret bounds of online gradient descent also show sublinear growth under mild conditions. Online Newton steps originated from the Newton-Raphson method choose a direction resulted from the inverse Hessian and the gradient. In this study we focus on online Newton steps for better performance in the following theories and experiments.

THEORETICAL DEVELOPMENT

We adopt ARIMA(k, d, q) models for general non-stationary processes. Data at time stamp t, X_t, from the ARIMA model are generated by

$$\nabla^d X_t = \sum_{i=1}^{q} \beta_i \varepsilon_{t-i} + \sum_{i=1}^{k} \alpha_i \nabla^d X_{t-i} + \varepsilon_t, \quad (5)$$

where ∇^d is $(1-L)^d$ for lag operator L. Then, the prediction for the t-th time stamp is given by

$$\tilde{X}_t = \nabla^d \tilde{X}_t + \sum_{i=0}^{d-1} \nabla^i X_{t-1}, \quad (6)$$

once one builds a prediction model, $\nabla^d \tilde{X}_t$, using past observations, $X_{t-i}, i > 0$. In the ARIMA(k, d, q) model, $\nabla^d \tilde{X}_t$ is obtained by ARIMA$(k, 0, q)$ using a sequence observations of $\nabla^d X_t$. We follow a typical online learning framework to update the model, in which a data engineer sequentially updates previous model parameters (now $\beta_i's$ and $\alpha_i's$) incorporating the incoming data and the updating action suffers from a loss since he or she could have built a better model using the entire data observations if a substantial amount of training time and capability had been available. The loss concept relates to a 'regret' value, denoted by R_T up to updating-action round T, for a certain online algorithm. We aim to propose an online learning algorithm of which regret grows sublinearly, $R_T \leq o(T)$, in this paper.

In specific, we propose the use of a discounted ARIMA(k, d, q) model to reflect the importance of recent observations compared to much outdated observations.
For that purpose, we first approximate the original ARIMA(k, d, q) model to ARIMA($k + m$, d, 0) model so that the size of the unknown-parameter space, θ, is $k + m$ for given difference order d. We justify the approximation by choosing a proper $k + m$ so that the loss values from the two models are sufficiently close. We will mention how to set $k + m$ from both theoretical and practical viewpoints.
We define the loss to be $f_t(\theta) = \frac{1}{2}(X_t - \hat{X}_t(\theta))^2$, where $\hat{X}_t(\theta)$ is a prediction from a model with parameter θ. If we consider a vector of measurements in the model, $f_t(\theta) = \frac{1}{2}\|\boldsymbol{X}_{k+m:t} - A_t\theta\|^2$, where $\boldsymbol{X}_{a:b} = [X_a\ X_{a+1} \cdots X_b]^T$ and A_t is the design data matrix of size $t - (k + m)$ times $k + m$ excluding constants, basically stacking up observations from time $k + m$ to t. Notice that we exclude initial boundary observations from time 1 to $k + m$ in the construction of A_t. Alternatively, stacking up stacking up recent h measurements, one may change $\boldsymbol{X}_{k+m:t}$ to $\boldsymbol{X}_{t-h:t}$ and previous A_t to A_t of size h times $k + m$ accordingly in $f_t(\theta)$.
Then, the proposed discounted ARIMA model is seen as a classical recursive least squares with a forgetting factor. The predictions can be solved by

$$\theta_{t+1} = \ arg\min_{\theta} \frac{1}{2}\sum_{i=1}^{t} \lambda^{i-1}(X_{t+1-i} - \hat{X}_{t+1-i}(\theta))^2 \quad (7)$$

$$= \frac{\lambda-\lambda^t}{1-\lambda^t}\theta_t + \frac{1-\lambda}{1-\lambda^t}X_t = \theta_t - \frac{1-\lambda}{1-\lambda^t}\nabla f_t(\theta_t), \quad (8)$$

where $\hat{X}_t(\theta)$ is

$$\hat{X}_t(\theta^t) = \sum_{i=1}^{k+m} \beta_i \nabla^d X_{t-i} + \sum_{i=0}^{d-1} \nabla^i X_{t-1}\,, \quad (9)$$

and model parameter $\theta = [\beta_1 \cdots \beta_{m+k}]$, meaning we use ARIMA($k + m$, 0,0) model for the $\nabla^d X_t$ sequence after the approximation. The result formula (8) is a form of online Newton step algorithm with learning rate $\frac{1-\lambda}{1-\lambda^t}$. The discounting parameter, λ, is the forgetting factor. It is a heuristic approach to forget older data and give more emphasis to recent data[17]. This came from the idea that recent data points will have more effect on the current data value. The closer λ is to 0, the weights between the recent inputs and older inputs will differ more.
Thus, we propose the following online Newton algorithm for ARIMA with a forgetting factor as follows:

Algorithm 1 ARIMA-ONS(k, d, q) with forgetting factors

Input : parameter k, d, q; forgetting factor λ.
Set m theoretically or sufficiently large.
Initialize $P_0 = I \in R^{(m+p)\times(m+p)}$
For t=1 **to** T-1 **do**
predict $\hat{X}_t(\theta^t) = \sum_{i=1}^{k+m} \beta_i \nabla^d X_{t-i} + \sum_{i=0}^{d-1} \nabla^i X_{t-1}$
observe X_t and incur loss, and set $\nabla_t = A_t^{\mathrm{T}}(\boldsymbol{X}_{t-1:t} - A_t\theta)$
Update $P_t \leftarrow \lambda P_{t-1} + \nabla_t \nabla_t^{\mathrm{T}}$
Set $\theta_{t+1} \leftarrow \Pi_{R^{(m+p)}}^{A_t}(\theta_t - \frac{1-\lambda}{1-\lambda^t} P_t^{-1}\nabla_t)$
end for

In the algorithm, we use the projection operator, $\Pi_S^{A_t}(y) = \arg\min_{z \in S} \|z - y\|_{A_t}^2$. To set m, one may use a theoretical formula give by $m = log_{1-\varepsilon}((TLM_{max}q)^{-1})$. Here, L is some Lipshitz constant for the loss function where $L > 0$, T and q are parameters from the model, and $\mathbb{E}[|\epsilon_t|] < M_{max} < \infty$. The setting of m is based on the previous research [1], and we plan to yield a better, tight and efficient, setting of m in our future research. Or one can set it empirically, sufficiently large. In this paper, we conjecture that the regret bound grows sublinearly, $R_T \leq o(T)$ under mild conditions. We envision its theoretical attributes in future works. Next, we observe the performance of the proposed model in the following section.

RESULTS

Figure 1(a). Sanity Check

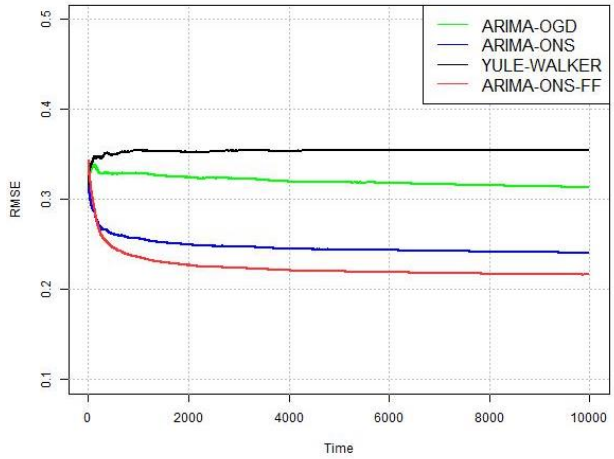

Figure 1(b). Abrupt change of α and β

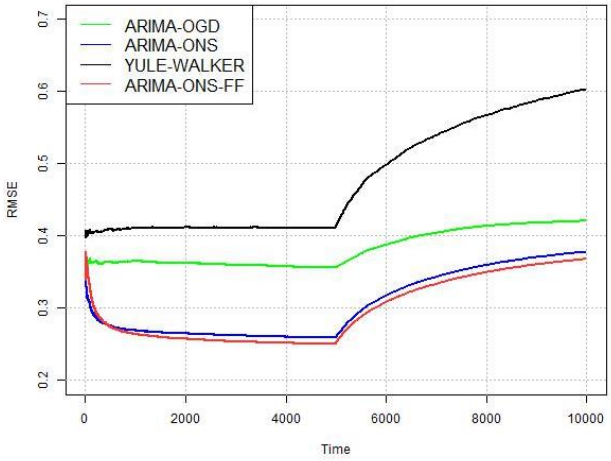

Figure 1(c). Two abrupt changes of α and β

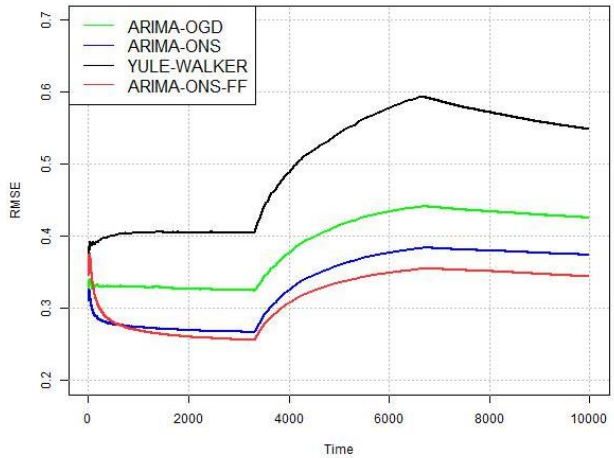

Figure 1(d). Steady change of α and β

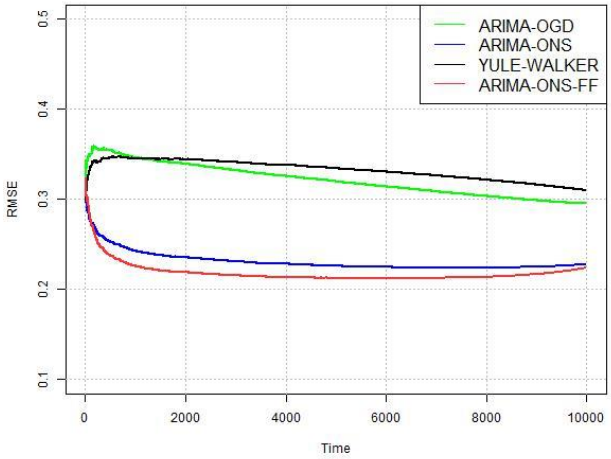

Figure 1(e). Basic test with $d = 1$

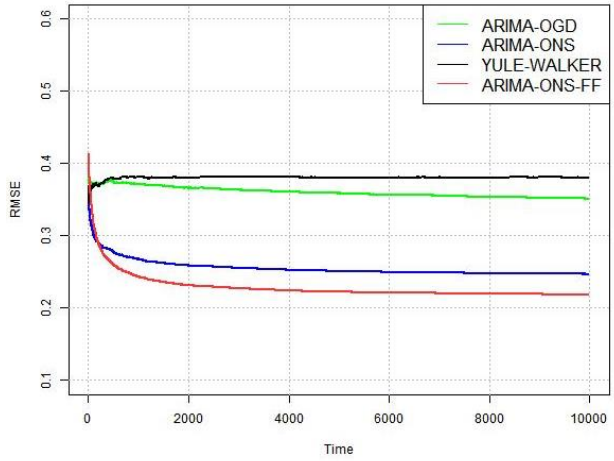

Figure 1(f). Abrupt change of d

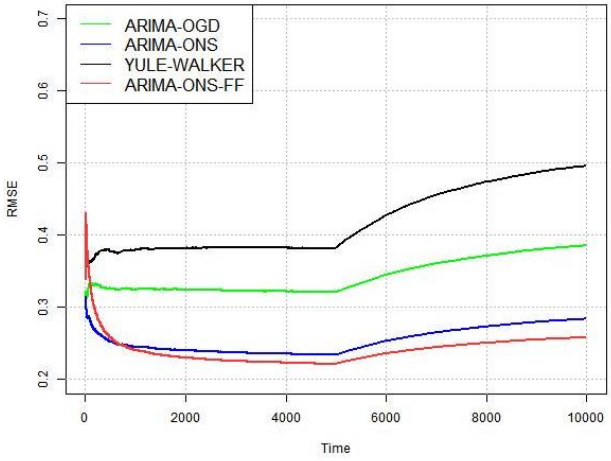

Figure 1(g). SK Telecom stock volumes

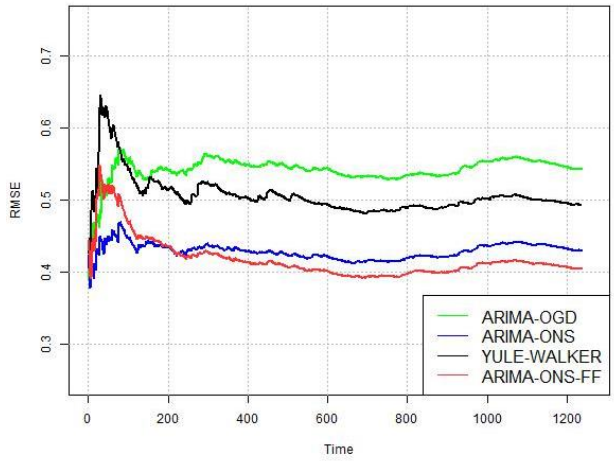

Figure 1(h). Weather wind speed

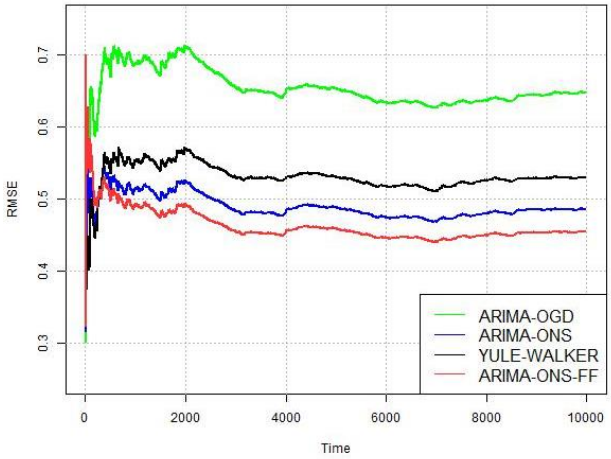

Figure 1. Test results in various settings with $k + m = 10$ run 20 times and averaged

We denote the proposed model as ARIMA-ONS-FF. To empirically prove the effectiveness and robustness of our new ARIMA-ONS-FF model, we present the following experiments. We tested it in comparison with 3 other algorithms in 8 different settings. The compared algorithms include online Newton step, online gradient descent, and the Yule-Walker method[8]. The traditional Yule-Walker method is a batch learning method, meaning it utilizes all data points up to the current time to make the next single prediction. As it takes much more time than its online counterparts, it will serve as a baseline model in this study. 6 of the 8 settings use generated artificial ARIMA time series data with various situations, and the last two use real-life stock volume data.

We set $k + m = 10$ for all test cases like most of the research done before[1,12] shown in Figure 1. In addition, we set the θ for ARIMA-ONS-FF to $\theta = 0.9$ where $\lambda = 1 - n^{-\theta}$ with n being current time. This means greater weights are assigned to recent observations than the past. For each of the test settings, we repeated 20 times computing RMSE(Root Mean Squared Error) to verify robustness. The formula for RMSE values is

$$RMSE = \sqrt{\sum_{i=1}^{T} \frac{(\hat{X}_i - X_i)^2}{T}}, \tag{10}$$

where $\hat{X}_i$ is the predicted value and X_i is the real value. Since we are dealing with online streaming data, the squared error value is continually stacked and this stacked value is divided by the current time point n. The root of this divided value is then shown in the results plot at all time points. For the synthetic data settings, we created 10,000 data points and recreated it every 20 times to counteract issues regarding randomness. For the 'real-life data' settings, we ran all 4 algorithms 20 times and averaged the results.
The x-axis represents the number of data points, or time. The y-axis represents the averaged RMSE value. Legends stand as following. "ARIMA-OGD" for online gradient descent, "ARIMA-ONS" for online Newton step, "YULE-WALKER" for the Yule-Walker method, and "ARIMA-ONS-FF" for our new proposed online Newton step with forgetting factor. Each algorithm has been designated a distinct color, and our proposed method is the red line for easy recognition. The results are shown in the Figure 1. We also added test results with $k + m = 8$ shown in Figure 2 and $k + m = 12$ in Figure 3 below for more reliability with the exact same settings with experiments using $k + m = 10$.

Setting 1.
We first test our algorithm on a simple sanity check. The data generated here is a simple stationary ARIMA based time series data with $\alpha = [0.6, -0.5, 0.4, -0.4, 0.4]$ and $\beta = [0.3, -0.2]$. Noise values are randomly distributed according to the Gaussian distribution with $\mathcal{N}(0, 0.2^2)$.
We can see in the test results that our ARIMA-ONS-FF shows the quickest convergence and minimal amount of RMSE in the convergence amount. This shows our algorithm estimates the model parameters better than the other three in a simple stationary time series data.

Setting 2.
Next, we make our dataset nonstationary by changing the α and β abruptly at the halfway point. We generated the first half the dataset with $\alpha = [0.6, -0.5, 0.4, -0.4, 0.3]$ and $\beta = [0.3, -0.2]$ and the later half with $\alpha = [-0.4, -0.5, 0.4, 0.4, 0.1]$ and $\beta = [-0.3, 0.2]$ as parameters for the ARIMA model. This setting was made to test how quickly each algorithm can adapt to the newly changed parameters, thus testing how flexible it is in real life abrupt changes.
As seen in the results, our algorithm shows the best convergence both before and after the abrupt changing point. This shows that our method is more flexible than the others in situations of drastic change. We also noticed that the result values showed similar trends to the Yule-walker method results near the end of the data.

Setting 3.
This time instead of changing it once in the halfway point, we changed the parameters two times. The two changing points were at the one third and two third point. For the first part the parameters are $\alpha = [0.6, -0.5, 0.4, -0.4, 0.3]$ and $\beta = [0.3, -0.2]$, for the second $\boldsymbol{\alpha} = [-0.4, -0.5, 0.4, 0.4, 0.1]$ and $\beta = [-0.3, 0.2]$, and the final part $\alpha = [0.6, -0.5, 0.4, -0.4, 0.3]$ and $\beta = [0.3, -0.2]$. One thing to notice is that the parameters are the same for the first part and third part. This assumes situations where the time series data underwent an abrupt but temporary change and later returned to its former state.

Results show best convergence from our method. It adapted the fastest to the first abrupt change and returned the fastest after the second abrupt change. We also notice that near the end of the data the RMSE values seem to converge to similar values to setting 1. This shows that each algorithm is estimating the parameters well even with abrupt changes in the past.

Setting 4.
For the final synthetic-data setting with constant d value, we changed the parameter α gradually (instead of abruptly) while leaving β untouched. Starting with $\alpha = [0.6, -0.5, 0.4, -0.4, 0.3]$ and $\beta = [0.3, -0.2]$ we gradually changed these parameters on a linear fashion such that the final parameter $\alpha = [-0.4, -0.5, 0.4, 0.4, 0.1]$ and $\beta = [0.3, -0.2]$. In other words, for time t $\alpha_t = [-0.4, -0.5, 0.4, 0.4, 0.1] \times \left(\frac{t}{10^4}\right) + [0.6, -0.5, 0.4, -0.4, 0.3] \times (1 - \frac{t}{10^4})$. This represents datasets with ARIMA parameters that keep changing slowly but surely.
Test results show our method again bests all other three methods. This shows our method predicts the best even in continuously changing time series data. This test concludes our four artificial dataset tests and shows that our method shows the best performance. We also point out that our test results show consistent RMSE values with the research we referred to [1].

Setting 5.
This time we change the d value of our ARIMA data generator. All previous settings were set to $d = 0$, but here we set it to $d = 1$. This setting has meaning in that it directly uses the integrated factor of ARIMA, differing it from ARMA. We used the same α and β values from setting 1 and set $d = 1$.
Test results still show best results from our proposed ARIMA-ONS-FF algorithm. This means our algorithm does the best even in datasets where the data values were differenced.

Setting 6.
For the final synthetic-data setting, we abruptly changed the d value from 0 to 1 at the halfway point. This setting was made to account for abrupt changes in either the environment or dataset, and better estimation means better adaptability to change.
Again our algorithm showed lowest convergence value and fastest adaptability to change. Thus with the six synthetic data generation settings we used above we show our algorithm shows best adaptability in abrupt changes of any type of parameter, being α, β and even d. As most real-life data constantly and abruptly go through changes in its inner pattern, this is a big advantage.

Real-world data
For the final two settings we used real-life stock volume data and real weather data. Setting 5 uses volume stock data from SK Telecom downloaded from Yahoo Finance. It consists of daily data from September 18, 2017 to September 16, 2022 making it a total of 1259 time points. We applied the log transformation of the data for more stable predictions. This dataset has meaning in that it is much shorter in length than the other settings, therefore

we can know if our forgetting mechanism works even in short term datasets. From the results we can see that our algorithm has a little trouble at the start, as it shows higher RMSE values than ARIMA-ONS. However it soon quickly reached lower convergence values later and still showed the best overall prediction performance.
The sixth and final setting pertains to weather data downloaded from Kaggle dating from April 1, 2006 to September 9, 2016 hourly, making it a total of 96,453 time points. However, we cut it from the beginning to the 10,000 time point and used these 10,000 data points for our tests. It contains various weather data, and we used wind speed in our test. As with the former real-life data, we applied log transformation of the dataset, too. We can see the results are similar to setting 5. Again, our algorithm showed the lowest convergence among the four models in comparison.

More results
Below are the test results from $m + k = 8$ and $m + k = 12$.

Figure 2(a). Sanity Check

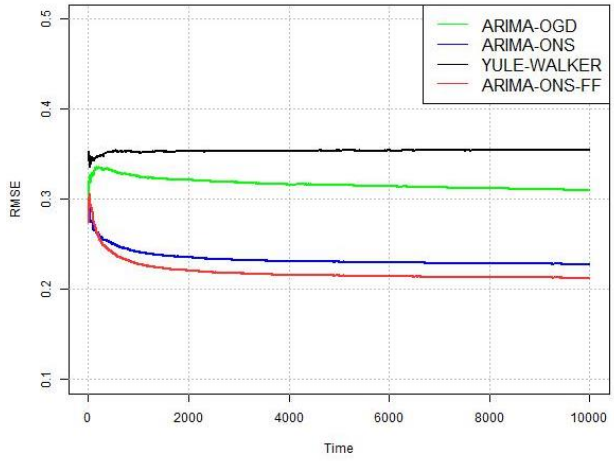

Figure 2(b). Abrupt change of α and β

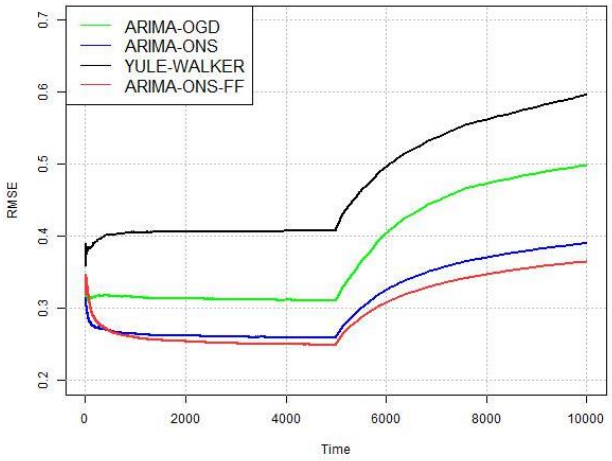

Figure 2(c). Two abrupt changes of α and β

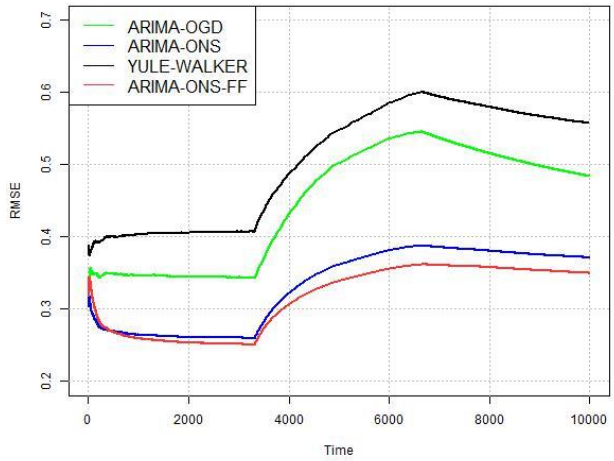

Figure 2(d). Steady change of α and β

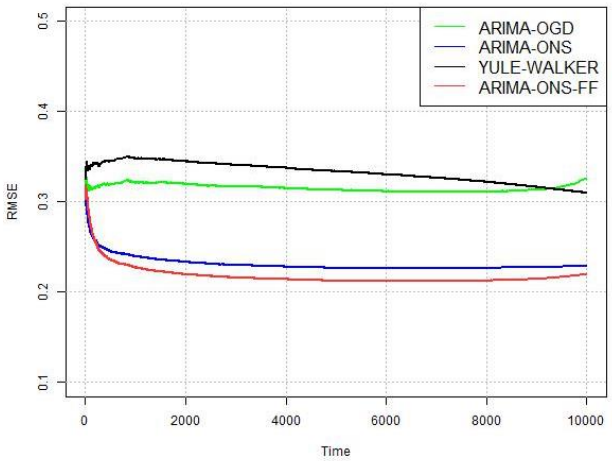

Figure 2(e). Basic test with $d = 1$

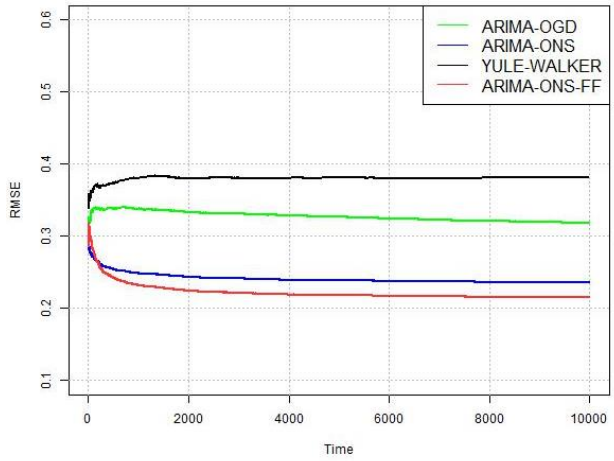

Figure 2(f). Abrupt change of d

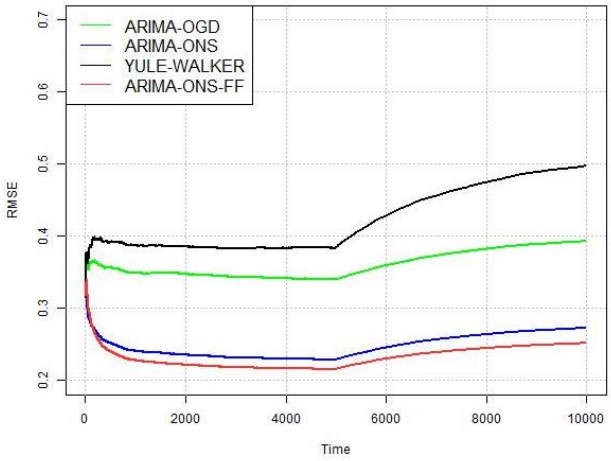

Figure 2(g). SK Telecom stock volumes

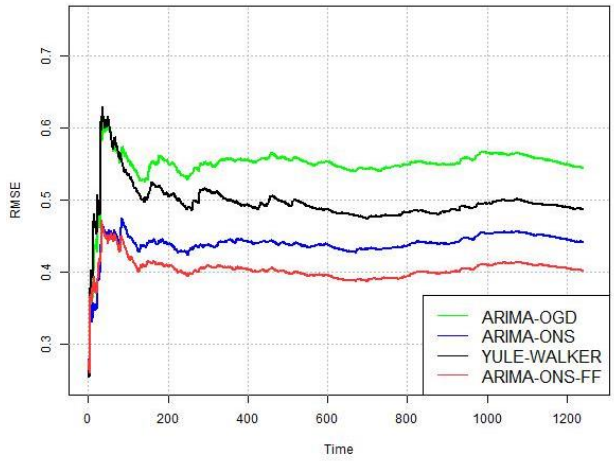

Figure 2(h). Weather wind speed

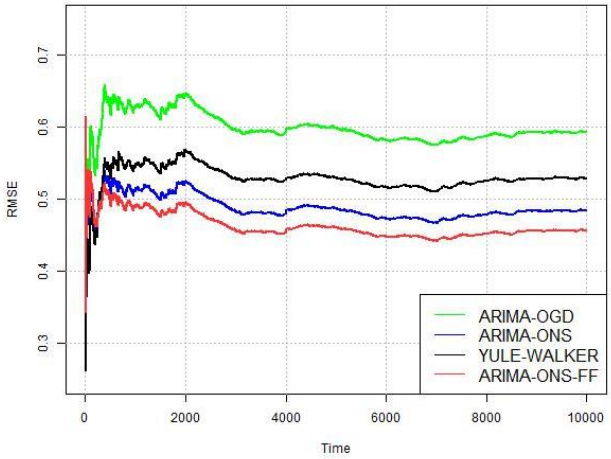

Figure 2. Test results in various settings with $k + m = 8$ run 20 times and averaged

Figure 3(a). Sanity Check

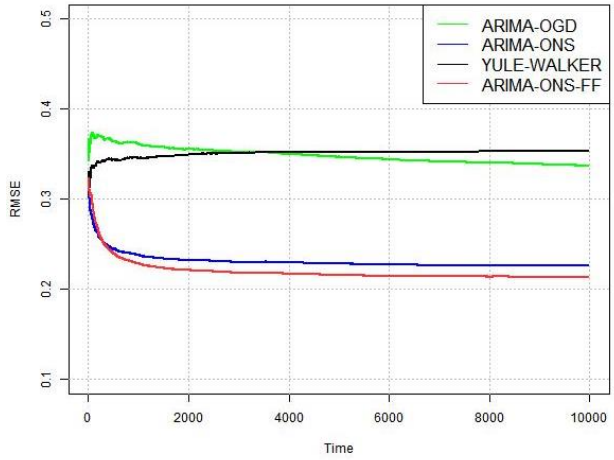

Figure 3(b). Abrupt change of α and β

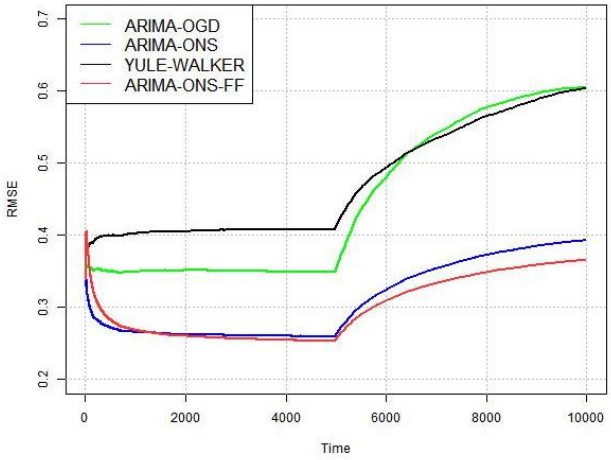

Figure 3(c). Two abrupt changes of α and β

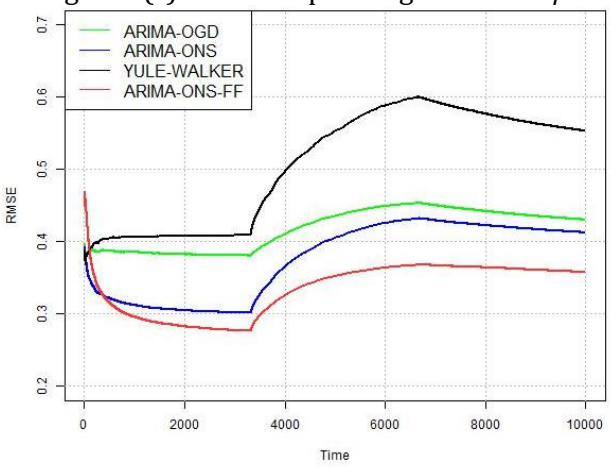

Figure 3(d). Steady change of α and β

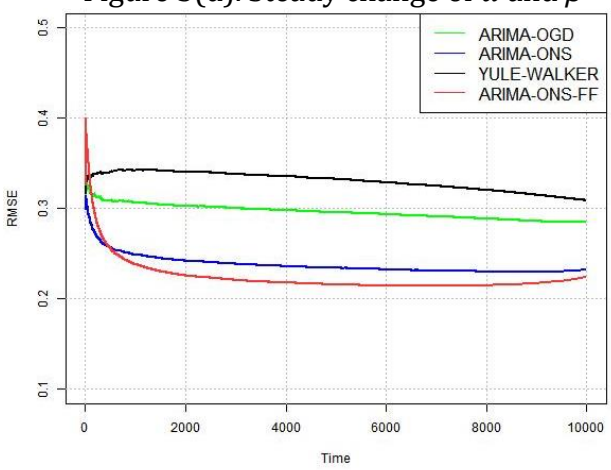

Figure 3(e). Basic test with $d = 1$

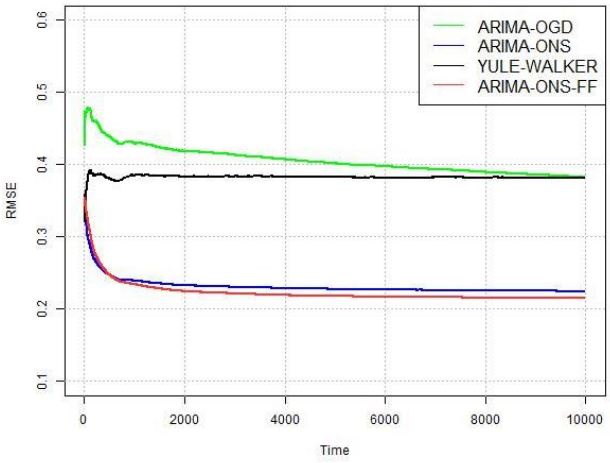

Figure 3(f). Abrupt change of d

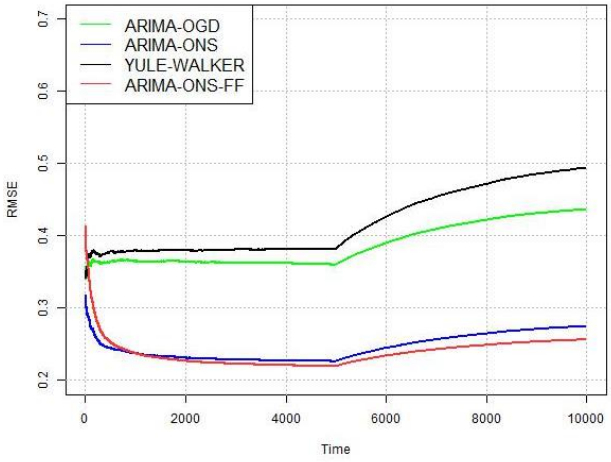

Figure 3(g). SK Telecom stock volumes

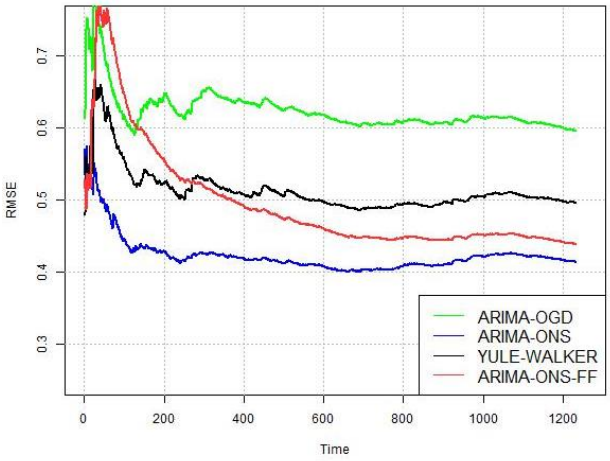

Figure 3(h). Weather wind speed

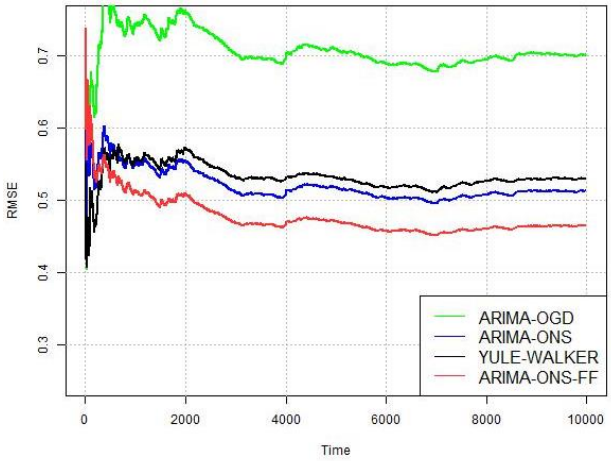

Figure 3. Test results in various settings with $k + m = 12$ run 20 times and averaged

We can see similar results in Figure 2 and Figure 3 to Figure 1. One noticeable difference would be in Figure 3(e), where our ARIMA-ONS-FF actually shows worse results than ARIMA-ONS. We think this is due to the fact that since more parameters(12 instead of 10)

are used in estimating the α and β parameters of ARIMA$(k+m, d, 0)$, our ARIMA-ONS-FF was unable to find enough stability within the short dataset of 1259 points. We can see the error value getting closer to ARIMA-ONS near the end. Thus, we expect if this dataset was longer (like the other settings), then our algorithm would have shown better results. In fact, when comparing the each (e) results from Figure 1,2 and 3, we can see that $k+m=8$ did the best with $k+m=10$ following behind and $k+m=12$ doing the worst. This shows the direct relationship between the number of parameters used in the ARIMA-ONS-FF model and the stability resulting from it. If more parameters are used, then more data is required to find convergence due to the increased tracking capabilities and lower stability induced by the forgetting factor. In real-life data where the amount of data is likely to be abundant, this will not be a problem.

CONCLUSION AND DISCUSSION

In this research we proposed a novel online learning algorithm with forgetting factors to estimate the ARIMA parameters. We improved the current online Newton step method by adding the forgetting factor and showed its potential in theory with sublinearly growing regret bounds $R_T \leq o(T)$ under mild assumptions. We also presented promising test results to prove our algorithm's superior estimating capabilities compared to other algorithms.
In future research, we envision on working with more various situations with our online ARIMA with forgetting factor algorithm. This includes more various value for parameters α, β and λ, or a wider range of noise. Such research would pave way for more flexible and wider applications of our algorithm in both synthetic and real-life data. Also, we will prove our regret bound of $R_T \leq o(T)$ with mild assumptions in later publications with more rigorous mathematical theories and enclose more new theoretical developments then.

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PREDECTION OF A MERCHANDISE SHOP'S REVENUE BASED ON DATA COLLECTED ON GOOGLE ANALYTICS 360

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ABSTRACT

In eCommerce industry there is a very low conversion rate. Based on the latest survey and studies in 2020 average conversion of eCommerce website is 2.68%. This is further less in the US market at 2.63% as compared to the global market which is at 4.31%[1]. So, for an eCommerce it is important to understand who the users are who are buying and what does their average spend.

Our business problem is to predict a customer's future revenue based on their past transactional data. Our paper uses past transactional data collected by Google Analytics 360 for a merchandise store to predict the future revenue created by those customers. The data for our analysis is for Google Merchandise store. This Google Open-sourced real-world data is fetched using Google Big Query[3]. The data[5] queried includes unique identifier for each user of the Google merchandise store channel, device, and browser via which the user came to the store, date on which he/she visited, geography of the user, engagement type, visit details like total session duration, traffic origin information and session number. The total number of records are ~12,000 records where each record corresponds to one visit to store.

The problem statement is solved using a Hurdle Model[7]. As we are predicting the future revenue generated by a customer, we could use a regression model. But before we predict revenue, we also needed to identify if a particular customer will visit the store or not. This is accomplished by a classification model. For classification model as we do not have any target variable, we created the target label. For that first we split the data into train and test by replicating real world scenario. When the user is present in both the dataset, we labelled it as '1' and if present in just train and not in test then labelled as '0'. This concept is called Time Series Featurization. For classification we ran Light GBM and XGBoost models.

This paper can help upcoming ecommerce to allocate funds to their promotional activities based on their customers behavior. Additional experiments can be done on the website if they see low predicted revenue for the future. The paper will also support them in identifying products which are widely sold vs those which are not. This will help in reducing inventory cost and overall reducing expenses.

INTRODUCTION

Google has an official online merchandise store 'Google Merchandise Store'. The Google Merchandise Store is an eCommerce website that sells Google-branded merchandise. Session level data for the eCommerce website is available for free for web analytics through Google's Big Query. Important data that is queried from Big Query are traffic data, content data and transactional data.

Traffic Data includes information about the users who visit the eCommerce website and how they interact once they land on the website. This data will help users to check traffic pattern and analyze visitors' behavior which in turn will help track a website's effectiveness and its overall digital presence. Content data provides information related to the behavior of the user on the eCommerce website. Content data will include details of the URL of the page's visitors browsed and what they did when they landed there. In addition, information like bounce rates, hit numbers, and time spent on the website. Transaction data has information about the transactions that occur, including transaction numbers, prices of the products, etc. For this paper we are using a demo version provided by Big Query, the demo version will allow user to query data between January 2017 and August 2017.[2]
For eCommerce website, one of the most important questions required to answer is '*What is that makes money?*'. It can be through sales, direct sales, developing leads for sales, or page views. Once a business objective is finalized, key performance indictor like #users visited, avg. session duration, conversion rate etc. are tracked using the data queried from Big Query. These KPI's can also be analyzed further by conducting a funnel analysis. The funnel analysis will help to set goals and decide on success metrics or identify issue with a website.

BUSINESS PROBLEM

The paper aims to build a predictive model using google analytics data to predict the total revenue per customer that will help eCommerce website use their marketing budget more wisely and interpret the impact of other factors on the total revenue prediction using different predictive models.

DATA OVERVIEW

The data is queried from Google's Big Query demo account [3] for Google Merchandise Store. The data was pulled for the period between August 2016 and July 2017. Additional data can be pulled with a free trial premium account or a premium account. Below is the query used to pull the data from the table.

'*Select * from 'bigquery-public-data.google_analytics_sample.ga_sessions_**'

The data queried was then exported as '.json' file and then the file was converted to '.csv' using the pandas library in python. Below is the code used to flatten the json file to csv file [4].

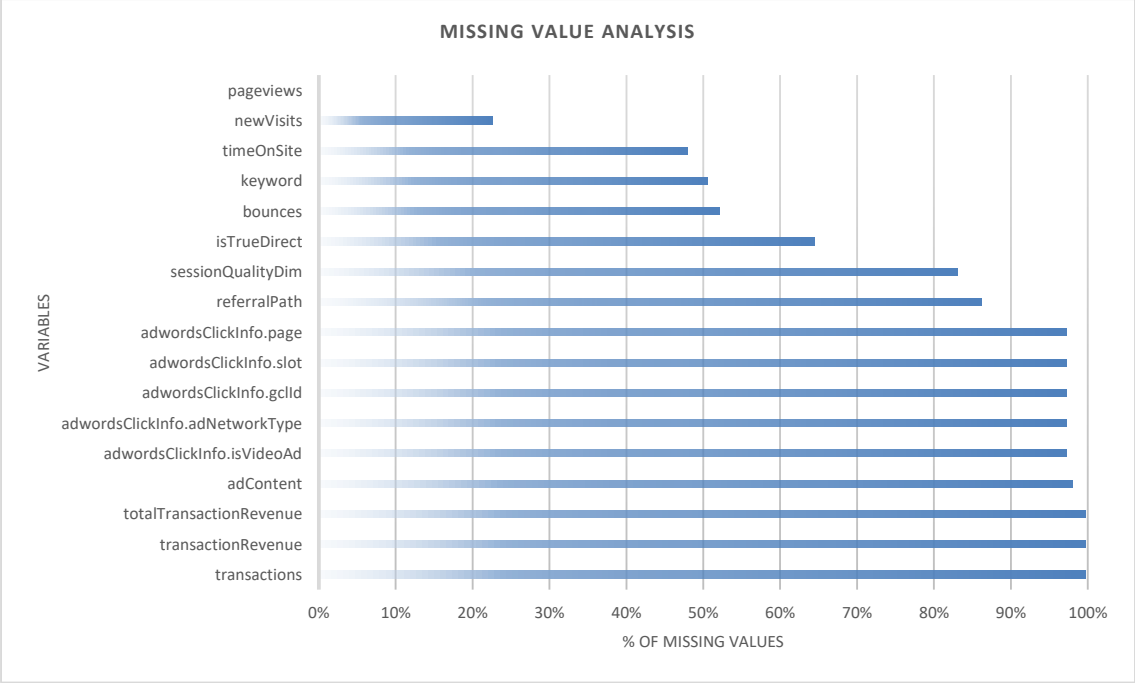
```
df = pd.json_normalize (
    json_list,
    record_path =['totals','trafficSource','hits']
)
df.to_csv('data.csv)
```

The data description for the exported file was available on the google analytics website[5]. Below is a sample data description for the exported data[6].

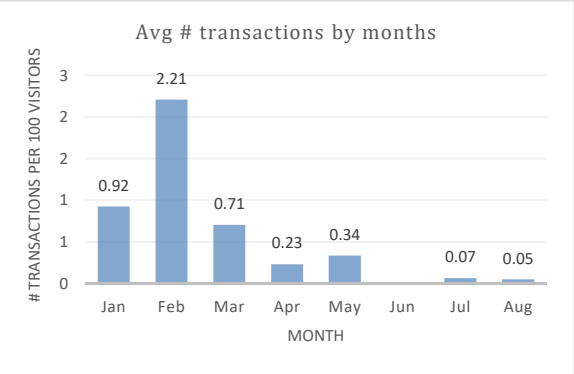
Variable Name	Description
fullVisitorId	A unique identifier for each user of the Google Merchandise Store.
channelGrouping	The channel via which the user came to the Store.
date	The date on which the user visited the Store.
device	The specifications for the device used to access the Store.
geoNetwork	This section contains information about the geography of the user.

socialEngagementType	Engagement type, either "Socially Engaged" or "Not Socially Engaged".
totals	This section contains aggregate values across the session.
trafficSource	This section contains information about the Traffic Source from which the session originated.
visitId	An identifier for this session. This is part of the value usually stored as the _utmb cookie. This is only unique to the user. For a completely unique ID, you should use a combination of fullVisitorId and visitId.
visitNumber	The session number for this user. If this is the first session, then this is set to 1.
visitStartTime	The timestamp (expressed as POSIX time).
hits	This row and nested fields are populated for all types of hits. Provides a record of all page visits.
customDimensions	This section contains any user level custom dimensions that are set for a session. This is a repeated field and has an entry for each dimension that is set.

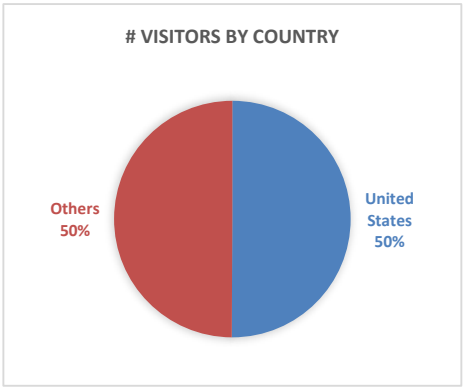
EXPLORATORY DATA ANALYSIS

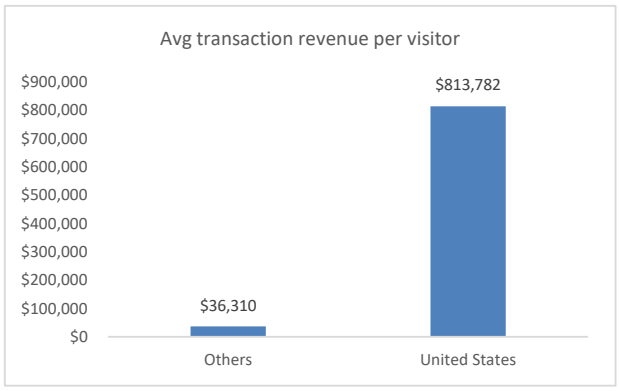


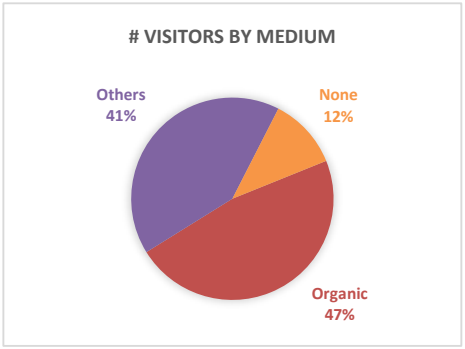
The above plot shows % of missing values on the x-axis and some of the variables present in our dataset on y-axis. The plot shows that transactionRevenue and transactions which indicates the revenue generated for each user have the highest percentage of missing data of about 98%. Other variables such as pageviews, newVisits, timeOnSite etc. which are the measure of individual user presence on google merchandise store have relatively low percentage of missing values.

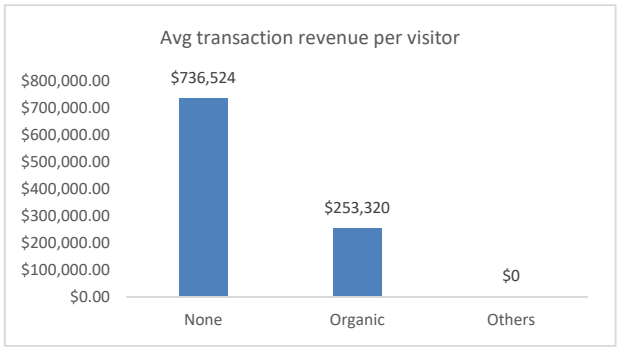


As per the above plot for number of visitors for each month, we noticed that maximum number of people have visited google merchandise store online in month of June whereas February month had least number of visitors. On the contrary, the number of transactions were highest in the month of February whereas June has absolutely no transactions. This shows that people visiting the sites does not guarantee that a transaction will be done at the end of his visit.

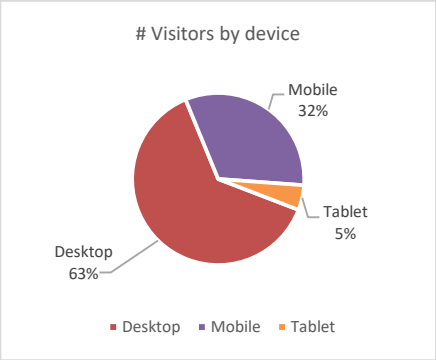


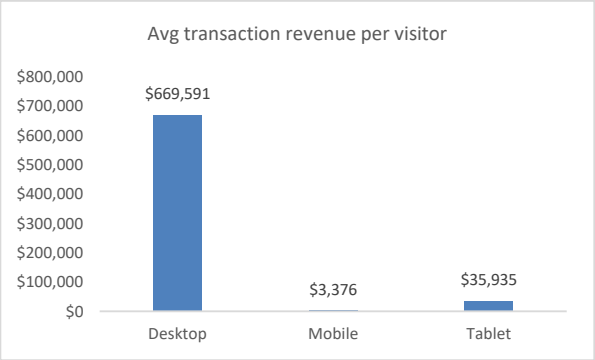






Based on the plot for visitors by country, we had about 50% visitors from the United States and rest were from other countries. Out of those, the revenue generated by the US visitors was massive with total of $813,782. Based on number of visitors by medium about 47% of the total visitors were organic and the total revenue generated through them was $253,320.





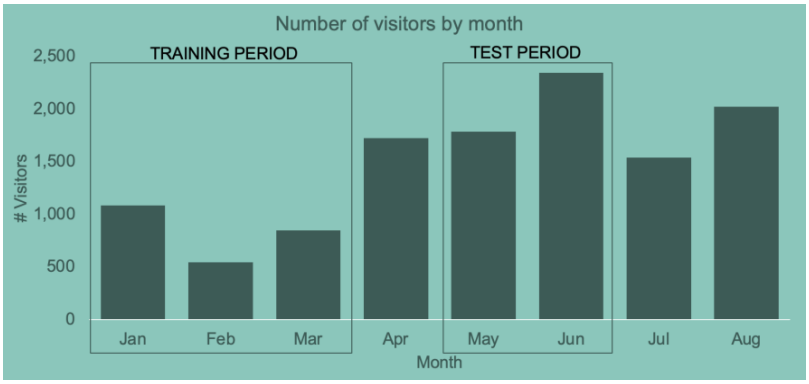
Most number of visitors prefer desktop for visiting online merchandising stores that is about 63%. After that mobile is a preferred medium. Total revenue generated by visitors who access google merchandising store though desktop is $669,591.

DATA PRE-PROCESSING

To start with the analysis, we investigated unique values in each column of the data. If the total number of unique values is one, then the column is removed from the analysis. The reason behind this is to remove all columns with no variance as these columns will not lift our predictive model performance. Next, we analyzed the missing values in the columns, so for the columns with missing values imputation methods 'median' was used in case of interval variable and 'mode' was used in case of class variable. For the target variable 'totals.transactionRevenue' 99% of the data was missing, the imputation value in this case was zero. This was because the missing data here meant there was no financial transactional and so the missing value was replaced with 0

Then all Boolean questions like 'device.isMobile' were converted from string to Boolean (true/false or 1/0). All numerical features were converted to float. This conversion helped to display values where there was partial page view or session. All categorical variables were then converted using label encoding. Over here we did not use one-hot encoding as that will increase the number of columns which will lead to the curse of dimensionality.

Finally, we will have our last pre-processing which is required to solve this problem using hurdle models. This step is time series featurization. Here we will split the data into train and test based on a cutoff date. Here the cutoff date used is April 30th, 2017. Based on the split, we will create new target variables like 'returned' and 'revenue'. For 'returned', we will mark it as 1 if they are present in both train and test data. The variable will indicate that the whether the user will come to store or not in test period. The variable 'revenue' indicates the revenue generated by the user.



Additionally, we will create variables which is grouped at visitor id. Few of these new variables are max value of network domain, max value of the city, max value of channel grouping, max value of referral path, etc.

MODELLING/ANALYSIS

We will use a hurdle model[7], It consists of a classification model and a regression model. The classification model will predict if the user visits or not. In case of a no-show the revenue from that user is set as zero. The target variable for the classification model is 'returned' which is created using the time series featurization concept (discussed in the previous section). After finalizing our classification model and regression model finalized, the final value of predicted value is :

classification model output (probability) X regression model output (revenue predicted).

For classification model, we have used models Light GBM and XGBoost. Below is the result of our classification model.

Model	Training F1 Score	Test F1 Score
Light GBM	0.34	0.32
XGBoost	0.31	0.29

Important variables for the best model are as follows:

1) hits
2) medium
3) operatingSystem

For regression model as well, we have used same models Light GBM and XGBoost. Below is the result of our regression model.

Model	Training RMSE	Test RMSE
Light GBM	0.45	0.51
XGBoost	0.52	0.54

Important variables for the best model are as follows:

1) browser
2) hits
3) deviceCategory

CONCLUSION

- More than 53% of customers are non-organic that means that most customers visit site through paid search results on search engines.
- Desktop is the most popular device among customers to access the google merchandise site.
- The hurdle model broken down into classification and regression model, was able to correctly predict the transaction revenue generated.
- Based on the 2 models(classification + regression) , medium and time on site, were able to identify important variables for predicting revenue

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ROBUST TRANSFER SUBSPACE LEARNING FOR IMAGE CLASSIFICATION

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ABSTRACT

Unsupervised domain adaptation helps improve the generalizability of the learned model by transferring knowledge from the labeled source domain (i.e. training set) to the unlabeled target domain (i.e. test set). However, most existing works only enforce the cross-domain consistency in the subspace while ignoring the relations of source samples to the target domain and the task-specific classifiers. To address this issue, we propose a robust transfer subspace learning method, called RTSL. RTSL learns domain invariant feature representations by jointly optimizing supervised classification and unsupervised subspace learning problems. Furthermore, the weights (importance) of source instances are estimated so that the classifier can be well adapted to the target domain. Experimental results on different cross-domain benchmark datasets demonstrate the encouraging performance of our RTSL over the state-of-the-art methods.

INTRODUCTION

It is natural that classification models suffer from severe performance degeneration when tested on datasets different from the ones used for training. Domain adaptation aims to transfer knowledge from a labeled source domain to a related but differently distributed target domain. There are many researches that build a neural architecture, adjust the deep network by adapting model parameters, and use a totally shared architecture for both domains. Such a deep domain adaptation method could benefit the classification of unlabeled target domain, but optimizing end-to-end deep neural networks remain a cumbersome procedure. Typically, to transfer the learned knowledge of source domain, last few layers are fine-tuned over the target data. This approach is conceptually clear because the original network that has learned an internal representation will also work well for a new task. Knowledge transfer takes place in the same way for convolutional neural network (CNN) models which consist of convolutional layers extracting low-level features followed by fully connected layers. The idea behind our proposed method stems from the assumption that the output of the last hidden layer can be interpreted as a feature encoding of the input facilitating classification. Hence, we focus on soft-max regression in the final layer for domain adaptation, which returns probabilities over all possible classes. However, not only does the presence of unexpected abnormal behaviors exist in the collected data, important information may also be lost in learning a domain-invariant representation, thus resulting in

performance degeneration on target classification. To tackle these challenges, we design a robust and discriminative regression model by reweighting each source instance and preserving the geometric property of target domain.

RELATED WORKS

In recent years, numerous unsupervised domain adaptation methods have been proposed with an aim to address the domain shift and further improve the discriminability on target data. Regarding the depth of architecture, the methods for domain adaptation can be mainly categorized into deep and shallow model-based approaches.

Deep domain adaptation methods learn a transferable classifier by embedding domain alignment into the pipeline of deep learning. Long et al. [11] added each layer for class classification of source domain versus target domain in the latter part of the DNN and performed the classification of the target data after learning so that the output distribution of each other was similar. Zhang et al. [23] used the pseudo-label of target data to improve the performance of the latter classification layer. Glorot et al. [3] proposed an autoencoder-based DNN structure that uses both source and target data to identify domain characteristics. Ghifary et al. [2] trained DNN to improve class discrimination from source data and identify characteristics from target data. Ganin et al. [1] increased the loss that distinguishes domains through gradient reversal layer (GRL) so that DNN confuses the domains while improving source data classification. Pei et al. [14] decided that a single network for class classification was insufficient to perform domain adaptation, and introduced as many networks as the number of classes. These methods high discriminative feature representations by leveraging deep networks. However, a long training time and a high computational cost pose severe challenges for deep domain adaptation.

