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Edited by:

Boniface P. Yemba

Marshall University

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2025 Appalachian Research in Business Symposium

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It is our pleasure to present the Proceedings of the Appalachian Research in Business Symposium at the 2025 conference. The conference was held on March 27-28, 2025, hosted by the Lewis College of Business at Marshall University.

The Appalachian Research in Business Symposium provides a venue for presenting new research, discovering contemporary ideas, and building connections among scholars at Appalachian State University, Eastern Kentucky University, East Tennessee State University, Marshall University, Radford University, and Western Carolina University. This year we had a participation of faculty and students from Morehead State University as guests.

Acknowledgements:

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Peter Hille, Mountain Association

CHOOSING BETWEEN TAX AND AUDIT: A COMPARATIVE ANALYSIS AND DECISION AID FOR ACCOUNTING STUDENTS

Brian K. Hasson
 Department of Accounting
 Walker College of Business
 Appalachian State University
 416 Howard Street
 Boone, NC 28608
 hassonbk@appstate.edu
 828.262.4084 (Contact Author)

C. Kevin Eller
 Department of Accounting
 Walker College of Business
 Appalachian State University
 416 Howard Street
 Boone, NC 28608
 ellerck@appstate.edu
 828.262.6208 (Contact Author)

Key words: Accounting careers, accounting students, audit versus tax, decision aid

Introduction

Accounting students face an important early-career decision: choosing between tax and audit as a specialization. This decision is particularly significant when applying for internships, as it often dictates career trajectory. However, most students must make this choice before taking coursework in either discipline, relying on external information sources, limited exposure, and personal inclinations. Given the importance of this decision and given that recruiters now often ask for this specialization preference even in the sophomore year, it is beneficial to provide students with a structured, comparative framework to aid in their selection process.

The need to differentiate between tax and audit stems from their distinct roles within the accounting profession. Audit professionals focus on independently verifying financial statement accuracy and compliance with regulatory standards, while tax professionals concentrate on compliance with tax laws and strategic tax planning. The decision between these paths has long-term career implications, influencing work environment, skill development, and professional opportunities. While both career paths can be rewarding, one path may be a better “fit” than the other for a particular student, based on a variety of factors. Prior research suggests that students benefit from structured comparisons when making such career-related choices (Dalton et al., 2014; Grossman, 2020). Therefore, this study aims to provide a detailed comparative analysis of key attributes distinguishing tax from audit to support students in their internship selection process.

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Literature Overview

The authors used their combined professional experiences in audit and tax, augmented by a scan of the limited academic and practitioner literature, to identify 26 attributes where audit and tax potentially differ. We then interviewed six pairs of accountants (12 individuals) from six accounting firms to refine and describe the list of attributes, shown below. The sample firms included two Big 4, two large national, and two regionals. Each pair included one tax manager/partner, and one audit manager/partner from the same firm. The interview data will be used to validate which of the 26 attributes are relevant in current practice and perhaps help identify any that may be missing from our listing or which may be combined or removed due to a lack of significant difference. The product of the research project will be an Excel-based tool that accounting students can use as a decision aid to produce a weighted score comparing tax vs. audit for each of the 26 attributes. Expanding on the work of Grossman (2020), this score will provide students with a structured comparative analysis of tax vs. audit. We hope this tool will help students, especially sophomores and juniors, who are routinely asked by firms to make a career trajectory decision before even having taken the courses.

Accounting as a profession is divided into various specializations, with audit and tax being two of the most prominent. The audit profession, regulated by bodies such as the Public Company Accounting Oversight Board (PCAOB) and the American Institute of Certified Public Accountants (AICPA), plays a critical role in ensuring financial transparency and reliability (AICPA, 2022). Auditors assess financial statements, evaluate internal controls, and provide reasonable assurance that financial information is free from material misstatement (PCAOB, 2023). Their work involves extensive interaction with clients, client records, regulatory standards/bodies, and financial reporting frameworks.

Conversely, tax professionals work within the framework of the Internal Revenue Code (IRC), guiding individuals and businesses through tax compliance, strategic tax planning, and regulatory filings. Their role extends beyond compliance to include tax minimization strategies, advisory services, and advocacy in tax disputes (IRS, 2023). Tax professionals often communicate with the Internal Revenue Service (IRS) and state tax authorities, applying tax laws to optimize financial outcomes for clients.

Both audit and tax careers offer unique advantages and challenges. Audit provides exposure to a broad spectrum of industries, requiring professionals to understand diverse business operations and risk assessment techniques (PwC, 2023). Tax, on the other hand, demands in-depth technical knowledge of ever-evolving tax laws and offers the opportunity for more advisory and consulting roles (Deloitte, 2023). Given the fundamental differences in daily responsibilities, client interaction, and career trajectory, it is crucial for students to evaluate their skills, preferences, and long-term goals before committing to a specialization.

This study identifies 26 attributes that distinguish tax from audit, highlighting key contrasts that impact students' decisions when selecting an internship path.

1. **Client Relationship** – Auditors take on a bit of an adversarial role (aligned with the public interest) while tax professionals are generally advocates for their clients.
2. **Client Interaction Diversity** – Audit engagements involve various departments, whereas tax interactions are often limited to certain teams.
3. **Client Interaction Timing** – Auditors frequently engage with clients from “Day 1” on the job, while tax professionals typically engage with clients a bit later on.
4. **Friction** – Auditors may experience friction due to their role in verifying financial statements; tax professionals experience less friction as they help clients plan and save money.
5. **Mindset** – Auditors adopt a skeptical mindset; tax professionals adopt an advisory mindset.
6. **Use of judgment** – Auditors employ very high levels of judgment, while tax professionals are called upon to exercise judgement a bit less.
7. **Way of thinking** – Auditors focus on applying logic and reason to evidence; tax professionals research laws and regulations and think strategically about them.
8. **Goal/objective** – Auditors ensure financial statement accuracy and compliance; tax professionals minimize tax liability within legal boundaries.
9. **Client scope (view into client)** – Auditors get a comprehensive view of financial statements; tax professionals focus on tax-related financial elements.
10. **Technical knowledge and research realm** – Auditors rely on GAAP, PCAOB, and AICPA standards; tax professionals work with the Internal Revenue Code and regulatory tax laws.
11. **Possible value-added outcomes** – Auditors may provide suggestions on internal controls and risk mitigation; tax professionals coordinate tax savings and planning opportunities, as well as compliance.
12. **Deadline orientation** – Auditors follow strict audit cycles; tax professionals work around quarterly and annual tax deadlines.
13. **Rhythm of year** – Auditors experience a seasonal workload with busy audit periods; tax professionals have peak seasons around tax deadlines.
14. **People orientation** – Auditors work closely with teams and multiple departments; tax professionals often work independently or in smaller, specialized groups.
15. **Communication/interaction** – Auditor work requires high levels of interaction and socialization; tax often requires less in comparison.
16. **Personality type** – Is there truth to the audit = extrovert, tax = introvert myth?
17. **Work variety – location, client type** – Auditors frequently travel to client sites; tax professionals primarily work in an office setting.
18. **Work type** – Auditors have more “dependent” work, while tax professionals have more independent work.
19. **Engagement length** – Audits last weeks to months; tax work ranges from short compliance projects to ongoing planning engagements.
20. **Travel** – Auditors may travel frequently; tax professionals typically travel infrequently.
21. **Environmental variety** – Auditors work in varied client environments; tax professionals work primarily in a stable office setting.
22. **Career diversity** – Auditors develop broad industry expertise; tax professionals specialize in specific tax areas.

23. **Scope** – Materiality matters more for auditors, precision matters a bit less; for tax professionals, materiality matters less, and precision matters more.
24. **Compensation** – Both fields offer competitive compensation, but tax professionals may have additional earning potential through specializations in tax.
25. **Open up your own firm?** – Tax professionals are more likely able to start independent practices; auditors may find it more difficult to open up their own firm.
26. **Similarity to what you studied in college** – It's hard to mimic an audit in the classroom, while tax coursework is relatively similar to practice.

Methodology

We went into the field with knowledge of the professional environment for auditors and tax professionals and, therefore, with a sense of the differences between an audit and a tax career in a professional services firm. Therefore, our interviews consisted of a guided inquiry, discussing each of the 26 attributes, and asking if the description of the attribute resonated or should be changed. All interviews were audio recorded with participant permission and were transcribed by a professional transcription service. Transcripts were provided to all participants for review and further editing before we began our analysis.

Once all transcripts are finalized, our analysis will begin. We expect to refine and further clarify both the number of relevant attributes and their description as a result of the transcription data. Before the paper is submitted to a journal for peer review, we will again review the extant practitioner and academic literature. The submission will also contain the Excel model with the final set of attributes and a weighting feature for students' use.

Results and Implications

Our goals for the project are to publish our findings and an Excel-based model for undergraduate accounting students to use during their recruitment process. The model will reflect the likely attenuation of the number of attributes currently in the framework and allow users to weigh the attributes. Weighting will allow for the outcome of the use of the tool to better reflect the choice based on the attributes most important to the user. We seek to publish our findings in a widely read journal such as *Issues in Accounting Education* so that the framework and decision tool can be read by accounting faculty and shared with their students.

Retention is a significant challenge for accounting firms. Part of the issue is likely a lack of fit between the new hire's attributes and preferences and the nature of the work in auditing and tax, respectively. Our work may provide better career path decisions at the outset, improving retention over time. We are not aware of any tool of this kind in the existing academic or practitioner-oriented publications.

Conclusion

The decision between tax and audit is one of the most critical choices accounting students face early in their careers. Given that most students must make this choice before extensive coursework

or practical exposure, having a structured comparison is essential. This study presents key differentiating factors across 26 attributes to provide students with a tool for making an informed decision. By understanding the differences in areas like client interaction, technical knowledge, work environment, and career growth opportunities, students can align their internship selections with their personal giftings and professional aspirations. Ultimately, both tax and audit offer rewarding career paths. However, awareness of individual preferences and strengths and how those align with attributes of the respective career paths can improve career fit and possibly lead to a long-term career and improved retention which can benefit firms and the profession.

THE EFFECT OF STATE CORPORATE INCOME TAX CONFORMITY LEVEL ON STATE TAX REVENUE: EVIDENCE FROM THE TCJA

Tyler P. Johnson
Department of Accounting
Walker College of Business
Appalachian State University
416 Howard Street
Boone, NC 28608
johnsontp2@appstate.edu
828.262.6216

Key words: State corporate income tax conformity, state corporate income tax revenue, TCJA

Introduction

State corporate income tax conformity (hereafter “conformity”) can be defined as state corporate tax policy that complies with federal corporate tax policy (Porter, Paxton, Arasu, and Snowden Rives, 2017). States primarily conform to the federal system of corporate taxation by adopting federal definitions of taxable income into their own tax codes (Duncan and Luna, 2007, Fox and Swain, 2007; Mason, 2013). Of the 44 states that levy a corporate income tax, 42 use a variation of federal taxable income as the starting point for computing their respective tax base (CCH State Tax Smart Charts 2024).

Prior research finds that states conform to tax base reducing federal corporate tax provisions roughly 68 percent of time (Morrow and Ricketts, 2010). Consistent with this finding, related studies also suggest that conformity to specific federal corporate tax provisions is associated with lower state corporate income tax revenue (Cornia, Edmiston, Sjoquist, and Wallace, 2005; Gupta, Moore, Gramlich, and Hofmann, 2009). However, the Tax Cuts and Jobs Act of 2017 (TCJA), enacted numerous provisions that broadened the federal tax base and as a consequence of conformity, the tax base of corporate income taxing states (Phillips and Wlodychak, 2018; Walczak, 2019). Moreover, because the increase in states’ tax base was not in conjunction with a substantial rate drop, states have applied historical corporate income tax rates to larger taxable bases, resulting in a significant increase in corporate income tax revenue following the passage of the TCJA (Congressional Budget Office [CBO]; 2021, Laplante, Lynch, and Vernon, 2021). Taken together, the findings of prior academic research appear to be in conflict with the documented effect of recent tax policy changes.

In this study, I posit that these contradictory findings stem from prior literature’s focus on conformity to individual federal corporate tax provisions as opposed to states’ holistic approach to conformity. This distinction is important because conformity is more than just the starting point of the state tax base or one specific provision. It also refers to the aggregate federal provisions the state elects to accept (conform to) or reject (decouple from), and the method by which the state

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adopts conformity. In other words, conformity can be viewed as a sliding scale, with corporate income taxing states conforming to the federal tax code at varying levels. This understanding, in conjunction with the divergent observations of prior research and recent tax policy, prompt an important empirical question: how does a state's conformity level affect its corporate income tax revenue?

I address this question by constructing a sample of 1,936 state-quarter observations from 2013 to 2023. I select this time period because it encompasses the TCJA and allows for the impact of conformity level on a state's corporate income tax revenue to be observed both before and after a major change to federal tax policy. I then develop a conformity index score which measures a state's conformity level on a quarterly basis. Lastly, I examine the effect of a state's conformity level on its corporate income tax revenue both before and after the TCJA was enacted.

Literature Overview

The number of factors that influence conformity has resulted in substantial variation among states regarding conformity (Duncan, 2005; Walczak, 2019). As stated in Walczak (2019) (p.3), "All states incorporate parts of the federal tax code into their own system of taxation, but how they do so varies widely." Such variation provides a rich setting for empirical research concerning the implications of conformity at both the state- and firm-level. However, prior research concerning differences in state corporate tax policy has largely focused on the state-level economic consequences of apportionment rules and corporate statutory tax rates. For example, a number of studies investigate the impact of state apportionment factors and sourcing rules on local economies (Wasylenko, 1997; Lightner, 1999; Goolsbee and Maydew, 2000, Gupta and Hofmann, 2003; Edmiston and Arze del Granado, 2006; Gupta et al., 2009; Davis and Hageman, 2014). Similarly, studies also examine the effect that states' corporate statutory tax rate has on subsequent tax revenue collections (Klassen and Shackelford 1998; Cornia et al., 2005; Fox and Luna, 2010; Suárez Serrato and Zidar, 2018).

Of the aforementioned studies, several examine the impact of individual tax provisions on state corporate income tax revenue and the structure of the state tax base (Cornia et al., 2005; Gupta et al., 2009; Suárez Serrato and Zidar, 2018). In their comprehensive study examining the impact of multiple provisions on state corporate income tax revenue, Gupta et al., (2009) include two provisions specific to conformity: the allowance of net operating loss (NOL) carrybacks, and the deductibility of federal income taxes on state tax returns. Using state-level aggregate data, the authors find states that do not allow NOLs to be carried back and applied to prior years are associated with higher corporate income tax revenue, and states that allow a deduction for federal income tax expense are associated with lower corporate income tax revenue collections. Relatedly, Cornia et al., (2005) document a negative association between the deductibility of federal tax expense and state corporate income tax revenue. In addition, Cornia et al., (2005) find that various depreciation allowances among states are also associated with a decline in state corporate income tax revenue.

While these studies provide valuable insight concerning the impact of specific state tax provisions, they do not approach their analyses from the perspective of conformity and states' conformity level. This may be problematic because individual provisions can result in divergent tax revenues

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streams (Gupta et al., 2009; Cornia et al., 2015; Suárez Serrato and Zidar 2018) and only represent specific facets of a broader, more complex methodology of state tax conformity legislation.