Recently, shallow domain adaptation methods pay attention to learning transferable feature representations across source and target domains. They try to find a transformation so that samples from either domain can be projected into the common subspace. In the learned subspace, the statistical distribution gap between two domains is minimized. Huang et al. [5] derived the importance in the optimization process by adding the weight of source data to the objective function. Sugiyama et al. [19] used KL-divergence as a metric to minimize distribution differences between domains. Pan et al. [13] derived a projection matrix that minimizes the maximum mean discrepancy (MMD) to align the two domains in subspace. Long et al. [12] used the pseudo-label of target data to obtain a projection matrix that minimizes the difference in the distribution of the two domains by class. Recent shallow domain adaptation methods have proven to not only explore the domain-invariant features effectively but also achieve superior performance to deep methods when given deep features [10, 16].

ROBUST TRANSFER SUBSPACE LEARNING

In this section, we present the details of our RTSL method to address unsupervised domain adaptation problems. We first describe the main notations and problem formulation for the proposed model. Then, we derive the analytical solution using alternating optimization.

Notations

Considering unsupervised domain-adaption (DA) problems where no labeled data is available in the target domain, we let $\{(x_{si}, y_{si})\}_{i=1}^{n_s}$ denote pairs of a source sample and its label, and $\{x_{tj}\}_{i=1}^{n_t}$ be the target data. Here, both data sets $X_s = \{x_{si}\}_{i=1}^{n_s}$ and $X_t = \{x_{tj}\}_{j=1}^{n_t}$ lie in a d-dimensional space where n_s and n_t are the number of source and target samples, respectively. For the classification task on the two domains, it is assumed that samples from the source and target domains share the same label space $\boldsymbol{Y}$, i.e., $y_{si}, y_{tj} \in \boldsymbol{Y}$ and $\boldsymbol{Y} \subset R$. To learn a discriminative regression model, we construct the label matrix of source data, $Y_s \in R^{C \times n_s}$, where C is the number of classes. If x_{si} belongs to the c-th class ($c = 1, 2, \cdots, C$), then only the c-th entry of $[Y_s]_{:,i}$ is one and all the other entries are zero. We denote the labeled source domain by $D_s = \{X_s, Y_s\}$ and the unlabeled target domain by $D_t = \{X_t\}$, correspondingly.

Problem formulation

We consider the problem of unsupervised domain adaptation where the goal is to align distributions across two domains as well as to learn a generalized classier. However, most of existing methods deal with this problem by reducing the class-level distribution discrepancy in the hope that there exists a projection matrix mapping two domains to one common latent space. Instead, we define two projections, $P_s \in R^{d \times h}$ and $P_t \in R^{d \times h}$, which are used to link the source and target domains to the subspace, respectively. We then feed the projected representations to a linear classification model parameterized by $R \in R^{c \times h}$. For the purpose of learning robust and discriminative linear transformations, we formulate the following claims: 1) learning a weighted discriminative regression model for the source domain 2) enhancing the reconstruction of unlabeled samples from the target domain 3) reducing the statistical discrepancy between the two domains. In the end, for unsupervised domain adaptation, our RTSL incorporates these three proposed losses into a unified objective function. In the following subsections, we will explain each part of the objective in sequence, providing a detailed description of our methodology.

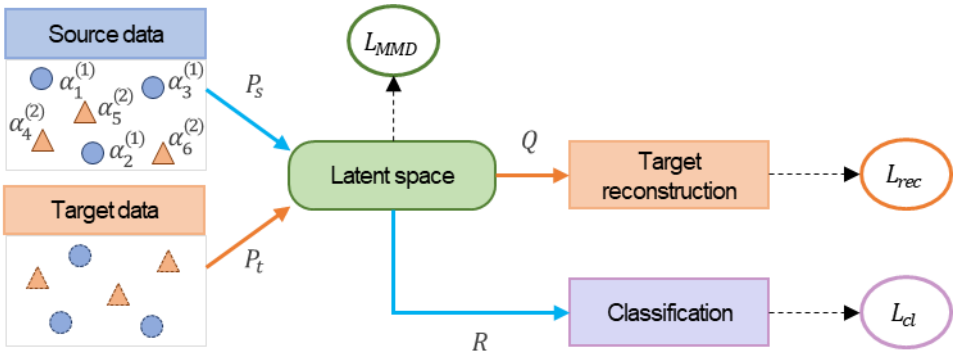

Figure 1. Overview of our domain adaptation method.

1) Weighted discriminative regression. To learn discriminative knowledge from the labeled source domain, we aim to optimize the associated transformations by minimizing the

classification error. Our formulation uses a least squares regression with the label indicator matrix Ys whose entries are either zero or one:

$$\boldsymbol{min}\frac{\mathbf{1}}{\mathbf{2}}\|\boldsymbol{Y_s} - \boldsymbol{RP_s^T X_s}\|_{\boldsymbol{F}}^{\mathbf{2}}, \tag{1}$$

where $\|\cdot\|_F^2$ is the Frobenius norm. In reality, however, transforming training samples into strict binary label is a too rigid scheme due to the diversity of data distributions from different classes. To construct a flexible intra-class structure, we develop an ε-dragging technique to relax the label matrix. Specifically, by introducing a non-negative slack matrix N, the hard label matrix Y_s is replaced by a soft label relaxation matrix, $Y_s + K \odot N$, where $N_{ii} = \varepsilon_{ii} \geq 0$, $\odot$ is the Hadamard product operator, and K is the constant matrix defined as

$$\mathbf{K_{ij}} = \begin{cases} +1, & \textbf{if } \mathbf{Y_{ij}} = 1 \\ -1, & \textbf{if } \mathbf{Y_{ij}} = 0 \end{cases} \tag{2}$$

In this way, the problem of (1) can be reformulated as

$$\begin{gathered} \mathbf{min}_{\mathbf{P_s,\,R,\,N}}\frac{\mathbf{1}}{\mathbf{2}}\|\mathbf{Y_s} + \mathbf{K} \odot \mathbf{N} - \mathbf{RP_s^T X_s}\|_{\mathbf{F}}^{\mathbf{2}} \\ \boldsymbol{s.t.}\ \ \boldsymbol{N} \geq \mathbf{0} \end{gathered} \tag{3}$$

Although the soft label based regression can make the features of source domain more discriminative, all samples are equally treated regardless their contribution to the learning process. That is, an effective solution is not easy to be optimized due to the influence of unusual and non-repetitive events. In order to mitigate the negative transfer caused by samples far away from the cluster centers, we intend to determine estimates of the error variance and yield the following formulation of weighted least squares:

$$\begin{gathered} \mathbf{min}_{\mathbf{P_s,\,R,\,N}}\frac{\mathbf{1}}{\mathbf{2}}\left\|(\boldsymbol{Y_s} + \boldsymbol{K} \odot \boldsymbol{N} - \boldsymbol{RP_s^T X_s})\mathbf{Diag}(\boldsymbol{w})^{\mathbf{1/2}}\right\|_{\boldsymbol{F}}^{\mathbf{2}} \\ \boldsymbol{s.t.}\ \ \boldsymbol{N} \geq \mathbf{0} \end{gathered} \tag{4}$$

where $w_i > 0$ is the weight of the i-th observation, $i = 1, \cdots, n_s$, and Diag(w) is the diagonal matrix of the weights. By taking the following update rule

$$\mathbf{w_i} = \mathbf{1/max}(\tau,\ \left\|[\mathbf{Y_s} + \mathbf{K} \odot \mathbf{N} - \mathbf{RP_s^T X_s}]_{:,\mathbf{i}}\right\|_{\mathbf{2}}), \tag{5}$$

where τ is the regularization parameter, we adaptively assign smaller weights to those with larger error. Accordingly, based on the interpretable statistical estimation, our RTSL has the ability to handle regression situations in which the source samples are of varying quality.

2) Reconstructable feature representation. In order for the learned transformation model to perform well on classifying samples in the target domain, it would be helpful to minimize the information loss caused by the dimensionality reduction. Thus, in our method, the unsupervised target data reconstruction serves as an auxiliary task to improve the

classification performance. We consider the reconstructive ability of target data representation with the following problem:

$$\min_{P_t,\,Q} \left\| X_t - Q P_t^T X_t \right\|_F^2, \quad s.t. \;\; Q^T Q = I \tag{6}$$

where $Q \in R^{d \times h}$ denotes a reconstruction matrix. The orthogonal constraint on Q is imposed to avoid a trivial solution. The learned representation can encourage the global geometry of the original target domain, but it is still insufficient to guarantee both local structure property and class discriminability. To ensure that the target data can be well recovered by the source data in the subspace, we seek another reconstruction matrix $Z \in R^{n_s \times n_t}$ which connects the source and target domains after feature transformation. Then, the reconstruction loss on the target data can be reformulated:

$$\min_{P_t,\,Q} \left\| P_t^T X_t - P_s^T X_s Z \right\|_F^2 + \|Z\|_1, \tag{7}$$

where $\|\cdot\|_1$ is the l1-norm promoting sparse solutions. The sparse regularization on Z enforces the target data to be reconstructed by fewer source data. In this respect, the minimization of (7) brings forth the intrinsic consistency across two different domains, helping us find the subspace where each target sample is linearly represented by its similar neighbors in the source domain. It is noted that by combining (6) with (7), the feature transformation revealing the underlying structure of target domain is obtained, which leads to a more generalized classification model.

3) Weighted distribution alignment. For domain adaptation tasks, it is assumed that the source and target domains share a same feature space but follow different marginal distributions. The goal is to extract domain invariant feature representations by narrowing the discrepancy between the two domains. In this paper, our RTSL method seeks to discover two projection matrices P_s for the source domain and P_t for the target domain so that the two different domains can be well interlaced in the latent feature space. The maximum mean discrepancy (MMD) is the most widely used non-parametric metric to compare distinct distributions, which measures the divergence between the mean embeddings in a reproducing kernel Hilbert space (RKHS). We consider the MMD as a loss function for our domain adaptation to make the features extracted from both domains undistinguishable, which is formulated as follows:

$$MMD = \left\| \frac{1}{n_s} \sum_{x_i \in D_s} P_s^T x_i - \frac{1}{n_t} \sum_{x_j \in D_t} P_t^T x_j \right\|^2. \tag{8}$$

The MMD loss, however, usually suffers from a negative transfer caused by outliers in the source data in that it matches the whole data distribution of the source domain with that of the target domain. To promote a positive transfer, we evaluate the adaptation ability of each instance in source domain with a properly assigned weight. Source instances with larger weights will be more likely to appear in the target domain. To this end, we express the objective function combining marginal and class-conditional weighted MMD, $WMMD_m$ and $WMMD_c$, as follows:

$$\min_{\mathbf{P_s},\mathbf{P_t},\boldsymbol{\alpha}} \boldsymbol{WMMD_m} + \boldsymbol{WMMD_c} \quad \textbf{(9)}$$
$$\boldsymbol{s.t.}\ \ \sum_{i=1}^{n_s^{(c)}} \boldsymbol{\alpha_i^{(c)}} = \boldsymbol{\gamma n_s^{(c)}}, \boldsymbol{\alpha_i^{(c)}} \in [\mathbf{0},\ \mathbf{1}], \boldsymbol{c} = \mathbf{1},\ \cdots, \boldsymbol{C}$$

where $n_s^{(c)}$ is the number of source data with ground-truth class c and $\alpha = [\alpha^{(1)};\ \cdots;\ \alpha^{(C)}] \in R^{n_s}$ denotes the weights of data in the source domain. The parameter $\gamma \in [0,1]$ controls the ratio of source data in each class to be utilized for domain adaptation. Considering that the value of 1 brings the traditional MMDs with equal weights on all instances, we fix $\gamma = 0.8$ in our experiments. The inequality constraint on α prevents only a few samples from being weighted explosively. Then, given the instance weights, the novel implementation of MMD in Eq. (9) to minimize global and class-wise domain discrepancy is defined by the following:

$$\mathbf{WMMD_m} = \left\| \frac{1}{\gamma n_s} \sum_{x_i \in D_s} \boldsymbol{P_s^T x_i \alpha_i} - \frac{1}{n_t} \sum_{x_j \in D_t} \boldsymbol{P_t^T x_j} \right\|^2, \quad \textbf{(10)}$$

$$\mathbf{WMMD_c} = \sum_{c=1}^{C} \left\| \frac{1}{\gamma n_s^{(c)}} \sum_{x_i \in D_s^{(c)}} \boldsymbol{P_s^T x_i \alpha_i^{(c)}} - \frac{1}{n_t^{(c)}} \sum_{x_j \in D_t^{(c)}} \boldsymbol{P_t^T x_j} \right\|^2, \quad \textbf{(11)}$$

where $D_s^{(c)}$ and $D_t^{(c)}$ denote the set of source and target samples belonging to class c respectively and $n_t^{(c)}$ is the number of elements in $D_t^{(c)}$. Due to the absence of target labels, pseudo labels predicted by the classier learned so far are adopted to calculate the class conditional WMMD iteratively. For the optimization, (10) and (11) can be equivalently expressed in the form of matrix as follows:

$$\boldsymbol{WMMD_m} = \boldsymbol{Tr}\left([\boldsymbol{P_s^T X_s},\ \boldsymbol{P_t^T X_t}] \begin{bmatrix} \boldsymbol{G_{ss}} & \boldsymbol{G_{st}} \\ \boldsymbol{G_{ts}} & \boldsymbol{G_{tt}} \end{bmatrix} \begin{bmatrix} \boldsymbol{X_s^T P_s} \\ \boldsymbol{X_t^T P_t} \end{bmatrix} \right), \quad \textbf{(12)}$$

where $G_{ss} = \frac{1}{\gamma^2 n_s^2} \alpha\alpha^2$, $G_{st} = \frac{-1}{\gamma n_s n_t} \alpha 1_t^T$, $G_{ts} = G_{st}^T = \frac{-1}{\gamma n_s n_t} 1_t \alpha^T$, and $G_{tt} = \frac{1}{n_t^2} 1_t 1_t^T$. We notice $1_t \in R^t$ is the column vector with 1. And similarly,

$$\boldsymbol{WMMD_c} = \boldsymbol{Tr}\left([\boldsymbol{P_s^T X_s},\ \boldsymbol{P_t^T X_t}] \begin{bmatrix} \boldsymbol{H_{ss}} & \boldsymbol{H_{st}} \\ \boldsymbol{H_{ts}} & \boldsymbol{H_{tt}} \end{bmatrix} \begin{bmatrix} \boldsymbol{X_s^T P_s} \\ \boldsymbol{X_t^T P_t} \end{bmatrix} \right), \quad \textbf{(13)}$$

where H_{ss}, H_{st}, H_{ts}, and H_{tt} are block diagonal matrices with $H_{ss}^{(c)} = \frac{1}{n_s^{(c)^2}} \alpha^{(c)} \alpha^{(c)^T}$, $H_{st}^{(c)} = \frac{-1}{n_s^{(c)} n_t^{(c)}} \alpha^{(c)} 1_{n_t^{(c)}}^T$, $H_{ts}^{(c)} = \frac{-1}{n_t^{(c)} n_s^{(c)}} 1_{n_t^{(c)}} \alpha^{(c)^T}$, and $H_{tt}^{(c)} = \frac{1}{n_t^{(c)^2}} 1_{n_t^{(c)}} 1_{n_t^{(c)}}^T$, respectively. Finally, the objective of WMMD in (9) can be further transformed to the following equivalent matrix form:

$$\boldsymbol{WMMD_m + WMMD_c = Tr\left([P_s^T,\ P_t^T]\begin{bmatrix} M_{ss} & M_{st} \\ M_{ts} & M_{tt} \end{bmatrix}\begin{bmatrix} P_s \\ P_t \end{bmatrix}\right),} \quad \textbf{(14)}$$

where $M_{ss} = X_s(G_{ss} + H_{ss})X_s^T$, $M_{st} = X_s(G_{st} + H_{st})X_t^T$, $M_{ts} = M_{st}^T$, and $M_{tt} = X_t(G_{tt} + H_{tt})X_t^T$

Overall formulation

As discussed above, we attempt to find two coupled projections, P_s and P_t, for jointly learning supervised classification and unsupervised reconstruction tasks. To make them share goals across both tasks, a simple but effective loss function to approximate each other during the learning process is as follows:

$$\mathbf{min}_{\mathbf{P_s},\mathbf{P_t}}\|\boldsymbol{P_s - P_t}\|_F^2. \quad \textbf{(15)}$$

In this way, we expect that the learned feature transformations enhance the discriminability while preserving useful information in the target domain. Finally, based on the aforementioned equations, we formulate the overall problem as follows:

$$\begin{aligned} \boldsymbol{min}_{\boldsymbol{P_s,\ P_t, \alpha, R, Q, N}} & \frac{1}{2}\left\|(\boldsymbol{Y_s + K \odot N - RP_s^T X_s})\mathbf{Diag}(\boldsymbol{w})^{1/2}\right\|_F^2 \quad \textbf{(16)} \\ & + \frac{\boldsymbol{\lambda_1}}{2}\left\|\boldsymbol{X_t - QP_t^T X_t}\right\|_F^2 + \frac{\boldsymbol{\lambda_2}}{2}\left\|\boldsymbol{P_t^T X_t - P_s^T X_s Z}\right\|_F^2 + \boldsymbol{\lambda_3}\|\boldsymbol{Z}\|_1 \\ & + \frac{\boldsymbol{\lambda_4}}{2}\boldsymbol{Tr}\left([\boldsymbol{P_s^T},\ \boldsymbol{P_t^T}]\begin{bmatrix} \boldsymbol{M_{ss}} & \boldsymbol{M_{st}} \\ \boldsymbol{M_{ts}} & \boldsymbol{M_{tt}} \end{bmatrix}\begin{bmatrix} \boldsymbol{P_s} \\ \boldsymbol{P_t} \end{bmatrix}\right) + \frac{\boldsymbol{\lambda_5}}{2}\|\boldsymbol{P_s - P_t}\|_F^2 \\ & \boldsymbol{s.t.\ \ N \geq 0, Q^T Q = I,\ Y_s \alpha = g,\ 0 \leq \alpha \leq 1} \end{aligned}$$

where $g = [\gamma n_s^{(1)},\ \cdots,\ \gamma n_s^{(C)}]$. It is worth noting that we seek to solve Eq. (16) for each iteration of the reweighting scheme Eq. (5) in weighted least squares. Below we describe how we solve the overall optimization problem as summarized in Algorithm 1.

Algorithm 1. RTSL

Input : source domain $D_s = \{X_s, Y_s\}$, target domain $D_t = \{X_t\}$,
parameter λ_1, λ_2, λ_3, λ_4, and λ_5;
Initialization $P_s = 0$; $P_t = 0$; $R = 0$; $Z = 0$; $B = 0$; $\rho_{max} = 10^5$; $\rho = 0.1$; $\delta = 1.01$
While not converged **do**
  $\mathbf{w_i = 1/max(\tau,\ \left\|[Y_s - RP_s^T X_s]_{:,i}\right\|_2)}$
  While not converged **do**
    Update Q
    Update A
    Update P_s and P_t
    Update R
    Update a and α
    Update N
    Update Z and B
    Update U_1, U_2, u_3, u_4, and ρ
  end while
end while

Optimization

The proposed objective function of Eq. (16) is not jointly convex for all decision variables. To efficiently solve it, we employ the ADMM which splits a complex optimization problem into a few simpler subproblems and solves them separately. By introducing auxiliary variables A, B, and α, Eq. (16) can be rewritten equivalently in the following formulation:

$$\begin{gathered} \boldsymbol{min}\frac{\boldsymbol{1}}{\boldsymbol{2}}\left\|(\boldsymbol{Y_s}+\boldsymbol{K}\odot\boldsymbol{N}-\boldsymbol{RP_s^TX_s})\mathbf{Diag}(\boldsymbol{w})^{\boldsymbol{1/2}}\right\|_{\boldsymbol{F}}^{\boldsymbol{2}} \\ +\frac{\boldsymbol{\lambda_1}}{\boldsymbol{2}}\left\|\boldsymbol{X_t}-\boldsymbol{QP_t^TX_t}\right\|_{\boldsymbol{F}}^{\boldsymbol{2}}+\frac{\boldsymbol{\lambda_2}}{\boldsymbol{2}}\left\|\boldsymbol{P_t^TX_t}-\boldsymbol{P_s^TX_sZ}\right\|_{\boldsymbol{F}}^{\boldsymbol{2}}+\boldsymbol{\lambda_3}\|\boldsymbol{B}\|_{\boldsymbol{1}} \\ +\frac{\boldsymbol{1}}{\boldsymbol{2}}\boldsymbol{Tr}\left([\boldsymbol{P_s^T},\ \boldsymbol{P_t^T}]\begin{bmatrix}\boldsymbol{\lambda_4M_{ss}}+\boldsymbol{\lambda_5I} & \boldsymbol{\lambda_4M_{st}}-\boldsymbol{\lambda_5I}\\ \boldsymbol{\lambda_4M_{ts}}-\boldsymbol{\lambda_5I} & \boldsymbol{\lambda_4M_{tt}}+\boldsymbol{\lambda_5I}\end{bmatrix}\begin{bmatrix}\boldsymbol{P_s}\\ \boldsymbol{P_t}\end{bmatrix}\right) \\ \boldsymbol{s.t.}\ \ \boldsymbol{N}\geq\boldsymbol{0},\boldsymbol{Q^TQ}=\boldsymbol{I},\ \boldsymbol{Y_s\alpha}=\boldsymbol{g},\ \boldsymbol{0}\leq\boldsymbol{\alpha}\leq\boldsymbol{1} \\ \boldsymbol{RP_s^T}=\boldsymbol{A},\boldsymbol{Z}=\boldsymbol{B},\boldsymbol{\alpha}=\boldsymbol{a}\end{gathered} \tag{17}$$

Then, the augmented Lagrangian of the problem Eq. (17) is formulated as

$$\begin{gathered} \boldsymbol{L_\rho}=\frac{\boldsymbol{1}}{\boldsymbol{2}}\left\|(\boldsymbol{Y_s}+\boldsymbol{K}\odot\boldsymbol{N}-\boldsymbol{RP_s^TX_s})\mathbf{Diag}(\boldsymbol{w})^{\boldsymbol{1/2}}\right\|_{\boldsymbol{F}}^{\boldsymbol{2}} \\ +\frac{\boldsymbol{\lambda_1}}{\boldsymbol{2}}\left\|\boldsymbol{X_t}-\boldsymbol{QP_t^TX_t}\right\|_{\boldsymbol{F}}^{\boldsymbol{2}}+\frac{\boldsymbol{\lambda_2}}{\boldsymbol{2}}\left\|\boldsymbol{P_t^TX_t}-\boldsymbol{P_s^TX_sZ}\right\|_{\boldsymbol{F}}^{\boldsymbol{2}}+\boldsymbol{\lambda_3}\|\boldsymbol{B}\|_{\boldsymbol{1}} \\ +\frac{\boldsymbol{1}}{\boldsymbol{2}}\boldsymbol{Tr}\left([\boldsymbol{P_s^T},\ \boldsymbol{P_t^T}]\begin{bmatrix}\boldsymbol{\lambda_4M_{ss}}+\boldsymbol{\lambda_5I} & \boldsymbol{\lambda_4M_{st}}-\boldsymbol{\lambda_5I}\\ \boldsymbol{\lambda_4M_{ts}}-\boldsymbol{\lambda_5I} & \boldsymbol{\lambda_4M_{tt}}+\boldsymbol{\lambda_5I}\end{bmatrix}\begin{bmatrix}\boldsymbol{P_s}\\ \boldsymbol{P_t}\end{bmatrix}\right) \\ +\frac{\boldsymbol{\rho}}{\boldsymbol{2}}\left[\|\boldsymbol{RP_s^T}-\boldsymbol{A}\|_{\boldsymbol{F}}^{\boldsymbol{2}}+\|\boldsymbol{Z}-\boldsymbol{B}\|_{\boldsymbol{F}}^{\boldsymbol{2}}+\|\boldsymbol{Y\alpha}-\boldsymbol{g}\|^{\boldsymbol{2}}+\|\boldsymbol{a}-\boldsymbol{\alpha}\|^{\boldsymbol{2}}\right] \\ +\boldsymbol{Tr}\left(\boldsymbol{U_1^T}(\boldsymbol{RP_s^T}-\boldsymbol{A})\right)+\boldsymbol{Tr}\left(\boldsymbol{U_2^T}(\boldsymbol{Z}-\boldsymbol{B})\right)+\boldsymbol{u_3^T}(\boldsymbol{Y\alpha}-\boldsymbol{g})+\boldsymbol{u_4^T}(\boldsymbol{a}-\boldsymbol{\alpha}) \\ \boldsymbol{s.t.}\ \ \boldsymbol{N}\geq\boldsymbol{0},\boldsymbol{Q^TQ}=\boldsymbol{I},\ \boldsymbol{0}\leq\boldsymbol{\alpha}\leq\boldsymbol{1}\end{gathered} \tag{18}$$

where U_1, U_2, u_3, and u_4 are Lagrange multipliers associated with the equality constraints and $\rho > 0$ is a penalty parameter. The optimization steps for each subproblem are as follows.

1) Update of P_s. The minimization problem with respect to Ps is formulated as

$$\begin{gathered} \mathbf{L_\rho(P_s)}=\frac{\boldsymbol{\lambda_2}}{\boldsymbol{2}}\left\|\mathbf{P_t^TX_t}-\mathbf{P_s^TX_sZ}\right\|_{\mathbf{F}}^{\mathbf{2}}+\frac{\boldsymbol{\rho}}{\boldsymbol{2}}\left\|\mathbf{RP_s^T}-\mathbf{A}+\frac{\mathbf{U_1}}{\boldsymbol{\rho}}\right\|_{\mathbf{F}}^{\mathbf{2}} \\ +\frac{\mathbf{1}}{\mathbf{2}}\mathbf{Tr}\left([\mathbf{P_s^T},\ \mathbf{P_t^T}]\begin{bmatrix}\boldsymbol{\lambda_4}\mathbf{M_{ss}}+\boldsymbol{\lambda_5}\mathbf{I} & \boldsymbol{\lambda_4}\mathbf{M_{st}}-\boldsymbol{\lambda_5}\mathbf{I}\\ \boldsymbol{\lambda_4}\mathbf{M_{ts}}-\boldsymbol{\lambda_5}\mathbf{I} & \mathbf{0}\end{bmatrix}\begin{bmatrix}\mathbf{P_s}\\ \mathbf{P_t}\end{bmatrix}\right)\end{gathered} \tag{19}$$

By setting the derivative $\frac{\partial L_\rho}{\partial P_s}=0$, we obtain the following:

$$\begin{gathered} \frac{\boldsymbol{\partial L_\rho}}{\boldsymbol{\partial P_s}}=(\boldsymbol{\lambda_2X_sZZ^TX_s^T}+\boldsymbol{\lambda_4M_{ss}}+\boldsymbol{\lambda_5I})\boldsymbol{P_s}+\boldsymbol{\rho P_sR^TR} \\ -\left((\boldsymbol{\lambda_2X_sZX_t^T}-\boldsymbol{\lambda_4M_{st}}+\boldsymbol{\lambda_5I})\boldsymbol{P_t^T}+\boldsymbol{\rho}\left(\boldsymbol{A}-\frac{\boldsymbol{U_1}}{\boldsymbol{\rho}}\right)^{\boldsymbol{T}}\boldsymbol{R}\right)=\mathbf{0}\,.\end{gathered} \tag{20}$$

P_s is essentially updated by solving a Sylvester equation.

2) Update of $\mathbf{P}_t$. The minimization problem with respect to P_t is formulated as

$$\boldsymbol{L_\rho(P_t)} = \frac{\lambda_1}{2}\left\|\boldsymbol{X_t - QP_t^T X_t}\right\|_F^2 + \frac{\lambda_2}{2}\left\|\boldsymbol{P_t^T X_t - P_s^T X_s Z}\right\|_F^2 + \frac{1}{2}\boldsymbol{Tr}\left([\boldsymbol{P_s^T},\ \boldsymbol{P_t^T}]\begin{bmatrix}\boldsymbol{0} & \boldsymbol{\lambda_4 M_{st} - \lambda_5 I}\\ \boldsymbol{\lambda_4 M_{ts} - \lambda_5 I} & \boldsymbol{\lambda_4 M_{tt} + \lambda_5 I}\end{bmatrix}\begin{bmatrix}\boldsymbol{P_s}\\ \boldsymbol{P_t}\end{bmatrix}\right) \quad \textbf{(21)}$$

By setting the derivative $\frac{\partial L_\rho}{\partial P_t} = 0$, we can update P_t as follows:

$$\boldsymbol{P_t = T_1^{-1} T_2} \quad \textbf{(22)}$$

where $T_1 = (\lambda_1 + \lambda_2)X_t X_t^T + \lambda_4 M_{tt} + \lambda_5 I$ and $T_2 = \lambda_1 X_t X_t^T Q + (\lambda_2 X_t X_t^T Q - \lambda_4 M_{ts} + \lambda_5 I)P_s$

3) Update of α. α can be updated by minimizing the following problem:

$$\boldsymbol{L_\rho(\alpha)} = \frac{u_4}{2}(\boldsymbol{\alpha^T V_{ss}\alpha - 2\alpha^T V_{st} 1_t}) + \frac{\rho}{2}\left[\|\boldsymbol{Y_s\alpha - g}\|^2 + \left\|\boldsymbol{\alpha - a} + \frac{u_4}{\rho}\right\|^2\right] \quad \textbf{(23)}$$

where V_{ss} is the coefficient associated with $(P_s^T X_s)^T P_s^T X_s$ and V_{st} is the coefficient associated with $(P_s^T X_s)^T P_t^T X_t$. By taking the derivative of Eq. (23) with respect to α and setting it to zero, its closed-form solution is obtained as follows:

$$\boldsymbol{\alpha = T_3^{-1} T_4} \quad \textbf{(24)}$$

where $T_3 = \lambda_4 V_{ss} + \rho Y_s^T Y_s + \rho I$ and $T_4 = \lambda_4 V_{st} 1_t + \rho Y_s^T\left(g - \frac{u_3}{\rho}\right) + \rho\left(a - \frac{u_4}{\rho}\right)$.

4) Update of a. a can be updated by minimizing the following problem:

$$\boldsymbol{L_\rho(a)} = \frac{\rho}{2}\left\|\boldsymbol{a - \alpha} + \frac{u_4}{\rho}\right\|^2, \quad \boldsymbol{s.t.\ 0 \le \alpha \le 1} \quad \textbf{(25)}$$

The optimal solution of Eq. (25) can be written as

$$\boldsymbol{a = min\left(1,\ max\left(a + \frac{u_4}{\rho}\right)\right).} \quad \textbf{(26)}$$

5) Update of R. The minimization problem with respect to R is formulated as

$$\boldsymbol{L_\rho(R)} = \frac{\rho}{2}\left\|\boldsymbol{RP_s^T - A} + \frac{U_1}{\rho}\right\|_F^2. \quad \textbf{(27)}$$

It can be easily derived that the closed-form solution of Eq. (27) is $\boldsymbol{R = \rho\left(A - \frac{U_1}{\rho}\right)P_s^{T^{-1}}}$. In order to calculate the matrix inversion in a stable way, we rewrite R by

$$\boldsymbol{R = \rho\left(A - \frac{U_1}{\rho}\right)P_s(\rho P_s^T P_s + \tau I)^{-1}} \quad \textbf{(28)}$$

where τ is a small positive constant.

6) Update of A. The minimization problem with respect to A is formulated as

$$\boldsymbol{L_\rho(A) = \frac{1}{2}\left\|(Y_s + K \odot N - RP_s^T X_s)\mathbf{Diag}(w)^{1/2}\right\|_F^2 + \frac{\rho}{2}\left\|RP_s^T - A + \frac{U_1}{\rho}\right\|_F^2} \quad \textbf{(29)}$$

By setting $\frac{\partial L_\rho}{\partial A} = 0$, we can update A as follows:

$$\boldsymbol{A = T_5 T_6^{-1}} \quad \textbf{(30)}$$

where $T_5 = (Y_s + K \odot N)\text{Diag(w)}X_s^T + \rho\left(RP_s^T + \frac{U_1}{\rho}\right)$ and $T_6 = X_s\text{Diag(w)}X_s^T + \rho I$.

7) Update of Q. The minimization problem with respect to Q is formulated as

$$\boldsymbol{L_\rho(Q) = \frac{\lambda_1}{2}\left\|X_t - QP_t^T X_t\right\|_F^2} \quad \textbf{(31)}$$
$$s.t.\ Q^T Q = I$$

This is actually the case of orthogonal procrustes problem, whose optimal solution is given by the following:

$$\boldsymbol{Q = UV^T,} \quad \textbf{(32)}$$

where the matrices U and V can be computed via the singular value decomposition (SVD) of matrix $\text{X}_\text{t}(\text{P}_t^\text{T}\text{X}_\text{t})^T$ as follows:

$$\boldsymbol{\mathbf{SVD}(X_t(P_t^T X_t)^T) = U\Sigma V^T} \quad \textbf{(33)}$$

8) Update of N. N can be updated by minimizing the following problem:

$$\boldsymbol{L_\rho(N) = \frac{1}{2}\|Y_s - K \odot N - AX_s\|_{wF}^2 \quad s.t.\ \ N \geq 0} \quad \textbf{(34)}$$

The optimal solution of N can be written as

$$\boldsymbol{N = max(0, (AX_s - Y_s) \odot K).} \quad \textbf{(35)}$$

9) Update of Z. The minimization problem with respect to Z is formulated as

$$\boldsymbol{L_\rho(Z) = \frac{\lambda_2}{2}\left\|P_t^T X_t - P_s^T X_s Z\right\|_F^2 + \frac{\rho}{2}\left\|Z - B + \frac{U_2}{\rho}\right\|_F^2} \quad \textbf{(36)}$$

By setting $\frac{\partial L_\rho}{\partial Z} = 0$, we can update Z as follows:

$$\boldsymbol{Z = T_7^{-1} T_8\,,} \quad \textbf{(37)}$$

where $T_7 = \lambda_2 X_s^T P_s P_s^T X_s + \rho I$ and $T_8 = \lambda_2 X_s^T P_s P_t^T X_t + \rho(B - \frac{U_2}{\rho})$.

10) Update of B. B can be updated by minimizing the following problem:

$$\boldsymbol{L_\rho(B)} = \boldsymbol{\lambda_3}\|\boldsymbol{B}\|_1 + \frac{\boldsymbol{\rho}}{2}\left\|\boldsymbol{Z} - \boldsymbol{B} + \frac{\boldsymbol{U_2}}{\boldsymbol{\rho}}\right\|_F^2 \quad \textbf{(38)}$$

According to the shrinkage operator, the problem (38) has the following solution:

$$\begin{aligned} \boldsymbol{B} &= \textbf{shrink}(\boldsymbol{Z} + \frac{\boldsymbol{U_2}}{\boldsymbol{\rho}}, \frac{\boldsymbol{\lambda_3}}{\boldsymbol{\rho}}) \\ &= \textbf{signmax}(\mathbf{0}, \left|\boldsymbol{Z} + \frac{\boldsymbol{U_2}}{\boldsymbol{\rho}}\right| - \frac{\boldsymbol{\lambda_3}}{\boldsymbol{\rho}}) . \end{aligned} \quad \textbf{(39)}$$

11) Update of $\boldsymbol{U_1}$, $\boldsymbol{U_2}$, $\mathbf{u_3}$, $\mathbf{u_4}$, and $\boldsymbol{\rho}$. Lagrangian multipliers $\boldsymbol{U_1}$, $\boldsymbol{U_2}$, $\mathbf{u_3}$, $\mathbf{u_4}$, and penalty parameter ρ are updated by the following equations:

$$\begin{aligned} \boldsymbol{U_1} &= \boldsymbol{U_1} + \boldsymbol{\rho}(\boldsymbol{R}\boldsymbol{P_s^T} - \boldsymbol{A}) \\ \boldsymbol{U_2} &= \boldsymbol{u_2} + \boldsymbol{\rho}(\boldsymbol{Z} - \boldsymbol{B}) \\ \boldsymbol{u_3} &= \boldsymbol{u_3} + \boldsymbol{\rho}(\boldsymbol{Y_s}\boldsymbol{\alpha} - \boldsymbol{g}) \\ \boldsymbol{u_4} &= \boldsymbol{u_4} + \boldsymbol{\rho}(\boldsymbol{\alpha} - \boldsymbol{a}) \\ \boldsymbol{\rho} &= \boldsymbol{min}(\boldsymbol{\delta\rho}, \boldsymbol{\rho_{max}}) , \end{aligned}$$

where $\delta > 1$ and ρ_{max} are settings for the update of ρ.

EXPERIMENTS

To verify the performance of the proposed method, we conducted extensive experiments on several benchmark datasets in this section.

Experimental settings

Table 1. Experimental data description.

Dataset	Type	Domain	Feature	#Feature	#Sample	#Class
CMU-PIE	Face	C05 (left pose), C07 (upward pose), C09 (downward pose), C27 (front pose), C29 (right pose)	SURF	1,024	41,368	68
Office-10	Object	Amazon (A), DSLR (D), Webcam (W),	DeCAF6	4,096	1,410	10

Caltech-10	Object	Caltech (C)	DeCAF6	4,096	1,123	10

As shown in Table 1, the CMU PIE dataset has 41,368 face images from 68 subjects. All images were captured under different poses, illumination, and facial expressions. All images were resized to 32×32 pixels in our experiments. The five subsets with different poses were chosen i.e., C05 (left pose); C07 (upward pose); C09 (downward pose); C27 (front pose); and C29 (right pose). Thus, there are 20 cross-domain classification tasks in total, i.e., C05→C07, ⋯, and C29→C27.

The Office dataset contains more than 4,000 images from 31 object categories in which each instance came from either Amazon (A, Amazon.com), DSLR camera (D, Digital single-lens-reflex), or Webcam (W, Web camera). Following previous works [6, 8, 9], we selected ten classes from Amazon (A), DSLR (D), and Webcam(W).

Caltech dataset includes 30,607 images and 256 categories. As the objects share same categories but have different distributions with the Office dataset, we chose images of ten common classes from the original Caltech (C) dataset. Then we performed experiments with the Office-Caltech dataset consisting of Office and Caltech datasets. Using four domains in total, we constructed the cross-domain tasks as A→C, ⋯, and W→D.

Table 2. Classification accuracy on CMU-PIE dataset

Source	Target	TSL [18]	RDALR [7]	LRSR [15]	RMTL [19]	ALML [17]	JMFR [20]	LPJT [8]	Ours
C05	C07	44.1	40.8	65.9	64.8	63.9	46.5	70.2	81.8
	C09	47.5	41.8	64.1	63.9	63.8	73.8	68.5	80.4
	C27	62.8	59.6	82.0	82.3	83.4	95.9	88.4	96.2
	C29	36.2	29.4	54.9	55.6	61.2	21.9	60.5	69.4
C07	C05	46.3	41.8	45.0	50.2	52.6	62.9	72.2	83.9
	C09	57.6	51.5	53.5	54.3	58.4	76.3	75.1	75.8
	C27	71.4	64.7	71.4	72.0	77.0	92.2	86.0	93.8
	C29	35.7	33.7	48.0	47.7	48.8	43.0	60.7	75.2
C09	C05	36.9	34.7	52.5	52.8	59.7	66.8	72.2	78.9
	C07	47.0	47.7	55.6	58.0	58.3	72.4	72.5	79.6
	C27	59.5	56.2	77.5	77.4	78.6	96.3	88.7	88.3
	C29	36.3	33.2	54.1	55.2	59.0	61.3	68.7	74.5
C27	C05	63.7	55.6	81.5	84.5	84.3	95.3	92.6	96.2

	C07	72.7	67.8	85.4	85.9	86.6	95.0	95.0	93.7
	C09	83.5	75.9	82.2	80.0	84.7	97.1	94.2	88.9
	C29	44.8	40.3	72.6	73.0	72.3	78.6	82.2	86.8
C29	C05	33.3	27.0	52.2	54.4	60.1	42.2	64.8	75.5
	C07	34.1	29.9	49.4	46.5	51.4	47.6	59.2	71.2
	C09	36.6	29.9	58.5	62.1	61.6	56.6	69.2	74.2
	C27	38.8	33.6	64.3	66.1	70.6	91.9	78.7	89.8
Average		49.4	44.8	63.5	64.3	66.8	70.7	76.0	82.7

From the results of Table 2, we can see that the proposed method obtained the best performance on CMU-PIE dataset in terms of average classification accuracy among all the comparison methods. In particular, RTSL obtained 14 out of the 16 highest outcomes in the cross-domain tasks. This is because our RTSL considered both discriminative information and sample reweighting but also incorporated them into a unified optimization problem.

Table 3. Classification accuracy on Office-Caltech dataset

Source	Target	GFK [4]	JDA [12]	JGSA [22]	DICD [9]	LPJT [8]	ACE [6]	Ours
A	D	82.2	80.3	88.5	83.4	86.0	86.0	89.8
	W	70.9	78.3	81.0	81.4	79.7	87.8	89.5
	C	79.2	83.6	84.9	86.0	85.3	84.5	86.1
D	A	76.3	91.7	92.0	92.2	92.4	91.9	92.1
	W	99.3	99.7	99.7	99.0	100	100	100
	C	71.4	85.5	86.2	86.1	86.5	86.3	89.0
W	A	76.8	90.3	90.7	89.7	88.9	92.3	93.5
	D	100	100	100	100	100	100	100
	C	69.8	84.8	85.0	84.0	84.0	84.5	86.4
C	A	88.2	89.6	91.4	91.0	91.4	92.1	92.3
	D	86.6	89.8	92.6	93.6	89.2	88.5	92.4
	W	77.6	85.1	86.8	92.2	84.4	89.5	100
Average		81.5	88.2	90.0	89.9	89.0	90.3	92.6

Table 3 presents the experimental results for Office-Caltech dataset. It can be seen that the classification performance of our method is better than other existing domain adaptation methods. In summary, we observed that RTSL can effectively narrow domain gap between source and target domains.

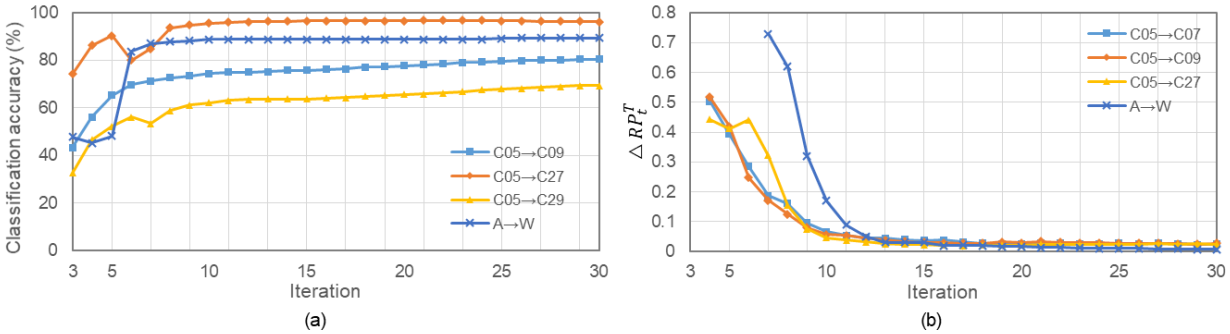

Figure 2. Convergence curves

In Figure 2, convergence curves of the ADMM-based domain adaptation are shown, which verify the behavior of the proposed method over iteration progression. For some classification tasks in CMU-PIE and Office-Caltech datasets, we plotted the accuracy and the parameter change rate, defined by $\triangle RP_t^T = \left\| R^{(k)} P_t^{T(k)} - R^{(k-1)} P_t^{T(k-1)} \right\|_F / \left\| R^{(k-1)} P_t^{T(k-1)} \right\|_F$. It can be observed that all tasks are converged well within 20 iterations.

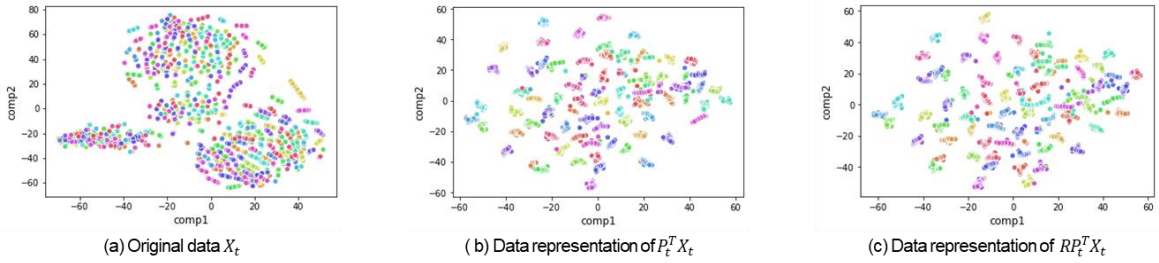

Figure 3. t-SNE visualization on CMU-PIE (C05→C07)

Figure 3 shows an illustration of two-dimensional visualization based on t-SNE for verifying our method. As shown in Figure 3, original instances in target domain are not clearly separable by class, which results in poor performance. On the other hand, the instances projected into the subspace by RTSL did not overlap each other. In addition, it was confirmed that the final model learned from the data representations has good classification performance.

CONCLUSIONS

In this paper, we propose a novel method for unsupervised domain adaptation, denoted by RTSL, which learns robust and discriminative feature transforms. RTSL achieves domain adaptation which covers following three aspects: 1) learning a weighted discriminative

regression model 2) preserving the target structural information in the subspace 3) extracting weighted domain-invariant features. These problems are incorporated into a single optimization, which is then solved using ADMM. To verify the effectiveness of our method, extensive experiments on a variety of benchmark datasets were conducted. The experimental results show that RTSL achieves the state-of-the-art performance.

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The Global Economy's Intangible Shift &

The Resulting Need to Attain, Utilize, & Protect Intangible Assets

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Abstract

As the global presence of an intangible economy grows, more multinational corporations are investing in and benefiting from the acquisition of intangible assets (IAs). As IAs and telecommunication networks become commonplace amongst global firms the products of IAs and telecommunication become consumer commodities, creating a new technological and electronic market worldwide. As the number of businesses and consumers seeking new forms of IAs grows, so does the necessity for corporations to develop, invest in, and utilize IAs to maintain a global competitive advantage.

In an increasingly competitive technological market, to gain maximum profits from IAs corporations must recognize the risks involved with keeping IAs secure from threats such as hackers and sites that would seek to claim the IAs for their own benefit. These corporations need to take precautionary measures such as the trademarking of IAs to avoid losses within the worldwide intangible economic climate. The need for the acquisition, utilization, and protection of IAs to maintain a global presence and competitive advantage has increased in the aftermath of the global Covid-19 pandemic.

Keywords: intangible asset (IA), telecommunication, competitive advantage, trademarking

Introduction

In their article "Excellence in the Electronics Industry: The Comparison of the Organizational Culture among Apple Inc., Samsung Electronics, and Google Inc.", Meirui Piao and Brian Kleiner point out that the technology industry has expanded significantly in recent years. According to Piao and Kleiner, "The development of the high-technology industry allows people to communicate over long distance . . .[and] to know better about the world and make [their lives] better" [8]. Because of this the electronics and technological service industry market has exploded with new possibilities, demand, and interest with various consumers purchasing electronic devices and the services provided for their use from various companies. Furthermore, advancements in microprocessors over the past three decades have led to increased usage of the Internet as a global manufacturing, data acquisition, and marketing platform for various global businesses. The push from both consumers and businesses for advancements in technology has led to an increased presence of intangible assets in international trade. As defined in "The Intangible Shift" by Lamb and Munro, Intangible Assets (IAs) are assets and resources that do not have a concrete physical existence but that can potentially generate long-term economic value [6]. Some examples of IAs include data, digital services, brand features, design and marketing, relationships, and expertise.

Recent advances in IAs have embedded them as vital factors in manufacturing and marketing processes. The widespread utilization of IAs in tangible and intangible product manufacturing as well as service industries has led to a fast-paced global market where competitive advantages depend upon the purchase and utilization of IAs by the corporations of developed and developing nations. The widespread utilization of IAs has brought to light the risks associated with investing in IAs and the need for companies to properly protect owned IAs.

The necessity for the acquisition, utilization, and protection of IAs has grown due to the recent Covid-19 pandemic.

Consumer Needs Drive The Intangible Asset Marketplace

As Piao and Kleiner indicate, consumer usage of technology and its related services has grown in recent decades [8]. As consumers have purchased more smartphones, personal computers (PCs), laptops, and other electronic devices from large retailers such as Apple, Inc., Samsung Electronics, and Hewlett-Packard, so too have consumers invested in more streaming services than in prior years to further increase the comfort felt in their daily lives.

Since Covid-19, many consumers have shifted from former ways of viewing media and entertainment to methods that involve remaining in the parameters of their homes. According to "Streaming services have accelerated during Covid-19. Will this continue?" by Tasneem-Azim-Khan, there has been a marked rise in the use of streaming services during the global pandemic [12]. Even after lockdowns were lifted for the Covid-19 pandemic, consumers have proven to prefer viewing movies not in theaters but via online streaming services such as Netflix, Hulu, Disney +, HBO Max, Amazon Prime, Apple TV+, Paramount +, and Peacock, paying a monthly fee for each service or for multiple services in the form of a bundle to watch films on or after their official release dates from the comfort of their homes [12]. As they have utilized these streaming services, many consumers have abandoned cable tv as well, preferring to receive their TV-related programing and news information from News websites, YouTube, and the previously mentioned streaming services [12]. Additionally, rather than go to concerts and stores to listen to and purchase music from their favorite bands and musicians, many have turned to electronic streaming services such as Band Camp, Apple Music, Spotify, and Amazon Music. The shift in consumers towards streaming services afforded to them via their personal electronic devices has been accompanied

with increased consumer dependency on social media such as Facebook, Instagram, and Twitter along with increased usage of online shopping platforms like Amazon.com.

As stated in "The Importance of Innovation in Business" by Will Purcell, due to these consumer market shifts various intangible asset service providers have had to increase their competitive advantages in the marketplace to try to profit from the growing target market of the electronic service industry [9]. In the process, many providers have been driven to develop and utilize innovative service designs to maintain their advantages [9]. For these companies, developing the latest intangible service asset features is imperative.

The Need for Intangible Assets Permeates Tangible Asset Markets

Not only do intangible asset service providers need to utilize innovative production methods to create intangible assets for consumers, tangible asset manufacturers must also utilize IAs to increase their production of and profit from tangible assets. To engage in global markets, manufacturers need to utilize innovative and efficient production methods to provide goods and services to consumers. According to Lamb and Munro, intangible assets involved in data analysis and R&D (research and development) can create innovative strategies for acquiring resources necessary for production and providing manufacturing process models that generate greater value at lower cost for corporations [6]. In these scenarios, the efficient strategies formed using IAs dictate manufacturing and resource acquisitions that can assist corporations in maximizing global profits.

According to Hill and Hult in *Global Business Today,* as corporations follow these models engage in a global production approach, taking advantage of the different qualities and availabilities of their factors of production in various nations, the need to maintain a level of control over their complex system of conducting business arises [5]. This need makes it

necessary for corporations to further develop and utilize IAs to create a telecommunication network and control infrastructure to maintain company standards and coordinate the transportation and manufacturing of goods across borders.

Advances in microprocessors and semiconductors have increased the ability of corporations to improve their marketing strategies as well as their manufacturing strategies. According to *Global Business Today, "*The Internet [a widely used IA] makes it much easier for buyers and sellers to find each other, wherever they may be located and whatever their size" [5]. The online platforms made available worldwide by microprocessors enable a seamless and straightforward process for performing global business transactions.

Intangible asset programs also provide corporations with important marketing data. As stated in "Advertising Benefits from Ethical Artificial Intelligence Algorithmic Purchase Decision Pathways", by gathering data from artificial intelligence (AI) systems and utilizing marketing algorithms, companies can determine what customers need and expect regarding their products as well as which advertising methods are most effective in reaching their target audience [10]. By properly utilizing online platforms, companies can expand the size of their customer base as well as utilize the information garnered through these platforms to coordinate effective marketing and advertising strategies on a global scale.

When Intangible Assets Can Be Bought and Sold

Intangible assets can also provide corporations with profit through the direct sale or licensing of IAs. As stated by Murray in "Making Intangible Assets Work for Your Business", by selling IA processes, products, algorithms, or services, corporations can then gain royalties from the utilization of their developed or acquired IAs by other businesses [7]. This aspect of global IA trade enables corporations to benefit from the use of their IAs as they are utilized by

and sold to other companies. In this scenario IAs are not just guiding corporate production and marketing. They are the product and the success experienced by the IAs is the advertising strategy being utilized.

Intangible Assets-A New Investment Opportunity

Due to the rising popularity and need for IAs both by the general public and corporations seeking to expand their services, the investment in and utilization of intangible assets has become commonplace for companies and countries seeking to maintain competitive advantages in foreign markets. As Goldfinger observes in his article "Intangible Economy and its Implications for Statistics and Statisticians":

> The economic landscape is no longer molded by physical flows of material goods and products but by intangible streams of data, images and symbols. The source of economic value and wealth is no longer the production of material goods but the creation and manipulation of dematerialized content. [4]

In response to the growing trend towards intangible economies, Lamb and Munro emphasize the need for firms to invest in intangibles to experience the quick growth and substantial productivity improvements synonymous with IA investment[6]. In the growing global market, acquisition and investment regarding IAs are key factors for continued economic growth and profit.

An added benefit regarding intangible assets is the amount of profit that their utilization can offer developed countries that are able to outsource their service industries to developing nations. With the new emphasis in the global economy on intangible assets, the service sector has increased its influence in the world trade market to 22.1% as of 2020[2]. Many firms outsource their service jobs to other nations, providing a form of income for the laborers of developing nations and greater profit for their individual corporations [5]. The extent to which

outsourcing can be utilized today has been made possible by IA improvements in telecommunication.

Developing nations are also taking the initiative and pursuing their own service industries by utilizing IAs. This is the case in Aruba, where the pursuance of intangible industries as opposed to tangible industries is of crucial importance to the island nation's continued economic growth. According to the article "Supply services: the shift from tangible to intangible goods", handling the trade in tangible goods from island nations is more expensive than handling tangible trade from larger countries, making tangible economies less profitable [1]. By taking advantage of their educated labor force and multilingualism, Aruba has gained a competitive edge in intangible service and hospitality markets [1]. The growth of the Aruba free zone's intangible economy and service industry is just one example of how developing nations can gear themselves towards IA success in the presence of physical and political barriers regarding international trade of tangible goods.

With IA Advantages Come IA Risks

As corporations invest in intangible assets, they run the risk of leakage and theft regarding their IAs to competitors. This potential theft is spawned from ill-protection of their intellectual property when entering alliances, interacting with consumers, and training employees. Two sorts of entry strategies within which companies risk losing control over their IAs are joint ventures with similar firms and the licensing of their IAs to other businesses. As stated in *Global Business Today,* both strategies involve the transferring of information and technology from one firm to another, thus putting any IAs vital to an organization's success at risk of being stolen or copied [5]. Other companies may attempt to use the IA processes and products in ventures independent from those engaged in with the intangible assets' original

corporation, thus reducing the competitive advantage held by the parent corporation. Employees and consumers who are exposed to the IA processes and products of a corporation may decide to do the same, adapting and utilizing IAs to achieve their own goals within a chosen industry [3]. By lacking in physical presence, intangible goods run a higher risk of leakage and theft when compared to tangible goods.

Another risk that corporations encounter regarding expansion in intangible industries is the hazardous use of open-source code software. As software is an essential part for most intangible industry ventures, the fact that 80% of software codes utilized in the IA industry are open-source codes can be detrimental to corporations attempting to utilize them [3]. The three main risks associated with the use of open-source code software is that the software's ownership can be questionable, the license terms of open-source code software can be poisonous when combined with the proprietary codes of other companies, and open-source code is an effective way of getting malicious codes such as hacks or trojans into a proprietary source code base [3]. Because of these risks, the process of utilizing software to promote company success regarding IAs can cause more damage than profit if proper safeguards are not put in place.

When Risks Rise So Too Could Trademarking Licenses

Given the listed risks regarding IAs, it follows that there is a need for the protection of intangible assets. A primary way to navigate an intangible economy safely is to engage in trademarking practices regarding intangible property. In *Global Business Today*, it is pointed out that protecting intellectual property in the current high technology and "knowledge" driven economy has become increasingly problematic, primarily when IAs can be reduced to digital forms and then copied and distributed at low cost to various companies and individuals [5]. The three main ways to insure and secure ownership over intellectual property are through patents,

copyrights, and especially trademarks [5]. Even with these protective measures in place companies should still decide to perform business primarily in countries known to uphold intellectual property rights within their borders.

In addition to creating trademarks for their intangible assets, other steps are required to ensure the security and future profitability of intangible economic ventures. These steps are outlined in "The accelerated shift to intangible assets and how to protect them". The steps begin with businesses developing the ability to assess and quantify IA values and identifying the events and risks that could cause major IA-related incidents [13]. Once said events are identified the business should then assess the likelihood of said events occurring and what the tangible impact of the events could be for the company [13]. Next the business should consider which controls are in place or could be deployed to protect the IAs and the business's position in the global economy, whilst understanding the residual exposures and impacts that still exist even with these controls in place [13]. By following these steps, companies can proactively maintain security and control of their intellectual and intangible property against theft and leakage. By following these steps companies could also put safeguards and firewalls in place to protect against the hazards of open-source code software.

Covid-19 Increases the Need to Utilize and Protect Intangible Assets

In the past three years, the world has experienced a shift in its global marketplace as trends have moved further away from tangible economies and towards intangible economies. According to the World Economic Forum, the recent Covid-19 global pandemic has further increased the growth of intangible economies. The primary way that Covid-19 has increased the global presence of IAs is through the physical distancing efforts which have altered corporate culture and called for more telecommunication methods to be developed and employed amongst

companies [11]. Furthermore, Covid-19 has encouraged the radical transparency that comes with the exchange of information within intangible platforms as well as a reckoning of workers' rights, leading companies to prioritize intangible approaches in manufacturing and marketing [11]. These changes have caused multiple companies to reassess and re-strategize regarding their movements within global markets, increasing their need to invest in IAs.

Conclusion

Given the worldwide movement towards intangible economies, the need to invest in IAs and reap the benefits found in the intangible industry are paramount to those wishing to succeed in the current post-pandemic global business environment. As the popularity of IA investment has grown, both developed and developing nations are employing IA strategies to maintain competitive advantages in various industries. With the increased usage of IAs, the requirement of incorporating risk-management practices such as trademarking IAs to prevent intellectual property theft between companies and their competitors along with safeguards to protect assets and resources critical for economic growth in the changing business environment has become of prevalent importance.

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Papers: Scholarly Journal Editors Panel

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Larry Clark

Chancellor- LSU Shreveport

Larry Clark became Chancellor of LSU Shreveport on July 1, 2014. Prior to this, Clark was Dean of the business schools at UNC Wilmington, 2000-2014, Sonoma State University, 1994-2000, and LSU Shreveport, 1985-1994.