Methodology

Because my goal is to measure state's holistic approach to conformity, I compute states' conformity level by determining whether each state conforms to several federal tax provisions in a given year as well as its current method of adoption. I refer to the numeric value assigned to states' conformity level as the conformity index score. Specifically, the index score is comprised of 13 distinct federal tax provisions and whether a state adopts a rolling conformity policy. Provisions included in the conformity profile are chosen based on conversations with several Big 4 state and local tax partners as well as personal professional experience. As such, the components selected should represent the prevailing provisions that comprise states' conformity profile.

The procedure for calculating the conformity index score follows Hung (2001) and applies an equal weight to each component of the index. Conformity index scores are computed so that they fall between [0,1]. A higher (lower) score indicates that state complied with more (fewer) federal provisions during a specific quarter.

To examine how state corporate income tax revenue is affected by varying levels of conformity pre- and post TCJA enactment, I estimate the following equation using ordinary least squares (OLS) regression with standard errors clustered by state:

$$SCIT/GSP = \beta_0 + \beta_1 HighCIS + \beta_2 Post + \beta_3 HighCIS*Post + \beta_4 FCIT/GDP + \beta_5 TaxRate + \beta_n Controls + \varepsilon$$

Results and Implications

Table 1 tabulates the results of my primary test. Column (1) presents the estimation of the base model, and Column (2) reports the estimation of the expanded model. Consistent with the findings of prior literature, the coefficient on *HighCIS*, is negative and significant in both Columns (1) and (2), based on one-tailed tests ($p\text{-value} < 0.05$). These results indicate that, on average, states with a higher conformity level collected 0.01 percent less corporate income tax revenue than states with lower conformity levels prior to the passage of the TCJA. Interpreted at the mean value of gross state product (\$346,665 million), this translates to \$34.667 million less in tax revenue per quarter for high conformity level states. Based on the summation of the coefficients on *HighCIS* and *HighCIS*Post*, this trend continues and, in the post, TCJA period as well. Specially, states with a higher conformity level collected 0.05 percent less corporate income tax revenue than their lower conformity counterparts. Translated at the mean value of gross state product, this equates to \$173.333 million less tax revenue per quarter among high conformers. Isolating high conformity states, the summation of *Post* and *HighCIS*Post* indicate that while states with a conformity level collected less corporate income tax revenue, their overall collections increased following the TCJA. Corporate income tax revenue increased by 0.04 percent. This is the equivalent of a \$138.666 million increase in quarterly tax revenue in the post-TCJA era relative to the pre-TCJA era.

	(1)	(2)
	<i>SCIT/GSP</i>	<i>SCIT/GSP</i>
<i>HighCIS</i>	-0.0002 ** (-2.18)	-0.0001 ** (-2.18)
<i>Post</i>	0.0007 *** (5.74)	0.0006 *** (5.37)
<i>HighCIS*Post</i>	-0.0002 ** (-1.81)	-0.0002 ** (-1.80)
<i>FCIT/GDP</i>	0.0993 *** (13.89)	0.0949 *** (13.13)
<i>TaxRate</i>	0.0032 *** (4.68)	0.0034 *** (4.79)
<i>SAF</i>		-0.0001 (-0.55)
<i>Addback</i>		-0.0000 (-0.12)
<i>Amnesty</i>		-0.0001 ** (-1.70)
<i>Unemployment</i>		-0.0078 *** (-5.00)
Constant	-0.0014 *** (-7.04)	-0.0010 ** (-2.63)
Observations	1,936	1,936
R-squared	0.2893	0.3156
Fixed Effects	None	None
Cluster	State	State

Table 1: The Effect of State Conformity Level on Corporate Income Tax Revenue

Conclusion

My study makes several contributions to state tax literature and state tax policy. First, it adds to prior research examining the economic consequences of state tax policy. While prior studies in this area have concentrated on the impact of various state-specific provisions, they have been silent as to state's holistic approach to conformity and its potential impact. To my knowledge, my study is the first to examine the economic effect of states' conformity level. My results provide evidence that while all states conform to the federal tax code to a certain extent, variations in states' conformity level have a significant impact on states' corporate income tax revenue. Given that states use tax revenue to fund education, healthcare, transportation, and infrastructure (among other state-run programs and services), my results should be of interest to policies makers, state legislators, and individuals alike. Additionally, my study develops a proxy for states' overarching conformity level. In doing so, it provides future researchers the ability to further explore this area of state taxation.

Nevertheless, my study is subject to several limitations. First, my state-quarter conformity index score is a proxy. I include prominent federal tax provisions following the guidance of subject matter experts; however, I recognize that my measure cannot account for every aspect of states' conformity level. Second, I cannot completely dismiss endogeneity or omitted variable bias concerns. I recognize that state conformity issues are decisions made by state legislatures. I employ several additional controls and econometric techniques to help address these concerns, but I cannot fully rule them out.

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Appendix

Variable	Definition
<i>SCIT/GSP</i>	State corporate tax revenue scaled by gross state product for state <i>i</i> in time <i>t</i> .
<i>ConformityScore</i>	State-quarter conformity index score computed in accordance with the outline documented under the Conformity Index Score section and Figure 1 weighting scale.
<i>HighCIS</i>	Indicator variable set equal to one for states with an average <i>ConformityScore</i> above the median, zero otherwise.
<i>Post</i>	Indicator variable set equal to one for quarters after the enactment of the TCJA (Q1 – 2018 through Q4 2023), zero otherwise.
<i>FCIT/GDP</i>	Federal corporate income tax revenue scaled by gross domestic product in time <i>t</i> .
<i>TaxRate</i>	The highest state statutory corporate tax rate scaled by the federal statutory corporate tax rate for state <i>i</i> in time <i>t</i> .
<i>SAF</i>	The sales apportionment factor for state <i>i</i> in time <i>t</i> .
<i>Addback</i>	Indicator variable set equal to one if the state has an addback requirement for related-party intangible expenses in time <i>t</i> , zero otherwise.
<i>Amnesty</i>	Indicator variable set equal to one if a state corporate income tax amnesty program was in effect in time <i>t</i> , zero otherwise.
<i>Unemployment</i>	The unemployment percentage for state <i>i</i> in time <i>t</i> .

Appendix: Variable Definitions

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DO PERCEPTIONS AND EXPLANATIONS OF SUPERVISOR INCIVILITY VARY BASED ON LEADER AND MANAGER TERMINOLOGY?

Jack Carson

Department of Management
Walker College of Business
Appalachian State University
416 Howard Street
Boone, NC 28608
carsonje1@appstate.edu
828-262-8332 (Contact author)

Caleb Pollard

IOHRM Program
Departments of Management and Psychology
Appalachian State University
416 Howard Street
Boone, NC 28608
pollardcd@appstate.edu

Key words: Workplace incivility, leadership, folk theory of the mind, explanations, qualitative

Introduction

Business managers are frequently referred to as *leaders* in both organizational practice and in popular discourse (Learmonth & Morrell, 2021; McLaren, 2013). Complicating matters is the widely held implicit assumption that *leader* terms connote benevolence, merit, and morality (Learmonth & Morrell, 2021). This has implications for studying workplace incivility, which is “rude, condescending, and ostracizing acts that violate workplace norms of respect, but otherwise appear mundane” (Cortina et al., 2017, pg. 299). Pre-existing notions associated with *leader* terms and *manager* terms may influence working persons’ perceptions of, explanations for, and attitudes toward uncivil behavior performed by *leaders* and *managers*.

The purpose of this study is therefore to understand what (if any) differences exist in the nature of subordinates’ explanations for supervisor incivility when it is termed (in research prompts) *leader incivility* versus when it is termed *manager incivility*.

This study contributes to the literature in three ways. First, this study contributes to the development of sounder methodological practices for studying supervisor incivility; should this study’s data indicate significant differences between responses to alternatively worded study prompts (i.e., *leader* versus *manager*), future research ought to control and/or account for these differences to best represent the particular phenomenon under study. Second, this study employs

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a relatively new approach to coding qualitative data, rooted in Malle's (2004; 2011) theory of the mind framework (described in the literature review and methodological sections below). Third, it provides information regarding practical implications of the usage of *leadership* terms to describe those in managerial positions.