Clark's academic background is in law- he has a Juris Doctorate and a L.LM. in Taxation. His professional publications include having been the lead author of **Law and Business: The Regulatory Environment**, a textbook with four editions with McGraw-Hill. Prior to academia, Clark was an Army Captain/Judge Advocate (lawyer).

LSU Shreveport's Spring 2023 enrollment, after enrollment in the second term, will be nearly 8,500 students. Over the past decade, LSUS has emerged as a national leader in online learning, including with nearly 6,000 online students, led by our MBA Program. Concerning face-to-face students, this academic year LSUS has students on-campus from 34 states and 47 different countries. As most universities, LSUS is focused on following the advice of hockey great Wayne Gretsky "to focus on where the hockey puck is going." To help give lift to this goal, LSUS has established a multi-disciplinary Cyber Collaboratory, that links well to discipline learning represented by the SEDSI.

On June 30th of this year, Clark will retire as Chancellor of LSUS. However, he expects to continue to teach at least one business course per year for the foreseeable future.

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Call for Papers:
Sustainable Human Systems Management in Post COVID-19 Era

Human Systems Management (**HSM**) seeks submissions for a special issue on
Post-Pandemic Human Systems Management:
Equity, Inclusion, Resilience, Risk and Sustainability for the Future

The unprecedent level of challenges for managing human systems in the post COVID-19 era poses many opportunities for academia and practitioners. This calls for further research in theories and applications to explore how to sustainably manage human systems. This special issue (SI) aims to contribute to this effort in collaboration with the 52nd Annual Conference of Southeast Decision Science Institute (SEDSI). The topics of the SI will be of particular interest in the context of the post pandemic era as there have been ongoing efforts to refine and re-define the management of human systems through the lens of equity, inclusion, and sustainability. While some of the papers published in this SI are expected to be presented at the 2023 SEDSI conference, we solicit submissions that are not connected with the conference but are within the scope of this SI. Papers are invited from a wide range of fields of research and applications impacting business and society. Topics of the SI may include (but are not limited to):

- Resilience and disruption management
- Risk management
- Public health
- Humanitarian operations
- Not for profit management
- Global supply chain
- Information systems
- Information security
- Organizational communication
- Innovative use of technology
- Data analytics and business intelligence
- Organizational strategy
- Human resource management
- Consumer behavior and innovative marketing
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Human Systems Management (**HSM**) is an interdisciplinary, international, refereed journal, offering applicable, scientific insight into reinventing business, civil-society and government organizations, through the sustainable development of high-technology processes and structures. Adhering to the highest civic, ethical and moral ideals, the journal promotes the emerging anthropocentric-sociocentric paradigm of societal human systems, rather than the pervasively mechanistic and organismic or medieval corporatism views of humankind's recent past.

Before submission, authors should carefully go through the Author Guidelines (https://www.iospress.com/catalog/journals/human-systems-management#author-guidelines). The review process will follow the journal's practice. Authors are requested to submit their manuscript electronically to the journal's Editorial Management System

(www.editorialmanager.com/hsm). The manuscript should be uploaded as one file with tables and figures included. The submitted files must be editable (e.g. MS word). Please use the journal's manuscript template.

Important dates:
• Manuscript submission deadline: 31st May, 2023
• Notification* of first decision: 31st August, 2023
• Revised version submission deadline: 15th October, 2023
• Notification of final decision: 31st January, 2024
• Expected publication date: Spring 2024

* The author(s) may be notified earlier if the manuscript is not within the scope of the special issue.

If any additional information is needed, please contact the Special Issue guest editors.

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International Journal of Management and Enterprise Development

SEDSI2023: Special Issue on: "New Paradigms for Management and Enterprise Development in Uncertain Times"

Guest Editors:
Dr. Ping Wang, Dr. Elham Torabi and Dr. Yuyun Zhong, James Madison University, The United States
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In the past few years, the COVID-19 pandemic imposed serious challenges for businesses across all industries. Many businesses found these challenges a wake-up call to pursue new paradigms in enterprise development and management under uncertainty. Therefore, further research in theories and applications is needed to help organisations restore in the post-COVID-19 era and its innate uncertainties and build up more resilience to mitigate future risks.

The topics of the SI will be of particular interest in the context of the current pandemic as there have been ongoing efforts to refine and re-define issues related to management and enterprise development through the lens of equity, inclusion, and sustainability. The Guest Editors will be inviting substantially extended versions of selected papers presented at the Southeast Decision Sciences Institute 52nd Annual Conference (SEDSI2023), for review and potential publication, but are also inviting other experts to submit articles for this call.

Subject Coverage
Suitable topics include, but are not limited, to the following:

- SMEs' start-up development, corporate venturing
- Technological opportunities, new firm creation, valuation
- Technological adoption, technology transfer and technopreneurship
- Joint ventures/alliances, franchising, and corporate ownership
- Business incubator development strategy
- Economic and social entrepreneurship
- Virtual coaching services for SMEs
- SMEs and entrepreneurship policy
- Start-up cognitions/behaviours
- Halo effect, technology licensing
- Long-run technology investments
- Knowledge management/technology strategy in SMEs
- Managing rapid growth, accelerating competitive effectiveness
- Strategy decision speed and SME performance
- Entrepreneurs in non-profit sectors
- Resilience and disruption management
- Risk management
- Public health
- Not for profit management
- Humanitarian operations
- Operations management
- Global supply chain and logistics
- Hospitality, recreation, and sports management
- Information systems
- Information security
- Innovative use of technology
- Data analytics and business intelligence
- Organisational strategy
- Organisational behaviour
- Human resource management
- Consumer behaviour and innovative marketing
- Equity and sustainability
- Innovative education and training

Notes for Prospective Authors
Submitted papers should not have been previously published nor be currently under consideration for publication elsewhere. (N.B. Conference papers may only be submitted if the paper has been completely re-written and if appropriate written permissions have been obtained from any copyright holders of the original paper).

All papers are refereed through a peer review process.

All papers *must* be submitted online. To submit a paper, please read our Submitting articles page.

Important Dates
Manuscripts due by: *31 May, 2023*

Notification to authors: *31 August, 2023*

Final versions due by: *30 November, 2023*

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Quality Engineering aims to promote a rich exchange among the quality engineering community by publishing papers that describe new methods ready for immediate industrial application or novel examples of employed techniques.

Some facts about

The Maria Curie-Skłodowska University in Lublin is the largest public university in Eastern Poland. We are an institution deeply rooted in the region, where since 1944, we have been acting as a cultural and opinion-forming factor, and we have made a significant contribution to building a knowledge-based economy. Nearly 260 thousand graduates have completed our Alma Mater. Some facts about us:

- The largest public university in Eastern Poland, stablished in 1944
- 13 Faculties with over 18 000 students
- 2 800 academic and administration staff
- About 1 800 international students
- Nearly 80 fields of studies and over 250 specializations
- Almost 150 research groups, including both – student and doctoral organizations
- A wide range of national and international exchange
- Over 182 agreements on scientific and educational cooperation with foreign partners
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Dr. Zbigniew Pastuszak, associate professor
Vice Rector for Development and Business Cooperation
Chairman of the Lublin Social and Economic Development Council, Lublin City Mayor
Chairman of the Economics and Management Committee of the Polish Academy of Sciences, Lublin branch, PAN O/Lublin

Main area of responsibility: To create a platform of cooperation among university, business, and administration is a particularly demanding task for all these parties relations-wise. To establish mutual relations, to understand partners’ needs, to ensure effective communication, to find ways to create interdisciplinary teams: these are some of the challenges that need to be faced in this work. The effects of scientific and research work should translate into social and economic development as well as contributing to the rising prosperity and quality of social life. This goal is within reach but only when the relations between the academia and business are rested upon mutual trust and understanding and are integrated into efficient social processes.

The UMCS Rector's Council consists of the Rector and 4 Vice-Rectors. Prof. Zbigniew Pastuszak is responsible for supervising, among others: activities related to the planning and implementation of the university budget, implementation of university development projects, commercialization of scientific research results, computerization of the university and cooperation with other universities and business environment. Prof. Pastuszak earned his master degree from Lublin University of Technology (Flexible Manufacturing Systems and production management), and Habilitation degree (post-doctoral) from Warsaw University (Management Information Systems, e-business management). His research background includes value networks management, e-business reception, net readiness and multichannel logistics. He serves also as the: Head of the Information Management and Logistics Department. His editorial activities are as follow: Associate Editor, Expert Systems with Applications; Editor in Chief, International Journal of Management and Enterprise Development; Editor in Chief, International Journal of Value Chain Management, Program Chair, Conference Board Member, MakeLearn & TIIM Joint Conference, Deputy Editor, ToKP – ToKnowPress, International Academic Publisher Bangkok-Celje-Lublin as well as Elsevier, Emerald, IEEE Computer Society and Inderscience reviewer.

Papers: College / School Deans Panel

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Papers: Department Heads Panel

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Papers: Post COVID-19 Academia: Special Topics on Instructions and Research (Online, Hybrid, and/or Face-to-Face)

A POST COVID-19 ACADEMIC ENHANCEMENT OF STUDENT UNDERSTANDING OF TYPE II ERROR EXAMPLE IN CLASSICAL HYPOTHESIS TESTING USING A FALSE NEGATIVE RESULT IN A DIAGNOSTIC COVID-19 TEST

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ABSTRACT

The transmission of a novel coronavirus known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that causes COVID-19 among college students has been an ongoing challenge for universities throughout the world. Student understanding of COVID-19 test results is critical to curtailing the spread of the virus and protecting oneself and others from infection. Specifically, student understanding of the risks of type II error (false negative) and the consequence of ignoring this risk has the potential to prolong the pandemic on university campuses. The focus of this research is on development of a teaching methodology in an "Introduction to Statistics" course to help students better understand the risks and consequences of a type II error in a diagnostic test for COVID-19. An example scenario will be created and utilized to demonstrate how a type II error (false negative) can occur and the risks and implications of this error. The practical nature of the example helps students identify with and understand type II error and how it relates to statistical testing and decision making.

Keywords: Type II Error, COVID-19, False Negative, Hypothesis Testing

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Covid-19 Ineffective Management in Technostress and Its Impact on Higher-Ed Student Learning Body

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Abstract

Nonpharmaceutical interventions (NPIs) became globally enforced safety practices during the Covid-19 pandemic. In compliance with NPIs, higher-ed systems shifted from offering Face-to-Face, Hybrid, and Online courses to only offering the latter to their student bodies. Many students experienced elevated levels of technostress while transitioning to an online platform, which, unfortunately, was shown to produce adverse student learning outcomes.

This study identifies existing technostress contributors and their academic impact on student learning outcomes. A sample from Middle Georgia State University's student population examines the effects of technostress. The data gathered will help define and implement strategies for managing the effects of technostress in higher-ed, leading to improvements in student learning outcomes.

Covid-19 Mental Stressors and Its Impact on Higher-Ed Student Body Groups

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Abstract

During the Covid-19 pandemic, nonpharmaceutical interventions (NPIs) became globally enforced safety practices. Common NPIs practices included social distancing and isolation tactics designed to limit the spread of the Covid-19 virus and its variants. As a result of worldwide NPI implementation, multiple higher-ed student body groups experienced mental stressors that impeded their academic performances and abilities to maintain a healthy lifestyle. This study identifies significant mental stressors prevalent during the Covid-19 pandemic and their effects on Middle Georgia State University students. The data gathered will offer insights about student mental health stressors, and present opportunities for identifying strategies to help them cope with stressors, excel in their academic pursuits of achieving excellence, and maintain a balanced healthy lifestyle.

EVALUATING COMMUNITY ENGAGEMENT IMPACTS FROM EVOLVING PANDEMIC PERCEPTIONS OF STUDENTS

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ABSTRACT

COVID affected community courses with disadvantaged people. Courses applied designs of learning for online platforms not ideal for engagement of disadvantaged people and students. The authors of the paper evaluate the impacts of a community engagement course from the perceptions of students that, despite issues, interacted with people with disabilities on an online platform. This paper finds the impacts of the interactions on the learning of the students, in the intimacy limitations of online platforms, to be generally positive for them. This study will benefit professors considering alternate but flexible learning options for students impacted by pandemic or non-pandemic scenarios.

Keywords: Active Learning, Community Engagement, Community Partnerships, Community Service, Online Learning, People with Developmental and Intellectual Disabilities (DID), Service Learning

BACKGROUND

Community engagement is defined as community service. Community engagement is designed from the engagement of faculty and students in helping community organizations (Heffernan, 2011). Collaborative community engagement is helping community people on community needs from a diversity of projects of the people and the students. Community engagement impacts the community learning of students, as they are learning about community people and community problems in courses in the field, with learning objectives in community service (Cress, et.al., 2013). Community engagement is a characteristic of the community ecosystem of a university (McNair, et.al., 2016).

COVID disrupted community engagement at colleges (Ohmer, 2022). COVID forced community engagement to be if feasible off-the-field on online platforms not ideal for community service with community organizations, in a landscape largely new to a university (Ahmed, & Opoku, 2021). Critically, community engagement on online platforms as zoom do not have the intimacy of one-on-one engagements on the field of community people and students (Kim, & Fienup, 2022). Community engagement on community projects may be inhibited in innovation on off-the-field online platforms (Fletcher, 2020). Online platforms may not be even an option for community organizations helping the community people, especially if the people are deprived in technology (Beery, 2020). Online platforms off-the-field are not options of readiness and simplicity for community people and students in a university. Beyond the platforms the people and the students may have COVID-19 health problems (Zarkhin, 2020). Colleges are challenged in effecting community engagement for disadvantaged people and in effecting learning for students in constrained pandemic periods (Liebowitz, 2021).

Community engagement in a crisis as a pandemic is clearly a daunting assignment for course faculty (Medina, & Kazen, 2021). Engagement is difficult especially for courses on online platforms for disadvantaged people and students (Macias, 2020). However, the authors of this paper continued a community engagement course of community people with disabilities in a creatively customized and inclusive online platform (Hayes, 2020), that is helping in community learning perceptions of the students with people with disabilities and in projects of solutions with those with disabilities. Though the people with disabilities and the students were on online platforms in the pandemic periods, they persevered in the semesters as if in offline pre-pandemic scenarios. The authors of this paper discuss community learning perceptions from a course that will be beneficial to professors desiring to pursue alternate learning scenarios.

INTRODUCTION

The community engagement course discussed in this paper is Web Design for Non-Profit Organizations, a 3-credit community service of Pace University. The course goal is helping a local non-profit organization in helping people with disabilities on projects on the Web. The clients of the course are higher-functioning (i.e. less impaired) people with developmental and intellectual disabilities (DID) that are helped one-on-one on the Web (e.g., WIX) by students. The goal importantly of the second-author professor is in the students learning – "learning by doing" (Munge, et.al., 2018) - in helping in experiential learning (Morris, 2020) – of people with disabilities and of their problems of recognition in society that may be partially solvable through reflection of the students (Guarasci, 2022) and through project-based (Scogin, et.al., 2017) technology of the Web. The course was pre-pandemic physical as the people with disabilities and the students were on the premises of the university.

The course currently is pandemic and post-pandemic remote for the people with disabilities and the students. The online platform is on Bright Space (NCE.HE.20.04.02), is facilitated by interventions of the professor, and is synchronous on zoom. The people with disabilities are in the course mostly from residences along with staff; and the students without disabilities are in the course from sites in the university, in breakout groups and general sessions on the system on Tuesdays, as below in Table 1:

Table 1

Web Design for Non-Profit Organizations

Fall 2021 and Spring 2022

	Community People with Disabilities	Community Students
Fall 2021 - Tuesdays		
10:05 AM – 12:05 PM	19	19
12:15 PM – 2:15 PM	20	20
Spring 2022 - Tuesdays		
10:05 AM – 12:05 PM	20	20
12:15 PM – 2:15 PM	24	24

The people with disabilities and the students do the projects synchronously on the Tuesdays, and the professor facilitates mentoring the students. The students learn about people with disabilities from readings, such as *About Us: Essays from the Disability Series of the New York Times* (Catapano, & Garland – Thomson, 2019) and *Disability Visibility: First-Person Stories from the 21st Century* (Wong, 2020), furnished by the professor at the beginning of the course (Parker, 2021). The students are motivated from the readings and especially from the relationships with those with disabilities, not as passive recipients but as producers of the projects in the semesters (Fede, et.al., 2018). They are responsible for results (i.e. personalized Web sites) for those with disabilities (Mejias, & Monereo, 2017). Finally, the course is held 2 hours in 14 Tuesdays, and the professor hosts online presentations of the results of the students and those with disabilities on the 14th semester Tuesday.

The authors of this paper attempt to evaluate the course impacts from the learning perceptions of the students. Though the people with disabilities and the students were fortunately knowledgeable in the mechanism of an online platform pre-pandemic, the pandemic platform for non-physical project relationships in the semesters of tele-education may be considered by others a failure in the perceptions of the students (Swisher, 2021). The online platform may be considered essentially a learning stigma, such that learning perceptions may not be a positive story of the students. The online platform may be considered a poor remote substitute for the students and those with disabilities. Therefore, this paper evaluates firstly the current and future impacts of the community engagement course in the perceptions of the students that persisted in the pandemic semesters at our metropolitan university.

FOCUS OF PAPER

The focus of the paper is to evaluate the course impacts of Web Design for Non-Profit Organizations in the perceptions of community service of the students. This paper is focused on inquiry of the students on perceptions from non-physical online platform relationships remote with those with disabilities. The focus of the paper is also inherently on the interventions of the professor in helping the students, expanding the literature (Ulum, 2022). The focus of this paper is not to evaluate impacts of learning perceptions from those with disabilities, anecdotally perceived to be positive, in that they will be evaluated by the community non-profit organization.

The findings from the students will be helpful however to professors pursuing community service in pandemic or post-pandemic scenarios.

METHODOLOGY

The methodology of this paper evaluates the course impacts of Web Design for Non-Profit Organizations in the pandemic fall 2021 – spring 2022 semesters of Pace University.

This paper evaluates the current impacts of community service and the potential future impacts of community service in the learning perceptions of the 39 (19 and 20) fall 2021 students and the 44 (20 and 24) spring 2022 students in the aforementioned Table 1. The evaluations of the learning perceptions are from inquiry by the professor to 10 current impacts of community service questions (from 5- very high impact to 1 – very low impact) and to 10 potential future impacts of community service questions (from 1- yes [1.00 – 1.40 as strong] to 2 – no [1.60 – 2.00 as weak]), anonymously responded at the end of the semesters by the 83 students in a Likert-like survey. The evaluations of the perceptions are from discipline – business, liberal arts and information systems, gender – female and male, and school status – freshman, sophomore, junior and senior of the students, furnishing further perspectives on the relationships with the people with disabilities.

This paper included other random reflections of the 83 students on the community service that was posted on to the Bright Space – Activities - Discussions system of the university (Ignatow, & Mihalcea, 2018).

The reflections of the 83 people with disabilities, and their staff, will be in a further future study by the non-profit organization, though preliminary reflections (Epstein, 2020) were positive as in prior pre-pandemic practitioner results.

The findings from the undergraduate students are descriptively interpreted by the first-author in Microsoft EXCEL V16.0 in the following Assessment and are also listed in the Appendix of this study.

ASSESSMENT

The findings from the pandemic perceptions of the students are consistently and favorably impactful in positivism.

The course current impacts of community service are evaluated in an average of means of 4.22 / 5.00 from 4.62 to 2.41, and the potential future impacts of community service are evaluated in an average means of 1.28 (strong yes) / 2.00 from 1.03 to 1.74, as below in Table 2 and as explained in its Legend.

Table 2

Web Design for Non-Profit Organizations

Course Impacts of Community Service

Fall 2021 -Spring 2022 – Consolidated

n=83 Students

Current Impact of Service	
Q1. I believe strongly in community service.	4.31
Q2. I had a clear definition of my community prior to this engagement.	2.41
Q3. I would not have taken community engagement if not required by the core curriculum.	4.44
Q4. This engagement has helped me build a better understanding of my community.	4.59
Q5. After this engagement I have a new definition of my community.	4.62
Q6. The project in this engagement facilitated community service.	4.49
Q7. I feel fulfillment from the interactions with the people with disabilities.	4.51
Q8. I have learned more about my fellow neighbors residing within my community.	4.44
Q9. I have learned a better means of being an active advocate for people with disabilities.	4.26
Q10. The principles of diversity, equity, inclusion and justice (DEIJ) were realized in the semester.	4.13
Average	4.22

Potential Future Impact of Service	
Q1. I am committed now to making a difference in my community.	1.18
Q2. I now plan to be an active advocate member of my community.	1.33
Q3. I now plan to help others who are in difficulty in my community.	1.28
Q4. I now plan to join a community advocate program to help others in my community.	1.74
Q5. I now plan to contribute as an actual volunteer in my community.	1.36
Q6. I now plan to become knowledgeable of events in my community.	1.03
Q7. I now plan to become knowledgeable of issues of sociality in my community.	1.15
Q8. I now understand why we need to change the attitudes of people in order to help solve problems of sociality.	1.26

Q9. I now understand why others in my community may have problems when there are numerous opportunities to help them.	1.18
Q10. I now understand why we need to institute policy reforms to help others with problems.	1.26
Average	1.28

(Legend: 5-Very High Impacts, 4-High Impacts, 3-Intermediate Impacts, 2-Low Impacts and 1-Very Low Impacts, of Current Service; 1- Yes [1.00 – 1.40 as Strong Impacts and 2 - No [1.60 – 2.00 as Weak Impacts] Impacts on Potential Future Impacts of Service)

Note: Current Impact of Service and Potential Future Impact of Service instrument of questions are from an earlier paper (survey) of the second author-professor at Pace University.

The current impacts of community service are indistinguishable in evaluations generally positive from fall 2021 (4.22 from 4.62 to 2.41) and from spring 2022 (4.19 from 4.59 to 3.07), as are the potential future impacts of service from fall 2021 (1.28 from 1.03 to 1.74) and from spring 2022 (1.33 from 1.14 to 1.82), as in Table 3 of the Appendix.

The current impacts of community service in the consolidated semesters are evaluated in an average of means of 4.15 (from 4.58 to 2.82) and 1.31 (from 1.10 to 1.80) by business students, the first largest group of students; 4.22 (from 5.00 to 2.11) and 1.28 (1.00 to 1.78) by information systems students; and 4.31 (from 4.83 to 2.88) and 1.31 (from 1.04 to 1.75) by liberal arts students, the second largest group of students, as in Tables 4, 5 and 6 of the Appendix.

The impacts of service are in balance favorable generally in positivism in the consolidated semesters by gender in averages of means of 4.54 and a strong 1.13 by female students and 3.84 but a neutral or slightly weak 1.50 by male students, as in Table 7 of the Appendix.

The impacts are favorable generally in positivism in the consolidated semesters by freshmen (3.85 but a neutral or slightly weak 1.55), sophomore (4.21 and 1.29), junior (4.21 and 1.26) and senior (4.24 and a relatively strong 1.33) students, junior and senior students as the larger groups of students, also in Table 8 of the Appendix

The findings are generally positive from the learning perceptions, in summary, as in the above presented Table 2.

The findings are in balance also favorably and generally positive from the learning perceptions of the students, in detail, from discipline, gender and school status, and semester-to-semester, in high current impacts of current service and in relatively strong potential future impacts of service, as in Tables 4-9 in the Appendix.

Findings denote that the students did not have "a clear definition of community prior to the engagement" (a low 2.41 in fall 2021 and a relatively low 3.07 in spring 2022) in Table 3 nor of people with disabilities, that allowed the course to be an educational eye-opener for them. Though the students denote that they do not "plan to join a community advocacy program" (a weak 1.74 and 1.82) in Table 3, they favor the other future services (averages of relatively strong 1.28 and 1.33) inquired in the survey, also in Table 3.

The findings of high impacts of service are flavored by the delegation "to do" the projects by the professor to the students. The findings are essentially flavored by the experiential "hands on" learning process initiated by the professor, such that he is not an intruder on the projects of the students nor of those with disabilities, an initiative process instrumental in the performance of the projects of service of the students. Moreover, the professor is flexible in not functioning as a lecturer but as a mentor, cognizant of a learning process for the students inhibited by a pandemic (Salvador, et.al., 2021).

Though the online platform in the semesters is not ideal for community service, the students, recognizing the problem (Woods, 2021), initiated interactions in self-started teams (Haidet, et.al., 2014) with the people with disabilities. The students owned the projects with the people with disabilities (Tubach, 2020), such that perceptions of pride in the projects flavored findings of perceptions of the program. The findings of high impacts in the learning perceptions of the students are influenced inevitably by the involvement of the students one-on-one personally with those with disabilities.

Overall, the findings argue for online platforms as a feasible, but not ideal, proposition in further pandemic and non-pandemic scenarios, if initiated in an experiential learning process initiated by the professor and the students as in this study.

IMPLICATIONS

The on-line pandemic platform benefited community engagement favorably. The engagement process on the system is discernably impacting the learning perceptions of the current and potential future impacts of service of the students. The implication is that online platforms are an effectively feasible, even if not an ideal, option for community service.

The passion of the professor empowered the enhanced feasibility of the online platform that favored the learning perceptions of the students. The professor engaged the students in flexible but fruitful interactions with the people with disabilities paired with them. The professor is functioning in interventions not as a lecturer but as a mentor in mitigating online and people problems (Moore, et.al., 2007). He is fueling experiential learning as a process in the involvement of motivating the students. The implication is that online platforms can help in learning perceptions if professors promote the role of students.

Though isolated from the people with disabilities, the students are engaging and infusing passion in performing if not "reimagining" (Brooks, 2020) the outreach projects with the people with disabilities. The students are learning the meaningfulness of the projects. They are learning in the process the problems of disadvantaged people with disabilities (Davies, et.al., 2012). They are optimistically persistent and resilient in the project-based solutions for those with disabilities, even if remote, in perceptions of "something greater than themselves". The implication is that issues of online platforms as zoom cannot preclude solutions of technology with the persistence and the resilience of students.

The community non-profit organization partner empowered the program in the involvement of its people with the students. The pandemic limited non-profit organizational resources for both the

people with disabilities and the students (Diament, 2022). Nevertheless, non-profit organizational staff is interfacing in the involvement of the students and those with disabilities on the online platform. The progression on the projects is pursued not only on the online sessions by the staff but in pre- and post- sessions by them with those with disabilities, illustrating problem-solving in a social transition. The help of the non-profit organization, even with limited staff, is an important implication in the partnership of community service with a university.

Finally, the community online platform of Web Design for Non-Profit Organizations is empowered from the Internal Technology Services of Pace University that is helping immediately the professor and the students. The organization of the university is interfacing in a mediating role in the pandemic quality of service of the technology, for both the people with disabilities indirectly and directly with the students (Turnbull, et.al., 2021). The implication is that the inclusion of an Internal Technology Services is instrumental in partnerships of productive community service.

LIMITATIONS AND OPPORTUNITIES IN RESEARCH

The findings are of a community engagement program of Pace University with an advantageously connected niche population. The program is helped from an interested non-profit organization, from students and from interestingly those with disabilities, all of whom are knowledgeable from remote residences and from sites of the university. The online pandemic platform is of a high quality of service of the university that may not be reliable as a strategy in other universities. Nevertheless, the findings of this paper indicate learning opportunities that are positive in results for students. This paper will be improved in findings of likely positivism from those with disabilities.

CONCLUSION

COVID contributed difficulty for faculty engaged in community service. Findings from the paper however inform that online pandemic platforms are an option for projects for disadvantaged people, such as people with disabilities, and for learning opportunities of students, if initiated properly. Interventions of professors, staff and students are needed as a prerequisite in the process of community service. The persistence and the resilience of students in helping disadvantaged people with disabilities are notable in this paper. This paper will hopefully inspire professors to be pursuing projects of community service in problematic scenarios.

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APPENDIX

Table 3

Web Design for Non-Profit Organizations

Detail of Semesters

Fall 2021 (n=39 Students) and Spring 2022 (n=44 Students)

	Fall 2021	Spring 2022
Current Impact of Service		
Q1. I believe strongly in community service.	4.31	4.27
Q2. I had a clear definition of my community prior to this engagement.	2.41	3.07
Q3. I would not have taken community engagement if not required by the core curriculum.	4.44	4.41
Q4. This engagement has helped me build a better understanding of my community.	4.59	4.59
Q5. After this engagement I have a new definition of my community.	4.62	4.36
Q6. The project in this engagement facilitated community service.	4.49	4.55
Q7. I feel fulfillment from the interactions with the people with disabilities.	4.51	4.52
Q8. I have learned more about my fellow neighbors residing within my community.	4.44	4.45
Q9. I have learned a better means of being an active advocate for people with disabilities.	4.26	3.93
Q10. The principles of diversity, equity, inclusion and justice (DEIJ) were realized in the semester.	4.13	3.73
Average	4.22	4.19

	Fall 2021	Spring 2022
Potential Future Impact of Service		
Q1. I am committed now to making a difference in my community.	1.18	1.23
Q2. I now plan to be an active advocate member of my community.	1.33	1.32
Q3. I now plan to help others who are in difficulty in my community.	1.28	1.41
Q4. I now plan to join a community advocate program to help others in my community.	1.74	1.82
Q5. I now plan to contribute as an actual volunteer in my community.	1.36	1.34
Q6. I now plan to become knowledgeable of events in my community.	1.03	1.14
Q7. I now plan to become knowledgeable of issues of sociality in my community.	1.15	1.20
Q8. I now understand why we need to change the attitudes of people in order to help solve problems of sociality.	1.26	1.32
Q9. I now understand why others in my community may have problems when there are numerous opportunities to help them.	1.18	1.20
Q10. I now understand why we need to institute policy reforms to help others with problems.	1.26	1.36
Average	1.28	1.33

Table 4

Web Design for Non-Profit Organizations

Fall 2021 - Spring 2022

Detail of n=51 Business Students

Current Impact of Service	
Q1. I believe strongly in community service.	4.20

Q2. I had a clear definition of my community prior to this engagement.	2.82
Q3. I would not have taken community engagement if not required by the core curriculum.	4.12
Q4. This engagement has helped me build a better understanding of my community.	4.60
Q5. After this engagement I have a new definition of my community.	4.36
Q6. The project in this engagement facilitated community service.	4.58
Q7. I feel fulfillment from the interactions with the people with disabilities.	4.50
Q8. I have learned more about my fellow neighbors residing within my community.	4.38
Q9. I have learned a better means of being an active advocate for people with disabilities.	4.02
Q10. The principles of diversity, equity, inclusion and justice (DEIJ) were realized in the semester.	3.90
Average	4.15

Potential Future Impact of Service	
Q1. I am committed now to making a difference in my community.	1.24
Q2. I now plan to be an active advocate member of my community.	1.32
Q3. I now plan to help others who are in difficulty in my community.	1.30
Q4. I now plan to join a community advocate program to help others in my community.	1.80
Q5. I now plan to contribute as an actual volunteer in my community.	1.40
Q6. I now plan to become knowledgeable of events in my community.	1.10
Q7. I now plan to become knowledgeable of issues of sociality in my community.	1.18
Q8. I now understand why we need to change the attitudes of people in order to help solve problems of sociality.	1.30
Q9. I now understand why others in my community may have problems when there are numerous opportunities to help them.	1.20
Q10. I now understand why we need to institute policy reforms to help others with problems.	1.28
Average	1.31

Table 5

Web Design for Non-Profit Organizations

Fall 2021 - Spring 2022

Detail of n=9 Information Systems Students

Current Impact of Service	
Q1. I believe strongly in community service.	4.44
Q2. I had a clear definition of my community prior to this engagement.	2.11
Q3. I would not have taken community engagement if not required by the core curriculum.	5.00
Q4. This engagement has helped me build a better understanding of my community.	4.44
Q5. After this engagement I have a new definition of my community.	4.67
Q6. The project in this engagement facilitated community service.	4.33
Q7. I feel fulfillment from the interactions with the people with disabilities.	4.67
Q8. I have learned more about my fellow neighbors residing within my community.	4.67
Q9. I have learned a better means of being an active advocate for people with disabilities.	4.11
Q10. The principles of diversity, equity, inclusion and justice (DEIJ) were realized in the semester.	3.78
Average	4.22

Potential Future Impact of Service	
Q1. I am committed now to making a difference in my community.	1.22
Q2. I now plan to be an active advocate member of my community.	1.44
Q3. I now plan to help others who are in difficulty in my community.	1.33
Q4. I now plan to join a community advocate program to help others in my community.	1.78
Q5. I now plan to contribute as an actual volunteer in my community.	1.33
Q6. I now plan to become knowledgeable of events in my community.	1.11
Q7. I now plan to become knowledgeable of issues of sociality in my community.	1.00

Q8. I now understand why we need to change the attitudes of people in order to help solve problems of sociality.	1.11
Q9. I now understand why others in my community may have problems when there are numerous opportunities to help them.	1.00
Q10. I now understand why we need to institute policy reforms to help others with problems.	1.44
Average	1.28

Table 6

Web Design for Non-Profit Organizations

Fall 2021 - Spring 2022

Detail of n=23 Liberal Arts Students

Current Impact of Service	
Q1. I believe strongly in community service.	4.42
Q2. I had a clear definition of my community prior to this engagement.	2.88
Q3. I would not have taken community engagement if not required by the core curriculum.	4.83
Q4. This engagement has helped me build a better understanding of my community.	4.63
Q5. After this engagement I have a new definition of my community.	4.67
Q6. The project in this engagement facilitated community service.	4.46
Q7. I feel fulfillment from the interactions with the people with disabilities.	4.50
Q8. I have learned more about my fellow neighbors residing within my community.	4.50
Q9. I have learned a better means of being an active advocate for people with disabilities.	4.21
Q10. The principles of diversity, equity, inclusion and justice (DEIJ) were realized in the semester.	4.00
Average	4.31

Potential Future Impact of Service	
Q1. I am committed now to making a difference in my community.	1.13
Q2. I now plan to be an active advocate member of my community.	1.29

Q3. I now plan to help others who are in difficulty in my community.	1.46
Q4. I now plan to join a community advocate program to help others in my community.	1.75
Q5. I now plan to contribute as an actual volunteer in my community.	1.25
Q6. I now plan to become knowledgeable of events in my community.	1.04
Q7. I now plan to become knowledgeable of issues of sociality in my community.	1.25
Q8. I now understand why we need to change the attitudes of people in order to help solve problems of sociality.	1.33
Q9. I now understand why others in my community may have problems when there are numerous opportunities to help them.	1.25
Q10. I now understand why we need to institute policy reforms to help others with problems.	1.33
Average	1.31

Table 7

Web Design for Non-Profit Organizations

Fall 2021 - Spring 2022

Detail of Gender

n=43 Female Students and n=40 Male Students

Current Impact of Service	Female	Male
Q1. I believe strongly in community service.	4.67	3.88
Q2. I had a clear definition of my community prior to this engagement.	2.79	2.73
Q3. I would not have taken community engagement if not required by the core curriculum.	4.53	4.30
Q4. This engagement has helped me build a better understanding of my community.	5.00	4.15
Q5. After this engagement I have a new definition of my community.	4.91	4.03
Q6. The project in this engagement facilitated community service.	4.93	4.08
Q7. I feel fulfillment from the interactions with the people with disabilities.	4.84	4.18
Q8. I have learned more about my fellow neighbors residing within my community.	4.79	4.08

Q9. I have learned a better means of being an active advocate for people with disabilities.	4.60	3.53
Q10. The principles of diversity, equity, inclusion and justice (DEIJ) were realized in the semester.	4.35	3.45
Average	4.54	3.84

Potential Future Impact of Service	Female	Male
Q1. I am committed now to making a difference in my community.	1.02	1.4
Q2. I now plan to be an active advocate member of my community.	1.05	1.63
Q3. I now plan to help others who are in difficulty in my community.	1.14	1.58
Q4. I now plan to join a community advocate program to help others in my community.	1.60	1.98
Q5. I now plan to contribute as an actual volunteer in my community.	1.14	1.58
Q6. I now plan to become knowledgeable of events in my community.	1.00	1.18
Q7. I now plan to become knowledgeable of issues of sociality in my community.	1.05	1.33
Q8. I now understand why we need to change the attitudes of people in order to help solve problems of sociality.	1.12	1.48
Q9. I now understand why others in my community may have problems when there are numerous opportunities to help them.	1.07	1.33
Q10. I now understand why we need to institute policy reforms to help others with problems.	1.14	1.50
Average	1.13	1.50

Table 8

Web Design for Non-Profit Organizations

Fall 2021 - Spring 2022

Detail of School Status

n=4 Freshman, 19 Sophomore, 31 Junior and 29 Senior Students

	Freshman	Sophomore	Junior	Senior
Current Impact of Service				

Q1. I believe strongly in community service.	4.00	4.26	4.10	4.55
Q2. I had a clear definition of my community prior to this engagement.	2.00	2.47	2.61	3.21
Q3. I would not have taken community engagement if not required by the core curriculum.	3.50	4.47	4.29	4.66
Q4. This engagement has helped me build a better understanding of my community.	4.00	4.79	4.68	4.45
Q5. After this engagement I have a new definition of my community.	4.00	4.48	4.68	4.28
Q6. The project in this engagement facilitated community service.	4.00	4.53	4.68	4.41
Q7. I feel fulfillment from the interactions with the people with disabilities.	4.00	4.37	4.58	4.62
Q8. I have learned more about my fellow neighbors residing within my community.	4.50	4.42	4.48	4.41
Q9. I have learned a better means of being an active advocate for people with disabilities.	4.50	4.26	4.06	3.93
Q10. The principles of diversity, equity, inclusion and justice (DEIJ) were realized in the semester.	4.00	3.89	3.97	3.86
Average	3.85	4.21	4.21	4.24

Table 9

Web Design for Non-Profit Organizations

Fall 2021 - Spring 2022

Detail of School Status

	Freshman	Sophomore	Junior	Senior
Potential Future Impact of Service				
Q1. I am committed now to making a difference in my community.	1.25	1.16	1.19	1.24
Q2. I now plan to be an active advocate member of my community.	1.50	1.37	1.26	1.34
Q3. I now plan to help others who are in difficulty in my community.	1.75	1.42	1.23	1.38
Q4. I now plan to join a community advocate program to help others in my community.	1.75	1.68	1.84	1.79
Q5. I now plan to contribute as an actual volunteer in my community.	1.50	1.32	1.23	1.48

Q6. I now plan to become knowledgeable of events in my community.	1.25	1.00	1.06	1.14
Q7. I now plan to become knowledgeable of issues of sociality in my community.	1.50	1.16	1.19	1.14
Q8. I now understand why we need to change the attitudes of people in order to help solve problems of sociality.	1.75	1.37	1.23	1.24
Q9. I now understand why others in my community may have problems when there are numerous opportunities to help them.	1.75	1.21	1.10	1.21
Q10. I now understand why we need to institute policy reforms to help others with problems.	1.50	1.26	1.29	1.34
Average	1.55	1.29	1.26	1.33

Legend: 5-Very High Impacts, 4-High Impacts, 3-Intermediate Impacts, 2-Low Impacts and 1-Very Low Impacts, of Current Service; 1 – Yes [1.00 – 1.40 as Strong Impacts] and 2 – No [1.60 – 2.00 as Weak Impacts] and [1.50 as Neutral Impacts] Impacts on Potential Future Impacts on Service

Experience in Teaching and Engaging Students with Recursive Relations

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Abstract
Recursion is one of the most powerful ways to solve problems with computers. The concept of recursive programming is often difficult for undergraduate students.

Active learning refers to a broad range of teaching and pedagogical strategies that engage students as "partners-in-progress" participants in their learning during class time with their instructors.

We will discuss some real-life experiences related to students' engagement in recursive relations. In this paper, commonly known best teaching practices such as Active Learning, and Problem-Based Learning, are implemented and proven to be effective given students' responses and quiz and homework submissions.

Keywords*: active learning, recursive relations, problem-based learning, engagement, Python programming, Turtle graphics*

1 Introduction

Recursive relation in computer science is a method of solving a problem where the solution depends on solutions to smaller instances of the same problem. The approach can be applied to many types of problems, and recursion is one of the central ideas of computer science. The concept of recursive programming is often difficult for undergraduate students although it is also usually the simplest way to write programs. It can be tricky to understand at first. Recursive thinking is difficult because it almost seems like circular reasoning. It's also not an intuitive process; when we give instructions to other people, we rarely direct them recursively.

Active learning is any instructional method that provokes thinking about an activity, which engages students to carry out meaningful learning activities in the learning process [1,2]. Active Learning Environments boost students' creative thinking, motivation for learning outcomes and performance, communication, and interaction, leading students to learn more and achieve better examination grades [3,4,5]. However, most computer course instructors in higher education do not use active learning methods and traditional teaching methods such as simple face-to-face-lecturing remain the common practice [6]. We hereby present our different and varied experiences in engaging students in active learning when we introduce recursive relations.

2 Learning Objectives

Learning objectives should be used to guide students as they work through the course, and to assess their learning progress. Excellent learning objectives provide a guide for students when reviewing materials and preparing for assessments. Learning objectives are the most powerful if they are actionable and measurable [7]. We provide students with the following learning objectives two or three days before the recursion lecture.

What recursion is?

What a base case is?

What a recursive case is?

What causes a recursive algorithm to stop calling itself?

How to solve recursive problems in Python?

3 Reading Assignment

Coming to class prepared and with some background knowledge transforms students from passive to active learners. The question is how to get students to read what was assigned. In general, we prepare three to five questions for each reading assignment and have students submit answers before coming to class or give students a quiz at the beginning of the class.

To prepare students for their engagement in the lecture on recursive relations, we post reading material and a 5-question quiz in the course learning management system two or three days before the lecture day. Students are asked to read the material and submit their answers before the lecture starts. The five questions in the quiz are the following.

Question 1:
What is the base case in a recursion?

Question 2:
What is the recursive case in a recursion?

Question 3:
Given f(0)=0, f(1)=1, and f(n)=f(n-2)+f(n-1) for n>1. Find n such that f(n)=0.

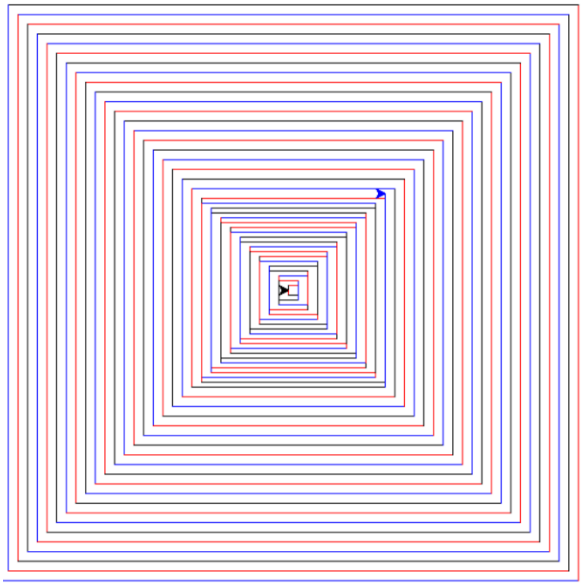
Question 4:
Does a recursion need a base case? Why?

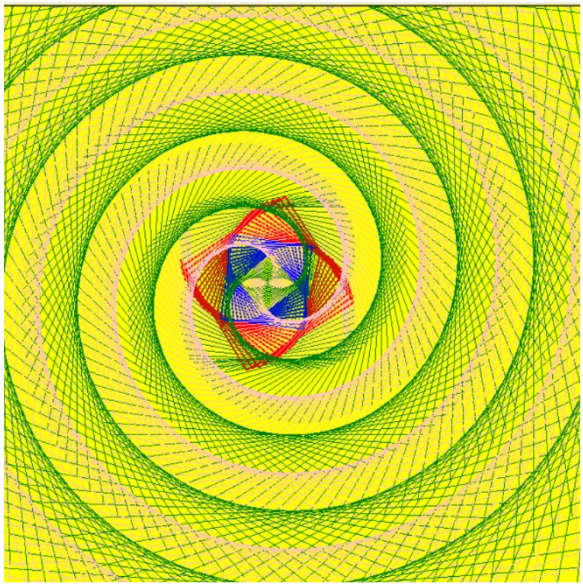
Question 5:
How to use recursion to search the phone book for a name?

4 How Long Will IT Take You to Draw the Following Patterns?

We ask students the above question at the beginning of the class.

The two patterns below were created in Turtle Graphics by simple Python programs using recursions. From them and question 5 in the reading assignment, students may realize that recursions are not only abstract mathematics formulas, but also practical. We can motivate students to learn recursions.





5 Answers to the Reading Assignment Quiz

Now we go over the quiz questions in the reading assignment, make comments, and connect to topics in the lecture.

Question 1:
What is the base case in a recursion?

Answer:
The simplest input possible, the solution immediately available

Question 2:
What is the recursive case in a recursion?

Answer:
The part of a problem that is solved with recursion.

Or, it invokes the algorithm on a smaller set of the input.

Question 3:
Given f(0)=0, f(1)=1, and f(n)=f(n-2)+f(n-1) for n>1. Find n such that f(n)=0.

Answer:
f(2)=f(0)+f(1)=1
f(3)=f(1)+f(2)=2
f(4)=f(2)+f(3)=3
f(5)=f(3)+f(4)=5
Therefore, such an n does not exist.

f(n) is the n-th Fibonacci number.

Further question:
We know f(10)=f(8)+f(9)
If we want to compute the 10-th Fibonacci number by using recursion, do we need to computer f(7)?

Further question:
How to make a Python program by using recursion to display the first 10 Fibonacci numbers?
We will study today.

Question 4:
Does a recursion need a base case? Why?

Answer:
Yes. Without the base case, recursion would be infinite!

Question 5:
How to use recursion to search the phone book for a name?

Answer:
Start in middle: if found, stop

Otherwise, repeat the process in the correct "half" of the book

Base case: only one name to search

Recursive call (Recursive case): search the remaining "half" of the book

6 Introducing Recursive Concepts in Class

At this moment, students already have some knowledge of recursions. We briefly discuss the recursive concepts, and we will list a few in the following. Students will read and answer questions. Although many students are eager to answer questions, the students who touch cell phones or other none lecture-related devices during class time are encouraged to be the priority volunteers. In this way, students will pay attention to learning, instead of playing on cell phones.

Recursion is a powerful tool for solving repetitive problems.

A recursion is never absolutely required to solve a problem.

Any problem that can be solved recursively can also be solved iteratively, with a loop.

In many cases, recursive algorithms are less efficient than iterative algorithms.

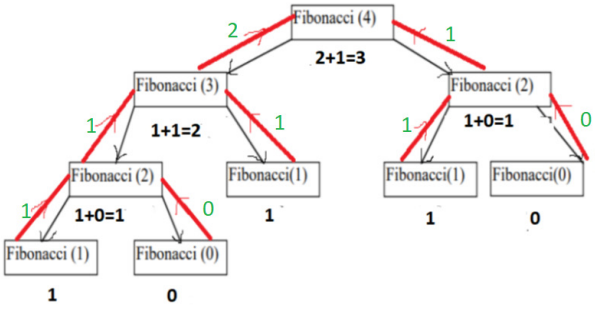
Most methods call other methods.

Recursion is when a method calls itself

A recursive function is a function that calls itself. Similar to a loop.

7 Recursive Fibonacci Trace Structure

Guide students to draw a recursive Fibonacci trace structure as in the following, and help them to understand the procedure of computing f(4).



We ask students whether it is possible to draw a recursive Fibonacci trace structure for computing f(50) on a piece by hand in ten minutes.

8 Collaborative Learning

Collaborative learning is an instructional method involving small group work to accomplish a

common goal and cooperative learning. Studies show that there are many advantages of collaborative learning, such as improving students' problem-solving and critical thinking skills, communication, and self-management skills, promoting student development and diversity, and mutual learning from peers. Despite the positive effects of collaborative learning, many instructors still tend to ignore or not use this method in their teaching [8].

To help students engage in a collaborative learning environment, two or three students form a group and are required to perform the following tasks on recursive factorial:

What is the base case?

What is the recursive case?

To draw a recursive factorial trace structure for computing 4!.

Remark:
We walk around to check student's work and discussion, and answer questions.

We may randomly select one or two students to present their work.

Students may be randomly divided into groups.

9 To Boost Students' Confidence

Contrary to popular belief, confidence is not something we're born with; it's a skill to be mastered, an art to be perfected over years of learning. Studies have shown that learners with higher confidence are more willing to learn, challenge themselves, and have better resilience in the face of difficult transitions. In fact, confidence has been quoted as the number one predictor of academic achievement [9].

From the foregoing responses from the above activities, we conclude that most students appear to be confident in recursions.

We would like to share a story. One student (say Lily) asked my help to install software on her computer in a lab. She installed it by herself with my guidance. When another student (say Tom) had issue to install the same software on his computer, I asked Lily, "would you like to help Tom?"

Lily said, "I know nothing. How can I help others?"

I told Lily, you will know something from helping Tom.

After Lily and Tom successfully installed the software on Tom's computer, Lily was excited and said, "Even I can help other students."

From then on, Lily paid great attention in class and studied hard after class. She was willing to answer questions, joining discussions, helping other students in class, and she did very well in that semester.

10 Problem Solving with Recursions in Python

We will show students how to solve problem 1 and guide them to solve problem 2.

Problem 1:
Make a factorial function (say factorial(n)) that uses recursion to calculate the factorial of its argument (say n), which is assumed to be nonnegative.

Write a test program that displays factorial(k) for k = 0, 1, 2, … , 10.

Problem 2:
Make a function (say fib(n)) that uses recursion to calculate the n-th Fibonacci number.

Write a test program that displays fib(k) for k = 0, 1, 2, … , 10.

Problem 3:
Is it possible to display the 100-th Fibonacci by using the following fib function in the above problem 2? Why?

We discuss problem 3 in class. Several future topics such as efficiency, time and space complexity might be introduced.

11 Summary of Recursions

We give students a summary as in the following by asking them questions. Students will speak out the answers.

Question 1:
All the cases of a recursive solution other than the base case are called the _____ case.

Answer: recursive

Question 2:
The base case does not require _____, so it stops the chain of recursive calls.

Answer: recursion

Question 3:
Recursive function calls are _____ efficient than loops.

Answer: less

Question 4:
A solution using a(n) _____ is usually more efficient than a recursive solution.

Answer: Loop

Question 5:
A recursion in which a function directly calls itself is known as _____ recursion.

Answer: direct

Question 6:
Usually, a problem solved by recursion is reduced by making the value of one or more parameters _____ with each recursive call.

Answer: smaller

Question 7:
Some problems are more _____ solved with recursion than with a loop.

Answer: easily

12 Problem-Based Learning

“Problem-based learning” (PBL) is an instructional method where relevant problems are introduced at the beginning of the instructional cycle and used to provide the context and motivation for the learning that follows. It is always active and usually (but not necessarily) collaborative or cooperative…" learning. PBL has many advantages, such as boosting students' motivation, facilitating enjoyment of the learning process, and understanding and applying the acquired knowledge [10].

We use PBL to enhance students' problem-solving skills and promote critical thinking. Students are required to solve the following homework questions after.

Problem 1:
Design a function that accepts a list as an argument and returns the smallest value in the list. The function should use recursion to find the smallest item. Run your program at least five times.

Problem 2:
Make a program to calculate the greatest common divisor (GCD) of two positive integers by using recursion. Run your program at least five times.

Problem 3:
Given pie(n)=4(1/1 -1/3 + 1/5-1/7+ ….+ (-1)**(n+1) / (2*n-1).

Make a program to calculate pie(n) by using recursion.

Write a test program that displays pie(k) for n = 1, 2, … , 1000. What can you say about pie(n)?

13 Conclusion/Remarks

Instructors want their students to be engaged and fully participate in class. However, some students are brilliant but will not talk in class. Many instructors, if not all, can relate to this issue. Active learning has helped to get students to speak in a class by creating an activity that gets the students to discuss some aspects of a course topic among themselves in class [8].

Through our approach in teaching/learning recursions, students discover their inner strength and drive for academic success by having a voice among their peers and an opportunity to show their capability so that no one would question their abilities.

Our approaches to active learning on recursions may apply to other subjects/fields such as Engineering or Mathematics. These fields have been known to have few interactions between instructors and students in the classrooms. We conclude that it is important to promote active learning methods in any STEM field and encourage instructors to participate in active learning. This will help increase the stem workforce that is needed in this country.

14 Acknowledgment:

We have discussed Active Teaching and Learning with many educators, especially with Dr. Barry Lawson, Professor Roland DePratti, Dr. Douglas Szajda, Dr. Kathy Hoke, Dr. Arthur Charlesworth, Dr. Prateek Bhakta, Dr. Joonsuk Park, Dr. Jory Denny, and Dr. Lewis Barnett. We appreciate their insight, help, and support.

We have used some materials in [11].

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ONLINE LEARNING BEHAVIORS AND LEARNER ACADEMIC SUCCESS

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ABSTRACT

To better understand online learning, especially when facing the challenges of emergencies, there is a need to study the factors that affect online learners' academic success in higher education. We developed a conceptual framework and built multiple regressions to argue how four online learning behaviors, prior online learning experiences, and assignment submission impact learners' academic success using the Open University Learning Analytics dataset (OULAD). Our findings show that the four learning behaviors and assignment submission are associated positively with learners' academic success. The assignment submission has a negative moderating effect. Besides, younger, higher education level, higher IMD level, and male learners have higher academic success.

INTRODUCTION

Online learning is education through electronic technologies and media in a fully virtual internet-based learning environment. It has developed fast in recent years, especially under the effects of COVID-19. According to the Department of Education's integrated postsecondary education data system, 51.8% of students took at least one online course in 2019-2020 [15]. To better understand online learning, especially when facing the challenges of emergencies, such as pandemics and natural disasters, there is a need to study the factors that affect online learners' academic success.

Previous research has investigated several factors that affect online learners' academic success. Online learning behaviors are the important factors that impact the learners' outcomes [9][12][16]. Online learning behaviors are characterized by the click, frequency, or duration of one or more types of online learning activities, such as the number of clicks on materials or the frequency of course links [3]. Different behaviors refer to various learning purposes. These online learning behavior data could construct different factors to predict learners' academic success. Also, the prior online learning experience has a significant impact on learning performance [1][6][7][8][13][14]. Logically, previous experience would be positively correlated with future learning achievements. However, based on the previous research, the effects of the prior online learning experience on learner academic success are inconsistent. It is a good opportunity to explore the relationship between the prior online learning experience and learners' academic success. In addition, early assignment submission is associated with course performance [4][5][10]. The assignment submission has an effect on the learner's academic success. Previous

research believed students who start their coursework early perform better, but some students who have "ideal" work patterns still end up performing poorly in the course [10].

Most previous studies focused on the single or various factors that affect online learners' academic success. However, little research has studied the effects of learning behaviors, prior online learning experience, and assignment submission on learners' academic success and the moderating effects of prior online learning experience and assignment submission on the relationship between learning behaviors and learners' academic success.

In this study, the research questions are as follows:

1. How do online learning behaviors impact the learner's academic success?

2. How do prior learning experiences and assignment submission impact the learner's academic success?

3. How are the relations between online learning behaviors and learners' academic success moderated by prior learning experiences and assignment submission?

This research explores how four learning behaviors, prior online learning experiences, and assignment submission impact learners' academic success. We also explore the moderating effects of prior learning experience and assignment submission on learning behaviors. Furthermore, we analyze how the control variables, such as age, gender, educational level, Index of Multiple Deprivation (IMD), and disability, impact learners' academic success.

CONCEPTUAL FRAMEWORK AND GUIDING LITERATURE

Learners' Academic Success

In the previous research, learners' academic success is referred to as learning performance, learning achievements, or learning outcomes [2][3][11][17]. Previous research always used the average or the weighted scores of their assignments and exams as the learning performance. [17] explored the relationship between learning performance and online learning behavior. They used the average scores of all assignments and exams as the learning performance. [2] studied whether learning management system tools have an effect on semester final grades. In his study, he measured student achievement using semester final grades. [3] measured the students' overall performance by the students' normalized final course score, including scores from homework, exams, lab activities, and classroom questions. [11] compared the effectiveness between online learning and traditional instruction in a case study. The student's performance was operationalized by final course grades derived from homework, test, class participation, and research project scores. In this study, we use the weighted grades of assignments and the final exam as the learner's academic success. In the dataset, each student needs to finish several assignments, which account for 50% and one final exam that accounts for 50%. It is calculated as Equation (1):

$$\text{Learner academic success} = 50\% \times weight \times final\ exam + \sum_{o}^{i} 50\% \times weight(i) \times assignment(i) \quad (1)$$

Where i is the number of assignments each student completed.

Online Learning Behaviors

Previous research notes that online learning behaviors are important to understanding online learning processes. [9] used the data from log files from the Learning Management System (LMS) to explore the impact of learning behaviors on academic achievement. [16] examined students' engagement characteristics (students' online activities on the courses, such as clicks on the homepage, learning units, video lectures, assignment submissions, and forums, and their course grades, such as assignments, final exam, and final course grade) in online courses and their impact on academic achievement using the data from Moodle LMS. [3] used the students' click-stream as students' online learning behaviors to explore the relationship between online learning behaviors and course performance. Based on summarizing the previous research, [12] constructed an e-learning process behavior classification model (PBC model) using interactive objects as the basis for the classification of learning behaviors. This model is centered on online learners and divided into four learning behaviors, learning preparation behavior (LPB), knowledge acquisition behavior (KAB), interactive learning behavior (ILB), and learning consolidation behavior (LCB). In this research, we use the PBC model as the method to classify learners' activities into different learning behaviors [12].

(1) Learning preparation behavior (LPB) is the most basic online learning behavior occurring during the learning stage. This behavior includes logging in to the learning platform, accessing the course activity interface and primary page of the course.

(2) Knowledge acquisition behavior (KAB) is the behavior related to acquiring knowledge directly during the knowledge acquisition stage, including browsing course content resources, watching videos, accessing resource links, and participating in course activities.

(3) Interactive learning behavior (ILB) is one important online learning behavior occurring in the interactive reflection stage. It includes publishing and replying to forums, participating in seminars, and interacting with instructors and students.

(4) Learning consolidation behavior (LCB) refers to behaviors of strengthening the degree of knowledge mastery during the stage of learning consolidation, including post-class reflections, tests, and exams.

In the dataset, several activities are recorded and the number of clicks for each activity. We aggregate the total number for each learning behavior for analysis. Based on the previous research, we propose that there is a positive relationship between learning behaviors and learners' academic success.

$H1$: LPB is positively associated with learners' academic success.

*H*2: KAB is positively associated with learners' academic success.

*H*3: ILB is positively associated with learners' academic success.

*H*4: LCB is positively associated with learners' academic success.