Literature Review

Workplace incivility is behavior characterized by the violation of workplace expectations for respect and its low intensity relative to other mistreatment constructs such as aggression (Andersson and Pearson, 1999; Cortina et al., 2001). It is a contributor to adverse individual outcomes which hinder organizational functioning, such as anger, negative affect, retaliation, absenteeism, disengagement, and job withdrawal (Schilpzand et al., 2016). The source of workplace incivility is a meaningful concern. Employees generally expect supervisors to be trusted resources for workplace guidance (Low et al., 2016), and employee-supervisor relationships are strongest when supervisors provide employees with desired levels of interesting work, access to information, and social and financial benefits (Marstand et al., 2017). These betrayed expectations may be why meta-analysis has found that supervisor incivility more strongly negatively impacts trust in one's supervisor, job satisfaction, and work engagement relative to coworker or customer incivility (Han et al. 2022).

However, the extant research literature uses a variety of terms to describe supervisory sources of incivility, including *manager incivility* (93 Google scholar results) and *leader incivility* (178 Google scholar results). This mixed use of *leader* and *manager* appears to be more than terminological variance. A critical perspective suggests that the discursive use of *leader* terminology and *manager* terminology represents and has resulted in disparate societal presumptions (Learmonth & Morrell, 2021), and the practitioner-oriented literature (e.g. Kotter, 1990; Kotter, 2013; Watkins, 2012; Zaleznik, 2004) has only served to widen this divide. According to arguments found in both research and practice-oriented literatures, *leaders* are charismatic visionaries who create positive change. *Managers*, on the other hand, allocate resources to accomplish tasks. *Leaders* are seen as galvanizing sources of future-oriented inspiration, whereas *managers* are seen as calculative analytics who work within established guidelines.

If such distinctions between *leaders* and *managers* are indeed widely held, then the injudicious use of *leader* and *manager* terms to assess supervisor incivility may pose a methodological and theoretical challenge to the workplace incivility research literature, and potential barrier to practical insights.

This study applies a folk theory of the mind framework to examine employee perceptions of and explanations for supervisor incivility. The folk theory of the mind suggests that explanations are primary resources of information useful for understanding how people perceive and make sense of others' intentional behavior (Malle, 2004; Malle 2011; Wellman, 2014). It is a framework focused on the primacy of explanations for others' behavior, which yield some combination of reasons, causal histories of reasons, and enabling factors. These components of explanation are in

turn useful for understanding how people perceive, make sense of, and communicate beliefs about others' intentional behavior.

According to Malle (2004; 2011), explanations communicate things like explainers' perceptions of actor intentionality, explainers' beliefs about why an actor behaved the way they did (e.g. to enhance performance or promote injury; Liu et al., 2012), explainers' perceptions of actors' justifications for their behavior (as well as explainers' agreement or disagreement with justifications), and insights into the intensity of explainers' blame toward actors.

Our **research question** is therefore: What (if any) differences are present in laypersons' explanations for supervisor incivility when it is termed *leader incivility* versus when it is termed *manager incivility*.

Methodology

Data from a sample of 250 working adults will be collected using prolific.com, which maintains a pool of potential survey respondents who are free to select surveys to complete for compensation. Respondents will be working adults of at least 18 years of age. The survey will take about 15 minutes, and respondents will be compensated US \$3. The data collection protocol attained institutional review approval by the first author's university (IRB # HS-24-261) and is supported by an internal grant from the first author's university (for which the authors are grateful).

The research process will involve asking respondents to describe a recent experience in which a supervisor was uncivil toward them. Then, respondents will be randomly assigned one of two conditions which will ask for explanations for why the "leader" (condition 1) or "manager" (condition 2) behaved this way. Prompts asking respondents for explanations of *leader* and *manager* incivility will be preceded by a prompt asking respondents for a description of supervisor incivility to preclude potential effects attributable to perpetrator selection due to formal use of leader and manager titles.

There are three survey paths for respondents; one for respondents who have experienced supervisor incivility in the last six months, one for respondents who have not experienced supervisor incivility in the last six months but have witnessed its occurrence in the last six months, and one for respondents who have neither experienced nor witnessed supervisor incivility in the last six months. All three survey paths are of very similar length and will result in the same compensation level.

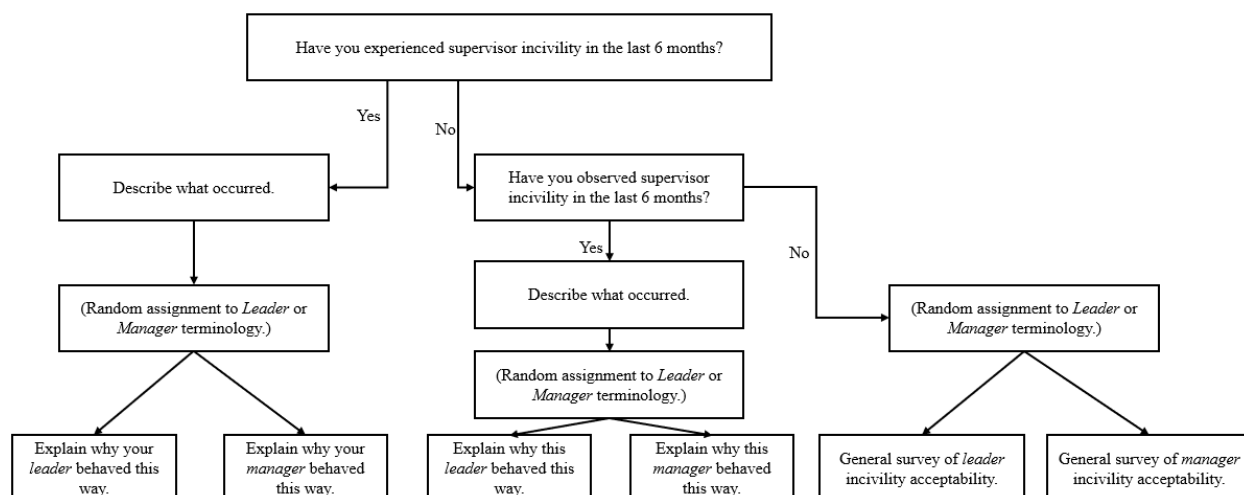


Figure 1. Flowchart of Survey Administration (with focus on primary question)

Qualitative data will be organized and coded in a qualitative data analysis software program. Data analysis will involve applying Malle's (2004; 2011) folk theory of the mind framework to code respondent data with regards to form (i.e., reasons, causal histories of reasons, enabling factors) and content (e.g., performance enhancement, injury intent, justification agreement). Data will be coded by the research team, with data initially blinded such that respondent prompts (i.e., *leader* or *manager*) are unknown by the coders. An initial orientation meeting, data coding overlap, and reconciling discussions will be employed to ensure a high degree of interrater reliability.

Once respondent qualitative data has been coded, emergent themes will be identified. Comparative analysis (with integration of quantitative data) will be performed to identify potential differences in how supervisors' actions are explained based on whether *leader* versus *manager* wording was used in the prompt.

Results and Implications

The data collection for this study is scheduled to begin in mid-February 2025, and data analysis will begin shortly thereafter. Preliminary results will be shared at the ARBS conference, and will be organized around the following themes:

- Emergent themes regarding form and content of explanations for experienced and observed supervisor incivility.
- Comparative analysis between explanations for experienced *leader* incivility and *manager* incivility.
- Comparative analysis between explanations for observed *leader* incivility and *manager* incivility.
- Comparative analysis between explanations for experienced and observed supervisor incivility.

- Comparative analysis between perceptions of acceptability for *leader* and *manager* incivility (as indicated by data from respondents who neither experienced nor observed supervisor incivility in the last 6 months).