Prior Online Learning Experience

Prior experience on the software or learning platform is essential for supporting learners' online learning. It is logical that previous experience would positively correlate with future learning achievements. However, there is a scarcity of empirical studies to support this assumption [8]. Some researchers found that prior online experience did not impact learner interaction and course outcomes [6][7]. Also, [13] believed that there was a negative relationship between prior online experiences and students' satisfaction. Learners' online learning experience strengthens students' learning experiences, especially for isolated students [1][14]. The results from the previous research are inconsistent. Meanwhile, few of the previous research focuses on the prior online learning experience as the moderating effect on the relationship between learning behaviors and learner academic success, which is one of the focuses of this study. In this study, we use the prior studied credits as the prior online learning experience. Based on the previous studies, we propose that prior online learning experience has a negative impact on learners' academic success.

*H*5: Prior online learning experience is negatively associated with learners' academic success.

Assignment Submission

Although the general trend seems to be that starting and completing coursework earlier leads to better course performance, starting earlier may be associated with more days of work [10]. [5] examined the students' course behaviors and their performance. They found that students who do not start working until the day before an assignment is due can perform significantly less well than those who start two or more days before the assignment is due. The assignment submission has an effect on the learner's academic success. [4] reported a quantitative evaluation to investigate students' behaviors that result in differing levels of achievement by comparing students' effective and ineffective behaviors. They found that students who received higher scores started earlier and finished earlier than students who got lower scores. However, [10] found that students who start their coursework early perform better, but some students who start work early and space their work over multiple days still end up performing poorly in the course. Even though previous studies have examined a positive relationship between early assignment submission and learner performance, few researchers focus on assignment submission as the moderating effect on the relationship between learning behaviors and learner academic success, which is one of the focuses of this study. This research uses the difference between the assignment due date and the assignment submitted date as an assignment submission. We propose that assignment submission has a positive effect on learners' academic success.

*H*6: Assignment submission is negatively associated with learners' academic success.

This research explores how four learning behaviors, prior online learning experiences, and assignment submission impact learners' academic success. We also study the moderating effects of prior learning experience and assignment submission on learning behaviors. Furthermore, we analyze how the control variables, such as age, gender, educational level, Index of Multiple Deprivation (IMD), and disability, impact learners' academic success. Thus, we develop a conceptual framework to assist our understanding of the causal or correlational patterns of interconnections across the above concepts or variables.

The conceptual framework is shown in Figure 1. All of the variables in this study are shown in Table 1.

Figure 1. Conceptual Framework

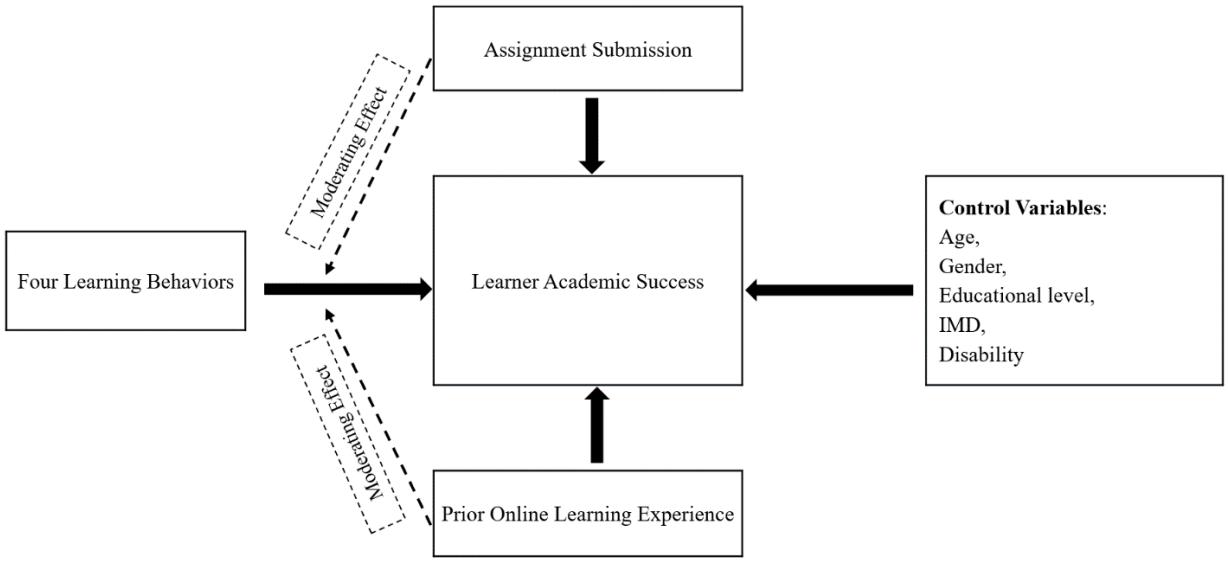


Table 1. *Variables and Descriptions*

Variables	Description
Dependent Variable	
Learner academic success	Weighted grades of assignments and final exam
Independent Variables	
LPB	Learning preparation behavior
KAB	Knowledge acquisition behavior
ILB	Interactive learning behavior
LCB	Learning consolidation behavior
Prior online learning experience (PLE)	Prior online learning experience: prior studied credits

Assignment submission (AS)	Assignment submission: average of the differences between the assignment due date and the assignment submitted date
Control Variables	
Age	Three ranges of learner's age, "0-35", "35-55", and "55<=".
Gender	Female ("F") and Male ("M")
Educational level	Four levels of education, "Lower Than A Level", "A Level or Equivalent", "HE Qualification", and "Post Graduate Qualification."
Index of Multiple Deprivation (IMD)	Three levels of IMD, "Low IMD level", "Medium IMD level", and "High IMD level"
Disability	Yes ("Y") and No("N")

METHODOLOGY

Method

We use multiple regression to test the relationships between independent and dependent variables. We build the multiple regression model (shown as equation 2) for estimating learners' academic success based on four learning behaviors, prior learning experiences, and assignment submission.

$$\textit{Learners' Academic Success} = \beta 0 + \beta 1 * LPB + \beta 2 * KAB + \beta 3 * ILB + \beta 4 * LCB + \beta 5 * PLE + \beta 6 * AS + \beta 7 * Age + \beta 8 * Gender + \beta 9 * Educational\ Level + \beta 10 * IMD + \beta 11 * Disability \quad (2)$$

This paper also focuses on the research question of whether the relationships between learning behaviors and learners' academic success are moderated by prior learning experiences and assignment submission. Then, we build the multiple regression model (shown as equation 3), including the interaction terms, to explore the interaction effect (moderating effect).

$$\textit{Learners' Academic Success} = \beta 0 + \beta 1 * LPB + \beta 2 * KAB + \beta 3 * ILB + \beta 4 * LCB + \beta 5 * PLE + \beta 6 * AS + \beta 7 * Age + \beta 8 * Gender + \beta 9 * Educational\ Level + \beta 10 * IMD + \beta 11 * Disability + (\beta 12 * LPB + \beta 13 * KAB + \beta 14 * ILB + \beta 15 * LCB) * PLE + (\beta 16 * LPB + \beta 17 * KAB + \beta 18 * ILB + \beta 19 * LCB) * AS \quad (3)$$

To aid interpretation, the four learning behaviors variables were divided by 100 and then centered around the means. Another two independent variables, prior learning experience (PLE) and assignment submission (AS) are also centered. To answer the research questions and infer whether engagement in learning behaviors or prior experiences and assignment

submission are more impactful in determining students' academic success, we build three sub-models (model 1 to model 3) and one full model (model 4). Model 1 includes only control variables. Model 2 includes four learning behaviors and control variables. Model 3 includes prior learning experiences, assignment submission, and control variables. Model 4 includes six independent variables and control variables. The Bayesian Information Criterion (BIC) is used to compare the goodness of fit of these four regression models. The lower value of BIC indicates that the model has better goodness of fit.

Data

The Open University Learning Analytics Dataset (OULAD) is considered one of the most comprehensive international open datasets in terms of e-learning data diversity, including student demographic data and clickstream of students' clicks on the Virtual Learning Environment (VLE) [18]. The dataset contains 7-course modules (AAA-GGG), 22 courses, online learning behavior data, and learning performance data of 32,593 students. In this study, we select the DDD course module (a STEM domain) as our sample because this course includes the final exam scores and holds a comprehensive measure of student performance. We used R language to clean the student information data from 2013 to 2014. After cleaning the data, we collect a sample of 3525 learners. We use the PBC model [12] as the method to classify 12 learners' activities into four learning behaviors, as shown in Table 2.

Table 2. *Classification of Learning Behaviors Using PBC Model*

No.	Activities	Explanation	Learning Behavior
1	Homepage	Access the main interface of the learning platform	LPB
2	Page	Access the course interface	LPB
3	Subpage	Access the course sub-interface	LPB
4	Glossary	Access the glossary	KAB
5	Ouwiki	Query with Wikipedia	KAB
6	Resource	Search platform resources	KAB
7	Oucontent	Download platform resources	KAB
8	URL	Access course URL link	KAB
9	Forumng	Participate in the course topic forum	ILB
10	Oucollaborate	Participate in collaborative exchange activities	ILB
11	Ouelluminate	Participate in simulation course seminars	ILB
12	Externalquiz	Complete extracurricular quizzes	LCB

Regression Diagnostics

Regression diagnostics are used to evaluate the model assumptions and investigate whether or not there are observations with a large, undue influence on the analysis. There are four assumptions of linear regression, including linearity, independence, homoscedasticity, and normality. We test the regression diagnostics in four aspects, linearity, outlier, multicollinearity, and heteroscedasticity on the baseline model.

RESULTS AND CONCLUSION

Descriptive Statistics

The descriptive statistics of the variables are shown in Table 3 and Table 4. Table 3 shows the descriptive statistics of interval/ratio variables. The number of observations is 3525. The dependent variable (SD = 25.98), learners' academic success, has a mean of 54.94 and a range from 0 to 98.95. Four learning behaviors are LPB (Mean = 554.20, SD = 564.53, Range = 9440), KAB (Mean = 341.70, SD = 298.06, Range = 5615), ILB (Mean = 362.80, SD = 556.33, Range = 7962), and LCB (Mean = 14.94, SD = 18.39, Range = 340). The mean of the prior online learning experience (SD = 32.64) is 80.18, which means the mean of the prior studied credits is 80.18, with a range of 220 from 60 to 280. The assignment submission (SD = 3.76) has a mean of 1.23 with a range of 50.71 from -21.71 to 29.00. It means students submitted their assignments can range from 29 days earlier than the due date to 21.71 days later than the due date.

Table 4 shows the descriptive statistics of categorical variables. Most learners are less than 35 years old, accounting for 74.27% (N=2618). Female learners (N = 1362, 38.64%) are less than male learners (N=2163, 61.36%). For the educational level, more than 81% of the online learners have "Lower Than A Level" and "A Level or Equivalent". The three levels of the Index of Multiple Deprivation (IMD), "Low IMD level", "Medium IMD level", and "High IMD level" are 934 (26.50%), 1145 (32.48%), and 1446 (41.02%), respective. More than 73% of the learners are from "Medium IMD level" and "High IMD level", which means their economic level is relatively wealthy. Around 10% of the learners are with disability (N = 349).

Table 3. *Descriptive Statistics of Interval/Ratio Variables*

Interval/Ratio Variables	N	Mean	SD	Min	Max	Range
Learner academic success	3525	54.94	25.98	0	98.95	98.95
LPB	3525	554.20	564.53	4	9444	9440
KAB	3525	341.70	298.06	0	5615	5615
ILB	3525	362.80	556.33	0	7962	7962
LCB	3525	14.94	18.39	0	340	340
Prior online learning experience	3525	80.18	32.64	60	280	220
Assignment submission	3525	1.23	3.76	-21.71	29.00	50.71

Table 4. *Descriptive Statistics of Categorical Variables*

Categorical Variables	N	Percent (%)
Age		
0-35	2618	74.27
35-55	866	24.57
55<=	41	1.16
Gender		
Female	1362	38.64
Male	2163	61.36

Educational level		
Lower Than A Level	1123	31.86
A Level or Equivalent	1769	50.18
HE Qualification	612	17.36
Post Graduate Qualification	21	0.60
Index of Multiple Deprivation (IMD)		
Low IMD level	934	26.50
Medium IMD level	1145	32.48
High IMD level	1446	41.02
Disability		
Y	349	9.90
N	3176	90.10
Total	3525	100

Model Comparison Results

After comparing the BIC values of all four models, Model 4 has the lowest BIC value, meaning Model 4 is the model that best fits the data (shown in Table 5). We can conclude that engagement in all learning behaviors, prior learning experiences, and assignment submission is most impactful in determining success. Therefore, we select Model 4 as the baseline model in this study.

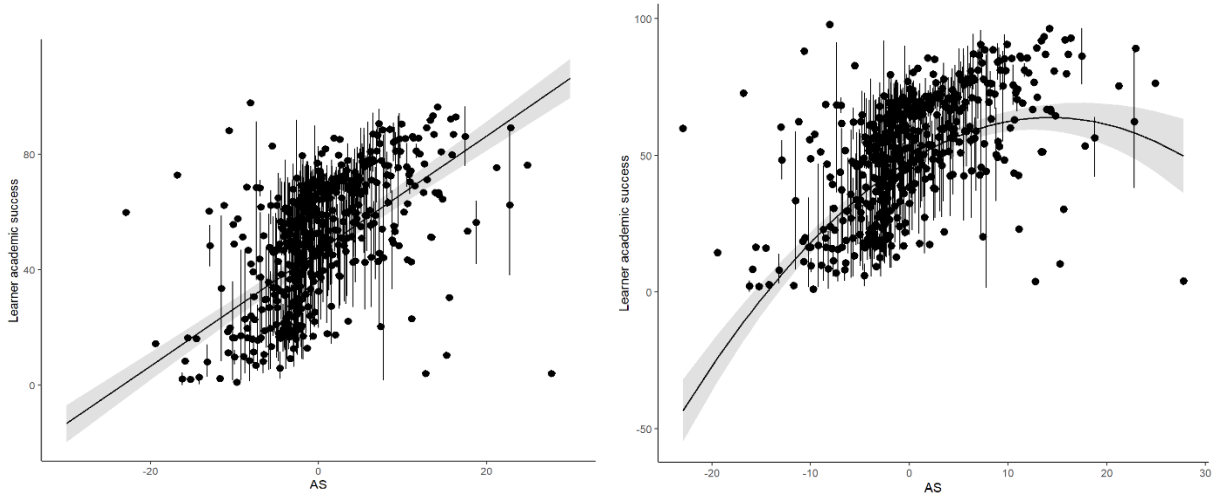
Table 5. *Bayesian Information Criterion (BIC) Multiple Regression Model Comparison*

Model	Residual *df*	BIC
1	11	32820.08
2	15	32217.63
3	13	32304.09
4	17	31861.07

Regression Diagnostics and Final Multiple Regression Results

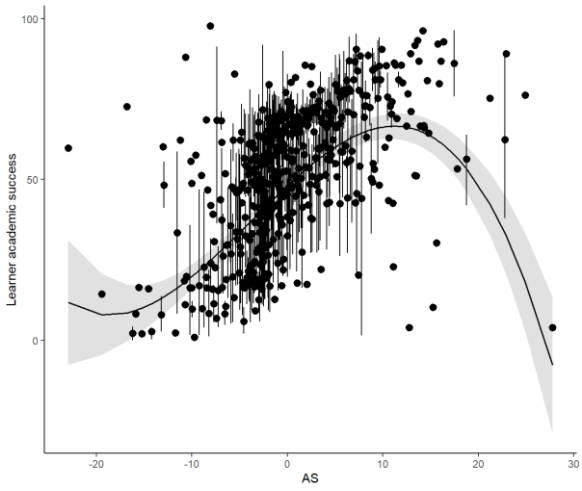
We test the regression diagnostics from four aspects, linearity (Figure 2), outlier (Figure 3), multicollinearity (Table 6), and heteroscedasticity (Figure 4) on the baseline model, Model 4. After regression diagnostics, the baseline model is transformed into a cubic polynomial model. The final model also includes the HC robust standard errors to correct heteroscedasticity's effect and result in more conservative test statistics. The results of the final model and final interaction model are shown in Table 7.

Figure 2. *Linearity Assumption Check (Assignment Submission)*



a. Baseline Model

b. Quadratic Polynomial Model



c. Cubic Polynomial Model

Figure 3. *The Plot of Cook’s Distance*

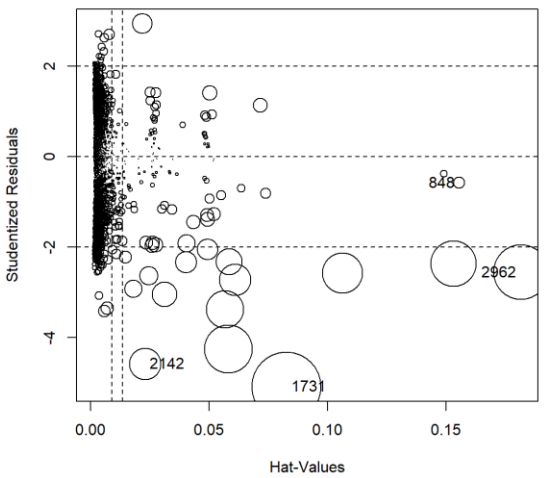
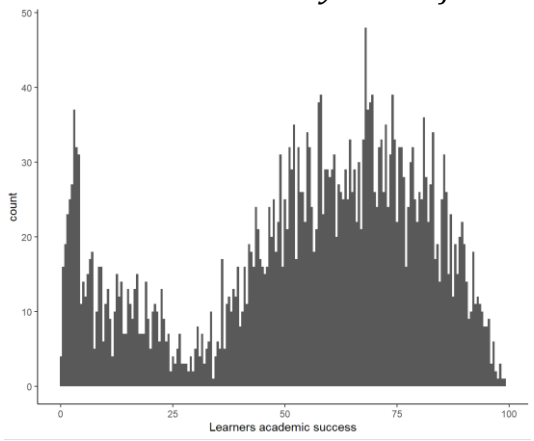
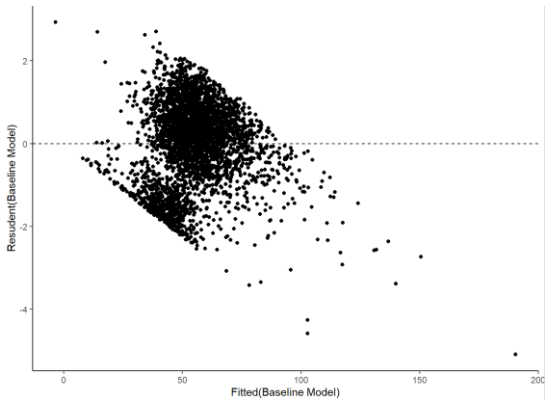


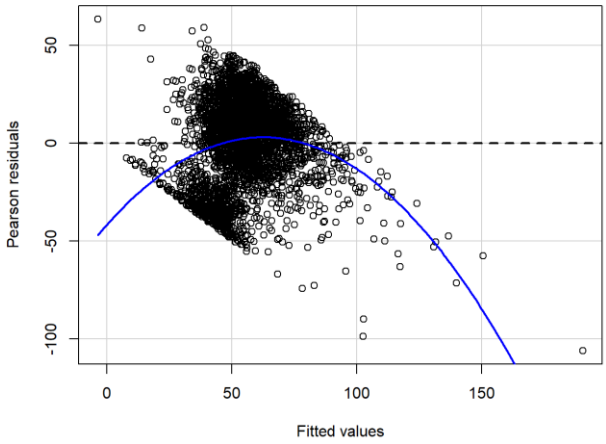
Figure 4. *Heteroscedasticity check of the dependent variable*



a. Histogram



b. ggplot



c. Residual Plot

Table 6. *Multicollinearity Check*

	GVIF	Df	GVIF^(1/(2*Df))
LPB	1.93	1.00	1.39
KAB	1.46	1.00	1.21
ILB	1.37	1.00	1.17
LCB	1.28	1.00	1.13
AS	1.04	1.00	1.02
PLE	1.01	1.00	1.01
Age	1.08	1.14	1.04
Gender	1.02	1.00	1.01
Education level	1.05	1.73	1.03
IMD	1.02	1.41	1.01
Disability	1.01	1.00	1.01

Table 7. *Final Robust Multiple Regression Model Results*

	Final Model	**Interaction Model**
Intercept	54.91 ***	55.35 ***
	(1.71)	(1.36)
LPB	1.40 ***	1.48 ***
	(0.40)	(0.24)
I(LPB^2)	-0.08	-0.08 ***
	(0.05)	(0.01)
I(LPB^3)	0.00	0.00 ***
	(0.00)	(0.00)
KAB	1.39 *	1.45 ***
	(0.60)	(0.03)
I(KAB^2)	-0.16	-0.20 ***
	(0.19)	(0.03)
I(KAB^3)	0.00	0.00
	(0.01)	(0.03)
ILB	1.33 ***	1.28 ***
	(0.20)	(0.20)
I(ILB^2)	-0.06 ***	-0.05 ***
	(0.13)	(0.01)
I(ILB^3)	0.00 ***	0.00 ***
	(0.00)	(0.00)
LCB	28.35 ***	29.18 ***
	(5.06)	(4.23)
I(LCB^2)	-59.80 ***	-62.98 ***
	(16.23)	(8.92)
I(LCB^3)	18.11 ***	18.95 ***
	(6.09)	(2.61)
PLE	-0.02	-0.02
	(0.01)	(0.01)
AS	2.18 ***	2.22 ***
	(0.15)	(0.12)
I(AS^2)	-0.04 **	-0.02 **
	(0.01)	(0.01)
I(AS^3)	-0.00 ***	-0.00 ***
	(0.00)	(0.00)
Age (35-55)	-2.64 **	-2.60 **
	(0.84)	(0.83)
Age (55<=)	0.63	1.56
	(3.11)	(3.23)
Gender (F)	-2.79 ***	-2.89 ***
	(0.71)	(0.70)
Education Level (A Level)	8.61 ***	8.45 ***
	(0.76)	(0.76)

Education Level (HE)	10.32 ***	9.91 ***
	(1.04)	(1.02)
Education Level (Postgraduate)	18.70 ***	17.31 ***
	(4.32)	(4.46)
IMD (Medium)	1.26	1.25
	(0.90)	(0.88)
IMD(High)	3.28 ***	3.34 ***
	(0.87)	(0.85)
Disability (N)	0.07	0.22
	(1.16)	(1.13)
AS * LPB		-0.15 ***
		(1.13)
AS * KAB		0.18 ***
		(0.03)
AS * ILB		-0.01
		(0.02)
AS * LCB		0.80
		(0.52)
N	3525	3525
Adjusted R^2	0.41	0.42
F	99.44 ***	88.28 ***

Notes. 1. All continuous predictors are mean-centered.

2. Four learning behaviors predictors, LPB, KAB, ILB, and LCB, are normalized by dividing 100.

3. Standard errors in parentheses. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

In Table 7, the four learning behaviors are all statistically significant at a $p<0.05$ level. PLE is not significant at a $p<0.05$ level. AS is statistically significant at a $p<0.001$ level. The Age (35-55), Gender (F), and the three Education Level are statistically significant at a $p<0.01$ level. The Adjusted R2 of the final model is 0.41, which means the final model can explain the 41% average score variation of the learners' academic success. In Table 7, the interaction model shows that AS has a moderating effect on the relationships between learners' academic success and LPB and KAB.

Based on the final model, the four learning behaviors and assignment submission have significantly positive relationships with learners' academic success. However, the square terms have significantly negative relationships with the dependent variable. This means that with the increase in the click rates of these four learning behaviors and the days students submitted their assignments earlier, a peak of performance exists for each variable. We reject these five null hypotheses: $H1$, $H2$, $H3$, $H4$, and $H6$. The prior learning experience has no significant relationship with learners' academic success. We cannot reject this null hypothesis: $H5$. The moderating effect of assignment submission exists. The assignment submission has a negative impact on the relationship between learners' academic success and learning preparation behavior. However, it positively impacts the relationship between learners' academic success and knowledge acquisition behavior.

The findings from the control variables are also interesting. First, online learners who are younger would have better performance in their online learning. Second, male learners would have higher academic success than the female group. The finding is consistent with the prior literature that male learners have better performance in their online learning in STEM courses than female learners [19]. Third, online learners with a higher education level would get higher academic success. Moreover, learners with high IMD perform better in their online learning. The higher IMD level represents a lower poverty level, which means online learners with a lower poverty level perform better. The reason might be that learners who have a higher poverty level lack resources, including equity and accessibility to technology, computer literacy, coordination of work and study hours, etc. Finally, the learners without disabilities do not significantly differ from those with disabilities in online learning academic success. This finding gives us an exciting result of educational equity for students with disabilities.

SCHOLARLY SIGNIFICANCE

This article sheds light on the relationship between learners' behaviors, assignment submission, and learning success in an online learning environment. Educators should examine their curriculum, consider what supports and strategies assist students' learning behaviors, and encourage more positive student attitudes in an online learning environment.

The theoretical contribution of this study is twofold. First, the research fills the gap in online learning by considering how learning behaviors and assignment submission affect learning success. Secondly, this research considers the moderating effect of assignment submission in terms of online learning behavior. This study is very practical for universities and institutions which make understanding the online nature of studies more comprehensive.

In the future, we will explore the findings based on a large dataset to compare students' different learning behaviors who register for STEM and non-STEM courses and their impacts on their academic performance. Also, we will focus on how to improve online learners' effective learning behaviors to enhance their learning performance in the online environment.

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Technostress and Its Impact on Higher-Ed Faculty Teaching Transitioning from Face-to-Face to Online Classes during Covid-19- Lessons Learned.

Abstract

Like many other industries, universities and colleges suffered adverse effects from the pandemic caused by Covid-19. Faculty who traditionally taught face-to-face were presented with challenges associated with learning new technologies to facilitate the delivery of their courses. Faculty across most disciplines experienced technostress, or the inability to comply quickly with the technological demands of fully online teaching their traditional face-to-face classes. The transition from an in-class teaching modality to that of fully online using advanced technology learning management systems (LMS) created a disconnect among many faculty members. Most felt overwhelmed by the radical shift change in pedagogy. The authors examine specific factors that contributed to faculty technostress through a survey and present a model from the lessons learned to help better prepare faculty for the next pandemic. This would benefit all faculty teaching face-to-face and enhance the delivery of hybrid and online courses.

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THE IMPACT OF COVID-19 ON STUDENTS' PERFORMANCE AND WORKFORCE READINESS

ABSTRACT

Students have been highly affected by Covid-19 through impacts on income, social life, mental health, changes in platform and academic performance. Here, we analyse survey responses of 85 Junior and Senior undergraduate students at Marymount University to identify the relative importance of each aspect of the impact. The results show that few students' academic performance was affected, but they were subjected to severe financial, social, mental health issues and lack of comfortable study place that affected their education. Therefore, preparation for similar events in the future should focus on these aspects especially focusing on students in vulnerable spots.

Keywords: Covid-19, Covid-19 impacts, Covid-19 Education

1. INTRODUCTION

When Covid-19 hit the world in early 2020, its impact on human lives was dramatic, killing thousands of people every single day and hospitalizing even more. Efforts against the pandemic were put in place swiftly by governments leading to the closure of businesses, education, and other social activities. These efforts were mostly reactionary in a rather novice society that was not ready to deal with such intense changes. Therefore, it is only logical to expect Covid-19 to have impacts on aspects of human life beyond health and well-being.

The first aspect of the impact involves the social life disruption that followed the quarantine and social distancing rules. Studies have found that several metrics of social life such as intimacy, norms, and support show the negative impact of Covid-19 [11]. On the other hand, the closure of businesses left many unemployed and others to lose their economic benefits. This is supported by estimates that show an increase in poverty [17] and an overall decline in the economy in response to Covid 19 [15].

Another aspect of Covid-19 impacts can be identified as its impact on mental health. This can be considered as an aggregate of its direct impacts on physical health, social life, and economic standing. The threat of exposure and death can lead to anxiety while lack of social interaction and unemployment can bring depression issues [4]. Distress, anxiety, stress, and even the tendency to commit suicide have a higher likelihood due to Covid-19 and its accompanying problems [4].

Finally, there have also been reports of decline in productivity concerning remote working. This decline in performance has been studied among employees and found to be caused by factors like changes in the work environment [8]. The same issue also affects students who were forced to study from home during the pandemic. However, the literature is not very consistent on the subject. Although some studies indicate an enhancement in academic performance [10], other studies indicate a negative impact [4].

The impact of Covid-19 on student performance and workforce readiness can come from all the other impacts of covid including economic status, mental health, and additionally, changes in learning platform and delivery. Since the damage caused by an impact can either be

amplified or diminished by the vulnerability of the recipient, it is logical to hypothesize that not all students feel these impacts the same way. That is, for instance, students with lower economic status initially would be more affected by the economic impacts of the pandemic than those with higher economic status.

Therefore, in this study, we analyse the impact of Covid-19 on college student's academic performance, satisfaction with their education, and workforce readiness from a different perspective. This is done by analysing how students experienced the overall change in performance, financial stress, social life changes and mental health issues.

The research aims to answer the question of what factors affected students' grades. Was it the financial and economic changes brought on by the pandemic or the impacts of the pandemic on students' mental health or both? In addition, the impact of change in format and delivery of content had on students' grades will also be evaluated. Furthermore, the same analysis is done to see how mental health, financial changes, environmental factors as well as content delivery affected students' satisfaction with the knowledge they received. Additionally, the research also aims to answer how students' workforce readiness was affected due to the change in the way they received education as well as the limitation of networking opportunities in-person.

The research analysis used empirical techniques to review the factors that significantly impacted students during the pandemic. Survey analysis was carried out to review how students at Marymount University were impacted by the shift. The methodology used includes different statistical tests and analysis methods to review the survey responses and answer what are the major factors that affected students' grades, knowledge, and workforce readiness.

The paper is organized in the following manner. Section 1 discusses the impact of Covid-19 on students' finances, mental health, and delivery of study material are assessed. Then section 2 represents the Literature review and the research used for the study. It talks about what previous works have done and what this project hopes to achieve. Section 3 incorporates the methodology and tools used for analysing the research. Section 4 has the Results and Analysis of the paper after different tools were used to analyse the data. Section 4 includes what results were found and visualizations to express the results. Section 5 includes the conclusion reached after reviewing the results. Section 6 discusses the problems and limitations that were encountered while working on this research and Section 7 includes future works that could be added to the paper to enhance better results.

2. LITERATURE REVIEW

The closure of businesses as a response to the pandemic directly affected the economic status of lower- and middle-class societies due to increased unemployment. Studies have found an increase in poverty in different regions as a consequence of Covid-19 [12]. The impact has been identified to be inconsistent amongst different communities. That is, lower-income communities with higher vulnerability to sudden restrictions and loss of jobs suffer significantly more than those with better social status. A research identified millions in poor communities would face poverty due to the impacts of Covid-19 [5].

In the academic communities, the economic impact of Covid 19 would similarly be felt as any other community. This may occur directly as universities get closed taking away job opportunities for students that support themselves [2], or indirectly as families supporting college students lose their jobs. This economic impact can have severe consequences on the academic progress of students as it can have a direct influence on students' abilities to cope

with expenses or on their mental status as many have reported stress over financial concerns [2]. The direct impact is naturally expected to be more damaging for those living with lower income in the first place as they may not be able to weather the impacts at the time.

As highlighted in the previous section, the direct impact of Covid-19 can lead to financial concerns that can cause mental pressure on those affected by it. At the same time, the high level of uncertainty regarding academic progress, anxiety over the health impacts of the pandemic itself, worry over job opportunities, lack of social contact, and isolation can all take a significant toll on the mental health of students. Several university students expressed difficulty with stress, solitude, depression, and other mental hardships [2]. This is supported by other studies such as the study by [19] that showed 70% of survey respondents indicated increased stress and anxiety after the pandemic. The study also indicated that some students experienced depression and even suicidal thoughts. Mental health can have a direct impact on academic progress as it can manifest through loss of sleep and appetite, lack of motivation, and issues with keeping one's focus on schoolwork.

Another aspect of Covid-19 impact on student lives and performance is the challenges posed by the abrupt change in learning platforms. Several universities/colleges switched their mode of learning to an online form to ensure social distancing during the pandemic. Efficiency of online learning is affected by students' ability to get access to learning materials such as the internet and lack of contact with educators. These aspects of online learning can harm the quality of education the students can get and their overall academic performance [14]. It is also important to note that the accessibility of learning tools can be significantly more difficult for students coming from low-income families.

A research also highlighted that online learning leads to diminished social skills that would otherwise be gained/maintained through peer contact [14]. The inability to maintain social skills such as communication and leadership can negatively impact students' workforce readiness since such skills are almost as important as academic performance when it comes to landing jobs.

The overall impact of Covid-19 on students' academic performance has been studied by several researchers [6][12][13]. Some of the literature shows that students have had an increased performance during the pandemic [6][13]. This may be related to better family supervision and freedom to chase hobbies [18]. On the other hand, other studies found a decline in academic performance [12][14]. It is stated that the negative impact is rather significant on low-income students who would face more difficulties with online learning during the pandemic [12].

The pandemic's impact on students' careers goes beyond a simple decline in performance. Studies have highlighted that the change in the learning platform has led to the delay of graduation dates, and the loss of internship and job opportunities for several students [14][15]. This directly impacts students' marketability and readiness for jobs since they have lost the chance to gain real-life work experience besides what they learn in the classrooms. Research has found that his impact is more severe for low-income students [1].

Most of these studies focused on the overall change in academic performance or considered a single factor such as financial status in relation to the pandemic [6][7][11][14]. Furthermore, there are diverging implications where some studies show positive while others show negative impacts on academic performance. The literature is still lacking the relative contribution of each aspect of Covid-19 impacts to the change in academic performance. Furthermore, given

the direct relation of academic performance to the work world, the impacts should also be investigated concerning students' workforce readiness.

3. METHODOLOGY

To understand how students' mental state, finances, and grades were impacted by the pandemic, a survey was sent out to 740 undergraduate students at Marymount University. The survey followed IRB guidelines and did not collect the personal data of responders. The goal of the survey was to answer how much students were impacted by the shift in learning. How did this shift affect their mental state and finances as well as their readiness to join the workforce?

The survey was sent out to rising seniors and juniors. This was done to understand how they were affected during their search for work and internships. It was felt that rising seniors and juniors would be more prone to looking for internships and joining the workforce and they would also have been in college when the pandemic hit. Therefore, their experiences would include the education system before the pandemic, during, and after giving a clear view of how significant of an impact the change had in their overall learning process.

The survey was sent out to students and was open for a month. It garnered a response from 85 undergraduate students at Marymount University. Out of the 85 respondents, 25 students were white, 24 were black or African American, 15 were Hispanic, 10 were Asian, 7 were Two or more races, and 4 were other. Of these respondents 66 were female, 17 were male and 2 were other. Out of these 85 students, 59 were seniors and 26 were juniors. This is shown in Figure 1.

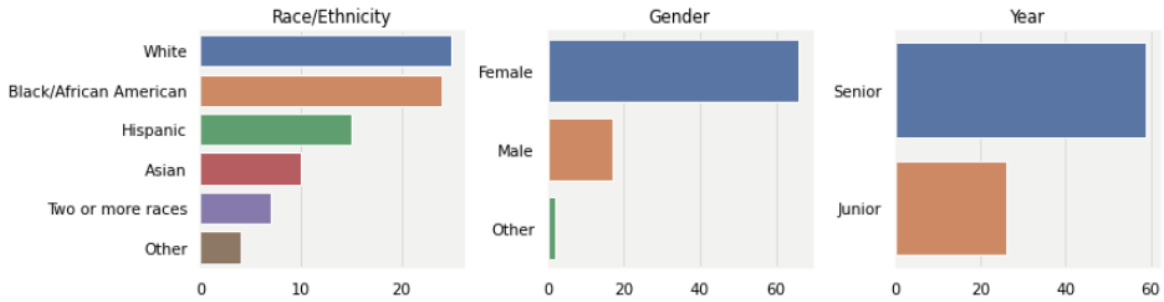

Figure 1: Number of students who responded based on race, gender, and year

The survey question analyzed four aspects that could impact students' education during the pandemic. These are their finances, environment, mental health, and learning platform. It also aims to understand the relationship these aspects can have with students' academic performance. Therefore, the survey also questions how the pandemic affected students' grades and satisfaction with the knowledge they received.

On the other hand, the survey also analyzed the level of readiness students felt to join the workforce. Due to the pandemic, most networking opportunities were made online. This shift could impact students and how ready they feel to work. In addition, the shift in how they received networking opportunities could be a factor in how they looked for internships. Furthermore, the complete shift in how they received education could also make them hesitant towards graduate school. Therefore, the survey asked questions that could shed light on how the shift to online platforms affected workforce readiness. The full survey questions can be found in the appendix.

To analyze the responses from the survey a Spearman rank correlation was used. Due to the nature of the responses being categorical, a regular correlation test would not be clear in helping understand the relationship [7]. A spearman correlation sheds light on understanding if the variables have a relationship with each other and give their statistical significance. This is vital to understand whether the relationship between each factor is purely coincidental or important.

In addition, a machine learning model was used for a classification analysis on what factors led to either a decline in a student's grade or affected their satisfaction with the knowledge they gained. Python was used to perform the analysis along with relevant software packages implemented in python. The results of the machine learning model are represented using a confusion matrix and classification report. The metrics for this analysis are accuracy, precision, and recall. Accuracy is the measure of correct predictions in relation to the total amount of results (1). It shows what percentage of data that was predicted is correct while precision is used to measure from all the results identified as positive, which means that were predicted positive correctly or results that were predicted as positive incorrectly, what percentage is positive (2). On the other hand recall measures the percentage of positive results that were identified correctly, which means percentage of the results that were predicted as positive correctly and results that were positive but were predicted as negative (3) [6]. This metrics gave a thorough review of the value of the model and how well it predicts.

$$\textbf{\textit{Accuracy}} = \frac{\textbf{\textit{True Positive + True Negative}}}{\textbf{\textit{True Positive + True Negative + False Positive + False Negative}}} \quad \textbf{(1)}$$

$$\textbf{\textit{Precision}} = \frac{\textbf{\textit{True Positive}}}{\textbf{\textit{True Positive + False Positive}}} \quad \textbf{(2)}$$

$$\textbf{\textit{Recall}} = \frac{\textbf{\textit{True Positive}}}{\textbf{\textit{True Positive + False Negative}}} \quad \textbf{(3)}$$

The survey also consists of statements that were collected on students' experience in various sectors. This is done to analyze how much students were affected by the sudden changes in the way they received their education. For this analysis, a Natural language processing tool was used to gather relevant information.

4. RESULTS AND ANALYSIS

A preliminary analysis was done to review the impact the pandemic had on students' finances. From the survey, 72.94% of students indicated that the pandemic affected their family's income and their ability to pay for their education while the rest indicated otherwise. In addition, 48.24% of the respondents had to increase their working hours to support themselves. Furthermore, out of the 32 students who responded that they are eligible for the Pell grant, 87.5% of them mentioned that their family's finances were impacted and hindered their ability to pay for school while 53.13% said they had to increase their working hours to pay for school.

Additionally, the changes in accessing the course material due to financial factors made 24 students delay their graduation date. As can be seen in Figure 2**,** students indicated that they had to delay their graduation by timelines ranging from one semester to one year. They indicated that this was due to financial stress and in some cases the type of curriculum. Medical students such as nurses were not able to participate in training and some students indicated that they had to delay their education because of that. These results show that majority of the students who responded to the survey were financially impacted due to the pandemic.

Figure 2: Amount of time students delayed their graduation

Regarding education tools, 88.24% of students suggested that they were able to afford the tools needed for their online school. Additionally, 87.06% also indicated that they had easy access to the internet. Thus, most students who responded to the survey were not severely impacted by having the tools to adapt to remote learning. This highlights that the financial stress reported by the students was not posed by the shift to online learning. On the other hand, 65.86% of students were negatively impacted by the environment available for studying, even though 85.88% of students said they had safe and comfortable living conditions. While students had safe and comfortable living conditions, the closure of libraries and other spots where students spent their time studying forced students to work in uncomfortable conditions.

Survey responses regarding social life indicated that 89.41% of students were affected negatively. Social life was mostly on hold due to the closure of businesses and various social activities. The pandemic also affected students’ mental states. Of the survey respondents, 56.47% indicated that their mental state was impacted negatively. In addition, 24.71% indicated that they lost a family member due to Covid-19. Over half of the respondents (54.22%) also stated that the pandemic impacted the relationship between family members negatively. Therefore, the various strains of no social life, loss of family members as well as the negative familial relationship could put a strain on students’ education.

The online format of content delivery was found to be effective and understandable by 67% of students. Additionally, 70% of students also indicated that they received adequate support from their teachers. These results indicate that majority of the students were not severely impacted due to the change in the learning format. To reinforce this, 71% of the students also stated that they could utilize online platforms to effectively communicate with their peers. This shows that students were not dissatisfied with the way they received education online or with the support they received from their teachers.

The survey also shows that 55.29% of students' grades declined significantly during the pandemic while 49% indicated that they were not satisfied with the knowledge they gained. The above results signify that majority of students were satisfied with the online content delivery. Therefore, relatively the factors that affected students’ grades could be related to the mental and financial strain brought on by the pandemic as can be seen in Figure 3**.**

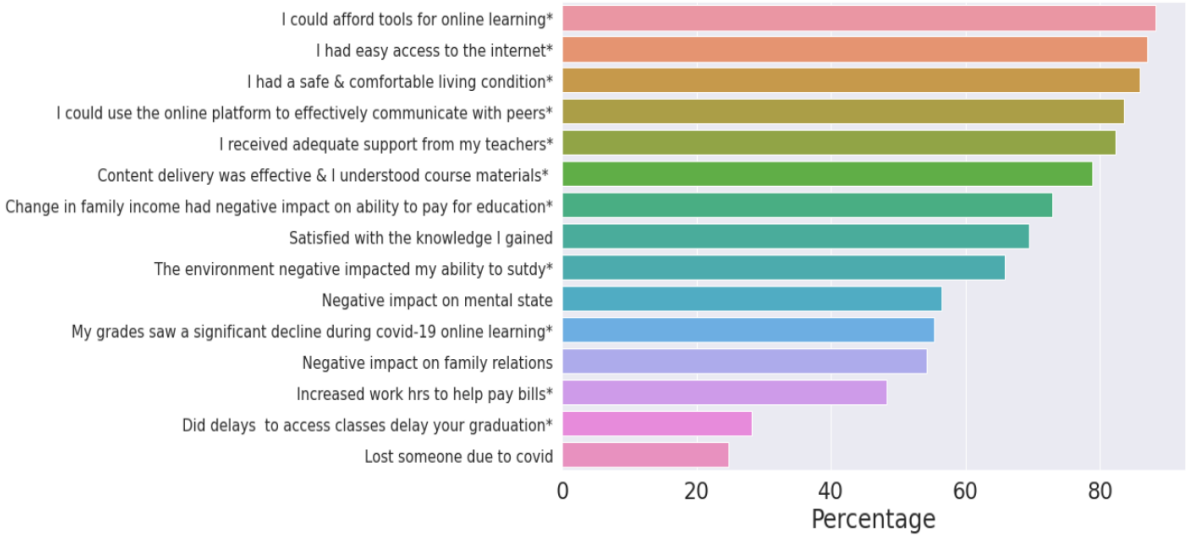

Figure 3: Factors that affected students during Covid-19

Concerning workforce readiness, 64.29% of students indicated that they did not access online resources for networking opportunities. In addition, 64.29% also stated that they were not satisfied with the information gathered in this remote format and78.48% indicated they would have preferred to attend these events in person. However, 67.47% of students indicated that the pandemic-related changes in their education experience did not affect their workforce readiness. Furthermore, 74.39% also indicated that remote networking and job fairs should play a significant role for students seeking career opportunities in the future. Hence, the result implies that even though students were not fond of online networking opportunities during the pandemic, they still felt that they were adequate and should play an important role in the future. Additionally, of 38 students who said they would pursue a graduate degree within one year of graduating, 76.3% indicated that the change to the remote format of education did not impact their readiness to pursue a graduate degree. Furthermore, most students indicated that the changes to the remote format of education did not affect their plans to pursue a graduate degree.

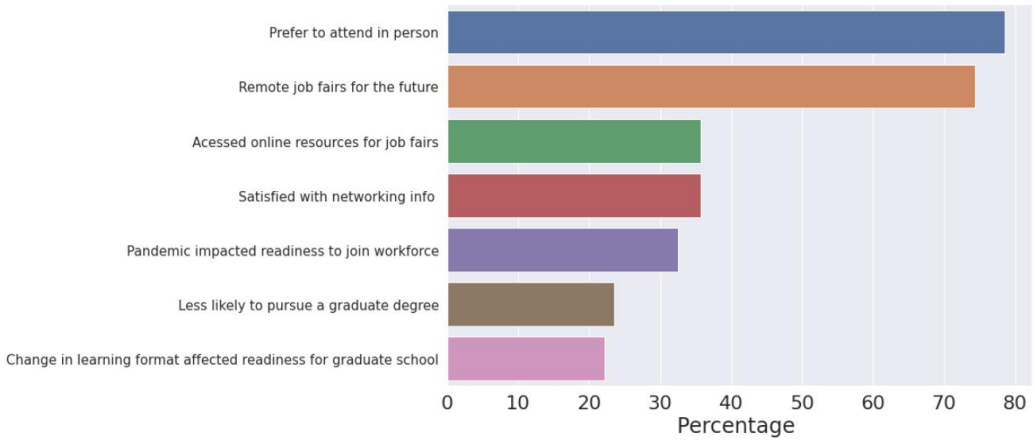

Figure 4: Factors affecting student's workforce readiness during Covid-19

From the preliminary analysis, a set of factors that directly affected students' grades were selected and a spearman rank correlation was carried out. Due to the categorical nature of the data and the size of the dataset, a correlation above 0.3 and below -0.3 is considered high [13].

From the results, as indicated in table 1 below, studying environment, mental state and negative impact on family relationships had a positive correlation as well as a statistically significant relationship with grades while other factors do not have a correlation or a statistically significant relationship.

Category	Spearmen correlation	P-value
Studying environment	0.356	0.001
Mental state	0.296	0.007
Negative familial relationships	0.288	0.009
Income changes	0.170	0.127
Social life	0.115	0.304
Internet access	-0.110	0.311
Support from faculty	-0.162	0.147
Living condition	-0.216	0.052
Afford tools for online learning	-0.240	0.030
Content delivery	-0.261	0.018

Table1: Spearman correlation for factors affecting students' grades

From the results shown in Table 1, being negatively affected by the studying environment, negative impact on mental state, changes in family's income, the pandemic's having substantial negative impact on ability to pay tuition, having a safe and comfortable living conditions and other education-related expenses correlated well with the pandemic affecting grades negatively. This result supports the preliminary analysis where most students indicated that they were negatively impacted by the studying environment, strains on their mental health, and negative impact on their family relationships. In addition, since most students were spending a lot of time with their families, this factor could also have caused a strain on students' mental health which is also another factor that affects students' grades. Negative impact on family relations and mental state also has a statistically significant correlation of 0.34. These results support that student who indicated they had harder familial relationships due to the pandemic also indicated their mental health was impacted negatively.

Concerning satisfaction with knowledge, the results in table 2 indicate that content delivery has a statistically significant positive correlation with students' satisfaction in their knowledge. On the other hand, negative impact on studying environment and negative impact on family relations have a slightly negative statistically significant correlation. This indicates that students who were satisfied with the content delivery were also satisfied with the knowledge they received.

Category	Spearmen correlation	P-value
Content delivery	0.326	0.003
Support from faculty	0.180	0.106
Living condition	0.129	0.247
Income changes	0.120	0.284
Internet access	0.066	0.553
Afford tools for online learning	0.012	0.913
Social life	-0.047	0.672
Mental state	-0.137	0.219
Studying environment	-0.254	0.021

Family relationships	-0.265	0.016

Table 2: Spearman correlation for factors affecting students' satisfaction with the knowledge they received

After the preliminary analysis, the factors that had a high correlation with declining grades were used for a classification model to review if they could be used to predict students' performance. For the dependent variables, we used negative impact on mental state, negatively affected by studying environment and the pandemic negatively impacted the relationships in my family. As indicated in Figure 6**,** the model had an accuracy of 62% and was able to predict accurately for many of the cases. However, the model does not do well in predicting students whose grade was not affected due to the pandemic as shown in the confusion matrix in Figure 5. This could be due to the lack of substantial data and more factors that could have impacted grades.

	Predicted 0	Predicted 1
Actual 0	4	5
Actual 1	3	9

Figure 5: Confusion matrix for predicting grades

	precision	recall	f1-score	support
0	0.57	0.44	0.50	9
1	0.64	0.75	0.69	12
accuracy			0.62	21
macro avg	0.61	0.60	0.60	21
weighted avg	0.61	0.62	0.61	21

Figure 6: Decision tree classification report for predicting grades

5. CONCLUSION

The pandemic impacted students in several ways. It affected their mental state, social life, income, workforce readiness, education and so on. According to the survey results we can conclude that the change in format brought about by the pandemic did not affect student's education negatively. Majority of students were satisfied with the knowledge they received, the support they had and the format in which they received their education. However, the financial changes in income had an impact in some students. It even led to some students delaying their graduation. Therefore, we can conclude that even though many students did not indicate a huge financial impact in the tools they could afford and tuition payments, the students that were affected had to delay their education and work more hours to support themselves. In addition, majority of students indicated that the environment they had for studying, their mental state and several other factors were significantly impacted.

In addition, we can conclude that the factors that affected student's grades are the pandemic wrought changes on student's mental health, the ability to not have a good studying

environment and the negative impact on family relationships due to lock down. Therefore, we can conclude that the factors that need work to ensure students' get the best grades is ensuring they always have a good working environment and making mental health support easily accessible. On the other hand, we can conclude that students were satisfied with the knowledge they gained. Therefore, we can conclude that even though there was a drastic change in how students were learning, the format and the other factors did not severely impact the level of satisfaction they had with the knowledge they received. This is further supported by students indicating that they are still open to pursuing graduate school. Furthermore, we can conclude that student's workforce readiness was not severely impacted due to the pandemic but due to the quality of networking opportunities provided online. If the networking events were upgrades, students would be more open to doing remote internships. We can also conclude that practical need work in terms of making remote internships and opportunities available. Most students indicated that due to the nature of courses they took in nursing the simulation system of learning was not as effective as doing it in person.

6. LIMITATIONS and FUTURE WORK

While working on this research paper one of the major limitations we faced was the small number of responses we received when we sent out the survey and the lack of male respondents. From 700 students only 85 students responded to the survey and of those 85 only 17 were male. This result indicates that the survey might have a different response based on different genders and we could not do such an analysis due to the small number of responses. In addition, since the survey only had 85 respondents, we were only able to make deductions, but a large number of responses could have yielded better results. Additionally, we were only able to do the survey for one University, therefore the results might be different if it was throughout the country.

Due to the limitations stated above, we couldn't do a more in-depth analysis if the different factors. Therefore, we suggest analyzing different universities and age groups. We also suggest expanding the university based in income and location to review if that makes any difference in how severely the pandemic affected students. Furthermore, to increase the accuracy of the model we suggest trying out different machine learning tools.

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UNDERSTANDIN GEN Z STUDENTS'S SUCCESS USING BLOOM'S TAXONOMY & LEARNING STYLES

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ABSTRACT

This research investigates Gen Z students' learning attributes to understand their learning styles and proposes appropriate instructional methods to enhance their learning strategies by promoting and elevating Gen Z learning to combat life's challenges. Gen Zs are highly collaborative, self-reliant, pragmatic, and Tech Savvy. In this Pilot study, we will apply Bloom's Taxonomy as a framework to understand the cognitive learning strategies of Gen Z students and explore the development of corresponding effective learning and appropriate assessment approaches for their academic success. Toward that end, a survey of students at a medium-sized southeastern university was conducted. The survey instrument comprises of a variety of questions covering respondents' demographic perceptions of course content, coverage, delivery method, level of computer use, and the impact of Learning Management System(s) on their learning and learning styles. An analysis of the empirical data reveals undisputable insight into Gen Z students' attitudes to learning and predictor learning attributes as gauged by the six cognitive levels of Bloom's taxonomy.

INTRODUCTION

Generation Z, also known as iGen or the post-Millennial generation, consists of individuals born between the mid-1990s and the early 2010s. Research on their learning styles is still emerging, but some studies suggest that they are more attuned and readily disposed to visual and interactive forms of learning. There is a general belief, that they have a strong desire for instant gratification and feedback and to be more adept at multitasking than previous generations. Additionally, Generation Z is thought to be highly influenced by technology and social media, which may impact their learning preferences and personal habits. However, more studies are needed to fully understand the unique ways of how Generation Z have been able to adapt to technological evolution and digitalization much easier than other generations. Whereas, older generations strengthen their digital abilities through continuous learning and adapting to change, the Z generation has a natural flair for new technologies. They have a passion for technology, speed, and efficiency and a learning style specific to online channels [7]. Learning is acquiring new skills, knowledge, and abilities. Most people continue this process as a lifelong activity to remain competitive. The learning process is influenced by cultural, social, economic, and even psychological factors. Each individual has a unique learning style influenced by their milieu, strengths, and weaknesses. These factors also impact generation Z students' learning styles, improve teaching styles, and enhance information flow during formative learning [6]. Researchers have been interested in the learning style of different generations for decades. The generations are

typically divided into baby boomers, generation X, millennials, and generation Z. This paper focuses on generation Z those born after the mid-1990s [17].

LITERATURE REVIEW

The generation born in the late 1990s or the early 21st century is perceived as being readily familiar with the use of digital technology, the Internet, and Social Media from a very young age. According to Wikipedia, Generation Z (Gen Z) are colloquially known as "zoomers", as the demographic cohort succeeding Millennials and preceding Generation Alpha. Merriam-Webster describes the word 'boomer' as a short form of 'baby boomer' [22]. Researchers and popular media use the mid-to-late 1990s as starting birth years and the early 2010s as the ending birth years for Generation Z. Most members of Generation Z are the children of children of Generation X. Baby boomers defined as those who were born between 1946–1964 are the generation who are focused on work and who like to learn new skills independently [17,11]. Generation X (1965–1980), are focused, independent, self-directed, tech sophisticated, open-minded, and comfortable with authority [12].

Empirical evidence supports the fact that how Gen Z students learn is different from how the previous generations learned [5]. Gen Z students expect the classroom environment to be more interactive and conducive to thinking and creating [5]. This generation differs from previous generations, as they arrived when the private and public sectors widely adopted the Internet. The Internet help integrates disparate cultures globally. Information and Communication Technologies (ICTs) and the Internet to enable fast communication with smartphones, digital and other gaming devices. [15]. Generation Zs' learning style suggests it is heavily influenced by technology, and primarily social media. Individuals belonging to different cohorts of generations show different personality traits in terms of interests (personal values) and learning styles [15]. Generational differences impact various aspects of life including work ethics, teamwork, career, leadership attitude, and organizational commitment. [13,14]. e-Learning tools, the fastest-growing digital environments delivery tools are universally used by most organizations to provide education and training. All things considered, Gen Z students are the perfect group for learning mediated by of digital tools. An exploratory study was conducted to evaluate e-learning through Blackboard based on Bloom's taxonomy [2] by surveying undergraduate students at a medium-sized university in the southeastern region of the United States. It determined that individual and instructional factors do not play a major role in the learning process in general [9]. Bloom's taxonomy was applied to assess computer science programs especially in designing examinations to improve the quality of assessment in computer programing courses [19].

Generation Z has a special connection with technology and social media. In an another study conducted by Turner [20], the author recommends that parents, teachers, and clinicians should use technology not as an enhancement but as a replacement to connect with a Gen Z child. In addition to understanding how Gen Z use technology, acquiring a deeper awareness of a different generation's frame of reference will help bridge the gap when building relationships. [20]. Gen Z students are considered to be native users of technology and are totally unfamiliar with a non-digital world, a world without smart devices and the Internet [3]. Hence, the way they learn & and

study and grasp as well as process information is different, and is changing relative to the previous generations. It is therefore, not far-fetched to encourage parents, teachers, and clinicians to consider a paradigm shift when connecting with Gen Z students.

Also, Gen Z students' learning styles involve visual, auditory, and kinesthetic dimensions. Hence, improvising and enhancing current techniques that incorporate these newer learning styles will help establish a connection with Gen Z [3]. Moreover, Gen Z are one of the profound changes that happened to business and society [16]; therefore, one must attempt to understand the Gen Z effect and the six forces that propel such effect as these forces are shaping the future of business [8]. Not only that Gen Z are the future of the global economy, they are career-focused, believe in diversity, are expert online researchers and shoppers, and are ethnically diverse [4]. Nurturing them at a younger age, understanding how they learn and comprehend and apply information for decision-making, and devising methods to educate them that fit their learning styles will result in preparing these Gen Z students for the future and yield immeasurable dividends to society.

Gen Z will be the target market for companies who will be recruiting them eventually in large numbers since 70 million Baby Boomers would retire by 2025 [10]. To attract such a large workforce with different and diverse characteristics, companies should prepare themselves by changing the way they recruit Gen Z [16] . Companies need to make changes and invent innovative recruitment methods to attract Gen Z. Top recruitment techniques that may attract Gen Z include, emphasizing the upward mobility, offer volunteer opportunities through work, recognizing their entrepreneurial spirit and the desire to have self-directed projects, and value face-to-face communication [16]. University and college faculty, staff, and administrators should gear up to meet, understand, teach, and guide Gen Z so they become fruitful citizens of the world particularly, workforce.

METHODOLOGY

This research investigated Gen Z students' focusing on attributes related to understanding their learning styles, and attempts to suggest appropriate instructional methods suitable to the generation to enhance their knowledge to accelerate and elevate their learning strategies, in order to be ready to face life's challenges in and out of their learning environment. We applied Bloom's Taxonomy framework to understand the cognitive levels of Gen Z students and developed learning and assessment methods for various mental levels based on the sampled Gen Z students. The data source used for the study is a survey administered in 2022 at a southeastern university. Participants were invited to complete an online survey (Qualtrics) sent to students through email. The research focused on the learning preferences of Generation Z. We collected data from a sample of 113 students (n=113). Of the 113 participants, 91% are Generation Z (born after 1996), with a distribution of 50% in the 17 to 20 age range, 41% in the 21 to 25 range, and 9% above 25 years of age. The gender breakdown was 59% females and 41% males. Most participants were undergraduate students (10% freshmen, 19% sophomores, 31% juniors, and 40% seniors). (Table 1 below).

Data on Gen Z students, such as demographics, education, social background, learning style, and other relevant attributes were collected and analyzed using appropriate statistical tools resulting in a framework to help design instruction methods and assessment techniques to improve Gen Z's graduate's preparation for the marketplace.