Conclusion

This study contributes to the supervisor workplace incivility literature, the critical language of leadership literature, and the folk theory of mind methodology literature. It is anticipated that presentation of this study will generate insightful discussion among ARBS conference attendees from a variety of background disciplines regarding the implications of using *leader* and *manager* terms in both research (especially methodologically) and practice. In addition, discussion is expected regarding the folk theory of the mind framework's ability to provide clearer insights into individuals' explanations for others' actions in the workplace.

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PORTFOLIO OPTIMIZATION USING GENETIC ALGORITHM

Inhwan Jung
Master's Student in Applied Data Science
Department of Mathematics and Statistics
East Tennessee State University
441 Stout Drive
Johnson City, TN 37614
jungi1@etsu.edu

Key words: portfolio, portfolio optimization, genetic algorithm, modern portfolio theory

Introduction

Constructing portfolios is the process of capital allocation to risky assets. (Bodi et al., 2015, p.178) When building financial portfolios, investors need to decide how much capital is allocated to various risky assets for high returns, while there must be the risks of potential loss. A diversification strategy helps reduce the overall risk of portfolios due to the risk-return tradeoff. Investors aim to select portfolios that not only maximize expected returns but also minimize the volatility of the assets.

The Genetic Algorithm (GA) can help search for the optimal allocation in choosing a desirable portfolio. A set of weights assigned to assets can be represented to indicate the proportion allocated to each corresponding asset. A number of chromosomes, a set of portfolios, are initialized with randomly selected weights that determine the allocation of assets and form the initial population for the selection process. After the initialization, the fitness function is defined to assess which portfolio dominates others. The Sharpe ratio plays a key role in evaluating their fitness, which identifies which portfolios have a higher Sharpe ratio than others. Next step is to select parents for generating successors. It is important to keep a population with higher Sharpe ratios in the crossover pool to produce better child chromosomes. During crossover, decisions must be made about which parts will be inherited from each parent. Lastly, mutation is a stochastic process that changes randomly weights in the chromosome based on a predefined mutation rate, without considering fitness. This feature in GA helps prevent the algorithm from getting stuck in local optimal points. These steps in genetic algorithm enable the exploration of various states and ultimately increase the likelihood of reaching a global optimum. (Chou et al., 2017, pp.21891-21894)

In this paper, I described preprocessing steps applied to the dataset for the genetic algorithm and explained the strategies employed to obtain optimal asset allocations. Furthermore, I detailed the algorithm's progress in finding the best asset weights, presented the results, and evaluated the algorithm's performance by comparing the evolutionary algorithm with the traditional method.

Approach

1. Data

The main dataset is U.S. financial market data (Kumar, 2024). It contained the fluctuation of the prices in dollars and trading volumes on a daily basis from 2/4/2019 to 2/2/2024. It covered various sectors: energy, metals, cryptocurrency, and stocks. The features that I was interested in were financial assets prices, such as Bitcoin, S&P 500, Apple, Tesla, Microsoft, Google, Nvidia, Berkshire Hathaway, Netflix, Amazon, and Meta. Additionally, I collected 1-year treasury interest rates as the risk-free rates from Federal Reserve Bank of St. Louis (Board of Governors of the Federal Reserve System, 2024).

I preprocessed a financial dataset that included stock prices and 1-year treasury interest rates. The goal of this process was to clean and prepare the dataset for its application to GA. The specific steps I took included handling missing values, converting data types, and merging two datasets based on the common dates. To impute missing values, observations where only the T-bill interest rates existed were removed. If the T-bill value was missing, it was imputed with the average of the preceding and following values.

2. The Application of Genetic Algorithm

The GA was implemented to find optimal portfolio weights. The structure of the algorithm included the following steps: initialization, fitness function, selection, crossover, and mutation. These steps were designed to search for the consistent best weights given the volatility and risk-free interest rates. The dataset contained eleven companies' daily stock returns, a date variable which represented each observation date, and treasury bill daily interest rates. The rebalancing period was set to 6-month cycles, with portfolios reconstructed on the first day of each half-year from 2020 to 2023. Rebalancing a portfolio involves reallocating assets in the portfolio to adapt to changes in the market environment or to satisfy new investment goals. Rebalancing every six months is a suitable strategy for resetting financial objectives (Schock, n.d.). In this paper, it is assumed that the portfolio would be constructed based on the 6-month performances of stock returns.

- **Initialization:** This step created a chromosome of a portfolio with random weights and generated an initial population until it reached a given number. Each chromosome contained eleven randomly chosen asset weights. The weights were normalized to ensure their sum to one.
- **Fitness Function:** The Sharpe ratio was used to evaluate the performance of each portfolio. It was calculated as the difference between the expected returns and risk-free return, which was divided by the standard deviations as risk indicators. A higher the Sharpe ratio indicates better portfolio performance.
- **Selection:** The elitism strategy was employed for parent selection. Chromosomes were sorted by their fitness values in ascending order. Five parent chromosomes with higher fitness values were selected for crossover.
- **Crossover:** My crossover strategy was single-point crossover. Two parents were selected from the five chromosomes with the highest fitness values. A random crossover point was chosen

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within the portfolio. The offsprings inherited up to the crossover point from one parent and the remaining weights from the other parent. Two offspring were generated for the mutation.

- **Mutation:** The mutation function randomly changed offspring's weights. It iterated through each weight based on a given mutation rate.
- **Generation Iterations:** The algorithm iteratively searched for the portfolio with highest Sharpe ratio. During this process, the top 10% of population with highest fitness values were retained for the next generation to preserve portfolios which show good performances.
- **Finetuning parameters of genetic algorithm:** I fine-tuned the parameters of GA to consistently achieve the highest Sharpe ratio. The performance of the algorithm depended on the following predetermined parameters: population size, the number of generations, mutation rate, and preserving factor. The population size determines the number of portfolios produced in each generation. The number of generations specifies the iteration used to maximize the Sharpe ratio for each population. Mutation rate introduces its diversity to help avoid local maxima. Preserving factor ensures that portfolios with highest fitness values are retained for the next generation, which maintains high-performing portfolios as the algorithm progresses.

Parameters	Numerical
Population Size	300/ 400
Number of Generation	20,000/ 50,000
Mutation Rate	2.2%
Preserving factor	10%

Table 1. Selected Parameters of Genetic Algorithms

Results

1. Optimization Process

During the optimization process, the algorithm searched for the maximum point by climbing up each fitness value. Figure 1 shows that the highest fitness was achieved as the number of generations reached 20,000. In the first few thousand generations, the fitness value improved significantly, which indicated that the algorithm rapidly identified better assets allocation. After around 5,000 generations, the improvements in the Sharpe ratio became minimal and showed that the algorithm began to converge to the optimal level. From around 15,000 generations, the fitness value remained nearly stable, which potentially represented that the algorithm has reached a near-optimal or optimal portfolio. The optimization processes exhibited similar patterns across different periods of time, but the points at which the algorithm escaped from local maximum points varied.