The data collected was analyzed using appropriate statistical techniques and descriptive statistics, such as frequency count analysis, chi-square tests, and nominal logistic regression analysis. This paper and the study's focus are on the six cognitive levels of knowledge-based domain from Bloom's Taxonomy [21] (Figure 1) as shown below:

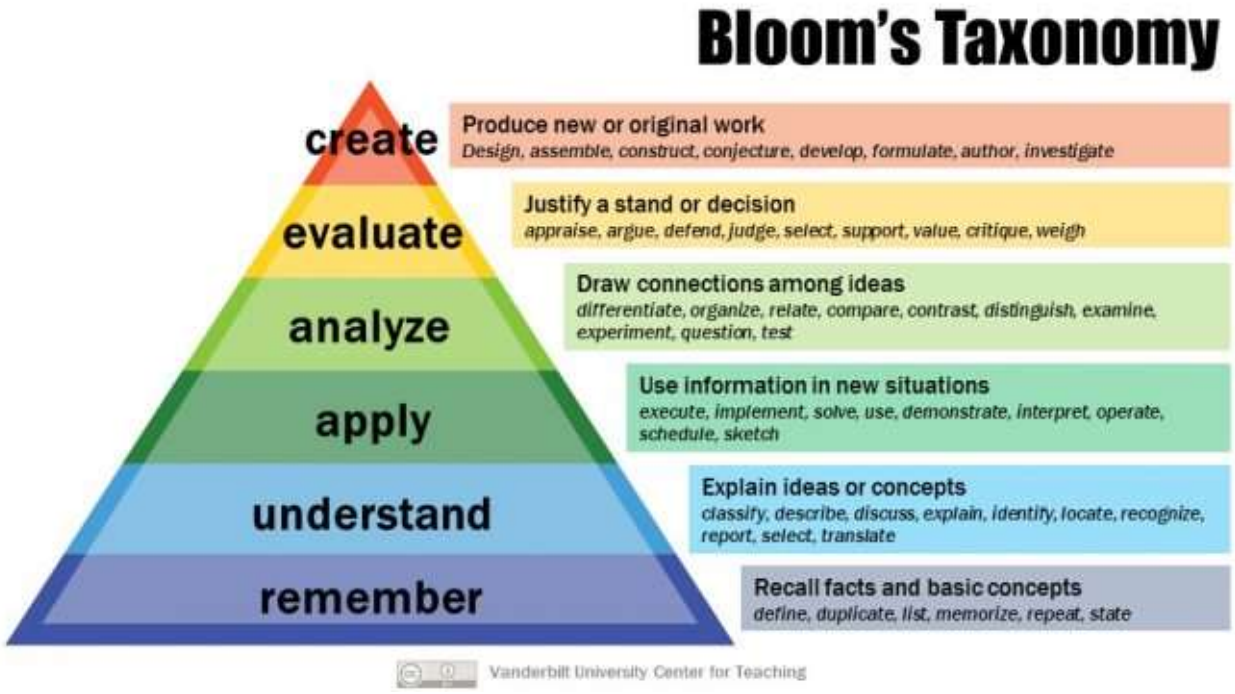


FIGURE 1: BLOOM'S TAXONOMY
Source: (Vanderbilt University Center for Teaching)

Bloom identified six levels within the cognitive domain, from the simple recall or recognition of facts, at the lowest level, through increasingly more complex and abstract mental tasks, to the highest order which is classified as evaluation [21]. The original Bloom's taxonomy as shown in Figure 1 was revised by a group of cognitive psychologists, curriculum theorists and instructional researchers, and testing and assessment specialists in 2001 [1]. The revision and transformation mapping from old to new is shown in Figure 2. The reason for the revision was to draw attention away from the static notion of "educational objectives" (in Bloom's original title) to a more dynamic conception of classification [1]. The revised Bloom's taxonomy is shown in Figure 3 which emphasizes the use of "action words" describing the cognitive processes which thinkers encounter and apply for knowledge acquisition[1]

FIGURE 2: BLOOM'S TAXONOMY: TRANSFORMATION FROM OLD TO NEW
https://www.psia-nw.org/blooms-taxonomy-levels-of- understanding/

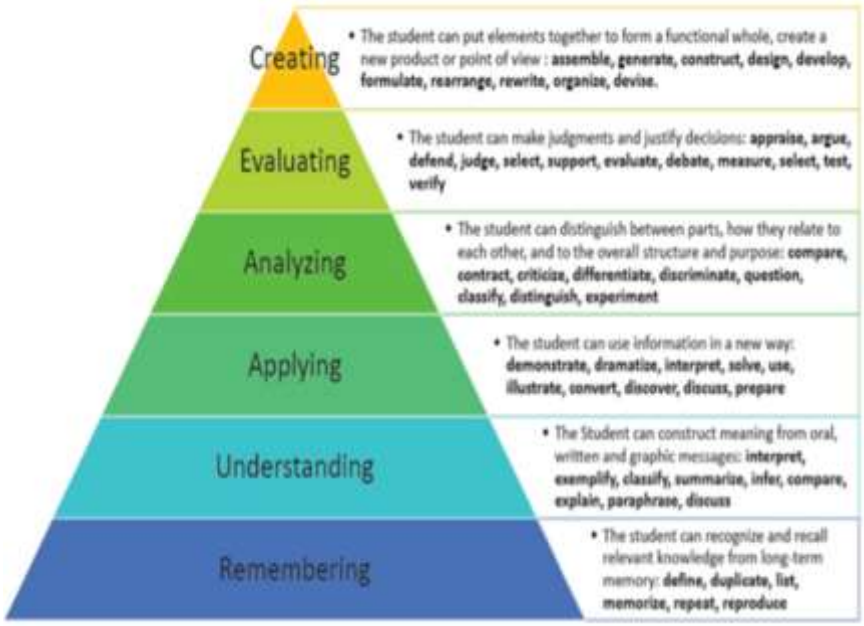


FIGURE 3: BLOOM'S TAXONOMY: SIX LEVELS OF COGNITIVE LEARNING
https://educarepk.com/the-revised-blooms-taxonomy.html

SURVEY RESULTS

The sample size was 113. The summary of the demographics of the respondents is shown in Table 1.

AGE GROUP	RESPONSES (%)
17-20	50%
21-25	41%
25 and Older	9%

GENDER	RESPONSES (%)
Male	41%
Female	59%

STANDING	RESPONSES (%)
Freshman	10%
Sophomore	19%
Juniors	31%
Seniors	40%

TABLE 1. DEMOGRAPHIC DATA SUMMARY

STATISTICAL ANALYSIS

Figures 4 below shows the respondents' opinion to a question on Blackboard (BB) Learning Management System (LMS), ***" Using LMS such as Blackboard has helped me to learn my subject more quickly"***

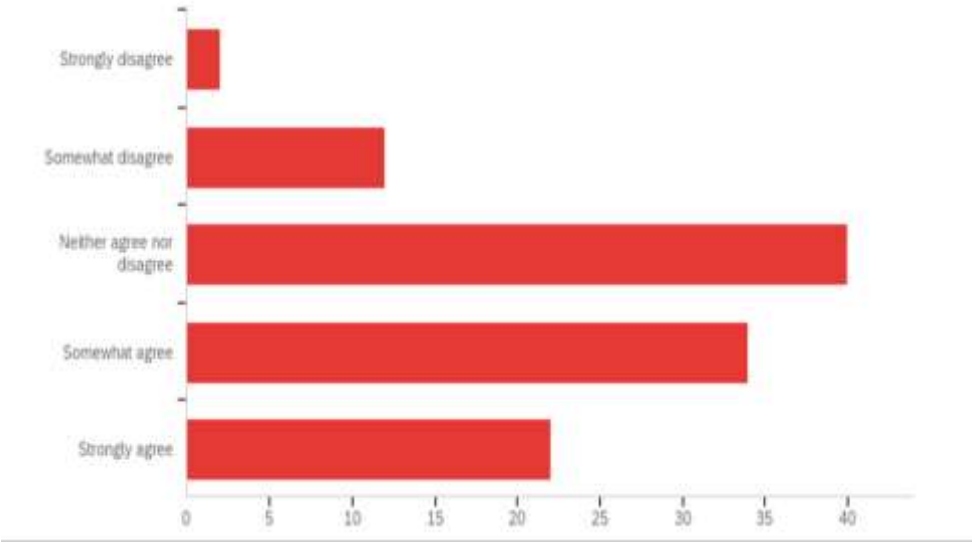


FIGURE 4 USE OF LMS DISTRIBUTION

As seen in Figure 4, while 40% of the respondents '***neither agree nor disagree'*** regarding the contribution of BB to quick learning, 56% of the respondents agree, (***22% 'strongly agree' and 34% 'somewhat agree'***), while only 14% disagree, (***12% 'somewhat disagree' and 2% 'strongly disagree'***) on the contribution of BB to quick learning, a positive reinforcement, considering Gen Z students are more favorable to digital learning.

Figures 5 shows the respondents' opinion on a question relating to the effort put in by students in the course; ***" The amount of work required was appropriate for the credits received for this course".***

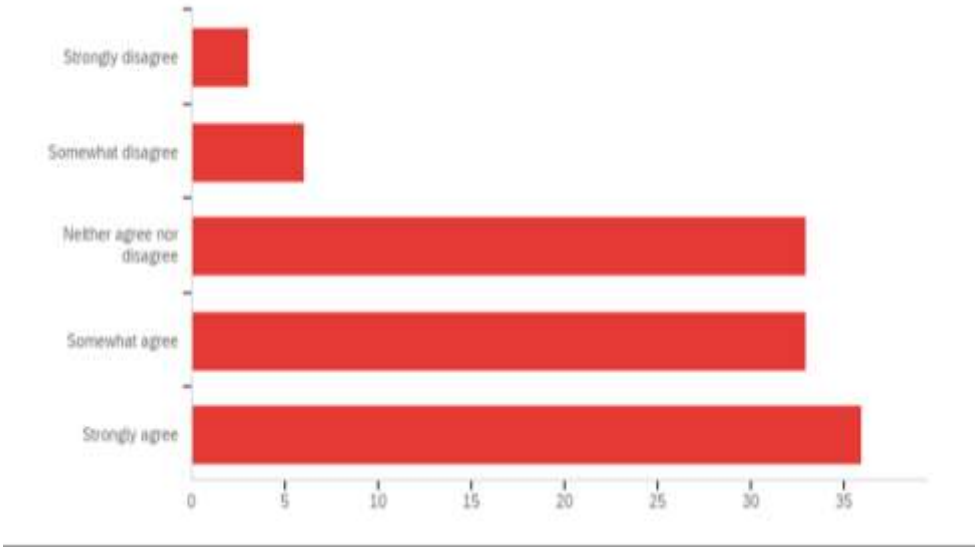


FIGURE 5: DISTRIBUTION OF AMOUNT OF WORK

As seen in Figure 5 above, while 33% of the respondents '***neither agree nor disagree'*** regarding the work required was appropriate for the credits received, 70% of the respondents agree, (***37% 'strongly agree' and 33% 'somewhat agree'***), while only 11% disagree, (***7% 'somewhat disagree' and 4% 'strongly disagree'***) on work required was appropriate for the credits received, again reinforcing the hypothesis that Gen Z students are more receptive to putting extra effort when they perceive that the output is positively related to their input.

Multivariate Correlation Analysis

Multivariate correlation analysis was done for the 'Bloom's Taxonomy' related questions, shown in Table 2.

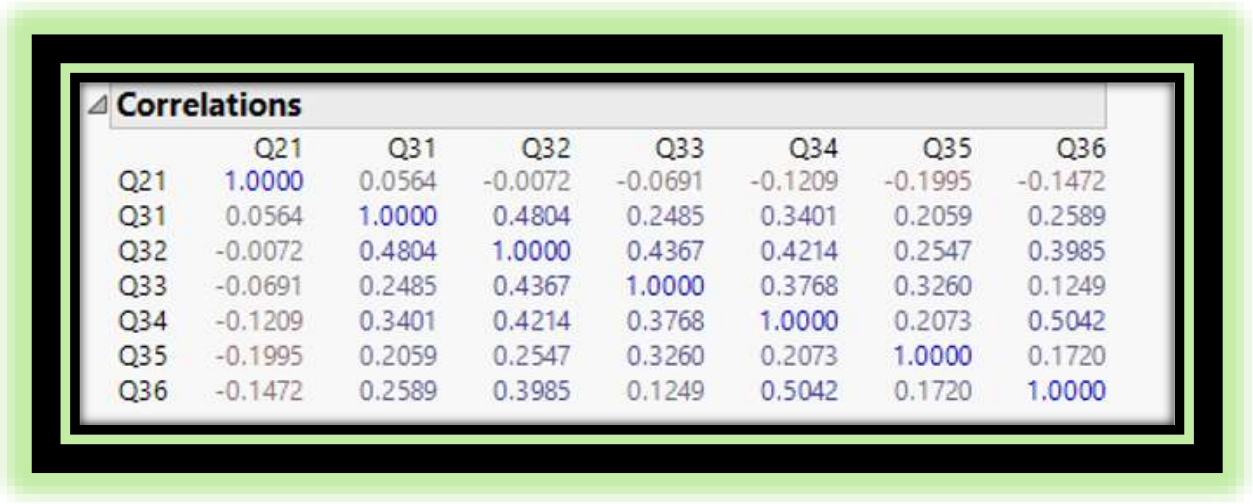
QUESTION	QUESTIONS ON BLOOM'S TAXONOMY
Q31	Which of the following activities do you use to remember information
Q32	Which of the following activities do you use to understand and making sense out of information
Q33	Which of the following activities do you use to apply information to a new setting
Q34	Which of the following activities do you use to take information apart & explore relationships
Q35	Which of the following activities do you use to examine information & make judgments
Q36	Which of the following activities do you use to create something new from existing information

TABLE 2: BLOOM'S TAXONOMY QUESTIONS

Survey Question 21

Survey question 21 which asked for the respondent's opinion on learning, i.e. ***"I learned a good amount of factual material in this course."*** was analyzed.

The multivariate correlation report is shown in Table 3 related to Bloom's Taxonomy survey questions on "Learning" (Theme of Survey Question 21).

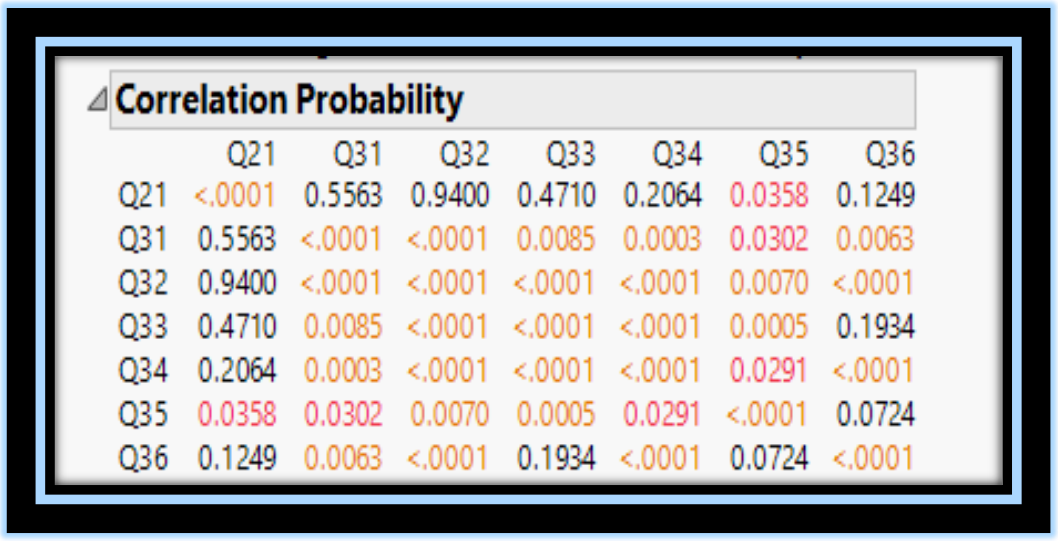


Correlations

	Q21	Q31	Q32	Q33	Q34	Q35	Q36
Q21	1.0000	0.0564	-0.0072	-0.0691	-0.1209	-0.1995	-0.1472
Q31	0.0564	1.0000	0.4804	0.2485	0.3401	0.2059	0.2589
Q32	-0.0072	0.4804	1.0000	0.4367	0.4214	0.2547	0.3985
Q33	-0.0691	0.2485	0.4367	1.0000	0.3768	0.3260	0.1249
Q34	-0.1209	0.3401	0.4214	0.3768	1.0000	0.2073	0.5042
Q35	-0.1995	0.2059	0.2547	0.3260	0.2073	1.0000	0.1720
Q36	-0.1472	0.2589	0.3985	0.1249	0.5042	0.1720	1.0000

TABLE 3 MULTIVARIATE CORRELATION

Significant negative correlations were found between learned significant amount of factual material and examined information (Figure 4, 5). Remembering information was significantly correlated with 'understand and make sense of information', 'apply information', 'take apart information and explore', 'make judgment', and 'create something new (information)'. Similarly, the various significant correlations between the variables are depicted in Table 3, and correlation probabilities in Table 4. Figure 5 shows the color map of correlations (the darker color emphasizes the higher correlations).



Correlation Probability

	Q21	Q31	Q32	Q33	Q34	Q35	Q36
Q21	<.0001	0.5563	0.9400	0.4710	0.2064	0.0358	0.1249
Q31	0.5563	<.0001	<.0001	0.0085	0.0003	0.0302	0.0063
Q32	0.9400	<.0001	<.0001	<.0001	<.0001	0.0070	<.0001
Q33	0.4710	0.0085	<.0001	<.0001	<.0001	0.0005	0.1934
Q34	0.2064	0.0003	<.0001	<.0001	<.0001	0.0291	<.0001
Q35	0.0358	0.0302	0.0070	0.0005	0.0291	<.0001	0.0724
Q36	0.1249	0.0063	<.0001	0.1934	<.0001	0.0724	<.0001

TABLE 4 CORRELATION PROBABILITY

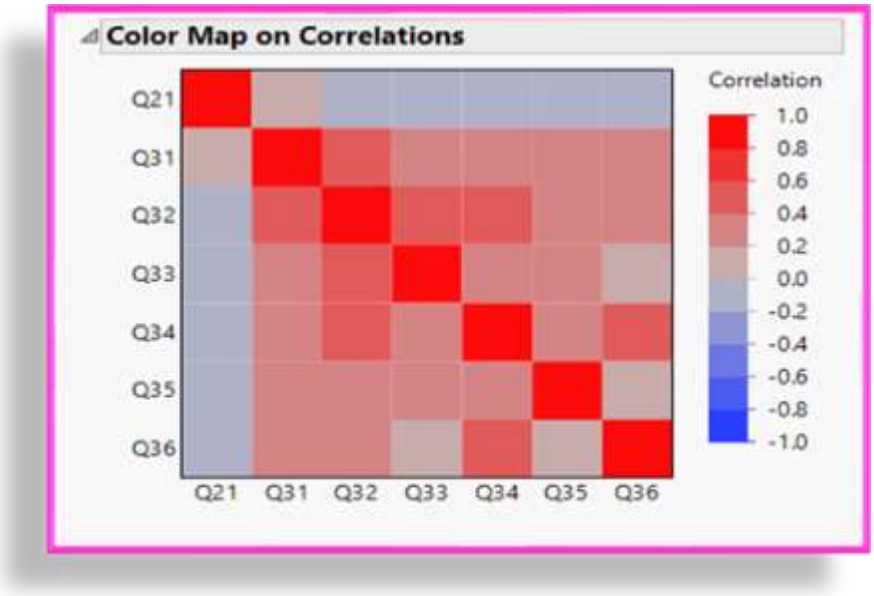


FIGURE 5 CORRELATIONS COLOR MAP

Regression Model

Results of the study using a linear regression model suggest that there is a significant relationship between the dependent variable: '***take information apart and explore (Q34)'*** and the *independent variables*: relationships with '***to create something new from existing information(Q36)***', '***to apply information to a new setting (Q33)***', '***helped me improve my computing skills (Q24)'*** and '***use to remember information (Q31)***'. The regression model showing the relationship between the dependent variable and independent variables is shown in Figure 6. Table 5 shows the p-value was less than 5% for all the variables(Q24, Q31, Q33, and Q36) estimated except the intercept.

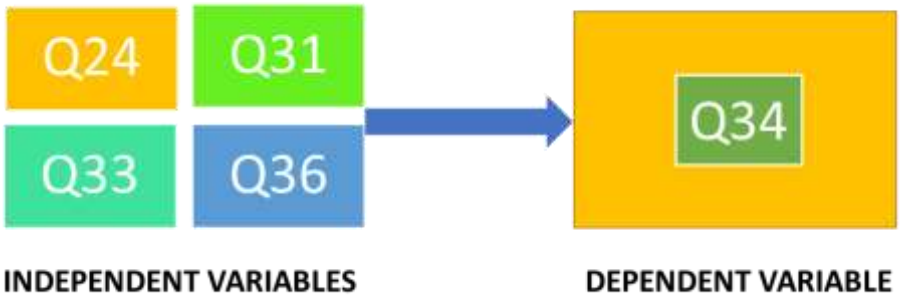


FIGURE 6 REGRESSION MODEL

Parameter	Estimate	nDF	SS	F -Ratio	p-value
Intercept	0.6004984	1	0	0	1
Q24	0.161609	1	11.022	7.864	0.006
Q31	0.0125878	1	6.13226	4.521	0.03583
Q33	0.3741466	1	20.0102	14.277	0.00026
Q36	0.6126828	1	60.1366	42.907	2E-06

TABLE 5 REGRESSION PARAMETERS ESTIMATES

IMPLICATIONS

The findings suggest that learning styles are influenced by the predicting Bloom Taxonomy variable specifically, '***take information apart and explore (Q34)***' to: '**remember, understand, apply use to make a judgment, and create new information'**. Further studies that adopt mixed-methods or qualitative design research methods using the Bloom Taxonomy variables are planned in the future to get deeper insights into Gen Z and examine the effectiveness of technology integration and Gen Z learning styles.

CONCLUSIONS

Based on the empirical evidence established in this paper, new strategies to improve Gen Z's learning style should be adopted to take advantage of emerging technological innovations. Since Gen Z learning styles are constantly evolving, new pedagogies should be introduced to meet their needs if these groups of learners are to get the most and optimal outcomes from their learning. Different disciplines' learning styles could be explored and examined to match the learning styles of Gen Z to make the most of available opportunities. A new theoretical framework could be constructed to help achieve the need for new pedagogies. These future directions could allow educators to initiate vital change strategies in guiding, supporting, and nurturing students across generations, including Gen Z [22]. The empirical results of this study indicate that there is a significant relationship between taking information apart and exploring relationships to create something new from existing information (Q36), to apply information to a new setting (Q33), which helped me improve my computing skills (Q24) and used to remember information (Q31), taking information and differences among the constructs of individual factors, instructional factors, and learning through an LMS such Blackboard.

APPENDIX-A- BLACKBOARD LMS QUESTIONS

QUESTION	BLACKBOARD LMS QUESTIONS ASKED IN THE SURVEY
Q5	Approximately how many hours have you spent on the LMS or Blackboard during a week?
Q9	Use of LMS such as Blackboard in this course changed how I learn
Q15	Discussions, private mail, and calendar were used effectively in the LMS such as Blackboard course
Q16	I was well informed about my grades on LMS such as Blackboard
Q17	User ID and password in LMS such as Blackboard worked efficiently
Q18	I received proper instructions on the use of LMS such as Blackboard for this course
Q19	My knowledge of computers was enough for performing the functions required
	of the LMS such as Blackboard course.
Q20	The use of LMS such as Blackboard has helped me develop new skills
Q23	Using LMS such as Blackboard has helped me to learn my subject more quickly
Q24	Use of LMS such as Blackboard has helped me improve my computing skills
Q27	Overall, I was satisfied with the LMS such as Blackboard course.
Q29	LMS such as Blackboard made it difficult to know what was expected of me in this course

APPENDIX-B SURVEY QUESTIONS

QUESTION	DESCRIPTION
Q1	Which age group do you belong to?
Q2	Are you a male or a female?
Q3	What is your classification?
Q4	Approximately how many courses have you taken that required the use of Learning Management Systems (LMS) such as Blackboard or similar tools?
Q5	Approximately how many hours have you spent on the LMS or Blackboard during a week?
Q6	Your level of ease in using a computer for your course(s)
Q7	How many years have you been using computers
Q8	Have you ever taken a certified computer course?
Q9	Use of LMS such as Blackboard in this course changed how I learn
Q10	I had a strong desire to take this course
Q11	I had sufficient computer resources for use to access my course in LMS such as Blackboard
Q12	That I had to find and use a computer to participate in this course was a source
	of annoyance to me.
Q13	The tools used in the course were effective
Q14	The tools used to give exams were effective
Q15	Discussions, private mail, and calendar were used effectively in the LMS such as Blackboard course
Q16	I was well informed about my grades on LMS such as Blackboard
Q17	User ID and password in LMS such as Blackboard worked efficiently
Q18	I received proper instructions on the use of LMS such as Blackboard for this course
Q19	My knowledge of computers was enough for performing the functions required
	of the LMS such as Blackboard course.
Q20	The use of LMS such as Blackboard has helped me develop new skills
Q21	I learned a good amount of factual material in this course
Q22	The amount of work required was appropriate for the credits received for this course
Q23	Using LMS such as Blackboard has helped me to learn my subject more quickly
Q24	Use of LMS such as Blackboard has helped me improve my computing skills
Q25	I feel that I will be able to apply what I learned in this course to other courses in the school
Q26	The mode of delivery was user friendly
Q27	Overall, I was satisfied with the LMS such as Blackboard course.
Q28	Being able to connect to Web sites that provide information helped me learn material better
Q29	LMS such as Blackboard made it difficult to know what was expected of me in this course
Q30	It is easier to read from a textbook than to read the same amount of material on LMS such as Blackboard.
Q31	Which of the following activities do you use to remember information
Q32	Which of the following activities do you use to understand and making sense out of information
Q33	Which of the following activities do you use to apply information to a new setting
Q34	Which of the following activities do you use to take information apart & explore relationships
Q35	Which of the following activities do you use to examine information & make judgments
Q36	Which of the following activities do you use to create something new from existing information

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Abstracts: Analytics, Big Data Applications, Business Intelligence, Data Mining, Statistics and Expert Systems

A NEW METHOD OF RANKING DECISION-MAKING UNITS UNDER EVALUATION WITHIN THE FRAME OF CONTEXT-DEPENDENT DEA

Oral

Prof. Jae-Dong Hong (South Carolina State University), Dr. Kiyoung Jeong (University of Houston Clear Lake), Dr. Judith Mwakalonge (South Carolina State University)

The conventional data envelopment analysis (C-DEA) method effectively identified the frontier decision-making units (DMUs). But C-DEA shows several intrinsic weaknesses due to its self-evaluation property. Several methods of extending the C-DEA model are proposed to overcome these weaknesses. The cross-evaluation DEA (CE-DEA) and super-efficiency DEA (SE-DEA) are considered excellent alternatives to the C-DEA. But they also reveal their shortcomings. This paper presents a new procedure for applying the context-dependent DEA (CD-DEA)-based approach (CDBA) to complement the weaknesses of C-, CE-, and SE-DEA. We demonstrate that the CDBA significantly improves the rating and ranking DMUs beyond the original methods.

BUSINESS ANALYTICS: Communicating with Numbers

Oral

Dr. Abdul-Aziz Bahha (Lander Univ)

Abstract

Data and analytics capabilities have leaped forward in recent years and have changed how businesses make decisions. The explosion in the field is partly due to the growing availability of vast amounts of data, improved computational power, and the development of sophisticated algorithms. More than ever, colleges and universities need a curriculum emphasizing business analytics, and companies need data-savvy professionals who can turn data into insights and action.

Can a Deeper Neural Network Model Perform Better in Forecasting Return Volatility?

Oral

Dr. Zhixin Kang (University of North Ca)

Volatility forecasting is pivotal in equity trading, portfolio construction, and risk management. Numerous studies have continuously been developing new methodologies and pushing the research from one frontier to another. Recently with the deep neural network being increasingly applied to volatility forecasting, one question emerges – would adding a deeper hidden layer in a deep neural network help garner better forecasting outcomes when it comes to forecasting return volatility? This study attempts to make an exploratory comparison in volatility forecasting performance by specifying the different number of hidden layers in a neural network (NN)model. Four forecasting performance measures, namely MSE, MAPE, MAE, and RMSE, are used in this study. Our focus is on comparing the practical differences of these different NN models in terms of making volatility forecasting, so we employ a Bayesian analysis for this purpose. Using the daily historical data of S&P 500 index, we will empirically compare the results for volatility forecasting performance with the different number of hidden layers in the deep neural network model. Daily realized return volatility serves as the proxy in the forecasting process. To incorporate the time-varying feature of return volatility, the daily conditional volatility generated from the conventional GARCH model is included as one input variable. K-fold cross-validation is adopted in the forecasting process to generate the corresponding MSE’s, MAPE’s, MAE’s and RMSE’s in all the folds. Then the differences of these measures between two competing NN models are calculated. The Bayesian analysis can generate the posterior distribution of these differences for each of the four forecasting evaluation measures, and thus the posterior probabilities of one NN model being better than the other, being the same as the other, or being worse than the other, can be calculated. This approach allows us to answer the research question as to whether competing NN models are practically different from each other if the number of hidden layers are different from each other.

Cybersecurity Certificate Selection Process: A Data Envelopment Analysis Approach

Oral

Prof. Brian Lambert (Metropolitan State University of Denver), Prof. Janos Fustos (Metropolitan State University of Denver), Prof. Abel A. Moreno (Metropolitan State University of Denver)

Organizations that face the threat of cyberattacks protect against those threats, in part, by hiring cybersecurity professionals who have both relevant experience and information security/cybersecurity certifications. Cybersecurity certificates vary in many aspects, involve costs, and offer associated potential financial returns. Given the large number of cybersecurity certificates available, the decision of which one(s) to pursue may not necessarily be straightforward. In this paper, we illustrate the use of Data Envelopment Analysis (DEA) for cybersecurity certificate selection. Our analysis identifies six of 18 certifications considered that demonstrate a maximal relative efficiency, and we analyze why the other certifications are relatively inefficient.

Estimating the Real Distance of the Optimal TSP Tour

Oral

Dr. Emre Kirac (Christopher Newport University), Dr. Dmitriy Shaltayev (Christopher Newport University), Mr. Ian Dors (Christopher Newport University)

Approximating the length of the Travelling Salesman Problem (TSP) tour is important where we do not need to know the exact tour, but the length. Examples of such cases include school bus routing, disaster relief tour planning, home health care routing systems, Amazon Flex delivery systems, and parcel delivery systems. This estimation comes especially in handy when a quick decision needs to make by a decision-maker regarding the duration or distance of the optimal tour. Consider, for example, a courier route planning where a manager needs to decide whether a single-vehicle tour would be enough to deliver all packages. In most realistic problems, the number of locations in the tour is fewer. It is typical for a tour to make less than 500 stops. For many of these applications, the city areas covered tend to be of irregular geometric shapes. Therefore, it is critical to derive an approximation to estimate the optimal real tour distance when fewer than 1000 randomly selected locations from the various US cities. In this study, we develop a regression-based model to predict the distance of the optimal TSP tour for the given locations.

Examining Parallel Analysis with Non-Continuous Data

Oral

Dr. Kellie Keeling (Unversity of Denver), Dr. Robert Pavur (University of North Texas)

Parallel analysis (PA) is a technique that is used to determine the number of factors in exploratory factor analysis. There are many documented uses for its application to continuous data. Its application to binary and other non-continuous data continues to be explored. This study expands work by Green, Redell, Thompson, and Levy (2015) exploring non-continuous data by investigating its application under different data generation factors including the number of observations, type of factor model, factor loadings, factor correlations, and thresholds. This study will replicate their generation of factors. In addition, it will also expand to examining ordered categorical data with more than two responses and measures with non normal, continuous distributions.

Exploring the Impact of Air Quality Indicators on Covid-19 Outcomes

Oral

Dr. Burcu Adivar (Fayetteville State University), Ms. Olga Postolachi (Fayetteville State University), Mrs. Jinong Sun (Fayetteville State University)

The recent pandemic has substantially affected human society, including healthcare, economic structures, and social relationships. The positive correlations between air pollution and the first year of the Covid-19 outbreak have been observed and reported in many studies. The varying level of correlations between Covid-19 and several air quality indicators have been reported in different geographical regions from January to December 2020. Building on prior research linking air pollution and Covid-19 infections, this study aims to explore a potential continuing association between air quality indicators and Covid-19 outcomes. Authors collected the daily particulate matter (PM,2.5 and PM10), Nitrogen Dioxide (NO2), Ozone (O3) levels, Air Quality Index (AQI) and the number of confirmed Covid-19 cases between January 1, 2021, to December 31, 2021. The geographical coverage is chosen to be the top ten states that have the highest Covid-19 outcomes: California, Texas, Florida, Illinois, New York, Pennsylvania, Ohio, North Carolina, Georgia, Michigan.

The study results show a significant correlation between NO2 and confirmed Covid-19 infections in Illinois (r=0.83), a moderate correlation in Michigan (r=0.54) and North Carolina (r=0.52), and clear positive correlations in Pennsylvania (r=0.45), Texas (r=0.39), and Ohio (r=0.22). We did not observe a significant association between Covid-19 infection and PM2.5, PM10, and Q3, even though PM2.5 was marginally associated with Covid-19 infections in California and Texas while PM10 was marginally associated with Covid-19 infection in Georgia only. Further analysis depicted that an increase in NO2 concentration and AQI in 2021 in Illinois positively impacted disease dispersion and Covid-19 infection rate. Our findings suggest that the strong level correlation between air pollutants (PM2.5 and PM10) and Covid-19 infections reported in 2020 has turned out to be very limited in 2021. In contrast, Nitrogen Dioxide (NO2) remained to be significantly associated with Covid-19 infections in some regions. NO2 may still increase the risk of Covid-19 infections in some of the most affected states in the U.S. in the following years of the outbreak.

Results also suggest that the correlation between air quality and Covid-19 outcomes might also be affected by face-mask mandates, stay-home orders, vaccination availability, and the virus mutation that occurred in 2021. Overall, our findings can inform the regulatory agencies to promote changes in environmental policies to reduce the harmful effects of air pollutants.

IoT Business Continuity

Oral

Dr. Bel Raggad (Pace University), Dr. Mukesh Srivastava (U of Mary Washington), Dr. Hassen Mzali (IHEC)

The IoT has very rapidly dephysicalized most of our world. Objects, that we cannot foresee, are now connected together on networks not initially created for, to collect data, share data, and play new smart roles that have unintentionally transformed our fundamental theories of living. The IoT has just imposed a new massive healthcare system, a new economy and new ways of doing business. The IoT has created IoT-context awareness capabilities among all IoT objects that through interactive learning have self-recovered owing to its embedded actuators that execute all sensors signals and all inbound insights produced by the rest of the IoT to align with all IoT members.
We propose a knowledge-based framework to manage the business continuity of an IoT given its edge computing, fog computing, and cloud computing capabilities. We take into account the tinternal edge data, inbound data locally reprocessed to generate edge knowledge, and gateway data generated by coalitions of nodes where fog knowledge is created. The cloud data is continuously reorganized to create more total knowledge that can be used in assessing the IoT security posture and its risk position.
This proposed framework will adopt evidential calculus in modeling and processing the states of IoT and its nodes and in assessing risks of nodes, coalitions of nodes, and the entire IoT. A numerical example will be provided to demonstrate the working of our framework.

Its (Not) Hammer Time

Oral

Prof. Craig Larson (Virginia Commonwealth University), Prof. Paul Brooks (Virginia Commonwealth University), Prof. David Edwards (Virginia Commonwealth University), Dr. Nico Van Cleemput (Ghent University)

A prevailing idea in searching for patterns in data is to attempt to model the data with familiar function forms. But there may be no reason to expect data to be, for instance, linear. We must *search* for patterns as they are rather than what we want them to be. We will discuss new approaches to finding all kinds of patterns in data and give examples.

When you only have a hammer it is natural to try to solve every problem with it. Sometimes its better to take the time to think about what else might work, what else might be needed, and what else can be done. If the goal is to find simple patterns, it is necessary to ask if a model can actually produce all the patterns that might conceivably exist in the wild.

Maternal Residence Social Determinant of Health and Adverse Outcomes During the COVID-19 Pandemic: A Real-World Analysis of National Electronic Health Records Data

Oral

Prof. Neset Hikmet (University of South Carolina), Prof. Peiyin Hung (University of South Carolina), Prof. Chen Liang (University of South Carolina), Prof. Jihong Liu (University of South Carolina), Prof. Jiajia Zhang (University of South Carolina), Mr. Lyu Tianchu (University of South Carolina), Ms. Adiba Promiti (University of South Carolina), Ms. Yiwen Shih (University of South Carolina), Dr. Berry Campbell (Prisma Health), Dr. Bankole Olatosi (University of South Carolina), Ms. Kewei Shi (American Cancer Society), Dr. Xiaoming Li (University of South Carolina)

The national efforts on electronic health record (EHR) data harmonization provide researchers with a centralized platform - National COVID Cohort Collaborative (N3C) Data Enclave – to elucidate multilevel factors for COVID-19 and health equity. During the COVID-19 pandemic, many vulnerable communities were hit hard, leading to disproportionate SARS-CoV-2 infection and death rates in socially disadvantaged populations. Among them, non-Hispanic black and Hispanic perinatal women appear to have worse outcomes than their white peers. This study leveraged the N3C data and other ecological level social determinants of health (SDoH) information to understand the patterns of the SARS-COV-2 infection and maternal health outcomes by residential county SDoH index. We measured the SDoH index, ranging from 0 to 1 with higher being better, by mirroring the Healthy People 2030 framework on the five following domains: neighborhood and built environment, health and health care, social and community context, education, and economic stability. Our goal is to inform policy and practice by examining nationwide pregnant, childbirth, and postpartum women’s risk factors, residence locations, and their maternal outcomes during the COVID-19 pandemic. This study understands the association between county SDoH characteristics and racial disparities in maternal outcomes. Adapted from the socioecological framework, our results posit that severe maternal morbidity risks were higher among women with SARS-COV-2 infections and among those living in lower SDoH communities. In addition, women with overweight or obese, those who had tobacco use during pregnancy, and those with preexisting or gestational diabetes, hypertensive disorder, and/or depression and anxiety during pregnancy were more likely to reside in low SDoH communities. These results further suggest that the most in-need perinatal populations live in the poorest SDoH communities where high-risk perinatal women would experience unstable housing, healthcare access barriers, low income, unsafe neighborhoods, or substandard education to support their pregnancy or postpartum life. In conclusion, the maldistribution of SDoH across maternal populations and its association with severe maternal morbidity highlights the importance of addressing both individual and community-level sociodemographic issues in the efforts to overcome maternal health disparities and improve health at birth.

Measuring the Performance of Sustainable Development Goals

Oral

Dr. Binshan Lin (Louisiana State University Shreveport)

In 2015, 193 member states of the United Nations (UN) adopted a fifteen-year sustainable plan “the 2030 Agenda” to work toward the achievement of the Sustainable Development Goals (SDGs) by 2030. The SDGs are a set of specific, measurable, and time-sensitive goals related to national development plans. The indicators for the UN SDGs are evaluated by the international community based on the data availability and methodological developments. Effective impact measurement and data collection are critical to the SDGs’ success. Poor quality, outdated, and incomplete data lead to poor decisions. The severe lack of data to track progress across countries and over time is one particularly demanding and critical challenge. This means that quality data and statistics must be available and comparable over time to make significant progress on the agenda. The quality improvement of the existing data is critical to assisting countries to build a solid evidence and to reach strategic decisions. Data quality evaluation criteria are already in place at the national and international levels; however, their practical implementation in the evaluation of specific SDG indicators is still in its early stages. The IAEG-SDGs (Inter-Agency Expert Group on SDGs) has made incremental improvements in the methodologies and data availability of SDGs, but many of the SDGs’ indicators remain beyond the financial and technical capabilities of many countries’ statistical organizations and units. Given the incompleteness of data, what viable alternatives can be used to solve the data quality issue to better monitor progress on SDGs’ indicators? Without data, especially high-quality data, sustainable development will also be doomed to fail. These critical issues are rarely touched on and fairly unexplored in previous research. Accordingly, this research aims to critically investigate the data challenges in measuring the performance of sustainable development goals. The use of big data as one of the cost-effective solutions is investigated for these problems. With insights gained from related research, we present our strategies and methodologies in order to expand our discussion. We hope to make a positive contribution to refining the SDG indicators and advancing their monitoring.

Reverse logistics processes forecasting using products’ package carbon footprint measurement and modeling

Oral

Dr. Marek Medrek (Maria Curie-Sklodowska University), Dr. Lukasz Wiechetek (Maria Curie-Sklodowska University), Dr. Jaroslaw Banas (Maria Curie-Sklodowska University), Dr. Zbigniew Pastuszak (Maria Curie-Sklodowska University)

The carbon footprint (CF) is a measure of the total amount of carbon dioxide emissions. The level of CF is directly or indirectly determined by the production, transport, storage and disposal of products and their packaging. The carbon footprint is the effect of the flow of products in the economy. Excessive carbon dioxide emissions can accumulate in the atmosphere and are considered the biggest contributor to global warming. For this reason, the level of carbon dioxide emissions, and consequently the carbon footprint of the product and its packaging, has become a concept widely used in the public debate related to the prevention of global climate change. The packaging sector is one of the industries that has recently come under strong pressure from consumers and legislators. As a consequence - packaging producers strive to reduce the impact of commonly used packaging on the environment. One way to reduce this impact is to replace single-use products with reusable packaging.

The aim of the presented research was to verify how the use of methods and models for the management of reverse logistics processes for used disposable packaging affects the CF level. Additionally, we examined whether (and how) the level of CF (characteristic for disposable packaging) could be reduced to the level of CF characteristic of reusable packaging. In our study, based on the concept of reverse logistics in the life cycle of food products, we compared two types of packaging materials for beverages: polyethylene terephthalate (PET) and returnable glass.

Two basic methodological approaches can be used to calculate CF. The first is based on a process analysis; the second - on the analysis of the inputs-outputs of the natural environment. We have collected detailed data describing logistics processes from the largest producers and distributors operating on the Polish market. These enterprises supply approximately 38 million citizens with food products. We then used them for a detailed benchmark, calculating the CF emissions at each step of the process (bottom-up approach).

The research results enabled the development of a model and a cradle-to-grave life cycle analysis system for selected food products using PET and glass packaging. The multidimensional parameterisation of the system enables the use of the tool created by the authors in various economic and geographical realities. As a consequence, the tool we have created enables the modeling of the CF level in various phases of food logistics. At the same time, it can constitute an effective decision support system for managers and legislators in decisions processes aimed at reducing carbon dioxide emissions in production and logistics.

SARS-CoV-2 Infections and Severe Maternal Morbidity in the United States: A National Retrospective Cohort Study

Oral

Prof. Neset Hikmet (University of South Carolina), Prof. Jihong Liu (University of South Carolina), Prof. Peiyin Hung (University of South Carolina), Prof. Chen Liang (University of South Carolina), Mr. Lyu Tianchu (University of South Carolina), Prof. Jiajia Zhang (University of South Carolina), Ms. Adiba Promiti (University of South Carolina), Ms. Yiwen Shih (University of South Carolina), Dr. Berry Campbell (Prisma Health), Dr. Bankole Olatosi (University of South Carolina), Ms. Kewei Shi (American Cancer Society), Dr. Xiaoming Li (University of South Carolina)

Using the retrospective longitudinal cohort data in the United States (n=209,289 childbirths) between March 1, 2020 and May 31, 2021, we found that SARS-CoV-2 infections during pregnancy through postpartum were associated with increased risks of severe maternal morbidity among birthing people in the United States.

Sequential Purchasing Behavior Analysis Under Brand Loyalty Context

Oral

Dr. Jin Fang (Clark University), Dr. Hanxi Sun (Purdue University), Dr. Junhee Kim (California State University Stanislaus)

This paper presents a network-based model for the sequential purchasing behavior analysis and brand prioritization problem. Our model can capture significant temporal structures and bring meaningful clustering solutions for customers' sequential purchasing paths. We also prioritize brands through a weighted hyperlink-induced topic search (HITS) algorithm to identify star brands. Finally, learning the linking relationships among brands provides illuminating advertising insights such as brand prediction.

SYNTHETIC LABELING FOR EXTREME RARE EVENT FRAUD DETECTION

Oral

Prof. Mike Ames (Wake Forest University)

Extreme rare event detection challenges are quite common in real-world classification problems. For example, card not present fraud occurs in less than 0.1% of online transactions, while account takeover attempts occur even less frequently (< 0.01% of login attempts). The risk of fraud, while extremely rare, is very real for organizations and their customers and comes at the cost of real dollars and reputation damage. While advances in machine learning have come a long way, they still struggle to detect the “needle in a haystack”. In this presentation we explain the challenges of rare event fraud detection, compare, and contrast different approaches and present a novel methodology using synthetic labeling to boost detection of extreme rare events. The methodology is tested on commercial wire transaction fraud in the financial services industry and results are presented based on practical impact to the organization.

TEXT MINING: HOW POPULAR IS ANALYTICS? WHERE TO PUBLISH?

Oral

Dr. Kaye McKinzie (University of Central Arkansas), Dr. Samira Nichols (University of Central Arkansas), Ms. Carla Barber (University of Central Arkansas)

One of the hardest things about getting published for academics is finding the right outlet for a particular research project. Of particular difficulty for business faculty is ensuring it is in a journal that meets their college’s criteria. Many institutions provide sources for approved journals such as they must not be predatory or they must come from a reputable list. A common list is the Australian Business Deans’ Council Journal Quality List. The list provides the name, publisher, field of research, journal rating, and ISSN. From this, a researcher can filter the list and find several potential journals. But knowing which journals have published on specific keywords could significantly help in focusing the search for a research outlet.

This research project began with collecting all titles, abstracts, and keywords from all A*, A, and B journals in the ABDC Journal Quality List for 2021. The process to bring these into a text format was the first hurdle. Not only were there over 1,500 journals in this list but many of them were published many times during the year. To add to the complexity, some abstracts were only available in a picture format. Another hurdle was that some were published in languages other than English. We then mined these for keywords (e.g. analytics) and will be reporting on which journals are publishing on which keywords. Next up for this research is collecting for 2022 and then 2020. We hope to develop a longitudinal study and report on publishing trends.

The Relation Between Psychological Distress and Chronic Illness

Oral

Ms. Mercedes McCrae (Savannah State University), Dr. Hadi Farhangi (Savannah State University)

The purpose of this paper is to offer readers a look at the relationship between psychological distress and chronic illnesses. The dataset that will be used to aid the analysis includes participants in Japan who worked between February 2021 and June 2021 during COVID-19. The introduction and literature review consist of a preface and a review of empirical and theoretical works that support or undermine the claims made about psychological distress and chronic illness. The research methodology will illustrate the use of logistic regression. The Discussion section will consider biases and other perspectives made about the relationship between psychological distress and chronic illness and how future studies can address the level of importance of this topic in hopes of developing better psychological testing or medicines.

“Revolutionarily-New” SiMULATION & OPTIMIZATION – Using only Directly-SCALABLE Vector-Processing with Single-Precision Arithmetic at Exa-Scale

Oral

Prof. Elmor Peterson (University)

In the ***Simplest*** **case** of *finding* ***All*** **solutions (if any !)** to the ***Most-General*** **system** of ***Linear*** **equations** $A\ x = b$ – ***Simply*** **minimize** *an appropriate (but elementary) separably-quadratic function* $h(y)$ **over** the “row space” Y of the “augmented matrix” $[A \mid b]$.

Abstracts: Healthcare, Public Sector and Not for Profit Management

A Machine Learning Approach to Describe the Performance of Home Healthcare Agencies

Oral

Dr. Mehmet Kilinc (Le Moyne College), Dr. Emre Kirac (Christopher Newport University)

Several quality metrics, such as patient satisfaction, care processes, and health outcomes, should be considered to analyze the performance of a home healthcare agency. Public performance reporting aims to inform customer decisions and incentivize agencies to improve the quality of services. However, there is limited research to understand the heterogeneous performance composition of home healthcare agencies without using ordinary ranking models or aggregated summary ratings. In this study, we sought to understand the common agency performance profiles and how they are related to agency characteristics. We applied a novel two-stage analytical approach using clustering analysis and rule mining to public data. In the first stage, agencies are grouped into four distinct clusters based on similarity in their performance profiles. Then, association rules were generated to investigate the underlying agency characteristics associated with cluster assignments. The results offer insight into home healthcare agency performance to improve the quality of care in the sector.

Improving Food Bank Equity and Delivery Capacity with Mobile Pantries

Oral

Dr. Jon Stauffer (Texas A&M University), Dr. Manoj Vanajakumari (University of North Carolina Wilmington), Dr. Subodha Kumar (Temple University)

Distribution equity is an important aspect of humanitarian operations and food banks. However, food bank equity is difficult since they do not directly control partner agencies that distribute their food. Using local food bank data, we illustrate how mobile pantries can fill food bank capacity and equity gaps.

Improving the Usability of Online Physician Reviews

Oral

Mr. Cuibing Wu (University of Massachusetts Lowell), Dr. Luvai Motiwalla (University of Massachusetts Lowell), Dr. Nima Kordzadeh (Worcester Polytechnic Institute)

Selecting a physician from the physician review sites (PRS) is a challenging and complex task for patients. PRSs overload users with multiple rating metrics, few ratings per doctor, positively biased ratings, and conflicts between numeric and narrative ratings. This affects proper use of PRS and impacts the healthcare quality received by patients. This paper addresses the issue of multiple ratings in the PRS application with analytical techniques of dimension reduction and text mining to address conflicts between narrative and star rating. We collected and integrated 5135 patient review data from two PRS websites: Vitals and Healthgrades. Our findings indicate that PCA reduces the complexity of multiple rating metrics from seven metrics to one capturing 78-85% of rating information, and sentiment analysis alerts the inconsistencies between numeric and narrative ratings. Additionally, we are developing an integrated dashboard website for patients to enable process reviews from multiple websites making better decisions.

In-Person Medical Visit Changes from the Initial to ‘New Normal’ Periods of the COVID-19 Pandemic

Oral

Dr. Weixin Liu (Tsinghua University), Prof. Jia Li (Wake Forest University), Prof. Christina Dalton (Wake Forest University)

After dramatic drops in in-person medical visits at the onset of the COVID-19 pandemic, little is known about how visits evolved as the pandemic progressed or how disruptions varied across medical specialties and individual characteristics at a comprehensive, national level. Using mobility tracking data from 19 million mobile devices from 50 U.S. states and D.C., this study documents decreasing in-person visits to inpatient and outpatient health facilities during the initial pandemic period (mid-March to mid-May 2020) into a new normal (after mid-May). The Northeast led initial decreases, dropping 40.5%, as well as areas of high income and education. Elderly and high income areas rebounded modestly in the new normal period, but Hispanic and low education residents were less likely to return. Visits to all specialty types initially dropped at least 31.5%, with growing gaps in new normal between a 49.3% drop in Cardiology to an 14.6% increase for sleep medicine. These results equip health care providers and policy makers with knowledge of the extent and composition of health care disruptions to target interventions in areas with sustained disruptions.

Integrating Machine Learning in Electronic Health Record to Detect Medicaid Fraud and Abuse

Oral

Dr. Qingsong Zhao (LSUS), Dr. Subhajit Chakrabarty (LSUS)

According to the National Health Expenditure Accounts (NHEA), U.S. healthcare spending grew 9.7 percent in 2020, reaching $4.1 trillion, or $12,530 per person. As a share of the nation’s Gross Domestic Product, health spending accounted for 19.7 percent. On the other hand, the National Heath Care Anti-Fraud Association estimates conservatively that healthcare fraud costs the nation about $68 billion annually. 95% of U.S. healthcare providers have adopted Electronic Health Records (EHR) for their practice and billing. The existing medical fraud and abuse detection systems are efficient at catching errors, verifying eligibility, checking procedure codes, etc., but are far from efficient at exploring patterns that could flag fraudulent or abusive behaviors. Considering the two facts above, this paper presents an EHR-based fraud detection and prevention system, which integrates machine learning technology and EHR. The EHR-based fraud detection and prevention system trains the Isolation Forest (IF) algorithm on the Medicare Part B dataset (2019 and 2020 data) and validates it on the List of Excluded Individuals/Entities (LEIE) database. By developing the EHR-based fraud detection and prevention system in openEMR, the most popular open-source EHR, this paper showcases a creative approach to efficiently detect and prevent medical fraud, and then to promote the delivery of evidence-based, high-quality, accessible, and cost-effective care to patients.

MAPPING POTENTIAL BEHAVIORAL AND VIOLENT CRISES IN 911 POLICE REPORTS TO ENABLE THREAT ASSESSMENT AND PRIORITIZATION FOR MULTI-LEVEL PREVENTION CAPABILITIES

Oral

Prof. Dominic Thomas (Kennesaw State University), Dr. Monica Nandan (Kennesaw State University), Mr. Martin Brown (Kennesaw State University), Mr. Cameron Broadnax (Kennesaw State University)

Interactions between first responders and individuals with behavioral crises pose complex challenges for police officers (Wells & Schafer, 2006). People in these crises have behavioral health challenges (mental, developmental, substance use disorders) and are likely to respond/act differently under stress/duress than what first responders may be prepared to handle (Lipson, Turner & Kasper, 2010). Often, these individuals are taken to jail, the ER or left in the community. In many instances, these are not appropriate dispositions and may result in increased threats to themselves, first responders, or the family/community rather than resulting in appropriate de-escalation.

In order to move upstream in detecting these crises, assessing their degree of threat, and mapping prevention capabilities, we need a clear definition and scope of the existing problem (Heath, 2020). The quantity and nature of such cases remains unclear. In a 2010 study in Canada, 7%–30% of calls involved mental illness (Coleman & Cotton, 2010). In Boston, in 2017, the rate was estimated at 0.8% (Morabito, et al., 2018). Individuals with behavioral health challenges are more likely to invoke a first responder call: 911, police, and fire/EMT services are more likely to be called to the scene especially if social disruption is occurring (Teller, et al. 2006). Clearly, based on existing research, there is great variability in estimating behavioral and violence related crisis. Consequently, inappropriate resources are being deployed in communities.

Formal coding schemes like NIBRS or IAED used in 911 emergencies tend not to track the behavioral crises unless that is the only nature of a call (Hashmi et al. *in press*). Consequently, possibility of early identification, detection, preventing crisis and promoting overall wellness and safety of the individual and the larger community is currently not available/built. This study addresses this need.

In our partner research site there are five 911 call centers, more than 10 police forces, six fire and EMS providers, each with their own coding, signal and incident recording systems. Using a sample of data from the 911 incident police reports from the largest force through our cooperative agreements with these stakeholders have developed analytics using a combination of supervised text mining, natural language modeling, and topic modeling to detect and categorize potential behavioral and violent crises in order to enable threat assessment and prioritization for deploying multi-level prevention strategies. The combined use of Natural Language Processing (NLP), Machine Learning (ML), Artificial Intelligence (AI), with manual coding (MC) enables us to develop and corroborate the assessment of first responder incident reports and categorization of cases for transparency and audit. Our methods import data from police incident report files, categorize data, identify and prioritize cases needing primary, secondary preventions and produce related analytics.

Predictive Analysis of the Environmental Friendliness of U.S. Congress Members using Machine Learning Techniques

Oral

Ms. Jiayu Fan (Temple University), Ms. Jie Bian (Clark University), Dr. Yue Gao (Clark University)

Founded in 1969 as a non-profit organization, the League of Conservation Voters (LCV) tracks the voting records of Congress members on environmental issues in its National Environmental Scorecard. Such a scorecard is a nationally accepted index used to rate members of Congress on the most important environmental issues of the year, such as energy, climate change, and spending for environmental programs. In this study, we employ various machine learning methods including KNN, Random Forest, SVM, Xgboost, etc., to predict the LCV Scores of congress members. Our results indicate that the Xgboost outperformed other models with the lowest RMSE. It also shows that Party affiliation show the most significant effect on LCV scores. Besides, the percentage of college-educated, unionization rate and population density at the state level are also essential factors in predicting LCV scores.

Re-Engaging Community Outreach After COVID Through a Disability Film Festival at a Metropolitan University

Oral

Dr. James Lawler (Pace University)

COVID decimated community engagement at colleges. The authors are analyzing the benefits of a Disability Film Festival community outreach program in a post-COVID environment. The findings of the program can benefit college faculty in community engagement of disadvantaged people with disabilities and students on outreach post-COVID projects of a university.

THE ROLE OF AGE, EDUCATION LEVEL AND IT-SELF EFFICACY IN INDIVIDUALS’ INFORMATION TECHNOLOGY CHANGE READINESS IN HEALTHCARE ORGANIZATIONS

Oral

Dr. U. Yeliz Eseryel (East Carolina University), Dr. Deniz Eseryel (North Carolina State University), Mr. Martijn den Breejen (ING)

Individuals’ IT-change readiness is one of the primary determining factors of organizational Information Technology (IT) change intervention’s success. We conducted in-depth qualitative interviews with 18 employees from two health-care companies. Based on our interviews with healthcare professionals, IS professionals and management in healthcare organizations, we found that IT self-efficacy contributed to individuals’ IT-change readiness. Demographics of the participants played an indirect role in that education level positively related to IT self-efficacy and age inversely influenced IT self-efficacy.

Abstracts: IS, IT, Blockchain Technology and Social Media

AN EMPIRICAL ANALYSIS OF BITCOIN PRICE DRIVERS – APPLYING MACHINE LEARNING IN THE EXPLANATORY VARIABLE SELECTION AND MODELING PROCESSES

Oral

Dr. Christopher Solano (University of North Carolina at Pembroke)

This paper makes the argument for the accelerated adoption of Bitcoin as a sustainable store of value/medium of exchange in the emerging digital economy, and as a viable investment alternative by providing data and market trends as support. Additionally, this paper will use Machine Learning Algorithms, and statistical methods to understand and explain Bitcoin's past behavior, to better understand and predict Bitcoin's behavior and performance in the future. In previous literature, analytical models use a single sample, or use qualitative/arbitrary reasoning for choosing the point of differentiation between subsamples and therefore the impact of any significant changes in Bitcoin's pricing behavior were not fully analyzed and investigated. This research applies statistical methods to identify significant structural breaks in the dependent variable, then fits three corresponding Ordinary Least Squares models to the three tested subsamples providing a more comprehensive assessment of the impact of the recent change in Bitcoin market price dynamics. Additionally, in previous literature, the Bitcoin price drivers were selected based on qualitative arguments and on pre-existing literature. The analysis in this paper considers additional potential price drivers measuring Bitcoin's exposure to macroeconomic, financial, and variables unique to the Bitcoin ecosystem while accounting for supply and demand relationships believed to play an important role in Bitcoin's price development. This analysis also applies Machine Learning Algorithms in the dimension reduction process and the identification of the best subset (Best Subset Selection) of explanatory variables that provide the best predictive model in terms of R^2 of Bitcoin returns pre and most importantly post significant structural breaks.