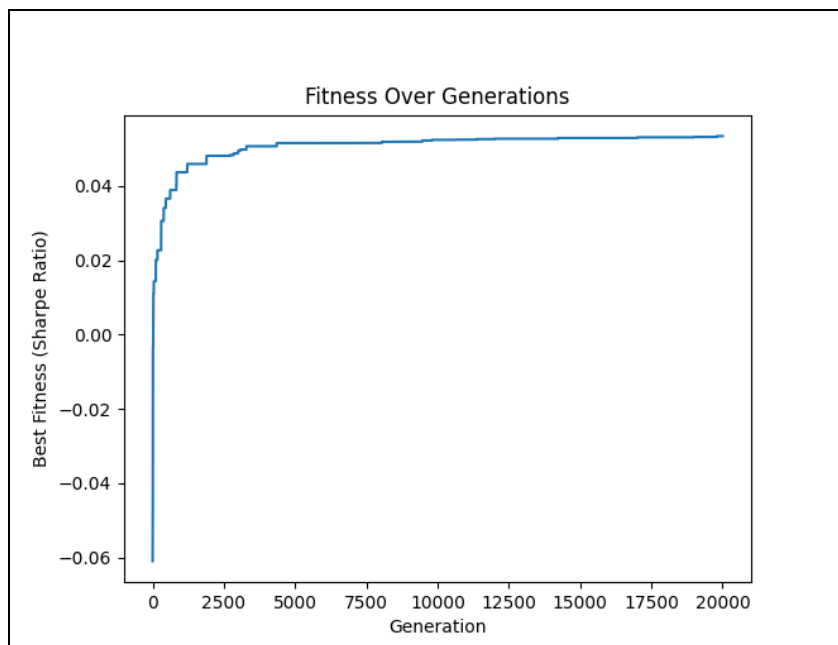


Figure 1. Optimization Process using Genetic Algorithm (1st half of 2020)

2. Optimal Portfolios

Fig.2. and Fig.3. show the weights of stock assets in optimized portfolio using GA and Modern Portfolio Theory (MPT) for each 6-month period from 2020 to 2023. In most periods, both methods displayed similar asset allocations and reflect comparable approaches to portfolio selection. However, notable differences emerged from the second half of 2022 to the first half of 2023. Both highlighted distinct strategies in order to maximize the returns.

In the second half of 2022, the GA centered its allocation on Tesla, which suggests a focus on its expected high returns during that period. In contrast, MPT emphasized Nvidia. It recognized its potential to achieve excessive returns above the risk-free rate rather than diversification. The first half of 2023 also illustrated these differences. The GA allocated almost the entire portfolio to Nvidia, while MPT allocated the entire portfolio to Tesla, which adhered to its principle of the theory.

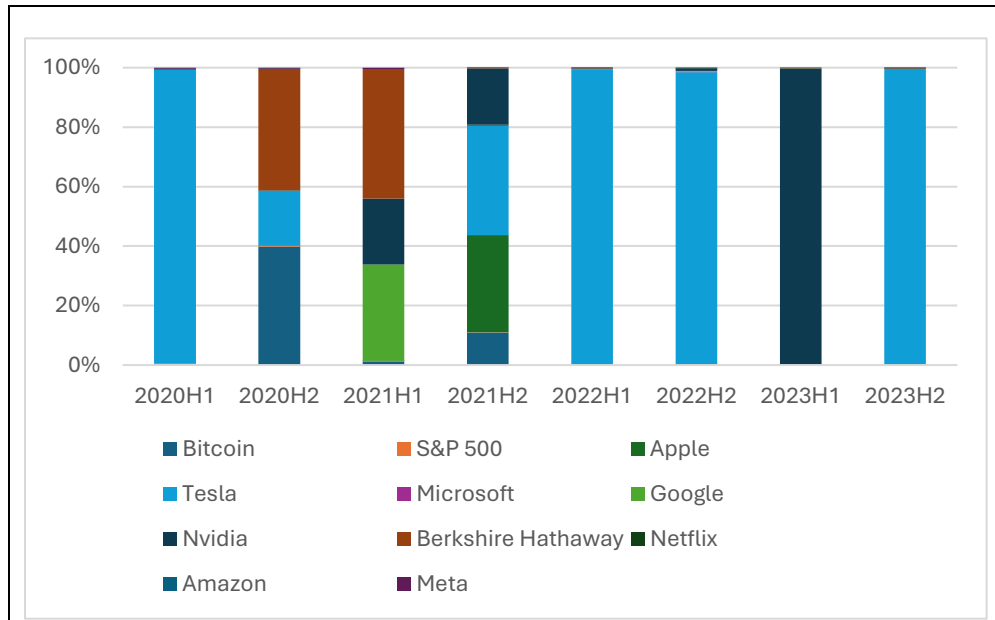


Figure 2. Optimal asset allocation using genetic algorithm (1st half of 2020 – 2nd half of 2023)

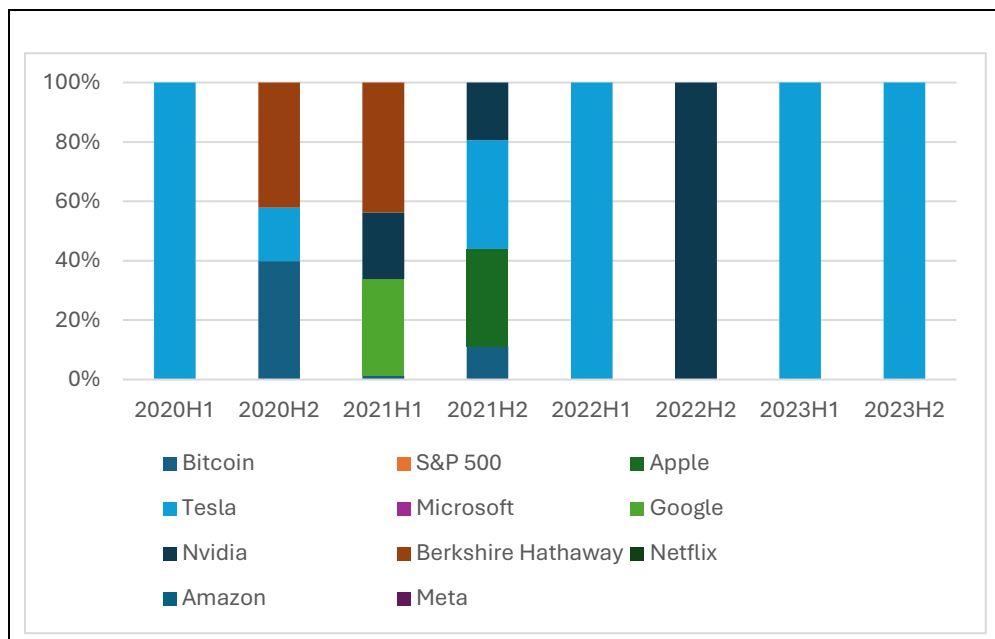


Figure 3. Optimal asset allocation using MPT (1st half of 2020 – 2nd half of 2023)

3. Evaluation

To evaluate the performance of GA, a conventional method for constructing portfolios was implemented to produce the benchmark weights of asset allocation. Modern Portfolio Theory (MPT) was used to build a portfolio that maximizes the expected return given the collective volatility of assets. Investors tend to achieve their goals by selecting an optimal mix of assets based on their assessments of expected returns and acceptable levels of risks (The Investopedia team, et al., 2023). Assets weights were calculated based on the concept of risk-adjusted returns in MPT.

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The optimization process was implemented using SLSQP(Sequential Least Squares Programming) method to minimize the negative Sharpe ratios. This optimization was subject to a constraint that requires the total weights to equal 1.

Table 2 shows the Sharpe ratios calculated using two optimization approaches: GA and MPT. The Sharpe ratio measured the risk-adjusted return of each portfolio. If its level is higher, this indicates better performance. The portfolios were constructed every 6-month period from 2020 to 2023, which represented 1H for the first half, 2H for the second half.

Both GA and MPT showed positive Sharpe ratio from 1 half of 2020 to 2nd half of 2021, which means that each portfolio achieved higher returns than the risk-neutral interest rates. The difference between GA and GMT is negligible across all periods, which means that both methods show similar performance.

From 2022 to 2023, the negative Sharpe ratios were shown due to unstable market condition. They indicated that investors had difficulty in gaining returns above the risk-free rate at the time. Interestingly, GA slightly outperformed MPT unlike the previous results.

Time	Sharpe Ratio (GA)	Sharpe Ratio (MPT)
2020 1H	0.0535	0.0545
2020 2H	0.2960	0.2971
2021 1H	0.1472	0.1477
2021 2H	0.1057	0.1059
2022 1H	-0.3951	-0.3932
2022 2H	-1.0375	-1.0634
2023 1H	-1.0871	-1.1164
2023 2H	-1.7674	-1.7599

Table 2. The Comparison of The Sharpe Ratios

Conclusion

This paper demonstrates the effectiveness of the Genetic Algorithm (GA) in optimizing financial portfolios by maximizing risk-adjusted returns. By using U.S financial market data, the GA identified optimal asset allocations from 2020 to 2023. The strategies in this algorithm, which included initialization, fitness function, selection, crossover, and mutation, enabled it to optimize the weights of assets while exploring diverse portfolio compositions. The algorithm's iterative property allowed it to achieve convergence to near-optimal Sharpe ratios.

When evaluated against Modern Portfolio Theory, the GA produced comparable Sharpe ratios in most periods. Interestingly, the GA slightly outperformed MPT in some periods, which reflected its ability to explore alternative portfolio compositions to maximize expected returns.

Overall, the Genetic Algorithm proved to be a robust and competitive optimization method. It can provide valuable insights into portfolio development. Its flexibility in adapting to changing market

conditions and identifying high-performing portfolios highlights its potential as a practical tool for other financial optimization problems.

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LOAN DEFAULT PREDICTION APPROACH USING MACHINE LEARNING

Kwaku Owusu
 Department of Computing
 College of Business and Technology
 East Tennessee State University
 227 Sam-Wilson Hall | PO Box 70686
 Johnson City, TN 37614
 Owusuk1@etsu.edu

Ghaith Husari
 Department of Computing
 College of Business and Technology
 East Tennessee State University
 227 Sam-Wilson Hall | PO Box 70686
 Johnson City, TN 37614
 husari@etsu.edu

Brian T. Bennett
 Department of Computing
 College of Business and Technology
 East Tennessee State University
 227 Sam-Wilson Hall | PO Box 70686
 Johnson City, TN 37614
 bennetbt@etsu.edu

Jeff Roach
 Department of Computing
 College of Business and Technology
 East Tennessee State University
 227 Sam-Wilson Hall | PO Box 70686
 Johnson City, TN 37614
 roachj@etsu.edu

Key words: Loan Prediction, Machine Learning, Bayesian Model, Outlier Analysis

Introduction

Credit extension is essential to both individual financial well-being and financial growth. Loans provide opportunities for education, property ownership, and business development, all of which enhance the prosperity of the community (Gashi, 2023). However, loan defaults pose serious

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challenges for the lending sector, potentially resulting in large financial losses and decreased lending capacity.

Customers defaulting on loans is a problem that banks and investors deal with on a regular basis. The 2008 global financial crisis brought to light the severe implications of significant loan defaults, highlighting the necessity for more precise risk assessment techniques (Filusch, 2021).

Improved credit assessment techniques can enhance loan risk management, potentially reducing losses for lenders while increasing access to credit for responsible borrowers (Kisten et al., 2024). By vetting customers more accurately, financial institutions can make better-informed lending decisions, ultimately leading to a more stable and efficient credit market.

In this work, we use the Naive Bayes machine learning model to predict loans that are at risk of being charged off. The Naive Bayes algorithm is particularly well-suited for this task due to its simplicity, efficiency, and effectiveness in handling high-dimensional datasets typical in financial applications.

Literature Overview

Predicting loan default is an essential task in the financial sector, especially in the newly emerging domains of peer-to-peer (P2P) lending platforms and online lending. Machine learning has shown itself to be a revolutionary technology in recent years for increasing the precision and effectiveness of credit risk models. This study examines several important research that demonstrate how machine learning approaches can greatly improve conventional credit scoring methods and play a role in loan default prediction.

Gashi, P. (Gashi, 2023) conducted a comparative study on various machine learning methods for predicting loan defaults. A significant challenge addressed in his research was dealing with imbalanced datasets, a common issue in loan default prediction. To tackle this, the author employed SMOTE (Synthetic Minority Over-sampling Technique), which helps in re-balancing the dataset and improving prediction accuracy. His study found that the application of more complex datasets could lead to even more accurate models, suggesting future opportunities for refining machine learning techniques to better handle complex financial data.

L. Lai (Lai, 2020) leveraged a real-world dataset and machine learning to classify and predict loan defaults. This study employed models such as AdaBoost, XGBoost, random forest, k-nearest neighbors, and multilayer perceptrons. The study demonstrates the exceptional accuracy of AdaBoost in predicting loan defaults, achieving a perfect classification rate. This work aligns with the broader adoption of machine learning in financial technology, showcasing how advanced algorithms can outperform traditional manual methods and other machine learning models in tackling complex financial problems.

Wang et al. (Wang, 2023) used machine learning to predict national student loan defaults, integrating multiple models for improved accuracy. Using SHAP analysis, it found that scholarships reduce default risk, while GPA strongly predicts repayment behavior. It also

identified college entrance exam scores as an influencing factor. These insights help universities develop targeted financial aid and academic support strategies to reduce loan defaults.

The Proposed Approach

The purpose of this work is to provide predictive analytics about loan default prediction. To this end, we use Naïve Bayes, a supervised machine learning approach that uses probability to estimate the likelihood that a borrower will not repay their loan.

The dataset used in this study belongs to Lending Club- Kaggle (utilized by Wang, X, 2023). It contains comprehensive loan data, including various features related to borrowers' financial profiles and loan characteristics, see Figure 1. The dataset initially has 100, 000 rows and 151 columns. We detail the step-by-step preprocessing approach in the next section. Table 1 details selected columns and their descriptions in the dataset.

Column/Variable	Description
loan_amnt	A numeric variable that describes the loan amount applied for by the borrower in US dollars.
term	The number of monthly payments (36 or 60 months)
dti	A ratio calculated using the borrower's total monthly debt payments on the total debt obligations (excluding mortgage and the requested loan), divided by the borrower's self-reported monthly income.
Int_rate	Interest rate on the loan.
grade	Loan grade assigned by Lending Club to the loan.
emp_length	Employment length in years.
annual_inc	Annual income of the borrower.
verification_status	Income verification status.
loan_status	The status of the loan e.g., paid off, charged off, etc (target variable)

Table 1. Selected Columns from the Loan Dataset

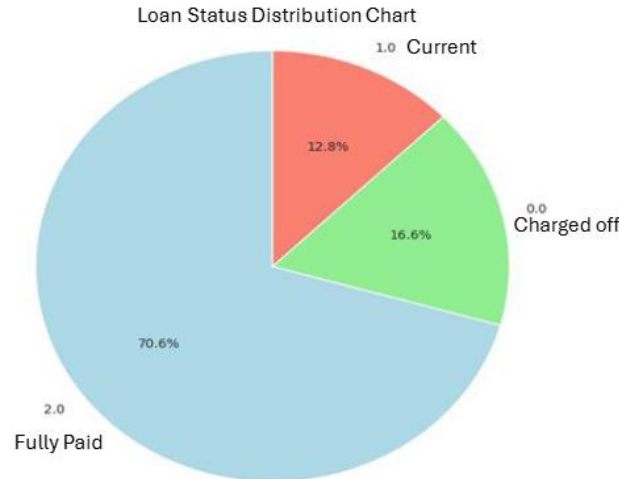


Figure 1: Loan Status Distribution Chart (Charged off label = 0, Current loan label = 1.0, and Fully paid label = 2).

Dataset Preprocessing and Cleaning

Null values: Initially, there were several columns with missing values. For example, the *deferral_term* column had 100% missing values, while *mths_since_recent_inq* had 10% missing values. Columns with 40% or more null values were dropped. After applying this step to the data, 61 columns were dropped due to the nature of their missing values.

Erroneous values: We encountered several instances of erroneous values, particularly in string columns. For example, some numeric fields contained special characters. We addressed this by removing special characters through regular expression function which takes any argument and converted data types where necessary. For example, employment length (*emp_length*) values consisted of “10+ years”, “< (less than)1 year”, etc. This issue was solved by converting “< 1 year” to “0.5”, “10+ years” to 10, and adjusting the other values accordingly.