Assessing the Intelligence Level of a Smart City

Oral

Mr. Jonah Ji (University of West Florida, Escambia Virtual Academy), Dr. June Wei (University of West Florida)

This research aims at discovering the major dimensions of intelligence in smart cities and developing an index to assess the intelligence level of a smart city. Specifically, this research first develops a smart city intelligence model based on the value theory by combining four infrastructures, namely information and communication infrastructure, application infrastructure, governance infrastructure and engagement infrastructure. Second, the survey method is used to quantitatively measure the mean and fundamental objectives in each infrastructure. Data analysis is performed from 261 valid survey data and factor analysis is applied to derive dimensions of intelligence for a smart city. Third, an intelligence index is developed based on the derived major dimensions of intelligence of a smart city. Last, recommendations will be provided, and theoretical and practical implications will also be discussed. Results of this research will have a large impact on the future smart city development and evaluation, hence accelerating the adoption of smart cities to enhance sustainable economy development and increase quality of citizens’ and organizations’ environments. Results will also help city administrators and developers when they make decisions on building a smart city.

Core vs. Diversity in Information Systems (IS) Research: A Survey

Oral

Mr. Hassan Shuaibu (Department of Information Science and System, Morgan State University, MD,), Prof. Ganesh Bhatt (Department of Information Science and System, Morgan State University, MD)

In the early IS research, scholars were seeing IS research as under theorized, which does not engage in the core matter of the IT artifact. In this research paper, we investigate the research trends in IS discipline from three journals (i.e., MIS Quarterly, Journal of Management Information Systems, and Information Systems Research) from 2015 to 2019) to determine the research focus of IS Discipline. We adopted a procedure for the classification from Culnan’s classification of IS reference disciplines as a method to determine the research focus of the IS discipline. The Culnan’s classification of IS reference disciplines comprises of 1) core IS research field (CISR), 2) related applied disciplines for IS research (RAD), and 3) basic underlying disciplines (BUD). The results show that the IS research trends in five years emphasize on diversity[DGB1] through research methods, problems, and theoretical foundations to account for IS phenomena.

DESIGNING BLOCKCHAIN APPLICATION PROGRAMMING COURSE FOR COMPUTER SCIENCE GRADUATE STUDENTS

Oral

Mr. Tushar Saini (Southeast Missouri State University), Mr. Vishwanath Varma Indukuri (Southeast Missouri State University), Dr. Reshmi Mitra (Southeast Missouri State University), Dr. Indranil Roy (Southeast Missouri State University)

Blockchain framework is an upcoming technology that secures transactions, lowers compliance costs, speeds up data transfer processing, and is immutable since a record cannot be modified without changing the cryptographic hash. These records are safe because it requires an exceptional amount of hardware resources (money) and processing time to modify the data stored in these blocks. Block processing happens through smart contracts, which are computer programs that are hosted and executed on a blockchain network. It consists of code specifying predetermined conditions when triggered allows multiple parties to come to a shared result in an accurate, timely, and tamper-proof manner. Finance, healthcare, digital governance such as voting system, supply chain management are some of many the emerging application areas for this digital record platform. We are presenting the course curriculum for Blockchain Application Programming to Computer Science graduate students with intermediate programming experience. We are using hands-on lab exercises with real-life examples, self-paced and peer feedback, which is appealing to current Gen-Z learning style. The courses contents are listed below:

Introduction

We begin with introduction to cryptography and digital signatures to understand the basic structure of each block. Second learning outcome is to understand and construct Merkle tree, which is a special data structure for securing the information and is based on binary tree where the parent is the hash of the child nodes. Finally, students are introduced to Ethereum platform to develop, compile, deploy and test smart contract using Solidity language. We will be using Remix as the Integrated Development Environment (IDE) and test on its JavaScript-based simulated test chain.

Intermediate module:

We begin with cryptocurrency and bitcoin mechanics, the concepts of distributed ledger for recording the transaction of assets, peer-to-peer networks architectures, integrity check for testing out programs, verification, and the process to create a secure and immutable records are dealt with. Proof of Work (PoW) concepts about mining algorithm for implemented distributed consensus protocols among peer nodes to prevent resistance against Sybil attack. This will extend to Proof of Stake (PoS) and Proof of Authority (PoA). Students will explore existing smart contracts to learn how to organize code and come up basic functionalities related to data types, function calls, inheritance through shared variables.

Advanced module:

Students are asked to collaborate on developing creative and innovative solutions with cost-benefit analysis of using blockchain technology in the given problem space (viz., private healthcare data, electronic governance, etc.). Accordingly, they implement and evaluate their primitive solution as a distributed blockchain application. We conclude the course with term paper with two components: (1) technical perspective of deploying smart contract i.e., challenges and lessons learned, and (2) performance analysis of deploying design architecture and component alternatives.

Diversity or Core in Information Systems (IS) Discipline: A survey

Oral

Mr. Hassan Shuaibu (Department of Information Science and System, Morgan State University, MD), Prof. Ganesh Bhatt (Department of Information Science and System, Morgan State University, MD)

in the core matter of the IT artifact. Information Systems (IS) research has witnessed three primary debates [DGB1] from various scholars both within and outside the discipline. This paper has investigatedIn this research paper, we investigate the research trends in IS discipline from three journals (i.e., MIS Quarterly, Journal of Management Information Systems, and Information Systems Research) throughout 5yearsfrom (2015 to 2019) to determine the research focus of IS Discipline. We adopted Thea procedure for the classification was adopted from Culnan’s classification of IS reference disciplines as a method to determine the research focus of the IS discipline. The Culnan’s classification of IS reference disciplines that includcomprisese of 1) core IS research field (CISR), 2) related applied disciplines for IS research (RAD), and 3) basic underlying disciplines (BUD). The results showed that the IS research trends in recent five years emphasizes on diversity[DGB2] . [DGB3] through research methods, problems, and theoretical foundations to account for IS phenomena.

The Role of Blockchain Governance within Business Processes

Oral

Dr. Jack Crumbly (Tuskegee University), Mrs. Savita Farooqui (SymSoft Solutions), Mr. Tom Klein (Business Block), Dr. Deniz Coskun (CDISC)

The hype of blockchain has come and gone. Organizations are unsure of the expectations of Blockchain application. As the role of blockchain is under consideration for projects, the role of governance is critical for organizations. The research will look at an effort to develop blockchain governance and the potential case study opportunities for research.

The Role of Institution Based Trust in IoT Environment: An Empirical Study

Oral

Dr. Anupam Nath (Georgia Gwinnett College)

The Internet of Things (IoT) is rapidly gaining popularity at the industrial and personal levels. However, this rapid adoption of IoT has created privacy, security, and other relevant concerns. Extant research found that Institution-based trust helps individuals operate within an impersonal and unfamiliar environment. Hence, in this research, we developed a theoretical model based on the Trust-based model that can help us understand a user’s adoption of an IoT device. Trust literature has identified two dimensions of institution-based trust: structural assurance and situational normality (McKnight et al., 1998). Based on that, in our proposed model, we identify Perceived IoT device quality, Perceived IoT device effectiveness, and Perceived Trustworthiness of IoT device host as the basis of Institution-based Trust in the context of IoT. Our result shows the importance of Institution-based trust in users’ adoption of IoT technology.

The Role of Institution-Based Trust in IoT Environment: An Empirical Study

Oral

Dr. Anupam Nath (Georgia Gwinnett College), Dr. Kowshik Bhowmik (The college of Wooster), Mr. Amit Kumar Nath (Florida State University)

The current trend to interconnect all devices and systems has produced the increasingly popular paradigm of the “Internet of Things (IoT).” IoT has brought several benefits to users through increased control, remote management, and volume of available usage information (Atzori & Morabito, 2010). Homes are being converted to “smart” by integrating IoT technology into various home activities. However, with numerous benefits due to increased information and control, the technology also introduced various vulnerabilities to allow remote management and communication between devices (Wendzel et al., 2014). These vulnerabilities have raised privacy, security, and overall trust concerns (Menard & Bott, 2018). Extant research found that Institution-based trust helps individuals operate within an impersonal and unfamiliar environment. Consequently, in this research, we developed a theoretical model based on the Trust-based model that can help us understand a user’s adoption of an IoT device. Trust literature has identified two dimensions of institution-based trust: structural assurance and situational normality (McKnight et al., 1998). Based on that, in our proposed model, we identify Perceived IoT device quality, Perceived IoT device effectiveness, and Perceived Trustworthiness of IoT device host as the basis of Institution-based Trust in the context of IoT. Our result shows the importance of Institution-based trust in users’ adoption of IoT technology.

Abstracts: Information Privacy, Security and System Resilience, Business Ethics, Business Law

AI vs. AI: Using AI to Detect AI-generated Phishing Emails in Ransomware Attack Protection

Oral

Dr. Qingsong Zhao (LSUS), Dr. Subhajit Chakrabarty (LSUS)

The rise of ransomware attacks over the past few years is an ever-growing problem that has quickly become an extremely serious threat to businesses and government organizations across the globe. Approximately 37% of global organizations said they were the victim of some form of ransomware attack in 2021. Phishing emails are the most common delivery methods and cybersecurity vulnerabilities causing ransomware infections. The rapid growth of Artificial Intelligence (AI) technologies has provided advanced and cost-effective AI text generation capabilities. Threat actors are taking advantage of these capabilities to deliver malicious phishing campaigns, which puts defending against phishing emails in a more disadvantageous situation. To date, several studies have been conducted to address the challenging threat of ransomware, and have tried to provide detection and prevention solutions. However, there is a lack of survey articles that explore the research endeavors in mitigating ransomware attacks by detecting AI-generated phishing emails. As an effort to review the present status and future prospects in the research area, this paper introduces ransomware, ransomware attacks, and its trends; discusses the state-of-the-art text generation engine (GPT Generative Pre-Trained Transformer); reviews significant research in detection algorithms and approaches for detecting AI-generated contents; and studies the challenges and future research directions in developing AI models to effectively distinguish between AI-generated and human-generated texts. The works reviewed in this paper are significant studies from scientific article databases: SpringerLink, ACM, IEEExplorer, ScienceDirect, and Arxiv. This work can be used as a simplified ready reference for the present status and future prospects in this research area.

Keywords: Ransomware Attack, Phishing, AI-generated Text, Generative Pre-Trained Transformer (GPT)

CYBERSECURITY BREACH MITIGATION STRATEGIES FOR ORGANIZATIONS – A HUMAN-CENTRIC TEXT ANALYTICS APPROACH

Oral

Mr. Soham Sengupta (University of Memphis), Dr. Asit Bandyopadhayay (Austin Peay State University)

Cybersecurity Breaches (CSB) are consistently one of the top five most important and worrisome IT management issues (Kappelman et al., 2021) over the last few years. The sophistication of cyberattacks and the technological innovation to detect and mitigate such attacks have been a cat-and-mouse race for over a decade (Nespoli et al., 2017). Interestingly, the top ten cybersecurity risks to web applications over the past 18 years have not changed (Loukas, 2021). This persistence of the same challenges insinuates that something is wrong with how organizations address cybersecurity challenges. Although there has been immense technological innovation in cybersecurity breach detection (Hu et al., 2018), less has been stressed on the human intervention helping to mitigate such CSB incidents in the security literature. Therefore, to better understand this landscape of cybersecurity breaches across organizations over the past decade, we propose to textually analyze thousands of breach study conducted over past 10 years from 2012 to 2023. This endeavor aims to understand better the evolution of the breach types occurring and recommend associated human-centric mitigation strategies adopted by the organizations using text analytics.

Cybersecurity is concerned with safeguarding computer networks and the information they contain from unwanted penetration and accidental or malicious disruption (Coventry & Branley, 2018). A data breach is an incident that results in the disclosure of confidential data to an unauthorized person or organization. Cybersecurity is a major concern across all industries as this leads to information divulges and data breaches, consequently impacting organizations' brand and financial health. As per the IBM Cost of a Data Breach 2022 Report, the data breach average cost increased by 2.6% from $4.24 million in 2021 to $4.35 million in 2022. This is also a 12.7% increase in cost from $3.86 million in the 2020 report (Reed, 2022). The UNCDF announced that "the economic cost of information and technology asset security breaches in 2020 was a staggering USD 4-6 trillion, equivalent to about 4-6% of global GDP." This translates into a $4.5 trillion impact in 2020. If the percentages stay roughly the same, the total cost will be approximately $5.2 trillion in 2022 (UNCDF, June 2022).

To understand several types of data breaches and mitigation strategies adopted by organizations, we collected breach studies over ten years. In doing so, we have explored the different facets of data breaches affecting organizations using text mining method where the following research questions are addressed:

RQ: What are the different types of human-centric mitigation strategies adopted by organizations in response to effectively managing cybersecurity breach events?

Our preliminary analysis indicates that there is a huge dearth of studies emphasizing on human-centric mitigation strategies even when 82% of the data breaches has a human element involved (Verizon, 2022)

Cybersecurity, continuity, and personality: Three interrelated necessities for the post COVID-19 resilience.

Oral

Dr. John Batchelor (University of West Florida), Dr. Gerald Burch (University of West Florida), Dr. Tyler Fezzey (University of Alabama)

The COVID-19 pandemic caused an abrupt change to remote work and has resulted in a greater openness to such versatile work arrangements post-COVID. Yet, the nature of the remote work environment poses greater cybersecurity threat than traditional work arrangements of the past. When addressing the enhanced cybersecurity needs of remote work, it is essential to not focus solely on technical aspects of security - individual differences (i.e., personality) and continuity planning must be incorporated. As Burch et al (2021) point out, people are often the weak link in any security plan. But not all employees are the same when it comes to security threats. Some personality types are more prone to engage in risky behaviors than others. Kichtenkamm et al (2022) discuss how individuals make what they perceive to be rational choices necessary to achieve their personal and professional goals and this relates to cybersecurity. As such, these “rational choices” vary from individual to individual based, in part, on their risk-taking preferences. That is, what may be an irrational risk for one individual may be perceived as perfectly reasonable to another. Burch et al (2021) take this concept of individual differences into account in their training recommendations for cybersecurity and continuity planning. Specifically, they state that not all individuals should receive the same security training and monitoring. That is, a personality assessment should be used to identify high risk individuals that need enhanced training and supervision. This paper gives specific recommendations on which personality types, based on the Big 5 model of personality, require additional security training and what this training and supervision should involve.

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Deepfake video forensics in cybersecurity – a select review of methods and tools for creation and detection

Oral

Dr. Subhajit Chakrabarty (LSUS), Dr. Qingsong Zhao (LSUS), Mr. Prabhat Dhungana (Louisiana State University Shreveport)

Video forensics plays a critical role in cybersecurity, particularly to assist with response to ransomware incidents. Mainly due to the rapid development of AI/ML, Deepfake has emerged as a big challenge in video forensic investigations. A Deepfake is a media file that has been altered deceptively using Deep Neural Networks (DNNs). Over 85 thousand harmful Deepfake videos, crafted by expert creators, were detected between December 2018 and December 2020, per the 'The State of Deepfakes 2020' report. The report mentioned that the number of expert-crafted videos has been doubling every six months. The task of detection can have a large scale, considering that 400 hours of video are uploaded to YouTube every minute worldwide and YouTube viewers watch over a billion hours of video on the platform every day. Generating fake videos through free open software can be easy. The underlying DNNs may be Convolutional Neural Networks, Long Short-Term Memory or Generative Adversarial Networks. Detection can be very difficult and this is an open problem. The quality of "faking" is more dependent on the quality of the source videos, than on the DNN methods used. The broad objectives of the study are to review the state-of-the-art in Deepfake video detection, and to develop a prospectus for a research agenda in this area. The works reviewed are significant studies from a search range from 2017 to current date. We looked at the following scientific article databases: SpringerLink, ACM, IEEExplorer, ScienceDirect, and Arxiv. We used following keywords for search: "deep fake", "deep fake tools", "deep learning" "deepfake detection", "cybersecurity". The significance of this work is that it can serve as a simplified ready reference for state-of-the-art tools available to create and detect Deepfake. This can also serve as a readable prospectus for research agenda in this area.

EXAMINING THE EFFECTS OF VIRTUAL WORK ON CYBERSECURITY BEHAVIOR

Oral

Prof. Amitava Dutta (George Mason University), Prof. Pallab Sanyal (George Mason University)

The Science of Security (SoS) initiative at the National Security Agency organizes its research into the so called Five Hard Problems (5HP), one of which is understanding and accounting for human behavior. Our study focuses on behavioral aspects of cybersecurity and is motivated by the COVID pandemic which has increased the virtual component of organizational work. More importantly, the prediction is that even after the pandemic is brought under reasonable control the footprint of online activities will remain extensive. Specifically, the work from home (WFH) component of organizational work is taking on increased significance. In this paper, we propose a theoretical model that incorporates WFH factors into existing models of intent to perform cybersecurity behaviors. Typically, existing models of cybersecurity behavior link two broad categories of latent variables – threat appraisal and coping appraisal – with some form of behavioral intent. These two latents, in turn, are derived from established theories such as the theory of planned behavior, protection motivation theory and deterrence theory. We see WFH as a moderator in the relationship between the driving latents and behavioral intent. Our research characterizes different dimensions of WFH which feed into latents based on Herzberg’s two factor motivation-hygiene theory of job satisfaction. A survey instrument is being developed based on this model and will be administered in the next phase of the study. Interestingly, this conceptualization of WFH in terms of job-satisfaction has an important implication for cybersecurity. Heretofore, the literature has generally viewed WFH as a negative force when it comes to cybersecurity. However, this job satisfaction view reveals that WFH can also be a positive force in cybersecurity behavioral intent. While WFH presents impediments such as isolation from work and frequent interruptions, it also provides spatial and temporal flexibilities that have a positive impact on job satisfaction, which in turn can have a positive impact on cybersecurity behavioral intent. We develop testable hypotheses based on this moderating influence view of WFH. The managerial implication of our work is that these positive elements of WFH should be taken into consideration in developing organizational strategies for cybersecurity resilience.

Human Factors: A Vulnerability in Risk Management Process

Oral

Dr. Olumide Malomo (Virginia State University), Dr. Shanzhen Gao (Virginia State University)

Information Technology (IT) risk is the likelihood that a loss occurs when a threat exploits a vulnerability. Losses can adversely affect both the survivability and profitability of any organization. While tangible losses may be more visible and quantifiable, intangible losses can devastate an establishment. Organizations face threats in many ways: natural threats like tornadoes, earthquakes, hurricanes, or man-made threats. Man-made types are those posed by humans and can be intentional or accidental, which may be from an internal or external entity.

IT security risk experts ensure critical business functions and operations are protected against risks by using the best risk management techniques to identify and mitigate the risks from expected and unexpected sources. However, managing organizational cyber and IT security risks are daunting and essential to any organization’s successful security program. It starts with risk identification, assessments, including cybersecurity risk assessment and ultimately, risk controls.

Risk assessment is a significant component of an organization’s overall risk management process. It helps stakeholders identify and evaluate threats and vulnerabilities and the likelihood of an asset exploit. All risk assessment methodologies, including the National Institute of Standards and Technology (NIST) special publication 800-39, have provided education in many ways, standards, and best practices to stakeholders on identifying threats, vulnerabilities, and the likelihood of internal and external risks. To improve risk assessment reporting and promote risk intelligence, Artificial Intelligence (AI), particularly Machine Learning (ML) with high capability to analyze a large amount of data and cyber risk metrics, was integrated into risk management to revolutionize the process. Still, cyber-attacks and data breaches on government agencies, defences, high-tech companies and many small businesses and organizations are not abating. In recent times, there have been troubling number of cyber incidents in 2022 alone. This raises an important question – Are risk assessment methodologies failing in overlooking organizations’ cyber and IT security risks or is human factor in the decision-making at several levels of risk assessments a significant vulnerability to the entire risk management program and defences?

In this paper, we attempt to take a deeper look at risk assessment, particularly in the human decision-making aspect of the risk management program. Also, we present cautionary notes that will help to facilitate informed decision-making at all levels in risk management.

INDIVIDUAL VALUE-BASED OBJECTIVES FOR GENZ ONLINE PRIVACY CONCERNS

Oral

Dr. Simran Dhillon (Virginia State University)

The connectivity between individuals, businesses and society has been growing over the past few years. This has given birth to a growing concern about online privacy. In this paper we focus on GenZ and how they perceive online privacy. We also collectively look at the individual privacy values of GenZ. This research also brings forth the importance of individual values and the fact that they are at the center of any discussion about privacy concerns. Values have an essential place in organizational research. We note that the concept of values is one of the under researched areas in information systems. To that effect, in this research, we present value-based objectives for GenZ online privacy. The objectives are developed based on 88 in-depth interviews of GenZers. The resultant objectives were classified into two categories – the fundamental objectives and the means to achieve them. In a final synthesis, our six fundamental objectives guide the management of GenZ Online Privacy Concerns. The fundamental objectives are: Increase trust in online interactions; Maximize responsibility of data custodians; Maximize right to be left alone; Maximize individual ability to manage privacy controls; Maximize awareness of platform functionality; Ensure that personal data does not change. Collectively our fundamental and means objectives are a valuable basis for GenZ to evaluate their privacy posture. The objectives are also helpful for the social media companies and other related platforms to design their privacy policies according to the way GenZ wants. Finally, the objectives are a helpful policy aid for developing laws and regulations.

PRINCIPLES FOR FACIAL RECOGNITION TECHNOLOGY: A CONTENT ANALYSIS OF ETHICAL GUIDANCE

Oral

Dr. Heather Domin (Capitol Technology University), Dr. Sondria Miller (Capitol Technology University)

Facial recognition technology can be of great benefit to society if used ethically. A variety of private sector, government, and civil society groups have created guidance documents to help guide the ethical use of this technology. A qualitative content analysis was performed on 25 of these documents published within the United States or by international groups that included representation from the United States to identify common ethical recommendations. The 25 documents included within the study came from eleven civil society groups (such as the World Economic Forum, the Future of Privacy Forum, and the Security Industry Association), five government groups (such as the FBI and the U.S. Department of Justice), and nine private sector groups (such as Microsoft, Google, and IBM). There were eight common ethical recommendations identified within the documents. These common recommendations were privacy, responsibility, accuracy and performance, accountability, transparency, lawful use, fairness, and purpose limitation. By following these recommendations, industry actors can help address the challenges that may arise when seeking to develop, deploy, and use this technology ethically. The research findings can inform the current debates regarding the ethical use of facial recognition technology and might help further the development of ethical norms and common ethical principles within the industry. The findings also show that certain ethical recommendations (accuracy and performance, lawful use, and purpose limitation) appear to be uniquely important for facial recognition technology when compared to general themes for artificial intelligence-based technologies and thus may deserve specific focus when using this type of technology.

WHEN PENNYMAC OBTAINS FORCE-PLACED INSURANCE ON IMPROVED REAL PROPERTY, FOR WHICH PENNYMAC HAS NO BENEFICIAL OR SECURITY INTEREST, HAS PENNYMAC BREACHED THE DEED OF TRUST AND VIOLATED RESPA?

Oral

Dr. Brad Johnson (Francis Marion University), Dr. KAY POSTON (Francis Marion University)

In 78 Fed. Reg. 10696, dated February 14, 2013, the Bureau of Consumer Financial Protection (BCFP) issued its final rules and official interpretations regarding its Mortgage Servicing Rules Under the Real Estate Settlement Act (Regulation X - 12 C.F.R. Part 1024). There the BCFP recognized:

"There is evidence that borrowers were subjected to improper fees that servicers had no reasonable basis to impose, improper force-placed insurance practices, and improper foreclosure and bankruptcy practices. *See* Kurt Eggert, *Limiting Abuse and Opportunism by Mortgage Servicers*, 15 Housing Pol'y Debate 753 (2004), available at http://ssrn.com/abstract=992095 (collecting cases). . .

[T]he amendments to section 6(k) of RESPA in section 1463 of the Dodd-Frank Act evince **Congress's intent to establish reasonable protections for borrowers to avoid unwarranted force-placed insurance coverage**."

Accordingly, the three primary objectives of this article are:

1. To establish the factual background of the case study [*PennyMac v. Johnson and Wijayaningsih*, 20 CVS 2436 (Superior Court, Forsyth County, NC 2020)] concerning PennyMac's actions (e.g., FPI charges, commissions, and kickbacks) in taking control of real estate for which PennyMac has no security or beneficial interest.
2. To establish (a) the North Carolina law at issue with regard to the rights of a trustee in a Deed of Trust and a lender, who is the beneficiary in such Deed of Trust, and (b) the federal consumer protection law with regard to forced-placed insurance (FPI) obtained by a lender upon default by a borrower of the provisions of such Deed of Trust.
3. To apply the law at issue to the factual background for purposes of arguing that, under the facts given, PennyMac, as beneficiary and trustee of a Deed of Trust, has (a) breached said Deed of Trust and (2) violated RESPA.

This article argues that if these objectives are met, the general public [including (1) the citizens of North Carolina, (2) the North Carolina Commission on Banks, (3) the North Carolina Department of Insurance, and (4) real estate owners, in general] will have a greater understanding of the law with regard to the rights of each party to a Deed of Trust and be better able to defend against unscrupulous banks and their loan service providers who illegally charge borrowers with the "cost" of forced-placed insurance (FPI). In particular, as a result of such increased understanding, and the implications thereto, it is expected that PennyMac will be motivated to change its business practices with respect to its loan servicing business, at least with regard to forced-placed insurance (FPI).

Abstracts: Innovative Education, Assessment, Engaged Learning Curriculum, Teaching and Pedagogy

A Gap Model for Systematic Continuous Improvement of Teaching and Learning

Oral

Dr. Elham Torabi (James Madison University), Dr. Bobby Vaziri (James Madison University)

Higher education is a knowledge-intensive service. In particular, the classroom is a service environment in which instructors are service providers and students can be customers, clients, products or producers in the process of learning depending on how engaging the design of the service experience is. Bearing that in mind, we suggest implementing two well-stablished approaches in operations management to assess and improve teaching performance: The Gap Model of Service Quality (GMSQ), and Deming’s Plan/Do/Check/Act cycle (PDCA). The visualization can help instructors structure their improvement efforts and organize their self-assessment.

GMSQ was developed by Parasuraman et al. in 1985. In 1989, Brown and Swartz suggested that the gap model can be applied to professional services. In 1993, Hampton applied this model to analyze college student’s satisfaction. According to GMSQ, customer satisfaction is the gap between customer’s perception and expectation of service quality. However, our goal in using the gap model is to improve teaching effectiveness and student learning experience by adopting the notion of gaps. Therefore, inspired by the Academic Plan Model (Lattuca and Stark 2011) and GMSQ, we created a gap model that applies to student learning experience in a course. When the instructor is evaluating their teaching effectiveness, they can map the shortcomings to the eight identified gaps and then use Deming’s PDCA cycle to reduce the gaps. The type of action will depend on the specific gap with the goal of minimizing that gap, i.e., achieving better quality of learning experience.

We present presumable symptoms of each gap and helpful actions to close the gap. We also present implementation results including student course evaluations and assessment of learning data in an operations management course to demonstrate the effectiveness of this systematic performance improvement in helping instructors improve along different metrics and guide their choice of innovative approaches in teaching and learning.

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A Survey of the Impact of Machine Learning in Higher Education System

Oral

Dr. Weizheng Gao (West Virginia State University), Dr. Olumide Malomo (Virginia State University), Dr. Somasheker Akkaladevi (Virginia State University), Dr. Adeyemi Adekoya (Virginia State University), Dr. Shanzhen Gao (Virginia State University), Dr. Ephrem Eyob (Virginia State University), Dr. Julian Allagan (Elizabeth City State University)

Machine learning has evolved rapidly in the past two decades. It is now responsible for rapid technological advances in different fields. One of the most prominent examples is self-driving cars. In addition, it plays a key role in vital and sensitive areas such as Agriculture, Banking, and Insurance. However, only recently have people started applying it to one of the most important industries in every country in the world, higher education. There are different objectives for applying machine learning. For example, some schools aim to use machine learning to reach or exceed retention goals, while others try to use machine learning to determine struggling students in different courses early in the semester before they drop their classes. This is a survey about the recent progress in utilizing machine learning to shake up the traditional higher education system.

As mentioned in this article [1], institutions use indicators such as low grades and poor attendance to identify students who are at risk. However, these indicators often only provide us with a subset of at-risk students, and such students are identified too late in a semester. Machine learning could be used as a part of a holistic approach to better identify vulnerable students early after studying the existing data. It is just one of many benefits of using machine learning in the higher education system. We will discuss the different benefits of applying machine learning in the system and the major challenges of machine learning in higher ed in detail based on new research results in our presentation. With this survey, we provide a roadmap for people to continue doing cutting-edge research on this new application of machine learning.

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AN EXAMINATION OF BUSINESS STUDENT PREFERENCES TOWARD CLASS SCHEDULING WITH REGARD TO BUSINESS EMPHASIS AND CLASSIFICATION

Oral

Dr. Mike Shurden (Lander University), Dr. Susan Shurden (Lander University)

This study addresses business student preferences regarding class scheduling. How much input do students really have in the scheduling process? What percentage of business students prefer early morning classes? What percentage of business students prefer evening classes? Is there is significant relationship between business emphasis and the preference of class scheduling? Do upper level business students scheduling preferences differ from lower level students? What percentage of business students prefer their classes be spread over five days? Surveys were administered to business students enrolled in a small university located in the southeast section of the United States. These surveys were given in Spring 2019, Spring 2021, and Spring 2022. Approximately 600 surveys were collected over this period. The data were combined and statistical analysis was used to determine if there is any significant difference between student scheduling preferences with regard to emphasis and classification. The results of this study would provide valuable input to the scheduling process. Instead of assuming what business students prefer in regard to class scheduling, this paper examined scheduling preferences based on student input.

Can robotic tutors help overcome learning loss?

Oral

Dr. Oliver Hedgepeth (American Public University)

Abstract: Each state in the United States has shown at least a 10 percent drop for students in mathematics and reading. The use of artificial intelligence (AI) to assist in teaching students is part of the evolving classroom of computer technology employed by some school systems. The use of AI and robots is expanding into our homes and classrooms. The use and acceptance of AI as a teaching instrument to assist a human teacher or replace a human teacher can be linked to business applications posed by companies such as Amazon and Boston Dynamics. In China, Squirrel AI is a tutoring software which students could use at private-tutoring facilities. Squirrel AI is believed by the backer to be in a safe zone with plans to expand into the United States. Squirrel AI tablets are now being given free in China to their public schools.

Anticipated participant learning outcomes: Participants will be asked to engage in discussions of their views on the use of AI as a replacement or support for human teachers in the classroom and for online learning and teaching.
Background and evidence of the effectiveness of work being presented: During 2021 and 2022, academic publications and news articles have been promoting the increased use of AI technology in teaching and learning, from home use to K-12 classrooms, to manufacturing, logistics and replacement of humans in the workplace.
Plan for engaging conference participants/attendees: Participants will be asked to view short videos of AI applications as a learning tool, use by teacher and used in the workplace today in the U.S. and other countries. They will be asked to participate in a brief survey of their views and assessment of using AI to replace or work alongside human teachers.
Author Background: Dr. William Oliver Hedgepeth earned a Ph.D. in Engineering Management from Old Dominion University, a M.E.M. in Engineering Management from Old Dominion University, and a B.S. in Chemistry and Mathematics from Atlantic Christian College (Now Barton College). He studied Nuclear Engineering at Catholic University of America. His research interests and publications include radio frequency identification, artificial intelligence, global supply chains, global logistics, transportation, reverse logistics, logistics, supply chain management, transportation, online teaching methods, and circular economics. He is a full-time professor at American Public University (APU). He was Chair of the Logistics Department at the University of Alaska Anchorage. Dr. Hedgepeth was the founding Director of the Army’s Artificial Intelligence Center for Logistics from 1985 to 1990, Fort Lee, Virginia. His textbook, *RFID Metrics: Decision Making Tools for Today’s Supply Chains*, was published by CRC Press in 2006.

Embedding STEM-based Modules to Integrate Design and Systems Thinking in Accounting Courses

Oral

Dr. Jiahua Zhou (Fayetteville State University), Dr. Jennifer Bushelle-Edghill (Fayetteville State University)

Abstract

This paper aims to develop a novel pedagogic solution embedding task-based course modules to train accounting students' STEM-based IT skills. The newly initiated CPA Evolution Curriculum project (AICPA and NASBA, 2020) requires adding IT technique training in accounting courses. Accounting Information Systems and IT Auditing are the courses expected to teach interdisciplinary knowledge across IT and accounting domains. The paper follows Bonner (1999) to explore a fit approach to teaching students in data and analytics skills with a technical learning focus. This novel pedagogic approach embeds IT and analytics skills into several course modules and integrates them with a well-designed task-based project to achieve the goal. The integrated course modules balance IT skills and accounting domain knowledge and let students see both “the trees and the forests.” This design offers a holistic view of data and analytics, starting with database design, then data collection, integration, cleaning through data analysis, and interpretation of results. The study has at least two contributions to the literature. First, the embedment design can save valuable curriculum space to make technology training more affordable for accounting education. Second, the learning analytics result from the prototyped course shows that the updated course design has a significantly higher engagement than the traditional one.

**This Study is supported by 2022 NC Collaboratory Funding.

Fostering a Mastery Mindset: Today’s Statistics Students

Oral

Ms. Carmen Mercer (Hawkes Learning)

With an application-based curriculum, instructional simulations, technology instructions and relatable chapter projects, Hawkes empowers students to master complex concepts and make real-world connections. Learn how the intelligent courseware instills a mastery mindset with intelligent, error-specific feedback and step-by-step tutorials. *Win one of THREE $25 Amazon gift cards!*

From Education to Certification & Continuous Education: Examining the Project Management Life Cycle in PMP Executives

Oral

Dr. Shekar Challa (Virginia State University), Dr. Jim Wynne (Virginia Commonwealth University)

Private sector companies engaged in federal, state and local projects are aware that to be competitive in winning contracts, they are increasingly measured on their ability to meet deadlines within scheduled time and budget. The Project Management Institute (PMI) recognized the need to develop continuous education programs necessary to meet with the demand for a more qualified project management workforce, offering a wider range of professional certifications. The goal has been to increase the number of project managers who have the project management skills that will ensure greater project success. In addition to PMI's initiative to provide a program of continuous education, colleges and universities began to address the need by including principles of project management in program curricula. Schools of business and specifically, information systems departments integrated project management principles throughout course requirements. The goal has been to prepare students to work within a project-oriented environment.

The ability to 'catch up' to the demand for qualified project managers has been hindered by the surge in the popularity of new project development methodologies such as agile
methodology (Schwaber & Beedle, 2001), continuous delivery (Humble & Farley, 2010) and the fail-fast development (Ries, 2011). Certainly, these new methodologies have some positive impact on increasing the projects' success rates and have been promoted by
PMI (PMI 2019). However, despite many organizations recognizing the importance of
following best practices for projects implementation, and the PMI's efforts, the failure
rates of projects remain high, just in new and sometimes more insidious ways (Geneca,
2017). New modes of communication, increasing use of specialized subcontractor services, and government regulations have placed additional hurdles that have not been 'absorbed' by organizations, and specifically, project managers. The means and modes are still turbulent and a steady state does not exist.

The question is whether the efforts by PMI and higher education programs have increased the rate of project success. This paper reflects on the efforts by PMI and higher educational programs, benchmarking the rate of project success prior to these initiatives to improve success rates, and the current reported assessment of project success. A major hypothesis purporting to support early findings of a plateauing effect was the result of seasoned project managers were 'old dogs' who resisted learning 'new tricks' that were becoming competencies needed to ensure a greater project success rate will be presented as a basis for determining the legitimacy of current trends in reported project success rates. In other words, did those engaged in project management tasks, although PMI certified, use the new skills and techniques in managing projects, or did they lapse into their old approaches using very few of the new skills and techniques to improve managing project success?

Knowledge Retention Issues Related to End of Course Performance: Accounting Principles Course

Oral

Dr. Rebecca Hutchins (Appalachian State University), Dr. Gerald Hutchins (Appalachian State University)

We have previously explored the role of knowledge retention from the first course in
Principles of Accounting to the second course. We have also explored how an initial targeted experimental intervention may reduce the negative impact poor retention has on mid-course student performance. Here we extend this line of research to explore the question of whether this intervention improves overall end of course student performance, measured as Final Exam performance and Final Grade in the course.
Earlier research found evidence that the intervention was able to overcome knowledge deficit midway through the course. Here we find the intervention dihttps://sedsi2023.exordo.com/submissions/mine/124/final/edit/step/authorsd not improve overall end of course performance.

Let’s jump right in: Utilizing customized first-day of class exercises pertaining to subject matter and assessment techniques

Oral

Dr. Vallari Chandna (University of Wisconsin-Green Bay), Mr. Praneet Tiwari (University of Wisconsin-Green Bay), Mr. Anup Nair (University of Wisconsin-Green Bay)

(abstract-only submission)
Icebreaker exercises are common in professional and educational settings. More specifically, first-day of class exercise pose an interesting challenge for higher-ed instructors as students often attend multiple new classes in the same day. Exercises that are anchored in the subject matter being taught or the type of assignments utilized by the instructor would have particular relevance while also serving the purpose of being icebreakers. Additionally, they serve as experiential learning opportunities for students. We describe three exercises developed for business classes in marketing, data science, and organizational behavior. While described in more detail in our work, a brief overview of the three exercises is provided here: (1) The marketing class exercise focuses on advertising. It involves students exploring social media and their news feed and then interacting with their classmates to find overlap. The exercise thus leads to student discussion and interaction and allows the instructor to briefly touch on the topics of personalized ads and targeting algorithms. (2) The data science class exercise focuses on data for decision-making. Students are asked what they think of when they hear the word “data” or “data science”. A word cloud is generated based on the same in real-time and discussed. The exercise thus leads to student engagement with instructor questions and allows the instructor to discuss practical applications of data science in different business fields based on student input (or missing input as well). (3) The organizational behavior class focuses on emotional intelligence. Students are grouped into teams of four or more, and a game of charades is played wherein a student from the team acts out a mood or emotional state of being. The exercise thus leads to small group engagement and allows the instructor to discuss mood, emotion, and affect and their role in the workplace. Other business instructors can adapt and modify the shared exercises in-line with their teaching disciplines and the assessment techniques typically utilized by them.

Predicting Student Performance from Online Behavior: A Growth Mixture Model.

Oral

Dr. Inigo Arroniz (Randolph-Macon College), Dr. Edward Showalter (Randolph-Macon College)

Abstract

Technological and environmental factors (e.g., Covid 19) have pushed the adoption and dissemination of Learning Management Systems (LMS) as a platform to help deliver courses online or in mixed settings. In this study we analyze the degree of engagement that students display with the Learning Management System as a potential antecedent of student success and ultimately student retention at the institution. To this end we collect data on 1454 students enrolled at a at a small Liberal Arts undergraduate institution, tracking them over a six-week period. The data tracks weekly interactions of students with the LMS and a series of academic performance metrics and finally whether the students enroll in classes in a future term (retention) at the same institution. Given that the data includes a series of repeated measures we model the trajectory of the student engagement with the LMS using a series of Latent Growth Curves [1]. In this study we acknowledge that there is unobserved heterogeneity among student's trajectories over the term of the degree of engagement with the LMS in any given time, so we create a mixture model that enables for the growth factors to vary over a series of unobservable clusters of students. In summary we estimate a series of Growth Mixture Models [2] that represent the changes in student engagement with the digital platforms of the courses over time and how these vary across the unobserved subpopulations of students. We find that student engagement with the LMS can be modeled using a quadratic growth curve but that there are at least 3 subpopulations of students according to the dynamics displayed by the data. In class or subpopulation 1 (About 1% of the students) students display an exceptionally high level of engagement with the LMS throughout the first 5 weeks of the term. Class 2 (about 14% of the students) display a step quadratic decline in engagement over the first 5 weeks of the term, announcing potential trouble for these students in these subjects. Finally, Class 3 (about 84% of the students) display a slow but steady quadratic growth in engagement with the LMS over the first 5 weeks of the term, the group that together with class 1 is more likely to perform well in these courses and hence be retained the following term.

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PROGRESS UPDATE ON THE DESIGN AND DEVELOPMENT OF AN INTEGRATED VIRTUAL LEARNING ENVIRONMENT FOR CYBERSECURITY

Oral

Mr. Jeff Greer (University of North Carolina Wilmington), Dr. Ulku Clark (University of North Carolina Wilmington), Dr. Rahmira Rufas (University of North Carolina Wilmington), Dr. Geoff Stoker (University of North Carolina Wilmington)

Next-generation cybersecurity leaders need expert level cognitive skills when working with uncertainty and synthesizing information to develop an enterprise cybersecurity strategy. Applied R&D at UNCW is yielding results that will conceptually improve the teaching method for enterprise cybersecurity and the development of student cognitive skills. Key to this initiative is the notion of an Integrated Virtual Learning Environment for Cybersecurity (IVLE4C.) At its core, IVLE4C is a data driven web application that will support large scale teacher and student use. Elements being integrated into a single virtual learning environment include digital business theory, model-based system engineering theory, and cybersecurity theory. Work is ongoing to position IVLE4C as an enabling capability for achieving the national cybersecurity workforce objective and development of next-generation enterprise cybersecurity tools and methods for cyber-defender use.

There are three new developments of note regarding IVLE4C’s design and planned application. First, is the development of a descriptive enterprise system model that serves as an artifact for educational use. It shows how enterprise type, digital strategy, and behavior functionally impacts its physical attack surface structure. The level of abstraction in the model can be varied to support different student grade levels and learning needs. Models can be developed, stored, and reused by teachers and students as needed. Second, is the development of a simple four-step work process for treating risk in the attack surface structure at a level sufficient for achieving security goals. The steps are model, analyze, design, and implement. Third, is the mapping of the four-step risk treatment work process to triple loop learning, reported to be a viable method for developing expert level cognitive skills.

The initial use case scenario for IVLE4C is student design and deployment of a risk treatment plan for a modern digital enterprise. Use case resolution is achieved using the four-step work process identified above. In step 1, a student parametrically defines a descriptive enterprise system model. Step 2, the model serves as an artifact which the student uses for analysis purposes when developing a risk register. Step 3, the student uses the risk register to design a risk treatment plan. Step 4, the student develops a plan of action with milestones for the risk treatment plan implementation. Data visualizations and descriptive statistics are generated from model data and displayed in a dashboard for student consideration.

This approach proposes that enterprise cybersecurity students will be more effective at developing strategic cybersecurity initiatives when hired, if they (a) understand digital business theory, which is a context for decision making; (b) grasp the principles of risk management via assumptions supporting a recommended risk treatment plan; and (c) can apply the methods (tactic, techniques, and procedures) required for implementing and operating an effective cybersecurity program.

THE USE OF APPLETS TO BRIDGE CURRENT GAP IN STATISTICS EDUCATION

Oral

Mr. Rory MacLeod (Rollins College), Dr. Serina Alhaddad (Rollins College)

The merging of technology and education has given rise to a new method of teaching known as blended learning. Although there are numerous potential benefits associated with this new form of teaching including a greater degree of interactivity in the classroom and higher student performance outcomes, there are also many challenges associated with its implementation. These challenges are particularly apparent in statistics education where visualization, interaction, and application play a combined role in promoting positive learning outcomes in students. Although multiple interactive learning materials exist to facilitate the blended learning of statistics at the elementary and high school levels, there are few options to assist the blended learning of statistics in higher education at the undergraduate level. The resulting gap in statistics education at the undergraduate level is apparent based on Advanced Placement (AP) cohort data comparing student performance in statistics to student performance in calculus AB and calculus BC. Over the last ten years, mean scores in AP statistics are consistently lower than in calculus AB and calculus BC. Given the prevalence of statistics-related concepts in many undergraduate majors and business careers, it is important to find a way to close the gap in current teaching methods for statistics. The present study used a prototype interactive statistical applet to help undergraduate students in a ‘statistics for business’ course learn the concept of hypothesis testing. Retrospective pretest and posttest survey analysis was then used to assess its effectiveness as well as determine student perceptions of the applet’s functionality. The results of the study indicate that applets could be used to support the blended learning of statistics at the undergraduate level closing the gap. These findings also suggest that applets may be beneficial to high school students studying AP statistics, allowing for a deeper level of understanding that could potentially promote positive learning outcomes and increase student performance on examinations.

The Well-Being Exercise

Oral

Prof. DeShannon McDonald (Alabama A&M University), Dr. Valentina Iscaro (Alabama A&M University)

The Well-Being Exercise Abstract

Before becoming successful, many entrepreneurs face stress and anxiety with an increased suicide rate in the past twenty years (Bressler and Bressler, 2020). Research shows that when personality strengths are aligned with career choices, the overall mental health improves. For this reason, more practical approaches to better aligning these factors and fostering well-being among future entrepreneurs and business managers are needed in entrepreneurship education.

To promote these objectives, we developed The Well-Being Exercise, a process in which business learners engage in self-exploration based in positive psychology concepts. Positive psychology is focused "on the character strengths and behaviors that allow individuals to build a life of meaning and purpose—to move beyond surviving to flourishing" (Psychology Today, 2022).

Learners will identify their character strengths, (using the VIA Institute of Character Survey), to guide their career choices, promote self-awareness, and minimize effects of mental health issues common among entrepreneurs and managers.

How participants will be engaged?

The Well-Being Exercise will follow this process:

1. **Explore:** Participants will complete an instructor-created survey to explore their individual interests, career goals, character strengths, and areas of improvement.
2. **Learn:** A local non-profit guest lecturer will speak with business learners regarding the mental health challenges associated with entrepreneurship and management.
3. **Research:** Conduct research to learn more about their career aspirations and the character strengths needed to foster success.

The overall goal of The Well Being Exercise is to promote self-awareness and start a conversation about mental health and career choices. The main takeaways are:

1. **Engage**: Complete the free VIA Character Survey
2. **Compare**: Compare their self-identified character strengths to the VIA Character Survey results.
3. **Reflect**: Consider the results of the survey, how they align with career choices, and make adjustments if desired.

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Using Personal Project to Teach Supply Chain Management

Oral

Dr. Huiling Liu (Alabama State University)

The COVID pandemic has highlighted not only the important role that logistics and supply chain management play in facilitating modern life but also the increasing demands for distance learning in the post-pandemic time. Accompanying such a teaching environment changing, improving the distance learning experience has become critical in enhancing teaching effectiveness. This hands-on active learning exercise aims at helping students to learn the concept of global supply chain management through a global supply chain project experience in a hybrid course. Students are expected to identify the global supply chain of a product, explore the complexity of a global supply chain, analyze the potential risks of disruptions for the supply chain, and provide solutions to manage those risks. Through this project, students are exposed to diverse aspects of a global supply chain with emphasizing on multimodal and international transportation, international trade, and potential risk management. Meanwhile, this project provides more opportunities for students to communicate and interact with both instructors and peers, enhancing students' learning experience of having a hybrid course.

Why a Four Day School Week Could Help Retain More Teachers

Oral

Mr. Vincent Johns (University of Michigan-Flint), Dr. E Shirl Donaldson (University of Michigan-Flint)

Retaining and recruiting teachers has become an urgent issue for many K-12 schools across America. Many teachers within the nation have started to leave the classroom due to feeling burnt out, underpaid, and many other stresses that have been amplified during the Covid-19 school closures. This has resulted in many job vacancies in various schools around America at the start of the 2022-2023 academic year. With the job vacancy issue expected to get worse within many K-12 schools, educational leaders around the nation are looking for innovative solutions to provide quality education to students while not significantly increasing costs. During this session, the presenters will review the early findings of districts around the United States who have started to implement four-day school weeks, the benefits and drawbacks of implementing this schedule, and recommendations for how a school or district can implement four-day school weeks within their region.

Abstracts: Management, Marketing, Accounting, Economics and Finance, Strategy, Organizational Behavior Organizational Theory, Human Resource Management, Consumer Behavior, International Business

A Before and After COVID-19 Assessment of Learning Loss on Human Capital

Oral

Mr. Brian Hunt (Clayton State University), Dr. Melva Robertson (Clayton State University), Dr. Reza Kheirandish (Clayton State University)

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

A review of literature on Japanese management in small and medium-sized enterprises

Oral

Prof. Said Elbanna (Qatar University), Mrs. Fareed Begum (Qatar University)

Japanese management has always been unique and examining what is speical about them will have immense implications for SMEs worldwide. Given this, this study aims to review the Japanese SMEs literature to identify research arenas that have been explored in the past and aids in classifying the factors that make Japanese SMEs unique and successful. Using a systematic review approach, 63 studies were identified and analyzed which helped to identify seven themes associated with Japanese SMEs. This review points out a few methodological shortcomings in the literature, identifies gaps and recommends several avenues for future research. It also highlights several implications for both practitioners and policy makers.

Accountants’ Familiarity with Excel: Does it Hinder Adoption of Newer Data Analytics Technologies

Oral

Dr. Sathasivam Mathiyalakan (Winston Salem State University), Dr. George Heilman (Winston Salem State University)

Technology is rapidly changing the business environment. As noted in Wikipedia, the term “Big Data” has been coined to represent large and complex data sets that require more capable data processing software than the traditional analytics software. In fact, this term “Big Data” has become the latest buzzword. Microsoft Excel is extensively used by Accountants and Business school students. Microsoft Excel by itself lacks the capability to analyze large and complex datasets. This has resulted in the use of a variety of software to analyze data sets. The ability to use new and more powerful Data Analytics Technologies and make use of Big Data has become one of the more important skillsets for accountants. With ever lowering cost of technology at the hands of Business professionals, Accountants are in a unique position to use sophisticated Data Analysis Technologies due to quantitative and computer skills. However, recent studies have shown otherwise indicating that some Accountants are showing resistance to the use of these Data Analysis Technologies and are relying on Microsoft Excel for their analytical needs. In this study, we examine prior studies on Accountants use of Excel and Data Analysis Technologies and examine factors that influence their adoption of newer Data Analysis Technologies.

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

BETTER SOONER THAN LATER? EFFECTS OF ADOPTING DRONE-ENABLED INVENTORY OBSERVATION ON AUDITOR LIABILITIES

Oral

Dr. Sarah Kim (National Cheng Kung University), Dr. Tom Downen (UNC Wilmington), Dr. Helen Kang (UNSW Sydney)

Audit firms have begun to explore the use of drones for inventory observation (PWC 2016; EY 2017). Despite the usefulness of drones in inventory observation in an audit, practitioners are hesitant in using the new technology due to the possible additional litigation and regulatory risks (Christ, Emmett, Summers, and Wood 2021). In this study, we investigate whether using drones for inventory observation, while it being consistent or inconsistent with the audit industry norms, might increase auditors' legal liabilities. We employ a 2 (inventory observation medium: drones versus human staff) x 2 (audit industry norms: consistent vs. inconsistent) between-participants design. Our results show that jurors assess higher negligent likelihood to auditors who use drones in inventory observation, if using drones was not the audit industry norm at the time of audit. However, our results also show that, if most other audit firms have already adopted drone-enabled inventory observation, jurors assess higher negligent likelihood to auditors who do *not* use drones in their inventory observation. Our results also show that this interaction effect is mediated through perceived foreseeability of the auditor over the audit failure. Our findings provide practical insights that, while adopting drones for inventory observation earlier than other audit firms may increase potential current legal liabilities, adopting later may also increase potential legal liabilities. This study also provides theoretical implications about the interaction between conventionality (i.e., previously used practice) and normalcy (i.e., widely used practice) which has been hardly distinguished in the empirical tests of the literature of normality bias.

CEO AND BOARD CHAIR: FORCES FOR INDEPENDENCE AND SEPARATION

Oral

Prof. Greg Kordecki (Clayton State University), Dr. Dustin M. Grant (University of West Florida)

The composition of the corporate Board of Directors, and especially the profile of its Chair, is subject to increasing scrutiny. Environmental, Social, and Governance (ESG) continues to grow with enthusiasm from corporate entities, users of reported information, regulators, and other stakeholders. While climate concerns and diversity, equity, and inclusion may have consumed the headlines in the early 21st century, a historically more predominant request in the ESG toolbox has been gnawing at corporate boards and once again is coming to light in view of overall sustainability. This paper describes recent trends in investor voting for large corporate proxy proposals on issues pertaining to the independence of the Chair. Prior research alludes to the importance of separation of top corporate management, especially the chief executive officer (CEO), from the overall governance provided by the Board, but does not adequately address the relevant issues and the progress achieved by the movement among some stakeholder groups. This paper analyzes key issues and surveys the results of corporate ownership voting demonstrating progress toward more practical and useful corporate governance, and providing a preliminary step to this end through the shareholder voice.

Keywords: Corporate Governance, Independent Chair, Proxy Proposals, Sustainability

Declarations: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. This paper does not contain any studies conducted by the authors on human participants or on animals.

JEL Classifications: G30, HOO, M14

COVID 19 AND THE PERFORMANCE OF RETAIL REAL ESTATE INVESTMENT TRUSTS

Oral

Dr. Davinder Malhotra (Thomas Jefferson University)

The steady decline of the retail sector in the years preceding Covid-19 had already had severe consequences for the Real Estate Investment Trusts (REITs) that owned the commercial property in the malls, shopping centers, and high streets. COVID-19 only accelerated the push towards digitization of business models as consumers shifted to online shopping even more. This study benchmarks the operating performance of retail REITs on a quarterly basis to analyze the winners and losers within the retail REIT category. Based on return on assets, earnings before interest taxes, depreciation, and amortization margin, revenue growth per year, capital utilization ratio, and interest cost as a percentage of basic earning power of a retail REIT, we found that only three out of 21 retail REITs have been consistently performing well relative to their peers from September 2019 to December 2021. The study also finds that a sharp decline in return on assets, EBITDA margin, and revenue growth started in March 2020 and bottomed out in June 2020.

CRITICAL AUDIT MATTERS: THE CASE FOR THE AUDITOR’S REPORT LIMITED USEFULNESS

Oral

Prof. Greg Kordecki (Clayton State University), Dr. Maria L. Bullen (San Jose State University)

The inclusion of comments regarding critical audit matters identified by the outside independent auditor of public company annual financial statements has been an established auditing standard since 2017 with the passage of the Public Company Accounting Oversight Board’s (PCAOB) pronouncement AS 3101, *The Auditor’s Report on an Audit of Financial Statements When the Auditor Expresses an Unqualified Opinion.* Prior studies have covered trends among selected topic areas CPA firms have assessed as critical in their engagements to render assurance over individual companies’ financial statements. More research is needed on the effect of recurring topics for individual corporations, the breadth of topics across larger entities, and the trends of CPA firms engaged for the annual audit. Research in this paper focuses on the trends emerging from the annual audits of U.S. companies comprising the Dow Jones Industrial Average (DJIA). This paper addresses under-studied information and offers suggestions on the efficacy of the current standard and practices in reporting critical audit matters.

Keywords: Auditing Disclosures, Audit Reports, Critical Audit Matters

Declarations: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. This paper does not contain any studies conducted by the authors on human participants or on animals.

JEL Classifications: G30, H00, M00, M42

DIVERSITY IN ORGANIZATIONS: DO WE NOW HAVE MORE QUESTIONS THAN ANSWERS?

Oral

Dr. Inessa Korovyakovskaya (Savannah State University)

Today, many organizations recognize the significant increase in their workplace diversity and its impact on groups and team dynamics as well as overall organizational performance and outcomes. Managers and leaders have made steps to embrace diversity to acknowledge and value differences of organizational workforce through diversity management initiatives, trainings and programs to yield competitive advantages. Companies of all sizes spend valuable resources on managing diversity to effectively compete in domestic and global markets. The pressure for organizations to employ diversified workforce is more intense today than even a few years ago. Research findings on team and organizational diversity of the past decades' report mixed results. Most empirical studies on diversity have not explored the complexity of the phenomena. There is a tremendous “potential value of adopting a multidimensional, multilevel approach in future theoretical” and empirical studies (Jackson & Joshi, 2004, p. 698). The present research examined the complexities of the relationships between workplace diversity and organizational performance as mediated by diversity management programs and moderated by multi-level organizational variables. The present study contributes to the extant research on workplace diversity through the development of a new conceptual model that links variables of interest while seeking answers to several research questions.

While we have answers to some research questions now, there will be more questions regarding workplace inclusion and diversity to address in future. Benefits and challenges of the workplace diversity are expected to continue impact organizational performance. It is essential that companies focus on development and implementation of best practices of diversity management. It is recommended that companies and diversity managers use trainings and procedures from a collection of best practices offered by government at all levels and professional organizations, for example, the Equal Employment Opportunity Commission (EEOC) and the Society of Human Resource Management (SHRM), to name a few, to effectively achieve desired organizational results.

DOES THE PAST MATCH THE FUTURE? GLOBALIZATION AND FOREIGN DIRECT INVESTMENT IN RUSSIA THROUGH THE LENS OF ACADEMIC PREDICTIONS

Oral

Prof. Christopher Ziemnowicz (University of North Carolina at Pembroke), Prof. Gaye Acikdilli (University of North Carolina at Pembroke)

Most academic articles, and the social sciences in general, are predisposed toward explaining the past. The objective of this paper is to review articles that were published around 2005 about globalization and foreign direct investment in the Russian Federation. Major shifts were occurring at that time in international business relations such as competition from an enlarged European Union, China was increasing its role in global economic growth, and the Russian Ruble was appreciating because of increasing oil prices. These articles also prognosticated Russian economic activity. This paper outlines the trends in Western corporate investments and the role of globalization in Russia since the predictions made around 2005. The results indicate that the historic academic papers were generally correct in their forecasts. Russia has turned out to be a poor destination for FDI even though new business opportunities opened, but the nation and its institutions did not prepare and organize all the systems necessary for success in a globalized business environment.

Effects of Employer Legitimacy perceptions on Strategic Recruiting and Organizational Commitment: A Preliminary Analysis

Oral

Mr. Monty Taylor (The University of Tennessee at Martin), Dr. Christie Hui-chuan Chen (The University of Tennessee at Martin)

As national unemployment rates in the US remain at historic lows, many organizations struggle to find workers to fill available jobs. While the overall size of the US labor force is predicted to remain steady due to overall population growth in the US, the Bureau of Labor Statistics (BLS) predicts that the labor force participation rate will decrease from 63.7 percent in 2012 to 61.6 percent in 2022. Such trends indicate that finding and hiring the right employees will remain a challenge for the foreseeable future. As such, businesses and other organizations must utilize best practices in their recruiting efforts to maintain sufficient human resources. Previous research has proposed that higher levels of perceived employer legitimacy may influence the success of recruiting efforts of potential employees who are seeking a predictable work setting and more trustworthy employers (Suchman, 1995). Notably, strategic recruiting procedures often involve enhanced internal/external promotion of available opportunities within an organization. Likewise, modern recruiting techniques involving social media campaigns, employer branding, and artificial intelligence (AI) may be suitable and necessary to obtain a sufficient applicant pool. Additionally, strategic recruiting may involve applicant tracking systems (ATS) and an emphasis on diversity, equity, and inclusion (DEI), along with High Performance Work Systems (HPWS). Affective commitment, as a component of organizational commitment, will be the focus of this proposed research. In this study, employer legitimacy perceptions are predicted to have a mediating effect on levels of organizational commitment of the individuals who are ultimately hired to join an organization.

Exploring the Effect of Mentoring Programs for Both Private and Public Sectors

Oral

Dr. Rodney McCrowre (Fayetteville State University), Dr. Reginald Silver (UNC Charlotte)

Studies on mentoring projects have highlighted the polarization of subjects, unique to therole of mentoring relationships, the role of that mentor, and the influences of those groupsthrough an individual’s journey toward career development. This quantitative study aims to match and cross reference a network of people that have experienced informal and wellregulated relationships within various organizations. This study aims to examine the association of two types of fit and achievement goals, as well as examine the influence of mentorship on the relationship between fit and two dimensions of achievement goals (Mastery Approach and Performance Approach). The research is grounded in traditional management theories of personorganization fit theory, person-job fit theory, mentorship theory and achievement goals theory. The research provides a framework to examine the role of these predictor variables and their effectiveness within the business sector.
Keywords: Mentoring Relationships, Person-Organization fit, Person-Job fit, Achievement goal

Exploring the Impact of the Paper Ceiling: An Introduction to the STARs Method

Oral

Dr. Rodney McCrowre (Fayetteville State University), Dr. E Shirl Donaldson (University of Michigan-Flint)

We are proposing an interactive presentation to explore the Paper Ceiling.
Businesses across several sectors are striving to correct a potential flaw that hinders qualified candidates from getting employed, while recruiting and advancing personnel with a bachelor’s degree during the great resignation post COVID. In discussing job qualifications, employees, and management techniques, we introduce the impact of the Paper Ceiling. We propose there is a credential gap that does not always represent a knowledge gap among baby boomers, millennials, and Generation Z. We are investigating algorithms, preconceptions, and misunderstandings across diverse industries. This study focuses on a proposed framework to generate labor market fairness among managers who undervalue skilled talent. According to several studies, social media refers to this aspect of the paper ceiling as “the Network Gap.” This research will focus on the unique experiences, abilities, and views of career professionals. Finally, we explain the STARs - Skilled Through Alternative Routes (STARs) Method by investigating how businesses screen new workers. More significantly, focus on the exclusion of minority participation. The power of networking and the potential impact on higher education as a hold. Participants will gain a better understanding of the paper ceiling phenomena and how to best use it to their advantage.
Key words: Credentials, Great Resignations, Career Paths, Student Loan Debt, Alternative Preparation, DEI

FACTORS AFFECTING AIRLINERS’ DECISION OF PURCHASING AIRPLANES

Oral

Mr. Cheng-Chien Shih (Embry-Riddle Aeronautical University), Mr. Cheng- Wei Wu (Embry-Riddle Aeronautical University), Ms. Portia Ani (Embry-Riddle Aeronautical University), Ms. Sheeba Grace Ratnakumar Rheuban (Embry-Riddle Aeronautical University), Mr. Rashid Samuels (Embry-Riddle Aeronautical University), Dr. Sohel Imroz (Embry-Riddle Aeronautical University)

Purchasing airplane is one of the most critical decisions in managing and operating airline companies. The emergence of more interconnected global economies and the expansion of international business operations have led to a steady increase in travel demand after the COVID-19 pandemic. Each airplane purchase includes a sizeable amount of money and consideration. With a clear plan and purchasing strategy, airline companies can buy the ideal range of airplanes for their size and operating requirements. However, if airline companies buy their fleet without a solid strategy, these expensive airplanes will become a financial burden to them. To create a solid airplane purchasing strategy, it is beneficial for airline leaders to understand the differences between two largest manufacturers of commercial airplanes—Boeing and Airbus. Therefore, the purpose of this paper is twofold. First, it provides a brief comparison between Boeing and Airbus in terms of airplane’s operational philosophy including control systems and cockpit differences. Second, the paper discusses the significant elements influencing airline company’s airplane purchasing practices. This paper can assist airline companies and airplane manufacturers in making effective decisions regarding their airplane purchasing strategies and policies.

Forecasting Liquidity Based Bank Failure

Oral

Dr. John Downs (Lander University)

Individual bank failure has the potential to contribute to an aggregate shortage of liquidity that spreads throughout the entire system. We investigate the forecasting capability of rare bank failures relative to failed to active banks ratio utilizing a sample of commercial banks from 1984-2020. We find that (i) the top twenty largest bank failures, the Expected Bond Premium and Return on Equity are important forecasting variables. (ii) The failed to active bank ratio is susceptible to economic shocks but continuous (iii) Return on Equity and Expected Bond Premiums not only forecast bank failures but also impact Gross Domestic Product.

Heterogeneous Portfolio Credit Risk Model Based on Tempered Stable One Factor Copula

Oral

Dr. Sung Ik Kim (Louisiana State University Shreveport)

Introduced is a one-factor copula model for portfolio credit risk based on normal tempered stable (NTS) distribution under heterogeneous portfolio assumption. Furthermore, instead of a constant dependence structure, I consider dynamic correlations for stochastic correlation and random factor loadings. I derive the unconditional characteristic function of the portfolio loss fraction and then expected losses through a complex inverse formula to obtain the fair premium for Collateralized Loan Obligation (CLO).

Initial strategy formulation by new entrepreneurial ventures: Examining the antecedents and outcomes for knowledge management, social media, and cybersecurity strategies

Oral

Mr. Praneet Tiwari (University of Wisconsin-Green Bay), Ms. Kanishka Mendhekar (Maynooth University), Dr. Vallari Chandna (University of Wisconsin-Green Bay), Mr. Anup Nair (University of Wisconsin-Green Bay)

Extant literature has established that new entrepreneurial ventures often struggle with the liabilities of smallness and newness. As compared to their more mature counterparts, these firms have limited resources, both tangible such as financial resources, and intangible resources such as human capital. Thus, they often struggle with formalizing different strategic elements in the initial stages of operations. While primary strategies such as the competitive strategy (i.e., cost or differentiation and narrow versus broad focus) are formalized and adopted in the initial period, nascent firms often struggle with more nuanced secondary strategic approaches. We examine how and when a formal knowledge management strategy, social media marketing strategy, and cybersecurity strategy would be developed and adopted by new entrepreneurial ventures. We examine the antecedents to the same and potential positive outcomes. Our proposed framework shows that the perceived value of a formal strategy, perceived ease of implementation of the strategy, industry norms, and the experience of the founding team, all act as antecedents to the three types of strategies. Formally adopting all three strategies has the potential to lead to a stronger competitive advantage as well as can result in optimal distinctiveness of the firm. Additionally, the adoption of a formal knowledge management strategy by the entrepreneurial venture early-on, would lead to a stronger organizational culture. The adoption of a strong social media marketing strategy would lead to improved firm performance provided the potential consumers' utilization of social media mechanisms is high as well. This would be a moderating factor. Finally, the adoption of formal organization-wide cybersecurity strategy would lead to improved industry reputation. We discuss practical applications and implications for entrepreneurs as well as for future research into the topic.

Macaroni and Management: Producing and Implementing Culinary Demonstrations to Teach the Four Functions of Management – Planning, Organizing, Leading, and Controlling

Oral

Dr. David Fowler (Lander University)

Abstract

Visual learning has achieved a paramount appointment in higher education (Hattie, 2015) as an effective way for students to acquire and enhance beneficial skills and abilities while preparing for post-graduation employment. The field of management is reliant upon potential personnel who are well-prepared for this competitive economic environment. Colleges, universities, and trade schools have embraced visual learning technology as an enticing, entertaining, and effective pedagogy method. An explosion of alternative pedagogy modalities has been realized over the past few years, as the COVID-19 pandemic transformed the way instructors deliver knowledge to a global audience of students (Lipomi, 2020). Many of the previously necessary modalities are now used perpetually (Miranda & Molina, 2020), including the extensive use of video in recorded and live demonstrations, lectures, and interactive classroom experiences (Ghosh, 2022).

Many business management programs offer opportunities for the usage of video technology to enhance learning probabilities (Islam et al., 2020). This study considers personal observations through active participation as a professor teaching management courses and creating videos for immersive learning to facilitate improved classroom performance. The author serves as an assistant professor teaching graduate and undergraduate business and hospitality courses for an AACSB-accredited institution. He holds a doctorate in human resource development, M.B.A. in management, and is pursuing a graduate degree in hospitality management. He spent over twenty-five years in corporate America in information technology, operations management, hospitality, and customer service, and is a former executive chef. Areas of expertise are introduced into the classroom using video technology to enhance student learning by recording cooking demonstrations

Engagement with undergraduate management students has been taking place over the past few years during observational data gathering. The researcher created cooking videos to help explain management principles to undergraduate students and implemented them into the curriculum. Multiple subjects are covered including management foundations, human resources, organizational behavior, and entrepreneurship. The pedagogy approach has been well received, and academic performance has improved.

The study and presentation consider one implementation of a culinary demonstration that explains the four basic functions of management. The instructor created a video of making a pasta dish accentuating different aspects of planning, organizing, leading, and controlling that the students were able to understand at a foundational level. A sample of ongoing assessments reveals the methodology to be effective as grades have improved since implementation.

Innovative teaching in higher education demonstrates positive correlations with retention, graduation, and student engagement (Aasriya, 2021), and this is true in management programs. As the study evolves, one may assume that positive results will continue.

The oral presentation provides an overview of results from foundational management course assessments as well as a demonstration of an example of the produced videos.

My Guy Says to Wait: How Some Financial Advice Can Cost You

Oral

Dr. George Lowry (Randolph-Macon College)

Those approaching retirement often face the difficult question of when to start taking social security retirement benefits. The common advice suggests waiting until age 70 to take advantage of a larger monthly benefit check but this important decision might rely on more than that increased payment. How long you might reasonably expect to live, the effects on federal and state income taxes, the timing of your cash needs, the coordination with your other retirement savings, and how much of your wealth you wish to leave to your heirs should be considered.
There are, then, several things to consider when making this decision. This paper looks at some of those factors in detail, addresses some key definitions and ideas, then provides examples and discussion to better understand them, wrapping up with a bit of advice.

Personal Consumption Adjustments in Wrongful Death Litigation

Oral

Dr. Tim Carpenter (Roanoke College)

Forensic economists regularly address economic losses associated with wrongful death cases. In doing so, any lost earnings must be mitigated to the extent that the decedent was likely to consume some portion of that income for their own personal use. While this is well established, the manner in which this adjustment is employed is not universal. This paper aims to suggest best practices in structuring this adjustment for the areas in which there is not likely to be substantial economic disagreement: (1) accounting for wage growth and inflation, and (2) accounting for family size. Further, this paper will highlight and discuss one major area of contention amongst practicing forensic economists – the use of the decedent’s personal income or the total family income in applying consumption rates.

PROFIT WITH PURPOSE COMPANIES: IS THERE A ROBUST METRIC FOR IDENTIFYING THIS ELUSIVE GROUP?

Oral

Dr. Suzie Smith (Presbyterian College), Dr. Kurt Gleichauf (Presbyterian College)

In a recent *Harvard Business Review* article, “The Messy but Essential Pursuit of Purpose,” Ranjay Gulati published a 2x2 grid showing Commercial Logic on the vertical axis and Social Logic on the horizontal axis. The author names the quadrants “Underachiever,” “Good Samaritan,” “Profit First,” and “Profit With Purpose.” He posits that companies should aspire to the high/high upper right quadrant, which he named “Profit With Purpose” companies. However, the author did not suggest ways to quantify these vertical and horizontal axis values.

This project seeks to quantify Commercial Logic and Social Logic using popular metrics applied to Fortune 500 companies. Return on assets, profit/revenue, and net profit margin are three commercial performance measures. Environmental, Social, and Governance (ESG) ratings, Net Promoter Scores (NPS), and American Customer Satisfaction Index (ACSI) scores represent stakeholder responsiveness.

As these metrics are publicly available, the research will plot these values in the 2x2 grid and identify which Fortune 500 companies fit in each of these four quadrants, with primary attention to the “Profit With Purpose” companies. The study also will explore the correlation between commonly used metrics within these important constructs and whether we can truly identify a single robust metric for each of these constructs. Lastly, the study examines the relationship between social orientation and financial performance and evaluates patterns that emerge from the Fortune 500 data.

The Beveridge Curve: The Great Recession, Recovery, and Pandemic Effects

Oral

Dr. C Barry Pfitzner (Randolph-Macon College), Dr. Steven Lang (Randolph-Macon College)

In this work 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 (the beginning of the Job Openings and Labor Turnover Survey) 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. The current position of the vacancy rate versus the unemployment rate in the Beveridge space is unprecedented in the JOLTS data era with exceptionally high vacancy rates relative to unemployment. The background of the current Beveridge Curve analysis is the Federal Reserve’s attempts to bring the current inflation rate down. We 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 the post-pandemic period. The idea of the possibility of a soft landing is whether the Federal Reserve is able to engineer a decreased inflation rate without a large increase in the rate of unemployment. A preliminary version of the full paper is available from the authors upon request

The Impact of the COVID-19 Pandemic on Local Labor Markets

Oral

Dr. Iryna Hayduk (Clayton State University), Dr. Anthony Hannah (Clayton State University), Dr. Reza Kheirandish (Clayton State University)

The COVID-19 pandemic induced a significant and unexpected shock to the economies on all levels—from local to national. The unique feature of the economic downturn caused by the pandemic is that the severity of the negative impact significantly varied across industries because the restrictions imposed by the government to combat the spread of the virus affected each industry differently. As a result, the industry composition of the economy played an important role in determining the magnitude of the adverse effect of the health crises on the economy. We focus on the local (county) level because the local economies are less likely to be diversified and, therefore, are more prone to shocks correlated with the structure of the economy. Specifically, we analyze the labor market of Clayton County, Georgia, which is a typical U.S. County because the average earnings per job in Clayton have been closely following the national trends in earnings over the last two decades, ranging between 90 and 100% of the national average.

The goal of our study is to assess the impact of the recent pandemic on employment dynamics in Clayton County. We utilize the Quarterly Workforce Indicators (QWI) dataset composed of a wide array of labor market indicators allowing us to examine employment flows by the firm (industry and size) and worker (sex and education) characteristics. We find that total employment has declined sharply after the onset of the pandemic, paralleling national and state trends, but the average earnings per job have risen by as much as 9%. This finding suggests that low-wage workers, who are more likely to be employed in the food services and retail trade, were disproportionately affected by the pandemic. Our analysis unveils interesting employment patterns by firm size, indicating that the initial employment shock, measured as a percentage change in the number of jobs, was similar across all firm sizes. In particular, in the first quarter of 2020, the net job change for the small businesses was equal to -5.0% and was similar to the changes experienced by the medium-sized (-6.1%) and large businesses (-4.8%). However, the small business sector, unlike medium-sized and large firms, witnessed the jobs recovery as early as the second quarter of 2020. In contrast, medium-sized businesses continued to shrink in the second quarter of 2020, losing 4.3% of jobs. The job losses were even larger and lasted longer for large firms, where employment declined by about 6% in the second and even the third quarter of 2020. The evidence is clear that the small businesses demonstrated higher resilience to the shock than their large counterparts.

The findings of this study will serve as a guide for the policymakers and business leaders for making future economic decisions.

The Value of Online Training to the Department of Defense (DOD)

Oral

Mr. Javed Mohamed (Nova Southeastern University), Dr. Baiyun Gong (Nova Southeastern University)

During the COVID 19 pandemic, DOD adopted online training as a response to travel restrictions for in-person training and a solution to standardize the new learning formation and approach. However, the design and delivery of online training need to be analyzed to measure its effectiveness and maximum potential for all personnel. Each career field offers online courses along with an extensive competency checklist that is required to be completed over a set period. DOD models online learning to address the need for talent through acquiring skills and developing talent in an online platform that incorporates a deeper learning experience. Will online learning lead to higher educational career goals and do the DOD training programs support this concept fully?

In spite of the benefit of the online training method (e.g., more flexibility for the trainee, less cost for the DOD), there are concerns about the effectiveness of the training programs with regards to (1) lack of digital literacy for online learning for both the trainees and the trainers, which may affect the effectiveness of content delivery. (2) trainees' information overload, which may lead to insufficient knowledge acquisition, and (3) sense-making of knowledge/ abilities/ skills acquired online, which may impede the ability of knowledge application on the job.

This paper intends to analyze the potential impact of the transition of DOD training program to the online mode on trainees' readiness for their career field after the training. The impact of the training program effectiveness on trainees' career success will also be discussed. The findings have broad implications to organizations beyond the scope of military services.

Transformation of a Static Financial Metric into a Stochastic Valuation Model: The Case of the Four-Stage Cash Dupont Analysis

Oral

Dr. Steven Lifland (High Point University)

Abstract

The accrual-based accounting multi-stage Dupont Method's Return on Equity (ROE) reveal strengths and weaknesses of a firm. A more pertinent question is whether-or-not it can be adapted to assess a stock's intrinsic value. This paper extends the financial literature by the *formation of a stochastic valuation model based upon a Modified DuPont and Monte Carlo Probability Analyses.*

The three stage DuPont is modified by a fourth stage metric referred to as *the cash conversion factor (CCF) which incorporates the Free Cash Flow to Equity (FCFE). The 'Cash' ROE, relative to the return on the market portfolio, proxies for the Required Price to Book Value. The resulting Alpha Value, the differential between the Required Price to Book and the Realized Price to Book, designates whether the stock is undervalued, overvalued, or fairly priced.*

While Traditional DuPont analysis would treat their components as static over a fixed time horizon, the measurement of the intrinsic stock value is further enhanced as the input/output components of the Cash DuPont model are defined by a Monte Carlo Probability Distribution Simulation. Here, the metrics are modeled with probability distributions in order to determine to what degree they may be considered critical decision variables. Utilizing the 'Cash' ROE in conjunction with the benchmark market portfolio return, acknowledgment of a risk-return tradeoff is incorporated in the valuation model, as well. These data metrics are blended into a process of stock price valuation that explains both the possibility and probability of the mispricing of a stock.

Understanding the impacts of pilots' mental health on aviation safety

Oral

Mr. Franklin Rujano Alain (Embry-Riddle Aeronautical University), Mr. Zachary Friedrichs (Embry-Riddle Aeronautical University), Mr. Alexis Barrios (Embry-Riddle Aeronautical University), Mr. James Hanover (Embry-Riddle Aeronautical University), Dr. Sohel Imroz (Embry-Riddle Aeronautical University)

In aviation, safety is the highest priority. Several recent aviation accidents and incidents have brought the mental health issue of pilots to the forefront of aviation safety. To protect the safety of crew members and passengers, the Federal Aviation Administration (FAA) and other civil aviation authorities across the globe strictly regulate the status of pilots' physical and mental health. The understanding of mental health has significantly changed over time, shifting from an illness-focused definition to a more person-focused one. Mental health is a fundamental component of well-being, which refers to a person's overall health and wellness, including physical, social, emotional, and psychological health. The World Health Organization (WHO) has defined mental health as "a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to her or his community." Mental health determines how we deal with stress, retain information, build relationships, and make choices.

Types of mental health condition pertaining to pilots can be divided into two broad categories: identifying their disqualifying mental health conditions and most common psychological conditions experienced by them. According to FAA (2022), disqualifying mental health conditions for pilots are attention deficit disorder, bipolar disorder, adjustment disorder, personality disorder, psychosis or disconnection from reality, substance dependence or abuse, dysthymia or persistent depressive disorder, suicide attempt, and depression requiring the use of antidepressant medication. Most common psychological conditions experienced by pilots are anxiety, depression, postpartum depression, alcohol misuse, occupational stress, adjustment disorder, mood disorder, relationship problems, and sexual dysfunction (Cahill et al., 2021; The British Psychological Society, 2017). According to a survey conducted by Dr. Brent Blue, a Senior Aviation Medical Examiner, 96% pilots do not think the FAA handles pilots' mental health issues appropriately. Therefore, to improve aviation safety, it is imperative to address the mental health issue for the pilots.

The purpose of this paper is threefold. First, it describes the significance of pilots' mental health and its impact on aviation safety. Second, it explores the state of pilots' current mental health and the causes and side-effects of mental health-related issues. Third, it reviews relevant regulations currently in place and summarizes available resources established by the FAA and civil aviation authorities to support pilots' mental health. The paper concludes by providing useful recommendations beneficial for the pilots, regulatory agencies, and readers interested in getting a better understanding of mental health-related issues in high-stress professions.

Use of Podcasts in the Classroom

Oral

Dr. Sara Kiser (Alabama State University)

This presentation will examine how to use a variety podcasts that every faculty member can utilize in the classroom. These resources can be used to bring the concepts from the textbook to the "real" world. Some of the podcasts to consider are the Business Wars with David Brown and "The Way I Heard It" with Mike Rowe. Business Wars is a podcast you find in a variety of places, but is sponsored by Wondery. There are currently 73 seasons and 462 episodes. They are multiple episodes on the "war" between two companies which typically run 30-40 minutes an episode. Examples include

- Toyota vs. Honda (6 episodes)
- Hasbro vs. Mattel (7 episodes)
- Boeing vs. Airbus (7 episodes)
- Death Row Records vs. Bad Boy Records (7 episodes)
- Gucci vs. Louis Vuitton (6 episodes)
- Taylor Swift vs. Scooter Braun (5 episodes)
- Netflix vs. Blockbuster (8 episodes)

Mike Rowe, who is the host of the Discovery Channel's "Dirty Jobs," created his own podcast. Early podcasts are rather short. Later podcasts can run up to an hour. He reviews a situation in history and reports "The Way He Heard It." Episodes to consider are

- No. 1 – The 25 Million Dollar Kiss – Hedy Lamarr and the creation of GPS
- No. 28 – An Incredible Reinvention – From wallpaper cleaner to Play-Doh
- No. 38 – On Self Abuse – Reverend Sylvester, Cracker Development, and Graham Crackers
- No. 54 – The Boy Who Loved to Fly – The Enola Gay and Hiroshima
- No. 73 – Monkey Business – Manoj Bhargava and 5 Hour Energy
- No.158 – On The Pursuit of Satisfaction – Mick Jagger and the Rolling Stones
- No. 167 – A Hooker You Can Trust – Hooker Telescope and Edwin Hubble and the Milky Way

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USING THE WORKABILITY INDEX (WAI) AND WORKABILITY SCALE (WAS) TO CALCULATE FUTURE EARNINGS CAPACITY LOSSES

Oral

Prof. Craig Galbraith (University of North Carolina Wilmington)

The problem of determining future economic lost in cases of personal injury is difficult, particularly when the injury is a partial injury, and the individual has some capacity of mitigating their income losses in the future. This paper examines one possible approach for examining this issue of future reduced income capacity, the use of the Work Ability Index (WAI) and Work Ability Scale (WAS). In this pilot study, empirical data is analyzed to determine the relationship between scores on the WAI/WAS and verified future income loss. We find a high correlation between the scores obtained on both the WAI and WAS scores, and future economic loss. This suggests that these indices may be useful in analyzing economic loss, and reduced future income capacity in partial disability cases.

VALUE RELEVANCE OF WEB SALES GROWTH RATES AND CONVERSION RATES ON FIRM VALUATIONS

Oral

Dr. Ravi Narayanaswamy (University of South Carolina Aiken), Dr. Nancy Kangogo (University of South Carolina Aiken)

Understanding the value relevance in e-commerce firms has been a great interest for both academicians and practitioners. There have been some mixed opinions about using financial versus non-financial measures to assess value relevance. Prior research has documented that in market valuations, some non-financial measures have higher value relevance than financial data. For instance, it was seen that web traffic data has greater value relevance than conventional financial data. Similarly, another study finds that the population size and market penetration have great value relevance. This research examines the value relevance of web sales growth rates and conversion rates on firm valuations. Specifically, we will examine the question whether the market incorporates web sales change data into stock valuations. It has been noted that the e-commerce marketplace has been volatile since its initiation. Starting from the dotcom bubble burst to the recent COVID-19 pandemic, e-commerce firms have experienced greater variations. So, this study aims to account for these volatilities by using longitudinal data of web sales and conversion rates.

The data for this research is obtained from three proprietary databases: Compustat and CRSP for financial information, and Digital commerce 360 for e-commerce performance measures. The robustness of these databases has been widely recognized by prior research. More importantly, this study will apply direct measures i.e., actual web sales and conversion rates instead of proxies. The goal is to examine the relationship between web sales data and stock returns. At present, data mapping is in progress. This research has several potential implications. The requirement to expense marketing and advertising costs may diminish the relationship between company growth and financial measures such as earnings which highlights the decrease in value relevance of financial information. This calls for a more balanced approach to evaluating firms, where marketing initiatives and their effects, and other factors receive adequate consideration. In addition to effects on sales and profit, marketing activities create marketing assets such as customer relationships, customer and brand loyalty, and brand equity. Such assets have long-term positive effects on firm value. A significant relation between web sales growth and conversion rate, and firm valuation can suggest improvement in financial disclosures to better communicate the sources of firm value. Disclosure of SG&A costs can be improved by separately reporting costs that have longer-term impacts on firm value. Further, a significant positive relation between web sales growth and conversion, and firm valuation has implications for managers. For instance, they can channel more efforts into marketing and other initiatives that create greater growth in web sales and conversions.

We got this: Examining Social Media Engagement by Small and Medium Enterprises (SMEs)

Oral

Mr. Anup Nair (University of Wisconsin-Green Bay), Dr. Vallari Chandna (University of Wisconsin-Green Bay), Mr. Praneet Tiwari (University of Wisconsin-Green Bay)

The old adage of ‘change is the only constant’ holds true more for Small and Medium Enterprises (SMEs) than any other type of firm. This sector varies extensively in size even within their category and also vary in their capacity for growth. They face a plethora of challenges and opportunities, but the one thing that is ubiquitous for them is the prevalence and importance of leveraging social media for a positive business growth and brand resonance. Primarily after the launch stage of the SME, their social media interactions are key to a positive brand score and building critical mass, which may help sustain their eventual brand growth and success. Their current, as well as prospective consumers are present on their preferred social media platforms either engaging, consuming, or scouting for their next social interaction – the challenge SMEs face is how to enter these conversations and try to be a relevant part of their lives. Thus, we propose that the nature of social media interactions of any firm directly influences how their respective target audience reacts to them. We propose that the accessibility and ease of use of the social media platform, the level of adoption by target consumer groups, and the frequency and mode of engagement, together comprise the composite elements of the SME’s social media marketing strategy. This in turn influences their approach and impacts the e-word of mouth of the SME. Our model shows how these relationships ultimately result in awareness, growth, and prospective brand loyalty for the SMEs. Additionally, any social media approach should be driven by their strategy and should govern the nature of strategic partnerships with influencers present on the respective social media platforms. This has significant practical applications for SMEs and new entrepreneurial ventures.

WHEN SHOULD YOU BEGIN RECEIVING SOCIAL SECURITY PAYMENTS? INCORPORATING TIME VALUE OF MONEY

Oral

Dr. Wesley Jones (The Citadel), Dr. John White (United States Coast Guard Academy)

It is commonly known that you may receive your Social Security benefits as early as age 62. However, the payment will increase by 8% for each year you defer your payments, up to age 70. If you expect to have a long retirement, waiting can be very beneficial financially. The decision on when to take your Social Security benefits is influenced by several factors. First and foremost, your death date is uncertain. But there are other factors that complicate this decision. Incorporating basic Time Value of Money (TVM) techniques we should be able to determine an economic breakeven point given an individual’s assumptions regarding these other complicating factors. Further work in this space should include incorporating known medical indications related to mortality to further refine the decision.

Abstracts: Production and Service Operations Management

EXAMINING THE RELATIONSHIP BETWEEN INVOLVEMENT IN ADVANCED MANUFACTURING TECHNOLOGIES AND EMPLOYEE SAFETY PERFORMANCE IN THE COVID-19 ENVIRONMENT

Oral

Dr. Birasnav Muthuraj (Associate Professor, School of Management, New York Institute of Technology, New York), Ms. Vandana Patibandla (Student, School of Management, New York Institute of Technology, New York), Mr. NAGA V S K R NANDI (Student, School of Management, New York Institute of Technology, New York)

The spread of covid-19 has affected thousands of businesses around the world and caused many manufacturing-related disruptions. It has also affected the well-being of manufacturing employees and their families. To prevent the spread of covid-19, governments have imposed lockdowns, which restrict temporarily employees' movement, social and professional gatherings, and their access to resources. Due to frequent lockdowns, companies have limited the involvement of employees with the manufacturing technologies. For example, the involvement of third-party maintenance employees to perform scheduled maintenance of machineries got affected. In addition, employees who provided technical support for soft manufacturing technologies (such as ERP and MRP) were reduced their availability to manufacturing companies.

Though employees' involvement in both soft and hard manufacturing technologies got affected, according to South Regional Education Board, companies will witness approximately 30% increase on implementing automated technologies in the shop floor next five years. Due to the projected growth of automated technologies, manufacturing companies should ensure employees' safety on using manufacturing technology. Companies should also come up with new regulations to protect employee safety and at the same time, they should encourage employees to come up with ideas to protect employee safety. To date, studies are very rare on investigating the relationship between employees' involvement in manufacturing technologies and safety compliance and participation. This study focuses on the involvement of employees in advanced manufacturing technologies (AMTs) and safety performance. This study expects to reveal the following: (a) employees who involve in soft AMTs will be most likely to show safety participation behaviors; (b) employees who involve in hard AMTs will be most likely to show safety compliance behaviors; (c) the strength of the effects of employees' involvement with soft AMTs on safety participation will be higher among employees who got infected with covid-19; (d) the strength of the effects of employees' involvement with hard AMTs on safety compliance will be higher among employees who got infected with covid-19; (e) the strength of the effects of employees' involvement with soft AMTs on safety participation will be higher among employees who play managerial roles; and (f) the strength of the effects of employees' involvement with hard AMTs on safety compliance will be higher among employees who play non-managerial roles. This study will also offer implications for theories and practice.

Keywords: Advanced manufacturing technology; safety compliance; safety participation; covid-19.

STRATEGIC FACTORS ON PORT PRODUCTIVITY WITH THE FOCUS IN LEAN TOOLS

Oral

Dr. Marvin Gonzalez (College of Charleston)

Much has been said about port productivity in non-academic journals such as those known as periodicals, but there is no model to evaluate lean process tools in this industry. Currently, the application of lean tools is applied according to the tactical strategy of the port (which are referred to as short-term strategies) seeking to solve problems immediately, however, a long-term plan will allow a standardization of the processes and a decrease in waste problems that affect the productivity of any system. This research seeks to identify the operational areas of a port and based on the activities carried out in each operational area, a strategy based on Lean tools is offered that allows for maintaining good productivity, reducing all potential areas of waste. This work aims to propose a conceptual model to integrate Lean process tools to improve port productivity indicators.

Abstracts: Sustainability, SCM, Quality Management, Logistics, Hospitality, Recreation and Sports

A meta-analysis of Airbnb price factors in the supply chain of the sharing economy

Oral

Dr. Rafael Teixeira (College of Charleston), Dr. Daniel Guttentag (College of Charleston), Dr. Wagner Junior Ladeira (Universidade do Vale do Rio dos Sinos)

This paper explores the supply chain of the sharing economy, more specifically, the supply chain of lodging services. There are many factors driving the pricing of lodging-sharing services. We proposed a theoretical model in which characteristics of services are hypothesized to influence the price. To test our hypothesized model, we conducted a meta-analysis on 34 papers published in the literature, resulting in 1065 effect sizes. Results show that characteristics such as distance to the city center, lodging amenities, and the number of bedrooms and bathrooms, among other variables, were significantly related to the prices of Airbnb offers.

A PRELIMINARY EMPIRICAL STUDY OF THE IMPACT OF RISK MANAGEMENT MATURITY ON ROBUSTNESS IN SMALL AND MEDIUM BUSINESSES AND ENTERPRISES

Oral

Dr. Mauro Falasca (East Carolina University), Dr. Scott Dellana (East Carolina University), Dr. Ying Liao (East Carolina University)

This preliminary study explores the relationships among multiple dimensions of supply chain risk management maturity (SCRMM) and supply chain robustness (SCR) in small and medium businesses and enterprises (SMBs/SMEs) from the United States. SCRMM is characterized by factors of continuous systematic improvement/learning of risk management processes (CSI), supply chain (SC) risk management collaboration (RMC), SC risk mitigation (MIT), and organization internal risk management (IRM).

A structural equation model is proposed and empirically tested based on the participation of more than 60 SC professionals from SMBs/SMEs spanning various industry sectors. The proposed model suggests that SC risk management collaboration efforts and improved internal risk management performance precede the effective mitigation of risk events. In the proposed theoretical model, the continuous development and improvement of risk management processes is included as a mediator between RMC and MIT as well as between IRM and MIT. Finally, the implementation of improved mitigation efforts is predicted to have a positive effect on overall SC robustness.

Preliminary empirical results indicate that in the case of SMBs/SMEs, CSI fully mediates the relationship between RMC and MIT while a partial mediation effect is found in the linkbetween IRM and MIT. Finally, the effective mitigation of risk events is found to have a positive impact on robustness. Overall, the preliminary findings indicate that the model constructs help predict SC robustness, suggesting that SMBs/SMEs in the United States can benefit from a culture of continuous improvement of risk management processes.

KEYWORDS: small and medium businesses, small and medium enterprises, supply chain management, supply chain risk, supply chain risk management maturity, supply chain robustness

A Visual Analysis of the Relationships Between Team Finances, Salary Caps, and Competitive Balance in Sports Leagues

Oral

Mr. Joschka Labinsky (University of North Carolina Wilmington), Dr. Aruna Lakshmanan (University of North Carolina Wilmington)

Competitive balance among teams within a sports league is considered important as it keeps players and fans engaged every season. Various policies like salary caps, revenue sharing, drafts, and player free agency have been instituted in North American sports leagues to encourage parity among teams. Most European sports leagues, however, have not established such measures, leading to the dominance of a few teams. In this paper, we use data visualization techniques to examine the relationships between competitive balance, mobility within a league, and team finances across multiple North American and European sports leagues.

An extension of Lean and Green: From Eco-efficiency to Eco-effectiveness

Oral

Ms. IBTISAAMA AHMED (Georgia Southern University)

The worsening climate conditions have engendered an increasing number of environmental groups calling on firms to take action to improve their operations. One area of sustainable operations in which manufacturing firms and researchers have directed their attention is lean operations. This study is twofold: first, to contribute to the ongoing debate of whether “lean is really green,” and second, to identify drivers that may weaken the relationship between lean and green; thus, extending the concept of eco-effectiveness, defined as the absolute and consistent improvement of the environment. This study posits that industry favorableness or munificence is the primary hindrance to achieving eco-effectiveness. It combines data from Compustat and Carbon Disclosure Project to analyze the hypothesized research model. To test the hypothesis, I employ ordinary least squares regression (OLS) to measure the environmental dynamism elements and nested hierarchical regression for the main analyses. Additionally, structural contingency theory is used to understand the alignment of company processes and the environment as well as the variations of main effects relationships; I test moderating effects relevant to the sustainable practices of firms. This study highlights the importance of embracing eco-effectiveness rather than eco-efficiency.

Assuring the Quality of Value-Added Services in the Post-Pandemic Third-Party Logistics Industry using Lean Six Sigma

Oral

Prof. Hokey Min (Department of Management, Schmidthorst College of Business, Bowling Green State University)

The ongoing COVID-19 pandemic coupled with the recent Russian invasion of Ukraine has created the unprecedented supply chain turmoil that swept across the world. This turmoil puts enormous pressure on the logistics industry to reassess the way it conducts business due to never-ending supply chain disruptions. Such reassessment includes the assurance of timely and error-free order fulfillment of value-added logistics services. This paper proposes a lean six sigma program to assure superior value-added logistics services for the first time. The proposed lean six sigma program aims to identify various sources of logistics fulfillment mistakes or inconsistencies and then eliminate them by reducing the variability of logistics fulfillment services. To validate the usefulness and practicality of the proposed lean six sigma program, we applied it to an actual third-party logistics setting where value-added services are rendered to a global marketplace.

EXPLORING SUSTAINABILITY AND RESILIENCE IN SUPPLY CHAIN PRACTICES FROM A MANAGERIAL PERSPECTIVE

Oral

Dr. Sergey Ponomarov (The Citadel)

ABSTRACT

The COVID-19 pandemic has exposed the vulnerabilities, increased risks, and uncertainty of interconnected and interdependent global supply chains. Under current conditions, risk management and sustainability become increasingly important phenomena in supply chain management research and practice. Subsequently, the climate-resilient supply chains are increasingly important for sustainable operations. Growing complexity and increased supply chain disruptions have raised questions for supply chain managers with limited answers from current 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 and the perceptions of climate-related risks at the managerial level. This research seeks to emphasize the importance of managerial opinions and individual perceptions of supply chain and logistics managers in the current challenging business environment. The proposed model will allow to better understand climate related risks and adaptation strategies from a managerial perspective at the individual unit of analysis, 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 from the individual level can help to build a better understanding, as managers are often the ones that formulate and implement sustainable and resilient supply chain strategies and tactics.

KEYWORDS: Supply chain sustainability, resilience, risk management

FACTORS INFLUENCING THE VALUE OF PRIMARY SPONSORSHIP FOR NASCAR CUP SERIES TEAMS

Oral

Dr. Clay Harshaw (Winston Salem State University)

The importance of sports sponsorship cannot be overstated. In the area of motorsports, sponsorship for every aspect of the sport is imperative. Racetracks must have sponsors for events to support prize purses. Sanctioning bodies such as NASCAR must have sponsors to provide championship prizes. Teams must secure sponsors to fund every aspect of the business including construction of racing vehicles, travel to events, and maintenance of their facilities. Prior research has concentrated on the development of sponsorship partnerships and the maintenance of those relationships. However, little research covers the valuation of sponsorship opportunities.

The NASCAR Cup Series is the highest level of stock car racing in the United States. Although it is the most popular type of American motorsports, teams have struggled to secure sponsorships. At NASCAR's peak of popularity, teams could rely on a single primary sponsor for the entire season. However, as the popularity declined and economic conditions changed, teams have had to rely on multiple primary sponsors, which might change from race to race. The number of primary sponsors for a team might be dependent on the team's structure and longevity. Only three of the 36 full-time teams in the NASCAR Cup Series retained single-entity sponsorships for the entire season. For example, in 2022 Hendrick Motorsports maintained Ally Financial as the primary sponsor for one of its four racecars. The 2022 NASCAR Cup Series Champion Joey Logano's Team Penske car featured four primary sponsors during the season. Live Fast Motorsports relied upon 23 different brands as primary sponsors, most of all full-time teams.

Primary sponsors are those with their branding on the hood of the car and on the driver's uniform. Typically, these sponsors garner the most exposure during the race broadcast. As a result, the primary sponsor of the car will pay the highest rate for that sponsorship. For those teams requiring multiple sponsors, they will do so for a set number of races for each sponsor. Sponsors determine the races that they will act as primary sponsor based on the opportunities to leverage the sponsorship and maximize the returns on investment. Thus, there is an assumption that certain tracks and races garner greater price than others.

There are several factors in addition to those mentioned that might influence the asking price of primary sponsorship. The goal of the current study is to determine what factors are most important to NASCAR Cup Series sponsorship managers. This presentation reports the findings of an ongoing Delphi study involving a questionnaire to determine factors influencing the valuation of primary sponsorship with follow-up surveys requesting rankings of the most influential factors. At least two rounds of rankings are being implemented to ascertain consensus among the participants.

Hybrid GA and Enhanced Jaya Algorithm for Supply Chain Network Model with Disruption Risk

Oral

Dr. Mitsuo Gen (Fuzzy Logic Systems Institute), Prof. YoungSu Yun (Chosun University), Ms. Tserendulam Erdenebaatar (Chosun University)

Design and optimization of logistics and *supply chain management* (SCM) network is very important issue, which plans, implements and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the origin and customers. A multistage-based logistics or SCM network can be modeled by means of a sequence of stages, each consisting of a set of functions, *i.e.* the existing or potential facilities located in several countries or regions of the world where goods are transformed or manufactured or stocked and delivered: suppliers, plants, distribution centers (DCs) and customers together. At the same time, we have to consider a disruption which is one of the major risks that can be occurred in the SCN model in the real world. Among the various risks the disruption as one of the categories which is occurred by natural disasters, terrorist attacks, war, etc.

In this paper we propose a *hybridized genetic algorithm* (HGA) combined the enhanced *Jaya algorithm*, HGA-EJA. In overall view, the HGA-EJA algorithm has better convergence behaviors than the others for effectively solving the SCN network models with disruption risk. We implement various metaheuristics such as GA, JAYA, TLBO, PSO, GA-TLBO, and GA-PSO for quantitatively evaluating the proposed HGA-EJA algorithm with different scenarios by using the performance measures: the best solution (BS), average solution (AS), and average CPU time (unit: sec.). Finally, we demonstrate the performance of the HGA-EJA algorithm is effectively superior to those of all single metaheuristic algorithms (GA, JAYA, TLBO, and PSO). For the CPU time, GA, JAYA, TLBO, and PSO are short than all GA-TLBO and GA-PSO including the HGA-EJA algorithm. In overall view, the HGA-EJA algorithm proposed has better convergence behaviors than the others.

Impact of Digitalization on SC Agility, SC Resilience, and SC Constraint Mitigation using a Hybrid Workforce

Oral

Dr. Kimberly Deranek (Nova Southeastern University), Dr. Barbara Hewitt (Texas State University)

Supply Chain professionals are vast and responsible for the activities that cut across the primary supply chain processes; plan, source, make, deliver, and return. This study is being framed to examine the impact of digital tools, digital maturity, and knowledge management (KM) on firms' supply chain (SC) agility and resilience within a hybrid working environment. The initial phase of the research is focused on the creation of the framework, which includes the identification and evaluation of applicable constructs by use of a detailed literature review. Expert judgement will be used with regards to the selection and inclusion of relevant variables and the emergence of hypotheses and research questions. The second phase of the study will focus on the development of the survey instrument, data collection and analysis, and the documentation of findings. The research team developed and submitted an internal grant proposal in an effort to solicit funding for phase 2 of the research. This research is significant because COVID-19 changed the work modality of business professionals, including SC specialists. The pandemic was a catalyst for firms to transition from traditional on-site work to a remote work environment. After the pandemic, many firms have continued to work under this new model with employees being allowed to work either fully remote or under hybrid conditions (i.e., mix of on-site and remote work). The researchers are interested in investigating if the transition to remote work is dependent upon the effective use of a KM system. Specifically, they are interested in understanding if the use of a KM systems and familiarization with digital tools and digital maturity are a determinant of SC agility and SC resilience within firms leveraging hybrid work conditions. The research will investigate if employees who leverage a KM system are more agile and able to mitigate SC constraints in a hybrid environment.

On Inequality Constraints in Well-Known Optimization Problems

Oral

Dr. Hadi Farhangi (Savannah State University)

This work studies some of the well-known optimization problems such as transportation problems, assignment problems, shortest path problems, transshipment problems, and dynamic lot sizing problems. Particularly, it is shown that the core constraints of these problems can be derived using the conservation of flow principle. This principle can lead to an alternative inequality expression of the core constraints. These inequality constraints, then, provide alternative formulations for these problems. It is shown that the resulting alternative formulations return the same optimal solution as the ones returned by the original problems. Finally, some of the applications of alternative formulations are explored.

Optimal Coal Mine Allocation and Delivery Schedule for a Power Company

Oral

Dr. nasreddine saadouli (Gulf University for Science and Technology)

A Power company uses high moisture and ash with low calorific content coal. The company needs to improve upon the present grade of coal being used through a network of coal suppliers from all over the world within time and budget constraints. A linear programming formulation is used to determine the optimal supply of coal from different mines in various countries depending on several technical and chemical specifications of the coal. Consequently, and to co-ordinate all activities, a delivery schedule is developed and monitored. A case of a real company is studied, and the results are analyzed and discussed.

REINTRODUCING TRANSPORTATION FUNDAMENTALS WITHIN THE MODERN SUPPLY CHAIN CURRICULUM USING SIMULATION

Oral

Dr. Stephen Rutner (Georgia College & State University), Dr. Rebecca Scott (UNCW), Dr. Scott Cox (Georgia College & State University)

Over the past thirty years, transportation programs and degrees have evolved first into logistics programs and then supply chain management (SCM). While there are clear arguments for the positive effects of these types of changes, one of the unintended consequences of this shift is an ever-decreasing amount of time and structure spent educating students on transportation fundamentals. All programs are faced with a limited number of contact hours to help prepare students for jobs within the SCM industry. While transportation remains a trillion-dollar industry in its own right, most programs are reducing the specific content. Therefore, an alternative method of incorporating transportation pragmatics is needed to help prepare students. One solution is the use of transportation specific simulation(s) as a class project to educate students. This article presents an argument for both the need to improve transportation education and a possible solution that can be applied. Furthermore, it presents results from multiple semesters of use of a transportation simulation and the impact on student learning. Finally, it concludes with some opportunities and limitations developed from this study of today’s SCM students.

RESHORING BOOM IN SUPPLY CHAIN: IS IT WORTH IT FOR FIRMS FINANCIALLY?

Oral

Dr. Purushottam Meena (College of Charleston), Dr. Rita DiFrencesco (Eada Business School, Barcelona), Dr. Gopal Kumar (Indian Institute of Management Raipur)

In recent years, most companies have faced supply chain disruptions from the demand and supply sides. The reshoring of manufacturing or service activities to the U.S. has gained significant attention from practitioners and scholars. The reshoring is considered one of the potential solutions to fix the ongoing supply chain crisis and also helps create jobs in the U.S. However, there are limited studies investigating the implications of reshoring decisions on the stock market performance of firms doing reshoring. We attempt to fill these gaps in the literature by conducting an event study to analyze the impact of reshoring announcements on firms' stock market performance. The results offer help to policymakers understand the reasons for reshoring decisions and their financial implications.

Retail Competition in Presence of Retail Arbitrage

Oral

Dr. Avinash Geda (University of North Carolina Wilmington), Dr. Yu Wang (University of North Carolina Wilmington)

Retail Arbitrage is the price exploitation of buying and selling of a product from offline to online platforms. The retail competition dynamic changes significantly in the presence of retail arbitrage. We model this in a game theoretic setting to understand the equilibrium behavior of the players involved. We also study the impact on consumer surplus under different conditions.

RURAL AND SEMI-RURAL ENTREPRENEURSHIP IN THE POST-COVID ENVIRONMENT OF AREAS DEPENDENT UPON NATURAL RESOURCES AND TOURISM

Oral

Dr. Janice Black (Western Carolina University), Dr. J. kay Keels (Coastal Carolina University)

Two recent economic events have shaped our world for the foreseeable future. These two events are the Great Recession of 2007-2009 (Weinberg, 2013) and the more recent impact of Covid 19 on our world’s economy (Roman, et al., 2022). It is interesting to note that the value of real estate was impacted in both. Immediately prior to the Great Recession, poor decisions in sub-prime lending resulted in a real estate bubble which burst during the recession leaving many homeowners upside down with their mortgages (they owed more on their homes than the price they could get by selling them) (Weinberg, 2013). This drop in value caused many to walk away from their homes with a ripple effect hitting the subprime market and ending up with more than 500 banks shutting down between 2008 and 2015 (Federal Reserve Bank of Cleveland Staff, 2017). For others, who kept their homes and mortgages, home values recovered towards the end of this time period (between 2013 and 2015). However, the housing stock in the US remained in slow or not growth since them due to restricted availability of loans. By July 2022, after a surge of home prices and sales (a seller’s market) from the last part of the Pandemic, there have been 6 months of declines in home sales that are speculated to be the result of increased interest rates on home loans along with increasing construction costs and time delays (Q.AI, a Forbes company, 2022).

Solving the team orienteering problem with time windows

Oral

Dr. Furkan Oztanriseven (Le Moyne College), Dr. Emre Kirac (Christopher Newport University), Dr. Ridvan Gedik (Amazon)

Constraint programming approach is utilized to solve the team orienteering problem with mandatory visits and time windows (TOPTW-MV). Disaster relief routing and tourist excursion planning are some examples of TOPTW-MV. In this problem, standardized vehicles must visit certain locations while visiting some other optional locations. The profit, service time, time window information is known by the decision maker. By defining vehicle routes from the same start/end depot the objective function maximizes the total profit by visiting the mandatory locations exactly once while optional locations at most once. Our approach finds 64 new best-known solutions while finding 99 of the best-known results for the benchmark cases.

Structure of JIT-Based Supplier Integration: Its Antecedents and Consequent

Oral

Prof. Osam Sato (Tokyo Keizai University), Prof. Yoshiki Matsui (The Open University of Japan)

The recent global supply chain disruptions and crises shed light on the importance of supply chain management again, particularly supply chain integration and risk/crisis management, for most business enterprises. This paper picks up the integration with upstream suppliers in the JIT-based supply chains. It focuses on the antecedents and consequent of JIT-based supplier integration. Supplier integration can be promoted by JIT delivery by suppliers, which depends on top management support, IT use with suppliers, and geographical proximity. On the other hand, supplier integration is expected to improve the performance of suppliers. Based on the review of the existing literature, a research model for the structure of JIT-based supplier integration and six research hypotheses are developed. With survey data collected from manufacturing companies, valid and reliable multi-item constructs are established and used to test the hypotheses by SEM. All the hypotheses are supported, which proves the positive sequence from IT use with suppliers and geographical proximity to supplier performance.

Supply Chain Control Towers – What to expect and what not

Oral

Prof. Markus Gerschberger (Josef Ressel Centre for Real-Time Value Network Visibility, Logistikum, University of Applied Sciences Upper Austria), Mr. Orlin Corea (Josef Ressel Centre for Real-Time Value Network Visibility, Logistikum, University of Applied Sciences Upper Austria)

Purpose - This study proposes a guiding framework that helps practitioners and researchers to understand how supply chain control tower solutions can be used to achieve supply chain visibility (SCV) and regain supply chain control (SCT). We first motivate the importance of supply chain visibility and supply chain control followed by a discussion of boundary conditions in terms of business requirements and critical success factors.
Method - We motivate the practical importance of SCTs by integrating the company needs identified through a series of semi-structured field interviews with academic and practitioner literature (cf. Hastig and Sodhi, 2020). Interview participants were either selected because of a known maturity in SCT (e.g., companies having successfully implemented control tower solutions) or a described need in SCV/SCT (e.g., companies willing to start a SCV project but not knowing how). Next, we use a design science approach following the guidelines proposed by Peffers et al. (2007) to develop and practically apply our artefact. Our artefact is a step-wise guiding framework for the implementation of a SCT solution in order to achieve SCV and regain SCT. Finally, we provide evidence in a detailed use-case that describes how our artifact can be practically applied (practical relevance) and how business benefits were generated for the case company (pragmatic validity) (van Aken et al., 2016).
Findings - We advance a framework that details how to implement a SCT solution. This framework was prototypically applied within a longitudinal case study. For each of the framework’s steps, we describe the critical action items, existing reference materials, and publicly available tools (e.g., Gephi for network visualization; Tableau for visuals) that can be consulted for successful implementation. Practical relevance and pragmatic validity are continuously evaluated by checking whether the business requirements derived from theory and practice are met. We highlight the practical relevance and the benefits that the case company was able to realize by leveraging this framework. Most notably, our findings show that the case company substantively reduced inventory and lead-times in each stage of its multi-tier supply chain.
Scientific contribution – SCV/SCT is of paramount importance in many industries. Our artefact therefore provides a foundation for a novel stream of subsequent research focused on systematically designing and/or improving SCT. Furthermore, we provide clear definitions of the related concepts traceability, transparency, visibility and supply chain control and highlight their overlaps and interdependencies. Based on the nature of existing supply chain control tower solutions we develop a two-by-two portfolio and highlight key features of all four quadrants. Future research can apply and refine our framework through the evaluation and redesigning steps of the design science methodology.

Abstracts: Student Papers (Undergraduate, Master and Ph.D Students)

1998-2018 MAJOR LEAGUE BASEBALL PAYROLL EFFICIENCY

Oral

Mr. Benjamin Stone (Presbyterian College)

Major League Baseball (MLB) has differentiated itself from the other two major American sports leagues (National Basketball Association and the National Football League) by designing the player salary system so that there is no official salary cap that a team can’t go past to spend on players. However, not all 30 Major League teams are built equally and the payrolls vary widely among the teams. The MLB allows the big market teams to remain dominant through investing as much money as they want into talent while many small market teams are allowed to consistently spend significantly less while they bring in enough money to easily clear their bottom line due to their low investment in talent. Through data visualizations in Tableau and explanations of the way in which MLB operates, this paper examines how and why money is invested in talent and what this typically results in in regards to attendance, wins, and playoff success.

A BETTER APPROACH TO PREDICT CHURN IN E-COMMERCE

Oral

Mr. Raja RANJAN Bobba (Oklahoma State University), Ms. Amani Kolli (Oklahoma State University)

Consumer retention using churn prediction is getting more important than ever in recent days. Though it is relatively easy to identify the churn in a contractual business setting such as Netflix, or Prime Subscriptions, it is still tricky to understand the churn concept in non-contractual business contexts such as retail and e-commerce.BG-NBD Model can be used to predict churn in non-contractual business. However, there are limitations as it cannot predict churn on first-time buyers. In this paper, we proposed an approach that uses the existing BG-NBD Model with the help of Lifetimes Python Library and extends it further to make it work in the area where the original model fails to work, i.e., on the first-time buyers. Thus, predicting churn becomes easier.

A CRITICAL REVIEW OF ACTIVE LEARNING IN OPERATIONS AND SUPPLY CHAIN MANAGEMENT: DIFFERENCES BETWEEN ANTICIPATED AND PERCEIVED BENEFITS

Oral

Ms. Lakshmi Madarasu (Georgia Southern University), Dr. Mark Hanna (Georgia Southern University)

The objective of this paper is to determine the distribution of topics, the distribution of perceived benefits attained, and differences between anticipated and perceived benefits when employing active learning to teach operations and supply chain management concepts. We utilize content analysis of a dataset composed of 118 teaching briefs published in Decision Sciences Journal of Innovative Education between 2003 and 2020. Both instructors and students perceive active learning to provide a wide range of beneficial outcomes vis-à-vis traditional lecture oriented approaches. However, there are significant differences in proportion between instructors anticipating certain student benefits and students perceptions of the actual advantages attained by these activities. Broadly speaking, the proportion of instructors expecting improved student performance, skills, knowledge development, critical thinking skills and engagement was generally higher than student perceptions of these benefits. By contrast, student views of experiential benefits were proportionally higher for areas such as interest, satisfaction, ease of use, and memorability of the topical lesson. We find that availability of active learning exercises varies substantially by Operations Management (OM) topic area, suggesting that there is potential benefit to efforts that would address under-represented topics.

A Study to Determine the Accurate Algorithm for House Price Prediction

Oral

Ms. Noreen Chihora (Oklahoma State University), Ms. Sushma Reddy Mandhadapu (Oklahoma State University)

The housing market can be overwhelming for both buyers and sellers. The process of finding a dream home can involve weeks or months of research. When it comes to housing prices, different factors affect the prices of houses. It is hard to fully predict the price of a house with 100% accuracy, or even 90%. There are factors like the economy, number of bedrooms, bathrooms, or location that come into effect. We may never get to 100% accuracy, but data science can help buyers and sellers to have an idea of what to expect. This paper compares different machine learning algorithms that include Linear Regression, K-Nearest Neighbor, Decision Trees, XGBoost, and Random Forests to predict the prices of houses. The data used in this project is a Kaggle dataset for King County, WA in the USA. There are 21,613 records and 21 variables including the ID variable and the target variable. The study determines which variables are important in predicting the prices of houses. The accuracy of each model was measured using mean absolute error. The analysis was performed using python programming software. The best two models from the analysis were XGBoost followed by Random Forest.

An Environmental and Economic Impact Assessment of Potential Spills in the Galveston Bay Area

Oral

Mr. Samuel Copley (University of South Carolina), Dr. Mawuli Afenyo (Texas A&M University at Galveston), Dr. Livingstone Caesar (Texas A&M University at Galveston)

Maritime businesses in Galveston Bay are at risk from environmental and economic damages caused by potential chemical/oil spills. Spills disrupt shipping lanes/ports, damage surrounding ecosystems, and can require expensive and laborious cleanup efforts. Despite improvements in technology and increased regulations that seek to mitigate the occurrence and risks of spills, they will continue to happen and cause damages. As such, it is vital that new, sustainable, and proactive approaches to solving the spill problem are created. We studied the risk-related factors involved with spills in Galveston Bay and the resulting environmental and economic impacts. To assess these factors, the extant literature was reviewed, and qualitative and quantitative questionnaires were distributed to eight experts on spills in the Galveston Bay area. The factors solicited from the literature and questionnaires were used to construct an Environmental and Economic Impact Model (EEIM) using the Bayesian theory. Important risk-related factors were found to be spill location, spill type, environmental conditions, seasonality, and the specific cleanup/recovery methods deployed. In addition, costs of the environmental and economic impacts were quantified for several potential spill scenarios. The information obtained in this study can be used to develop transferrable tools, guidelines, and frameworks to support decision-making in the Galveston Bay area and elsewhere. Further, the paper underscores the need for a holistic and proactive evaluation of the different dimensions of a spill (policy, economic, health, social, remediation mechanisms, etc.) for effective outcomes.

Analysis of Social Media Interactions about COVID-19 and its Impact on Vaccination

Oral

Mr. Srinivas Pramodh Kotipalli (Oklahoma State University), Mr. Neeraj Kankani (Oklahoma State University)

COVID-19 is an unprecedented calamity with no prior data to understand and combat the pandemic. Thus, in such uncertain times and in the absence of adequate studies on the disease, people rely on other people and society for guidance on combating the virus. Although there are strong indicators of vaccines being beneficial in generating antibodies for the COVID-19 virus, not enough research has been conducted on the long and short-term effects of the vaccine on pregnant individuals, infants, and older populations with several underlying health conditions. Social media has played an essential role in influencing an individual’s inclination towards vaccination. Although classical surveys are helpful to investigate public health viewpoints (Peretti-Watel et al., 2020), because of the nature of the pandemic and consequently the rise of social media as a medium to discuss and share viewpoints around infectious diseases ([Velasco et al., 2014]), Social media has emerged as a viable tool in analyzing and identifying people’s opinion around vaccination.

Our research aims to understand how such interactions on social media websites like Twitter, play their part in understanding the trend of Vaccination rates across the state of Oklahoma. Data is scraped from Twitter under appropriate hashtags to create a corpus of interactions surrounding COVID-19 and vaccination. To identify key topics of the discussion, topic modeling is performed to subcategorize the data. Further, to identify and compare the trends in the vaccination rates to that of the underlying conversations, sentiment analysis is performed for interactions occurring on the same timeline, i.e., from December 2020 to March 2021. Overall conversations in favor of vaccination should indicate a better vaccination rate and vice-versa. Thus, this analysis aims to be a steppingstone in identifying the underlying impacts of social media on knowledge sharing and decision-making for an individual.

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ANALYZING THE IMPACT OF SOCIAL MEDIA MARKETING ON REVENUE | FORECASTING TOMMY HILFIGER'S REVENUE USING TWITTER SENTIMENTS & MARKETING-CUSTOMER INTERACTION

Oral

Ms. Sai Sreeshma Thupakula (Oklahoma State University), Ms. Nitika Dwivedi (Oklahoma State University)

This paper aims to study the impact of customer engagement with marketing events and their associated sentiments on the sales revenue of an organization. To achieve the same, financial datasets of Tommy Hilfiger was considered to predict the revenue. Furthermore, to study the impact of customer engagement and sentiments, twitter data of Tommy Hilfiger's page was extracted from the year 2009 to 2021. Sentiment as well as emotion analysis was performed on this twitter data to get positive, negative, neutral sentiment score. Along with that Happy, Sad, Fear, Surprise and Anger emotion score was generated for each event (tweet) posted by the company. The marketing trends and customer engagements were studied using visualization made in Tableau. The results showed that the sentiment scores, emotion scores as well as the number of likes improved the model's R^2 by 8%.
Keywords: Tommy Hilfiger, Forecasting Model, Sentiment Analysis, Emotion Analysis.

Attitude, perceived behavior control and learning outcome: A student perspective

Oral

Ms. Grace Murphy (Grace Murphy)

Changes in students’ motivation to learn and attitudes towards learning have become prevalent recently with the outbreak of the pandemic. Students were forced to change not only their study habits, but also their mindset towards learning, which in turn affected their overall performance. Grounded on Theory of Planned Behavior (TPB), this research focuses on student’s attitudes, subjective norms, and perceived behavioral control and their relationships with their intention of learning, perceived learning and actual learning in undergraduate business analytics courses. From the perspective of students, this study tests hypotheses about the relationships among factors of attitudes towards learning, perceived behavioral controls, behavioral intention, and perceived and actual learning outcomes. The research indicates the importance of how a multitude of aspects directly affects how students learn, their willingness/motivation to learn, their overall attitudes towards learning and their learning outcomes. A few theoretical and empirical implications of this study will be presented.

AUGMENTING COLLABORATIVE FILTERING MODEL BASED APPROACH LEVERAGING RFM METHODOLOGY TO INCREASE CUSTOMER ENGAGEMENT

Oral

Mr. Sarik Koirala (Oklahoma State University), Ms. Srishti Srivastava (Oklahoma State University)

The success of any online retail business hinges on the efficacy of its three fundamental pillars: understanding customer’s shopping patterns, mapping the demands created by it to its product base and efficiently managing the supply chain from procurement to delivery. While most businesses have developed an efficient process around each of these three pillars, a cross-functional strategy that allows businesses to build customized recommendations has been elusive. This paper explores solutions through a novel idea that segregates customers based on clustering indices from Recency-Frequency-Monetary (RFM) analysis. The customers groups are analyzed through a combination of descriptive and preceptive analytics to decipher inherent problems and propose business solutions on how to overcome these issues.

BIG DATA ANALYTICS CAPABILITIES AND ORGANAIZATIONAL CULTURE IMPACT ON FIRMS’ PERFORMANCE: EMPIRICAL STUDY

Oral

Mr. Hussam Alansari (Department of Information Science and System, Morgan State University, MD), Prof. Ganesh Bhatt (Department of Information Science and System, Morgan State University, MD)

The potential of Big Data Analytics Capabilities (BDAC) to provide firms competitive advantage has been a topic of interest to practitioners and academicians. This interest is reflected in the large number of studies that have examined the relationship between big data analytics capabilities and firms’ performance. Currently, efforts are focused on enhancing methods for the analysis and treatment of large amounts of data, with the goal of improving the decision-making process and generating more value for the company.

To examine the impact of big data analytics capabilities and organizational culture on firms’ performance, this study will draw from the resource-based view (RBV) which connects firms ‘performance to firm-specific, rare, and difficult-to-replicate or substitute resources and skills. Adopting a resource-based perspective of information systems, firms can leverage their investments to create unique resources and skills that determine a firm’s overall effectiveness. This study will adopt a formative construct measurement from which is made up of two first-order reflecting constructs: operational performance and market performance. This performance indicator will provide how well a firm is performing relative to direct competitors.

BUILDING A MACHINE LEARNING MODEL FOR FINANCIAL TRANSACTIONAL FRAUD DETECTION

Oral

Ms. Ngoc Dao (University of North Texas)

Nowadays, with the development of technology, financial organizations are facing a global issue where customers' credit cards and financial information are stolen frequently. Mark Crichton mentioned in his article "Transaction Fraud, How to Protect your Business & Customers" (2021) that transaction fraud is defined as illegal transactions created from financial information which are stolen or counterfeit. According to the Payments Fraud and Control Survey Report from J.P.Morgan (2021), the percentage of organizations that experienced actual payment fraud from 2014 to 2020 increased from 62% to 74%. Especially, in 2018 and 2019, an estimated 82% and 81% respectively of financial companies confronted this problem. Besides, Technology and online retail industries have changed people's shopping behavior from in-person stores to e-commerce which results in potential fraudulent transactions and payments such as "account acquisition, financial information theft, fake chargeback, money laundry, and many more." (Rao et al., 2021). Transaction fraud detection has been a prominent topic for many researchers to pick and various detecting models and techniques have been developed as well; however, it's not ending. Numerous online papers have used machine-learning models to predict fraudulent transactions; however, they only use the dataset generated from a mobile platform which is not an appropriate model for financial institutions. Therefore, in this paper, we focus on applying machine learning models to detect the financial transaction fraud for banking institutions.

COLD CHAIN: A QUALITATIVE APPROACH TO INFRASTRUCTURAL DESIGN AND ESTABLISHMENT IN THE FRESH FOOD INDUSTRY IN BANGLADESH

Oral

Mr. Nurullah Humayun (Virginia Commonwealth University), Dr. Jeff Shockley (Virginia Commonwealth University)

The importance of the cold chain in the Bangladesh market, the causes of the current problems, and strategies for creating a top-notch cold chain management system are all highlighted in this paper. It further outlines a performance management framework to apply when evaluating distributors or supply chain designs for temperature-controlled, time-sensitive food products that are sourced through global/local supply chain networks (a.k.a., the cold chain). The new model considers how five attributes unique to managing the cold chain are related to the “Six Ts” of food supply chain management proposed in extant supply chain literature. The model aims to create a more detailed performance management framework to define the characteristics of a top-notch food distribution system that is dedicated to maintaining the quality, safety, and integrity of the food product.

Designing a Chatbot for Assisting Students in Learning Python Programming

Oral

Dr. Christelle Scharff (Pace University), Ms. FNU Kaleemunnisa (Pace University), Mr. Krishna Bathula (Pace University), Mr. Sada Anne (Alioune Diop University of Bambey), Dr. Amadou Dahirou Gueye (Alioune Diop University of Bambey)

Traditionally a chatbot is software that analyzes user input based on natural language processing techniques (NLP) and produces pertinent and intelligent responses to send back to the user. Currently, chatbots are powered by artificial intelligence (AI) and typically, communicate with users through text or voice interfaces. They essentially attempt to simulate human response and assist users.

Over the years, students' learning routines and interactions between instructors and learners have changed. Teaching modalities have also transformed to integrate more online modules. Students learn anywhere, anytime, and from any device. They want to have access to help immediately. Education chatbots have the potential to support students in their learning and adapt to different contexts.

Chatbots have a role to play in the learning of programming. Python is becoming the first programming language to be learned by computer science students. It is also beginning to be taught in business and digital humanities programs. Learning programming requires practice, trial-and-errors, and research. Using chatbots to support learning programming has gained some initial attention.

We have created a dataset of Python questions and answers and designed and implemented a chatbot based on GPT3 technology to support students in their learning of Python programming. This research presents existing chatbots used to support learning programming, the collection of the data, the design of the chatbot, the technical evaluation of the chatbot, and the plan to evaluate the chatbot by students new to the programming language.

Keywords: Online Education, Chatbot, NLP, Deep Learning, Python Programming

Development and Usability Testing of the GP and DSP for Down’s Syndrome (DS) Care Coordination

Oral

Ms. Brianna Boston (Virginia Commonwealth University), Mr. Edward Ladia (Virginia Commonwealth University)

321Connect was first drafted by Dr. Bethany Cosgrove as a way to help caregivers of children with Down’s Syndrome coordinate their care better. Children with Down’s Syndrome have to meet with many health professionals throughout the course of their life. Having a PHR (personal health record) for the child would help in keeping track of this information. There currently is not anything in the market that seeks to help this problem, so 321Connect was created for that purpose.

Do Respect for Safety and Neutralization Influence Distracted Driving Behavior Among Young Adults: The Moderating Role of Polychronicity

Oral

Dr. Janeth Gabaldon (University of North Texas), Dr. Suman Niranjan (University of North Texas), Dr. Timothy Hawkins (University of North Texas)

This study explores how respect for safety, neutralization, and polychronicity contribute to safety–transportation research through engagement in distracted driving behavior. The study harnesses a sample (N = 309) of young drivers’ data collected through a survey and vignette-based approach. From a methodological standpoint, structural equation modeling analysis was used to investigate the research outcome, followed by a post-hoc analysis to obtain a driver’s profile. The framework is analyzed through the cognitive dissonance theory lens to explore the cognitive human factor variables that increase or decrease engagement in the behavior. Results indicate that drivers’ predetermined respect for safety significantly reduces distracted driving behavior. Nonetheless, driver polychronic tendencies or preference to engage in more than one activity at a time weakens the relationship increasing their engagement in the behavior. Similarly, young drivers that employ neutralization techniques to justify their actions as a precursor of the behavior are associated with increased distracted driving regarding traffic laws violations. Based on the findings, academic and practical implications are discussed, which can lead to proactive and tailored education content in distracted driving behavior.

EXAMINATION OF THE EFFECTS OF FACULTY COMPENSATION AND LEVEL OF EXPERIENCE ON STUDENT OUTCOMES AT 4-YEAR SOUTHERN COLLEGES AND UNIVERSITIES

Oral

Mr. Seth Cooper (Presbyterian College)

Business literature has shown that compensation and work experience are linked to improved employee performance [19] [24]. Four-year institution faculty are instrumental to student outcomes; thus, their performance is essential to the institution’s success. Retention, graduation rates, and graduate earnings are outcome metrics used by institutions to benchmark effectiveness. Due to the COVID-19 pandemic, institutions are falling short in these areas [23]. Through regression techniques, this research determines that instructional staff experience and compensation significantly impacts each of these metrics. Therefore implying, through administrative policies institutions could indirectly influence student outcomes thus improving their ability to meet desired benchmark figures.

HOW CONSUMERISM CONTRIBUTES TO POLLUTION

Oral

Ms. Victoria Martinez-Paz (University of North Carolina Wilmington), Dr. Lizzette Perez-Lespier (University of North Carolina Wilmington)

The oil, plastics, and fast-fashion industries are among the top polluters in the world. Each stage in these industries life cycles generate environmental and health hazards. Adoption of sustainability practices in these industries supply chains has become necessary to stay ahead in today’s competitive globalized market. This research evaluates and understands each industry’s history and their respective impacts to the environment and health, along with their current economic importance, both to the government and to consumers. A survey was conducted to gauge at consumers’ knowledge of these topics and industries and were analyzed and compared to show how consumers are unknowingly contributing to worldwide pollution and highlight what consumers can do to demand or demonstrate that change is wanted. This research will provide organizations and stakeholders in these industries with understanding their status and potential areas of improvement as perceived by consumers. Ultimately, this work aims to encourage consumers to adopt a more sustainable behavior towards these industries.

Improving Data Integrity for Long-Term Research Production

Oral

Mr. Gustaf Barkstrom (Virginia Commonwealth University)

Long-term data archives are used in disaster recovery systems to mitigate information loss risks in information systems. In long-term archival, it is common to provide byte-level data integrity checking to detect data corruption. Less commonly, data archival systems include the capability to repair corrupted data when it is detected. We introduce high-level data integrity tracking for context provenance, meaning metadata that tracks information about the usage processes as well as authorship and other metadata. Related literature in design science is reviewed to survey systems and frameworks that provide different levels of data integrity. We find that the lack of high-level data integrity provision is a gap that our research begins to address. We propose a design called FASTINT that adds semantic and contextual metadata processing using natural language processing artificial intelligence to provide this high-level data integrity tracking and demonstrate a use case in bioinformatics. By providing this model that integrates data validation at low levels with the higher-level metadata, we can work toward achieving an end-to-end data integrity system that provides greater confidence in data integrity at all levels of data management – from byte-level to application-level, we will provide a model that gives us integrity of the applications, algorithms and context of our data.

IS MORE INNOVATION BETTER? A STUDY ON FIRM INNOVATION AND OPERATIONAL PRODUCTIVITY

Oral

Ms. Senali Amarasuriya (Georgia Southern University)

This study investigates the financial and operational implications of firms choosing to be leading (lagging) innovators within the context of innovative (non-innovative) industries. The study specifically explores the moderating role of industry innovation on the relationship between firm innovation strategy and financial performance, and on the relationship between firm innovation strategy and operational performance. The Schumpeterian theory of competition and innovation is leveraged to develop the relevant hypothesis, and econometric analysis of secondary data on U.S. manufacturing companies from Compustat is used to investigate the innovation-performance link. The results of this study seek to further unravel the conventional wisdom that ‘more innovation is always better?’
Keywords: firm innovation strategy, industry innovation, operational performance

ONLINE ARIMA WITH FORGETTING FACTORS FOR TIME SERIES PREDICTION

Oral

Mr. Sungwoo Kim (Hanyang University), Prof. Kichun Lee (Hanyang University), Dr. Geonseok Lee (Hanyang University)

ARIMA is one of the most popular and fundamental models in time series data analysis and prediction. Simple and flexible, it also supports online model updates for streaming data. However, these online ARIMA models still face some challenges such as stable parameter estimation and regret bound analysis. Thus, in this paper, we improve online ARIMA models by applying the concept of forgetting factors. By combining the two, we propose online ARIMA with forgetting factors which has the ability to assign recent data points more weight compared to data points of the past. We demonstrate our algorithm’s performance with promising test results in various, synthetic and real-life, experiments.

Prediction of a Merchandise Shop Revenue Based On Data Collected On Google Analytics 360

Oral

Mr. Suraj Goel (Oklahoma State University), Ms. Tanushree Ghosh (Oklahoma State University)

In eCommerce industry there is a very low conversion rate. Based on the latest survey and studies in 2020 average conversion of eCommerce website is 2.68%. This is further less in the US market at 2.63% as compared to the global market which is at 4.31%. So, for an eCommerce it is important to understand who the users are who are buying and what does their average spend.

Our business problem is to predict a customer’s future revenue based on their past transactional data. Our paper uses past transactional data collected by Google Analytics 360 for a merchandise store to predict the future revenue created by those customers. The data for our analysis is for Google Merchandise store. This Google Open-sourced real-world data is fetched using Google Big Query. The data queried includes unique identifier for each user of the Google merchandise store channel, device, and browser via which the user came to the store, date on which he/she visited, geography of the user, engagement type, visit details like total session duration, traffic origin information and session number. The total number of records are ~12,000 records where each record corresponds to one visit to store.

The problem statement is solved using a Hurdle Model. We could use a regression model to predict the future revenue generated by a customer. But before we predict revenue, we also needed to identify if a particular customer will visit the store or not. This is accomplished by a classification model. For classification model as we do not have any target variable, we created the target label. For that first we split the data into train and test by replicating real-world scenario. When the user is present in both the dataset, we labelled it as ‘1’ and if present in just train and not in test then labelled as ‘0’. This concept is called Time Series Featurization. For classification we ran Light GBM and XGBoost models.

This paper can help upcoming e-commerce to allocate funds to their promotional activities based on their customers’ behavior. Additional experiments can be done on the website if they see low predicted revenue for the future. The paper will also support them in identifying products that are widely sold vs those which are not. This will help in reducing inventory cost and overall reducing expenses.

ROBUST TRANSFER SUBSPACE LEARNING FOR IMAGE CLASSIFICATION

Oral

Dr. Geonseok Lee (Hanyang University), Prof. Kichun Lee (Hanyang University), Mr. Sungwoo Kim (Hanyang University)

Unsupervised domain adaptation helps improve the generalizability of the learned model by transferring knowledge from the labeled source domain (i.e. training set) to the unlabeled target domain (i.e. test set). However, most existing works only enforce the cross-domain consistency in the subspace while ignoring the relations of source samples to the target domain and the task-specific classifiers. To address this issue, we propose a robust transfer subspace learning method, called RTSL. RTSL learns domain invariant feature representations by jointly optimizing supervised classification and unsupervised subspace learning problems. Furthermore, the weights (importance) of source instances are estimated so that the classifier can be well adapted to the target domain. Experimental results on different cross-domain benchmark datasets demonstrate the encouraging performance of our RTSL over the state-of-the-art methods.

THE BELT-AND-ROAD INITIATIVE AND CHINESE M&A MOTIVATIONS: A SYSTEMATIC REVIEW

Oral

Ms. Karen Lynden (UNC Greensboro), Mr. Benjamin Kempton (UNC Greensboro), Mr. Chris John (UNC Greensboro)

In an effort to expand foreign investment and build connected networks, China created the Belt and Road Initiative (BRI). This systematic literature review highlights 77 articles across 44 journals published between the years 2010-2022, providing a background of BRI Chinese Cross Border Mergers and Acquisitions, with focus on Chinese foreign direct investment activity. We uncover dominant theoretical perspectives found in the literature, and spotlight prevalent conversations and research in the field, and conclude with a discussion related to how BRI Merger and Acquisition activities might create or inhibit resilience strategies of associated firms and economies. Future research propositions are discussed.

The Efficacy of Heads-Up Versus World-Fixed Multi-plane User Interfaces in Head-worn See-through Augmented Reality

Oral

Mr. Jonathan Flittner (Roanoke College), Dr. Joseph Gabbard (Virginia Polytechnic and State University)

This study focuses on understanding and quantifying the effects of user interface type in multiple plane Augmented Reality User Interfaces (AR UI’s). It determines the effect of AR UI type (heads-up vs world-fixed) on user performance in increasingly complex interfaces, where complexity is defined as the clutter of the interface. The two AR UI types were chosen as they represent two directions in which AR UI’s can go. Heads-up displays being a more established UI type which has been implemented in variety of ways such as ski goggles, car windshields, and cockpits versus world-fixed AR UI’s which rely on spatial mapping to embed the UI to a fixed place in the real world. The end goal of this research is to develop an algorithm capable of predicting user performance for a given AR UI. In this experiment, twelve participants performed a visual search task of locating a target 3D object in an array of 3D objects where objects were located in seven different focal planes. Participants completed this task under two different clutter levels (low and high) where the target was found in every available AR UI plane for each combination, with repetition. Task performance was measured through response time. Response time was chosen as it represents an important factor of the decision-making process for many domains including military, manufacturing, medical, and vehicle operation tasks.

The Global Economy’s Intangible Shift & The Resulting Need to Attain, Utilize, & Protect Intangible Assets

Oral

Ms. Victoria Horton-Roark (Middle Georgia State University)

As the global presence of an intangible economy grows, more multinational corporations are investing in and benefiting from the acquisition of intangible assets (IAs). As IAs and telecommunication networks become commonplace amongst global firms the products of IAs and telecommunication become consumer commodities, creating a new technological and electronic market worldwide. As the number of businesses and consumers seeking new forms of IAs grows, so does the necessity for corporations to develop, invest in, and utilize IAs to maintain a global competitive advantage.

In an increasingly competitive technological market, to gain maximum profits from IAs corporations must recognize the risks involved with keeping IAs secure from threats such as hackers and sites that would seek to claim the IAs for their own benefit. These corporations need to take precautionary measures such as the trademarking of IAs to avoid losses within the worldwide intangible economic climate. The need for the acquisition, utilization, and protection of IAs to maintain a global presence and competitive advantage has increased in the aftermath of the global Covid-19 pandemic.

Keywords: intangible asset (IA), telecommunication, competitive advantage, trademarking

The impact of the Russian Ukraine War on the energy sector in Europe

Oral

Ms. Tove Rosengren (Rollins College), Dr. Serina Alhaddad (Rollins College), Dr. Mari Robertson (Rollins College)

The impact of Russian and Ukraine war has been seen all around the world, causing significant economic disturbance and pushing up inflation to levels we have not seen in years. It has triggered one of the biggest human displacement crises and caused severe impact on the economic life, as per the World Bank. The impact has affected multiple sectors including metals, food and gas, especially in the European counties. The main objective of this research is to analyze how the war has come to affect the energy sectors in the biggest European economies (Germany, France, and UK). The analyzed energy sector includes public companies engaging in electricity, gas and oil – creation and distribution. In the United States of America, Stock Indices are often utilized to discover market trends, such as the S&P 500. This index is comprised of 500 of the largest publicly traded companies in the US and captures about 80 % of the country’s total market capitalization. However, the European countries do not have an equivalent. To accurately summarize trends between the countries, this research proposes new indices (based on float adjusted market capitalization). Four indices will be provided, one for each county and one index including all three. Stock market data will be imported from the mentioned market and counties and then comprised into an index through excel. Additionally, this research will engage in statistical procedures such as forecasting to highlight further trends and relationships. Furthermore, the research will include an economic discussion regarding how the energy market has been impacted by Russia with focus on economic inequality.

Abstracts: Scholarly Journal Editors Panel

Behavioral Research in Accounting

Oral

Dr. Charles Bailey (James Madison University)

Behavioral Research in Accounting publishes original research relating to accounting and how it affects and is affected by individuals and organizations. Theoretical papers and papers based upon empirical research (e.g., field, survey and experimental research) are welcomed. It prints semi-annually in Spring and Fall, and is indexed in Scopus and ESCI.

Chancellor Larry Clark

Oral

Prof. Larry Clark (Louisiana State University Shreveport)

Larry Clark

Chancellor- LSU Shreveport

Larry Clark became Chancellor of LSU Shreveport on July 1, 2014. Prior to this, Clark was Dean of the business schools at UNC Wilmington, 2000-2014, Sonoma State University, 1994-2000, and LSU Shreveport, 1985-1994.

Clark’s academic background is in law- he has a Juris Doctorate and a L.LM. in Taxation. His professional publications include having been the lead author of **Law and Business: The Regulatory Environment**, a textbook with four editions with McGraw-Hill. Prior to academia, Clark was an Army Captain/Judge Advocate (lawyer).

LSU Shreveport’s Spring 2023 enrollment, after enrollment in the second term, will be nearly 8,500 students. Over the past decade, LSUS has emerged as a national leader in online learning, including with nearly 6,000 online students, led by our MBA Program. Concerning face-to-face students, this academic year LSUS has students on-campus from 34 states and 47 different countries. As most universities, LSUS is focused on following the advice of hockey great Wayne Gretsky “to focus on where the hockey puck is going.” To help give lift to this goal, LSUS has established a multi-disciplinary Cyber Collaboratory, that links well to discipline learning represented by the SEDSI.

On June 30th of this year, Clark will retire as Chancellor of LSUS. However, he expects to continue to teach at least one business course per year for the foreseeable future.

Decision Sciences Journal

Oral

Dr. Xenophon Koufteros (Texas A & M University)

Decision Sciences Journal is a premier business research publication with international visibility and impact. Some of the finest research on business decision making appears in our pages, and we specifically invite papers which address contemporary business problems primarily focused on operations, supply chain and information systems and simultaneously provide novel managerial and/or theoretical insights.

Decision Sciences Journal of Innovative Education

Oral

Dr. Cheryl Aasheim (University of Florida)

The ***Decision Sciences Journal of Innovative Education*** (*DSJIE*) is a peer-reviewed journal published by the Decision Sciences Institute. Its mission is to publish significant research relevant to teaching and learning in the decision sciences - quantitative and behavioral approaches to managerial decision making. The journal welcomes submissions relevant to the application and practice of the decision sciences both in business and other domains such as, but not limited to, healthcare, product development, and engineering management. Articles submitted to the journal should offer either proven innovation in classroom instruction/delivery, new insights into pedagogy, program development, delivery, or assessment, or empirically based analysis of the application of the decision sciences in learning and education. The goal of the journal is to not only provide resources that can enhance instruction, but serve as a forum for disseminating best practices and new insights.

Digital Transformation and Society

Oral

Dr. Robin Qiu (Pennsylvania State University)

Digital Transformation and Society publishes peer-reviewed research in the interdisciplinary field of digital transformation and society. It’s an international journal fostering discussions how digital technologies disrupt and transform society, nationally and internationally. It promotes critical analysis and inquiries into the theory and development of digitalization in business and society.
Topics covered include but are not limited to the following:
Theory and Fundamentals

1. The Theory and Development of Digital Transformation and Society
2. Values and Impacts of Digital Transformation
3. Digitality and Intangibility
4. Digital Transformation and Intellectual Property
5. Digital Identify, Trust, Security, and Privacy
6. Governance, Regulations, and Policies

Business and Organization Transformation

1. Digital Transformation in Business
2. Digital Transformation in Organizations
3. Service Digitalization
4. Industry Digitalization
5. Digital Logistics and Supply Chain

Society Transformation

1. Digital Arts and Life
2. Digital Citizenship
3. Digital Transformation in Cultural Institutions
4. Digital Transformation and Cultural Change
5. Digital Literacy and Societal Engagement
6. Digital Community and Urban Development and Sustainability
7. Digital Divide and Societal Challenges

Platforms and Technology

1. Blockchain
2. Digital Twin Technology
3. Metaverse and Immersive Technology
4. Data, Systems, and Society
5. Artificial Intelligence, Machine Learning, and Analytics in Digitalization
6. Platformization and Digital Transformation

Applications and Trends

1. Digital Economy
2. Digital Healthcare
3. Digital Currency and FinTech
4. Digital and Smart City
5. Digital Education and Workforce
6. The Future of Work, Life, and Society

Digital Transformation and Society is an Open Access Journal. It has no article processing charge, while adopting a fast-review process with the target of less than 60 days for the first round of review.

Electronic Government

Oral

Dr. June Wei (University of West Florida)

Electronic Government, a fully refereed journal, publishes articles that present current practice and research in the area of e-government.

Expert Systems with Applications

Oral

Dr. Binshan Lin (Louisiana State University Shreveport)

Expert Systems With Applications is a refereed international journal whose focus is on exchanging information relating to expert and intelligent systems applied in industry, government, and universities worldwide. The thrust of the journal is to publish papers dealing with the design, development, testing, implementation, and/or management of expert and intelligent systems, and also to provide practical guidelines in the development and management of these systems. The journal will publish papers in expert and intelligent systems technology and application in the areas of, but not limited to: finance, accounting, engineering, marketing, auditing, law, procurement and contracting, project management, risk assessment, information management, information retrieval, crisis management, stock trading, strategic management, network management, telecommunications, space education, intelligent front ends, intelligent database management systems, medicine, chemistry, human resources management, human capital, business, production management, archaeology, economics, energy, and defense. Papers in multi-agent systems, knowledge management, neural networks, knowledge discovery, data and text mining, multimedia mining, and genetic algorithms will also be published in the journal.

Human Systems Management: Special Issue

Oral

Dr. Ping Wang (James Madison University)

Human Systems Management (HSM) is an interdisciplinary, international, refereed journal, offering applicable, scientific insight into reinventing business, civil-society and government organizations, through the sustainable development of high-technology processes and structures. Adhering to the highest civic, ethical and moral ideals, the journal promotes the emerging anthropocentric-sociocentric paradigm of societal human systems, rather than the pervasively mechanistic and organismic or medieval corporatism views of humankind’s recent past.

INFORMS Journal on Computing

Oral

Prof. Paul Brooks (Virginia Commonwealth University)

The theory and practice of computing and operations research are necessarily intertwined. The *INFORMS Journal on Computing* publishes high quality papers that expand the envelope of operations research and computing. We seek original research papers on relevant theories, methods, experiments, systems, and applications. We also welcome novel survey and tutorial papers, and papers describing new and useful software tools. We expect contributions that can be built upon by subsequent researchers or used by practitioners.

International Journal of Management and Enterprise Development

Oral

Dr. Zbigniew Pastuszak (Maria Curie-Sklodowska University)

International Journal of Management and Enterprise Development (IJMED) is a major international research journal dedicated to business development strategy and entrepreneurship policy as well as management processes in an international and cross-cultural context. *IJMED* provides a venue for high quality papers including theoretical research articles, evidence-based case studies and practical applications seeking to explore best practice and investigate strategies for rapid growth management in SMEs. *IJMED* has a history of contributing to the academic literature, providing conceptual and practical insights and generating innovative ideas for organizational enterprise.

International Journal of Management and Enterprise Development Special Issue

Oral

Dr. Ping Wang (James Madison University)

Special Issue on “New Paradigms for Management and Enterprise Development in Uncertain Times”
Guest Editors
Dr. Ping Wang (Corresponding Guest Editor), James Madison University, Harrisonburg, VA, USA
Dr. Yinhong Dong, Hainan University, Haikou, Hainan, P. R. China
Dr. Elham Torabi, James Madison University, Harrisonburg, VA, USA
Dr. Yuyun Zhong, James Madison University, Harrisonburg, VA, USA
Dear Colleagues,
The International Journal of Management and Enterprise Development (IJMED) seeks submissions for a special issue (SI) on New Paradigms for Management and Enterprise Development in Uncertain Times.
In the past few years, COVID19 pandemic imposed serious challenges for businesses across all industries. Many businesses found these challenges a wakeup call to pursue new paradigms in Enterprise development and management under uncertainty. Therefore, further research in theories and applications is needed to help organizations restore in the post-COVID19 era and its innate uncertainties and build up more resilience to mitigate future risks. This special issue (SI) aims to contribute to this effort in collaboration with the 52nd Annual Conference of Southeast Decision Science Institute (SEDSI). The topics of the SI will be of particular interest in the context of the current pandemic as there have been ongoing efforts to refine and re-define issues related to management and enterprise development through the lens of equity, inclusion, and sustainability.

International Journal of Mobile Communications

Oral

Dr. June Wei (University of West Florida)

The world of mobile communications is not a trend, but a phenomenon. *International Journal of Mobile Communications* (*IJMC)*, a fully refereed journal, publishes articles that present current practice and theory of mobile communications, mobile technology, and mobile commerce applications.

International Journal of the Analytic Hierarchy Process

Oral

Dr. Enrique Mu (Carlow University)

IJAHP is a scholarly journal that publishes papers about research and applications of the Analytic Hierarchy Process(AHP) and Analytic Network Process(ANP), theories of measurement that can handle tangibles and intangibles; these methods are often applied in multicriteria decision making, prioritization, ranking, and resource allocation, especially when groups of people are involved. The journal encourages research papers in both theory and application *AHP/ANP and extensions, integration with other MCDM methodologies, the Internet of Things (IoT), and big data analytics, especially prescriptive analytics*. Empirical investigations, comparisons, and exemplary real-world applications in diverse areas are particularly welcome.

Any visitor to this site can browse the abstracts, read the contents and download the PDF files if you want to be informed about the new issues and the AHP/ANP news you need to be a registered user. Registration is free for authors, reviewers, and readers in general, and your contact information will only be used to inform you when a new issue is published. Most importantly, ***there is no article processing charge for the authors, publications are free of charge*** since IJAHP production is subsidized by the Creative Decisions Foundation, established in 1996 by Thomas L. Saaty and his wife Rozann Whitaker Saaty with the purpose of educating people in the world to help them make more rational decisions.

International Journal of Value Chain Management

Oral

Dr. Zbigniew Pastuszak (Maria Curie-Sklodowska University)

Pressures of competitive forces have enhanced production process changes, supercharged by shortening product/technology development lifecycles, decreasing delivery times, reducing inventories and increasing customer satisfaction. Today’s complex, globalised organisations focus on procurement, HRM, technological development and infrastructure. Integrating communication and increasing cooperation between production chain members is essential for managing value chains, critical for organisational survival and growth. Progressive organisations should cover physical as well as cyber market space. ***International Journal of Value Chain Management (IJVCM)*** reflects and explores these issues and developments in value chain management.

Journal of Global Information Management

Oral

Dr. Justin Zhang (University of North Florida)

The **Journal of Global Information Management (JGIM)** provides a forum for researchers and practitioners to share leading-edge knowledge in the global information resource management area. Playing a pivotal role in the discussion of the organizational applications and managerial implications of information resource management technologies, JGIM's contributors include a growing list of 2,400+ industry-leading experts, making the scope and breadth of the research diverse as it provides solutions to concepts like reengineering, rightsizing, network organizations, and the virtual corporation.

As stated by John Naisbitt, in his book **Global Paradox**, “the bigger the world economy, the more powerful its smaller players.” While the world is becoming more interconnected, international strategic alliances are increasing due to the reality that no single company and/or country can be a successful player in this new global game. As such, big international companies are deconstructing themselves and creating new structures to survive in the new world order. JGIM is highly indexed, with prestigious placements such as Web of Science® - Social Sciences Citation Index®, Scopus®, Compendex®, INSPEC®, and more, placing it well within that global communicative space.

Quality Engineering

Oral

Prof. David Edwards (Virginia Commonwealth University)

Quality Engineering aims to promote a rich exchange among the quality engineering community by publishing papers that describe new methods ready for immediate industrial application or novel examples of employed techniques.

Vice Rector Zbigniew Pastuszak

Oral

Dr. Zbigniew Pastuszak (Maria Curie-Sklodowska University)

Dr. Zbigniew Pastuszak, associate professor

- Vice Rector for Development and Business Cooperation
- Chairman of the Lublin Social and Economic Development Council, Lublin City Mayor
- Chairman of the Economics and Management Committee of the Polish Academy of Sciences, Lublin branch, PAN O/Lublin

Main area of responsibility: To create a platform of cooperation among university, business, and administration is a particularly demanding task for all these parties relations-wise. To establish mutual relations, to understand partners' needs, to ensure effective communication, to find ways to create interdisciplinary teams: these are some of the challenges that need to be faced in this work. The effects of scientific and research work should translate into social and economic development as well as contributing to the rising prosperity and quality of social life. This goal is within reach but only when the relations between the academia and business are rested upon mutual trust and understanding and are integrated into efficient social processes.

The UMCS Rector's Council consists of the Rector and 4 Vice-Rectors. Prof. Zbigniew Pastuszak is responsible for supervising, among others: activities related to the planning and implementation of the university budget, implementation of university development projects, commercialization of scientific research results, computerization of the university and cooperation with other universities and business environment. Prof. Pastuszak earned his master degree from Lublin University of Technology (Flexible Manufacturing Systems and production management), and Habilitation degree (post-doctoral) from Warsaw University (Management Information Systems, e-business management). His research background includes value networks management, e-business reception, net readiness and multichannel logistics. He serves also as the: Head of the Information Management and Logistics Department. His editorial activities are as follow: Associate Editor, Expert Systems with Applications; Editor in Chief, International Journal of Management and Enterprise Development; Editor in Chief, International Journal of Value Chain Management, Program Chair, Conference Board Member, MakeLearn & TIIM Joint Conference, Deputy Editor, ToKP – ToKnowPress, International Academic Publisher Bangkok-Celje-Lublin as well as Elsevier, Emerald, IEEE Computer Society and Inderscience reviewer.

Abstracts: College / School Deans Panel

College/School Deans Panel Dean Dr. Shanan Gwaltney Gibson

Oral

Dr. Shanan Gibson (Embry-Riddle Aeronautical University)

Dean of David B. O’Maley College of Business, Embry-Riddle Aeronautical University

BIO

Information / Description of the success stories at the David B. O’Maley College of Business, Embry-Riddle Aeronautical University.to share at SEDSI.

Dean Robert Burrus of UNCW Cameron School of Business

Oral

Dr. Robert Burrus (Cameron School of Business University of North Carolina Wilmington)

Rob Burrus became Dean of the Cameron School of Business in July 2015. Dr. Burrus serves as editor of the Academy of Economics and Finance Journal and has served as president of the Academy of Economics and Finance and as a manuscript reviewer for
multiple scholarly journals in his discipline.

The Cameron School of Business, accredited by AACSB, has over 70 full-time faculty. The school offers a B.S. in Business Administration and a B.A. in Economic. The school offers four graduates’ degrees: Professional MBA, MSA, MSCSIS, and a dual-degree International MBA (with five European partner universities). The school is highly recognized for its Cameron Executive Network mentoring program, with over 225 executive mentors. The school has expanded to the new CIS Building that features the Financial Trading Room, the Edward Jones Financial Lab (“Bloomberg Room”) and the $1.25M Seahawk Student Managed Investment Fund. The H. David & Diane Swain Center for Business & Economic Services provides regional economic analysis and oversees UNCW professional and continue education.

Effectively Measuring Journal Impact of Technology-related Business Journals: A Multi-Measure Approach

Oral

Prof. Nancy Albers (University of South Carolina Aiken), Prof. Tami Knotts (Louisiana State University Shreveport)

For more than a decade, universities have been encouraged to consider the impact of research as a means of self-evaluation. Even before measures of impact became an important component of accreditation standards, universities struggled with determining methods for assigning journal publications' level of quality and distinguishing exceptional publications from average ones. In tackling this challenge, some universities created restrictive, acceptable outlet lists; others relied on lists or indices generated for broader applications. As the number of journals grew dramatically, the proliferation of “predatory” journals complicated the process. New scholars were often explicitly targeted by predatory journals because of their inexperience and elevated need to obtain published research. As universities established policies to guide scholars and reward outstanding work, there were resulting winners and losers. Disciplines that were fundamental to traditional business programs, such as accounting, economics, finance, management, and marketing, tend to have clearly identifiable sets of recognized journals. The disciplines that make up information and decision science areas, such as operations, information systems, logistics, project management, analytics, etc., tend to have more interdisciplinary aspects. Because of this, many methods for evaluating journals may disadvantage research in these disciplines and undervalue quality publication in the reward and recognition process. This study examines a variety of methods to evaluate journal quality and considers the degree to which each method effectively measures journal quality of information systems/decision sciences research.

The College/School Deans Panel Dean Mary Lois White

Oral

Dr. Mary Lois White (Louisiana State University Shreveport)

Dean of Louisiana State University Shreveport College of Business

BIO

Information / Description of the success stories at the Louisiana State University Shreveport College of Business.to share at SEDSI.

The College/School Deans Panel Dean Prof. Nancy D. Albers

Oral

Prof. Nancy Albers (University of South Carolina Aiken)

Dean Prof. Nancy D. Albers, Timmerman Chair in Enterprise Development Professor of Marketing, of the University of South Carolina Aiken School of Business Administration.

BIO

Information / Description of the success stories at the University of South Carolina Aiken School of Business Administration.to share at SEDSI.

Abstracts: Department Heads Panel

Department Heads Panelist Dr. David J Edwards

Oral

Prof. David Edwards (Virginia Commonwealth University)

Bio

VCU College of Humanities & Sciences Department of Statistical Sciences and Operations Research

Department Heads Panelist Dr. Oleg Korenok

Oral

Dr. Oleg Korenok (Virginia Commonwealth University)

Bio

VCU School of Business Economics Department

Department Heads Panelist Dr. Paul Brooks

Oral

Prof. Paul Brooks (Virginia Commonwealth University)

BIO

VCU School of Business Information Systems

Department Heads Panelist Dr. Reza Kheirandish

Oral

Dr. Reza Kheirandish (Clayton State University)

BIO

Clayton

Department Heads Panelist Dr. Rhonda Syler

Oral

Dr. Rhonda Syler (James Madison University)

Bio

JMU COB CIS/BSAN Department

Abstracts: Post COVID-19 Academia: Special Topics on Instructions and Research (Online, Hybrid, and/or Face-to-Face)

A POST COVID-19 ACADEMIC ENHANCEMENT OF STUDENT UNDERSTANDING OF TYPE II ERROR EXAMPLE IN CLASSICAL HYPOTHESIS TESTING USING A FALSE NEGATIVE RESULT IN A DIAGNOSTIC COVID-19 TEST

Oral

Dr. Barry Wray (University of North Carolina Wilmington), Dr. Aruna Lakshmanan (University of North Carolina Wilmington)

The transmission of a novel coronavirus known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that causes COVID-19 among college students has been an ongoing challenge for universities throughout the world. Student understanding of COVID-19 test results is critical to curtailing the spread of the virus and protecting oneself and others from infection. Specifically, student understanding of the risks of type II error (false negative) and the consequence of ignoring this risk has the potential to prolong the pandemic on university campuses. The focus of this research is on development of a teaching methodology in an “Introduction to Statistics” course to help students better understand the risks and consequences of a type II error in a diagnostic test for COVID-19. An example scenario will be created and utilized to demonstrate how a type II error (false negative) can occur and the risks and implications of this error. The practical nature of the example helps students identify with and understand type II error and how it relates to statistical testing and decision making.

APPLYING NEUROSCIENCE PRINCIPLES TO INNOVATIONS IN BUSINESS WRITING PEDAGOGY

Oral

Prof. Dianne Garrett (University of North Carolina at Greensboro)

Teaching is the business of helping students change their brains. To do this work, instructors offer new information and practice opportunities for students to learn – to change their thinking to advance their life skills. Therefore, the more instructors know about brain science the better they can craft learning experiences. More specifically, this workshop focuses on business writing, writing pedagogy, and neuroscience. We'll have a conversation on the intersection of these three topics in order to create valuable course experiences.

Summary & Interest for SEDSI

In the session, there will be three foci: the process of writing and writing pedagogy, neuroscience, and the application of brain-friendly strategies and tactics. The first grouping of conversations will center on students' self-perception of their writing quality and the habits they have established. To decide how to lead them to the next level, we first need to meet them where they are. The second group will center on foundations in neuroscience relative to learning and writing, and the last topic will be a conversation on the brain-friendly strategies and tactics instructors can employ to better the learning and writing of students. Special topics are as follows:

To "meet students where they are," the topics will include (1) data demonstrating student perceptions of their writing, (2) their common writing process habits that resulted from the standard academic writing pedagogy, and (3) conversation on the needs of Millennials and Gen Z generation.

The mid-section will focus on human thinking and brain science that impact learning and writing. The priority topics will be (1) our brain's orientation to threat and reward, (2) the five social domains that impact human interactions, the five social domains of interaction, and (3) why reading and writing is mentally exhausting. We'll also have conversations on emotions, mental energy usage, the drive to shortcuts, chunking, and attention strategies, such as decision fatigue, mirror neurons, and multitasking.

The last section will deliver strategies of tactics instructors can employ to aid in students elevating their ease of learning and boosting writing quality. The speaker will offer the attendees a handout of possible tips and suggested action items. Topics include

1. How to reduce threat and increase the reward, relative to the human five social drivers of status, certainty, autonomy, relatedness, and fairness.
2. Managing student attention through curriculum design and classroom management (face-to-face and online) of items such as context before details, emotions (affect), starting where they are and what they care, surprise, reward, mirror neurons, offering meaning (purpose and application to self), assignment information first, and informing of "the why."
3. How to carefully craft feedback communication (feedforward) to not cause undue stress and create a desire for self-improvement.

COVID ERA CLASSROOMS: FORMAT FLEXIBILITY OF BUSINESS SIMULATIONS

Oral

Dr. Brandon Kilburn (The University of Tennessee at Martin), Dr. Ashley Kilburn (The University of Tennessee at Martin), Mr. Monty Taylor (The University of Tennessee at Martin)

If you were involved in a class during the spring of 2020, whether it be an instructor or a student, you know how important flexibility is in academia. Flexibility in course delivery has been proven paramount. Some instructors were fortunate enough to already have resources in place via existing online or hybrid courses that could be converted and applied to their formerly face-to-face classes. Some were not that fortunate and had to start from scratch at the mid-point of a semester. No matter what the situation, it was a challenge for us all. Upon reflection, 2020 highlighted the need to prioritize course adaptability.

This work addresses a tool that allows for flexibility and seamless adaptation if employed correctly. That is the utilization of web-based business simulations in the classroom. The web-based nature of the simulation allows for flexibility and greater alternatives for student interaction. Web-based simulation flexibility allows participants to function in face-to-face, on-line, or hybrid settings while engaging in the exact same learning environment. This is a proven pedagogical tool provides great potential for post COVID-19 era instructors. Promotion of flexibility and adaptability allows for instructors to convert from one delivery method to another if an environmental shift occurs such as it did in the Spring of 2020.

Over the last few decades simulations have evolved into very useful pedagogical tools. Benefits such as real-world decision-making, promotion of decision-making speed, extension of information retention (Bolt, 1993), and promotion reinforced learning (Dweck, 1986) can be realized by participants. Business simulations have even been linked to oral and/or written presentation skills through operationalized simulation variables (Alpert, 1995). While the benefits of simulations have been firmly established, the question of validity across delivery methods needs to be addressed. Does learning occur equally across delivery formats? This research focuses on assessing the validity of utilizing a business simulation across course delivery formats.

The study examines longitudinal data extracted from 27 simulations over a 5-year period. These 27 simulations include 587 students comprising 114 teams. Student competency data (average number of fatal flaws per group) will be separated based on class delivery method (online vs. live) and analyzed using Pearson Correlation. Results and analysis will be provided to validate and improve administration of business simulations among delivery methods, in order promote effective learning regardless of delivery method. Pearson Correlation examined the relationship between delivery format (online vs. live) and the average number of fatal flaws per group. The

mean for average number of fatal flaws is 1.21 (SD=.83). Results indicate that the relationship is positive, moderate in strength and statistically significant ($r(25)=.43$, $p=.03$).

Covid-19 Ineffective Management in Technostress and Its Impact on Higher-Ed Student Learning Body

Oral

Ms. Victoria Horton-Roark (Middle Georgia State University), Dr. Anthony Narsing (Middle Georgia State University), Dr. Greg George (Middle Georgia State University)

Nonpharmaceutical interventions (NPIs) became globally enforced safety practices during the Covid-19 pandemic. In compliance with NPIs, higher-ed systems shifted from offering Face-to-Face, Hybrid, and Online courses to only offering the latter to their student bodies. Many students experienced elevated levels of technostress while transitioning to an online platform, which, unfortunately, was shown to produce adverse student learning outcomes. This study identifies existing technostress contributors and their academic impact on student learning outcomes. A sample from Middle Georgia State University’s student population examines the effects of technostress. The data gathered will help define and implement strategies for managing the effects of technostress in higher-ed, leading to improvements in student learning outcomes.

Covid-19 Mental Stressors and Its Impact on Higher-Ed Student Body Groups

Oral

Ms. Victoria Horton-Roark (Middle Georgia State University), Dr. Anthony Narsing (Middle Georgia State University), Dr. Greg George (Middle Georgia State University)

During the Covid-19 pandemic, nonpharmaceutical interventions (NPIs) became globally enforced safety practices. Common NPIs practices included social distancing and isolation tactics designed to limit the spread of the Covid-19 virus and its variants. As a result of worldwide NPI implementation, multiple higher-ed student body groups experienced mental stressors that impeded their academic performances and abilities to maintain a healthy lifestyle. This study identifies significant mental stressors prevalent during the Covid-19 pandemic and their effects on Middle Georgia State University students. The data gathered will offer insights about student mental health stressors, and present opportunities for identifying strategies to help them cope with stressors, excel in their academic pursuits of achieving excellence, and maintain a balanced healthy lifestyle.

EMERGING EVIDENCE OF THE IMPORTANCE OF LIVE PROJECT-BASED LEARNING

Oral

Dr. Sanela Porca (University of South Carolina Aiken), Dr. Paul Goodchild (University of South Carolina Aiken), Ms. Harshi Lodha Jain (University of South Carolina Aiken)

COVID-19 has had a profound effect on all aspects of our lives. After COVID-19 businesses are raising questions about workers' education, training, and skill development. What kind of workers will businesses need in the future? Will there be changes in the long run that we need to account for? (3). This realization led to a shift in mindset from focusing on degrees to focusing on the skill set one possesses (4).

Post-COVID-19 higher education is no longer the same. Colleges are focusing more on practical-based teaching than theoretical. With this change in mindset a new teaching approach – “Live project-based learning” (LPBL) has emerged (5). LPBL is a teaching method that allows students to overcome real-life challenges and find solutions not just in a classroom setting, but by bridging the gap between theoretical and practical methods of learning.

The purpose of the current study is to analyze the impact of LPBL on a student's life and understand if a mixture of theoretical classroom teaching and practical experience is what the current and future generations of college students need. In our study, LPBL includes either a student working on a research project or a student helping emerging entrepreneurs or small businesses grow under the guidance of a faculty member.

To conduct this study, we will do two sets of structured interviews with two groups of students. The first group will include students who are currently part of LPBL, and the second group will involve students who are not participating in any LPBL. All these students will be given a questionnaire composed of the following three scales: The Academic Resilience Scale (2), the College Student Survey (1), and the COVID-19 Student Stress Questionnaire (6). We will be using this questionnaire to analyze, understand and compare how satisfied both the group students are with their academic experience and if the LPBL approach makes a difference.

Evaluating Community Engagement Impacts from Evolving Pandemic Perceptions of Students

Oral

Dr. James Lawler (Pace University)

COVID affected community courses with disadvantaged people. The authors of the paper evaluate the impacts of a community engagement course from the perceptions of students that, despite issues, interacted with people with disabilities on an online platform. This study will benefit professors considering alternate learning options for students impacted by pandemic or non-pandemic scenarios.

Experience in Teaching and Engaging Students with Recursive Relations

Oral

Dr. Shanzhen Gao (Virginia State University), Dr. Weizheng Gao (West Virginia State University), Dr. Olumide Malomo (Virginia State University), Dr. Jianning Su (Midway University), Dr. Julian Allagan (Elizabeth City State University), Dr. Ephrem Eyob (Virginia State University), Dr. Adeyemi Adekoya (Virginia State University), Dr. Somasheker Akkaladevi (Virginia State University)

Recursion is one of the most powerful ways to solve problems with computers. The concept of recursive programming is often difficult for undergraduate students.
Active learning refers to a broad range of teaching and pedagogical strategies that engage students as “partners-in-progress” participants in their learning during class time with their instructors.
We will discuss some real-life experiences related to students’ engagement in recursive relations. In this paper, commonly known best teaching practices such as Active Learning, and Problem-Based Learning, are implemented and proven to be effective given students’ responses and quiz and homework submissions.

MEASURING THE IMPACT OF COVID-19 PANDEMIC PROTOCOLS ON THE DEVELOPMENT OF RELATIONSHIP SKILLS OF NINTH GRADERS

Oral

Dr. Ben Blair (Columbus State University), Dr. Russell Spears (Kennesaw State University)

The closure of American schools driven by the COVID-19 pandemic prompted a notable concern for academic progress and potential lag. Evidence from Chafouleas (2022) suggests that the majority of all schools, regardless of income, race, and geography exemplify nearly a yearlong lag in learning. In addition, Chafouleas found psychological behavior from the pandemic may have amplified this lag with a rise in social anxiety, increased obesity, and aberrant conduct. According to Hoffman and Miller (2020), school closures were related not only to a decline in academic performance of elementary and high school students but also led to physical and mental health issues, increased domestic violence and child abuse. They also found that stress and anxiety levels increased for students when returning to in person classes after the pandemic.

In this study, we analyze the impact that pandemic protocols – school closures and the move to virtual learning – had on the perceived relationship skills of students just beginning their high school years. Specifically, we use the results of surveys designed to evaluate the effectiveness of a two-week education program aimed at teaching ninth graders the skills necessary to build healthy relationships and resist personally destructive behavior. Effectiveness of the program is measured using surveys administered before and after instruction. Survey data was gathered both in the academic year prior to the school pandemic protocols and after the pandemic when schools were reopened for in-person instruction. Of interest is the impact, if any, that the isolation of students from their peers had on the development of relationship skills and attitudes of students in this age group. Exploratory factor analysis reduced the dimensionality of our survey data to four skill groups – general relationship skills, intimate relationship skills, skills necessary for a committed relationship, and skills to resist destructive behavior. Our results indicate that overall, the two-week program is effective in improving scores across all skill groups from pre to post instruction both in the pre-pandemic group and the post-pandemic group. However, relationship skills, as measured by the post survey results, were lower for the post-pandemic group relative to the pre-pandemic group, indicating a possible lag in their development. We also find that the effectiveness of instruction, as measured by the improvement in scores on the pre and post survey results, also declined post-pandemic and that the nature of this decline was specific to gender.

Online Learning Behaviors and Learner Academic Success

Oral

Mrs. Xiaoye Yang (University of Massachusetts Lowell), Mr. Cuibing Wu (University of Massachusetts Lowell)

To better understand online learning, especially when facing the challenges of emergencies, there is a need to study the factors that affect online learners’ academic success in higher education. We developed a conceptual framework and built multiple regressions to argue how four online learning behaviors, prior online learning experiences, and assignment submission impact learners’ academic success using the Open University Learning Analytics dataset (OULAD). Our findings show that the four learning behaviors and assignment submission are associated positively with learners’ academic success. The assignment submission has a negative moderating effect. Besides, younger, higher education level, higher IMD level, and male learners have higher academic success.

Technostress and Its Impact on Higher-Ed Faculty Teaching Transitioning from Face-to-Face to Online Classes during Covid-19- Lessons Learned.

Oral

Dr. Anthony Narsing (Middle Georgia State University), Dr. Greg George (Middle Georgia State University), Dr. Troy Sullivan (Middle Georgia State University), Dr. Mimi Ford (Middle Georgia State University)

Higher-ed, like many industries, suffered adverse effects from covid-19. Faculty who traditionally taught face-to-face were presented with challenges associated with learning new technologies to facilitate the delivery of their courses. Faculty across disciplines experienced technostress, or the ability to comply quickly with the demands of teaching their traditional face-to-face classes and having to transition using advanced technology online teaching platforms. The authors examine specific factors that contributed to faculty technostress through a survey and present a model from the lessons learned to prepare for the next pandemic. This would benefit faculty teaching face-to-face and enhance the delivery of hybrid and online courses.

THE EFFECTS OF COVID-19 ON PERFORMANCE IN A COORDINATED MULTI-SECTION INTRODUCTORY STATISTICS COURSE

Oral

Dr. Keshav Jagannathan (Coastal Carolina University), Dr. Lindsey Bell (Coastal Carolina University), Dr. Nicholas Pritchard (Coastal Carolina University), Dr. Paul Hill (Coastal Carolina University)

An essential priority of every college and university is student learning and success. This article investigates the impact of COVID-19 on student learning and academic performance. Approximately 1,500 students in an introductory statistics course at a mid-sized public university were studied. Data collected from 2019, 2020, and 2021 were used to analyze and compare student performance before and during the pandemic. Further consideration was given to whether course modality (streaming only, face-to-face with streaming option, and face-to-face only) impacted student success during the pandemic. Findings showed that there was little difference in student performance in assessments prior to and during the pandemic. However, during the pandemic, significant differences were observed based on the course modality. In addition, while student demographics had a lesser impact on their modality choice, academic performance showed stronger relationships to course type selection.

THE IMPACT OF COVID-19 ON STUDENTS’ PERFORMANCE AND WORKFORCE READINESS

Oral

Ms. Mahederemariam Dagne (Marymount University), Dr. Alex Mbaziira (Marymount University)

Students have been highly affected by Covid-19 through impacts on income, social life, mental health, changes in the platform, and academic performance. Here, we analyze survey responses of 85 Junior and Senior undergraduate students at Marymount University to identify the relative importance of each aspect of the impact. The results show that few students’ academic performances were affected, but they were subjected to severe financial, social, and mental health issues and a lack of comfortable study places that affected their education. Therefore, preparation for similar events in the future should focus on these aspects especially focusing on students in vulnerable spots.

UNDERSTANDIN GEN Z STUDENTS’S SUCCESS USING BLOOM’S TAXONOMY & LEARNING STYLES

Oral

Dr. Shekar Challa (Virginia State University), Dr. Ephrem Eyob (Virginia State University), Dr. Adeyemi Adekoya (Virginia State University), Dr. Emmanuel Omojokun (Virginia State University)

This research proposes to investigate Gen Z students’ learning attributes, and understand their learning styles, and to design appropriate instructional methods to enhance their learning methods by enhancing and elevating Gen Z learning preferences for life’s challenges.

Gen Zs are highly collaborative, self-reliant, pragmatic, and Tech Savvy.

In this Pilot study, we will apply Bloom’s Taxonomy as a framework to understand cognitive learning strategies of Gen Z students, and explore the development of corresponding effective learning and assessment approaches for their academic success.

Toward that end, a survey of students at Virginia State University will be conducted. The survey instrument will comprise of a variety of questions covering respondents’ perceptions of course content, coverage, method of delivery, level of computer uses, impact of Learning Management System(s) on their learning and learning styles, and more. An Analysis of the empirical data should reveal insight into how Gen Z students learn, their attitudes to learning, and predictor learning attributes as gauged by the six cognitive levels of Bloom’s taxonomy.

Abstracts: Symposia, Workshops, Tutorials, and Special Sessions

ENHANCING STUDENT SUCCESS IN INTERNATIONAL BUSINESS COURSES BY USING THE GLOBAL MARKET POTENTIAL AND STRATEGY ONLINE SYSTEM (GMPSO)

Oral

Prof. Gaye Acikdilli (University of North Carolina at Pembroke), Prof. Christopher Ziemnowicz (University of North Carolina at Pembroke)

Prepare your students to succeed in global business environments. The objective is to provide a fail-safe learning environment for students to practice applying course material and to have them effectively learn by doing.
The Global Market Potential and Strategy Online system (GMPSO) is an interactive project-based learning, research, and planning tool. It will enhance the success of your students taking any international business course. It is a teaching method where students gain and apply skills by working on a long project where they complete in-depth research required in conducting international business decisions. An example is a semester-long project to research business conditions and recommend entry into a new market abroad. The GMPSO tool provides students with an opportunity to provide a report to an actual company’s managers. The system allows students to make recommendations for entering their particular product into a new international market.

ROBOTIC PROCESS AUTOMATION WORKSHOP WITH UiPATH

Oral

Dr. Paige Rutner (Georgia College & State University), Dr. Feruzan Williams (North Carolina A&T State University), Dr. Joy Godin (Georgia College & State University), Dr. Jeannie Pridmore (University of West Georgia)

Robotic Process Automation (RPA) helps companies automate repetitive, rules-based tasks to enable cost savings and free employees to perform other work that adds value to the organization. RPA has proven to be a technology that helps organizations more efficiently use the technology they already have by mimicking human interaction with those systems and bringing the benefits of automation to legacy processes without having to completely replace those legacy systems. However, there is a shortage of professionals who have the needed knowledge and the skills required by industry to meet the demand for RPA. This workshop will introduce RPA using UiPath and present best practices for using RPA in the classroom. Participants will be able to complete exercises suitable for a range of students and classes. Links to resources for further training and exercises will be provided.

Authors Index