Outlier detection and removal: We used the Interquartile Range (IQR) method to detect and handle outliers. IQR is the range between the first quartile (25th percentile) and the third quartile (75th percentile) of the data. We specifically applied this method to the “*annual_inc*” and “*loan_amnt*” columns. Any values below the lower bound or above the upper bound were considered outliers and removed as shown by the Equations below:

$$IQR = Q3 - Q1$$

$$Lower\ bound = Q1 - 1.5 * IQR$$

$$Upper\ bound = Q3 + 1.5 * IQR$$

Duplicates values: Duplicated rows and columns were assessed by using both variance and Pearson Correlation. Columns with variance of 20% and Pearson Correlation of 85% were dropped which reduced the data by dropping 20 columns. Figure 2 shows the correlation matrix

for the dataset attributes where dark red and dark blue colors indicate potential duplication (or redundant information) of columns.

After preprocessing, the dataset reduced to less than 95,000 rows and less than 60 columns. The target variable is “loan_status”, which takes three values: Fully Paid, Charged Off, or Current.

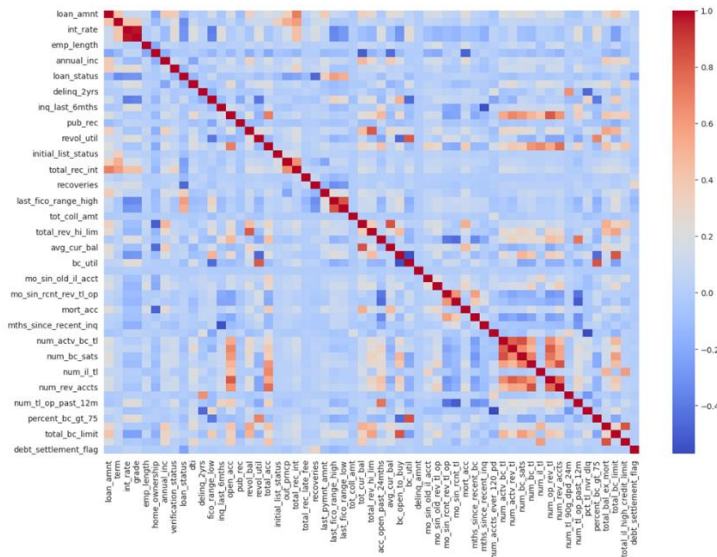


Figure 2: Duplicate Attribute Removal Using Pearson Correlation Analysis.

Data imputing: We applied the K-Nearest Neighbors (KNN) imputation method to address the remaining missing values. This technique identifies the K nearest neighbors based on other features and uses their values to estimate the missing data. Before imputation, we processed 61 columns with missing values. Additionally, duplicate analysis led to the reprocessing of 20 more columns, bringing the total number of dropped columns to 81. The remaining missing values accounted for 29% of the dataset, with employment length contributing the largest portion at 12%. After implementing KNN imputation, all missing values were successfully filled, resulting in a complete and clean dataset.

Machine Learning Predictive Modeling

To construct a machine learning model, we need to split the data into a training part and a testing one. We chose the popular Test-Train Split of 80% training and 20% testing sets, following the standard practices

We applied stratified sampling to maintain a consistent loan_status distribution across training and test sets, addressing dataset imbalance. Without it, minority classes (e.g., charged-off, current) could be underrepresented, leading to biased model performance. This ensures both sets reflect the overall distribution, improving accuracy on unseen data. The evaluation results follow in the next section.

Results and Implications

To evaluate the accuracy of the proposed approach, we use several accuracy metrics to report the accuracy of the loan status detection model. These metrics are Recall, Precision, and F1 score.

We used the Naive Bayes algorithm to construct our machine learning model, then the model was tested on the testing set explained in the previous section. Figure 3 shows the accuracy metrics of the proposed approach to detect the loan status to be fully paid, current, or charged off. As depicted in Figure 3, the Naive Bayes model correctly classified the bank loan status with F1 score accuracy values of 86%, 98%, and 97% for charged off loans, current loans, and fully paid loans, respectively. With a detection accuracy of 86% (F1 score) for loans that will be charged off (unpaid or written as a loss), our approach shows that creditors and customers can utilize this machine learning approach to make better decisions regarding applying or approving loans based on their risk model.

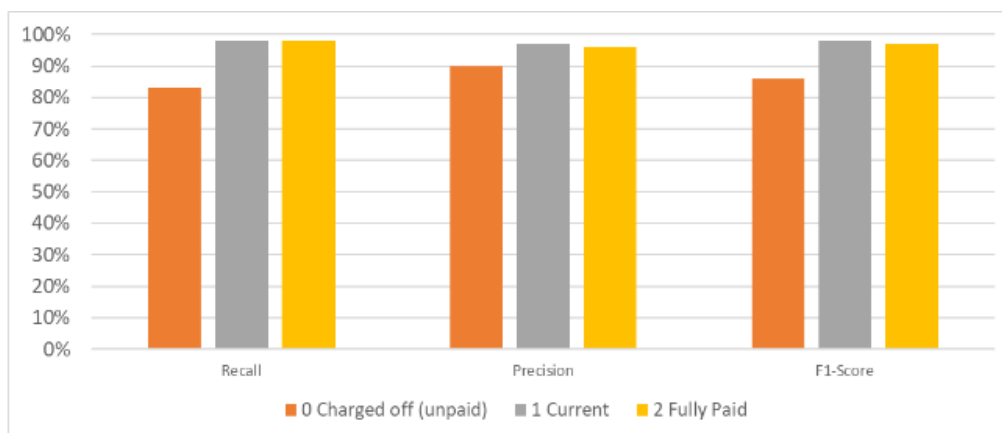


Figure 3: The Accuracy Scores of Predicting Loan Status Using the Machine Learning Model.

Conclusion

In this work, we present a machine learning approach designed to detect bank loans that are at risk of becoming charged off, meaning they remain unpaid. The objective is to explore the potential of using machine learning techniques to assist both creditors and borrowers in making more informed decisions during the loan application process. By accurately predicting the likelihood of a loan default, this approach can help mitigate financial risks for lending institutions.

An unpaid loan not only represents a considerable financial risk for creditors but can also have long-lasting consequences for borrowers, potentially damaging their credit scores for years to come. By leveraging machine learning models, this work aims to reduce these risks by providing predictive insights, ultimately contributing to more secure and responsible lending practices.

The Naive Bayes model has shown promise in forecasting loan defaults, with an accuracy rate of 86% (F1 score). It is a useful tool for credit risk assessment because of its computational

efficiency and capacity to handle high-dimensional data. However, there is room for improvement, particularly in predicting charged-off loans.

Future work could focus on several key areas to improve the model's performance and accuracy. One area for further exploration is incorporating more alternative data sources, which could enhance the model's predictive capabilities by providing additional insights. Another avenue for improvement is to explore ensemble methods, particularly those that combine Naive Bayes with other algorithms, to potentially increase prediction robustness.

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BENCHMARKING MACHINE LEARNING MODELS: A PERFORMANCE COMPARISON ACROSS DIVERSE METRICS

Avas Bajracharya
 Department of Computing
 College of Business and Technology
 East Tennessee State University
 227 Sam-Wilson Hall | PO Box 70686
 Johnson City, TN 37614
 bajracharya@etsu.edu

Maxwell Kyei
 Department of Computing
 College of Business and Technology
 East Tennessee State University
 227 Sam-Wilson Hall | PO Box 70686
 Johnson City, TN 37614
 kyeim1@etsu.edu

Ghaith Husari
 Department of Computing
 College of Business and Technology
 East Tennessee State University
 227 Sam-Wilson Hall | PO Box 70686
 Johnson City, TN 37614
 husari@etsu.edu

Key words: Heart Disease Detection, Machine Learning, Regression, Decision Tree, Deep Neural Network, Support Vector Machine, Naïve Bayes, Random Forest, Healthcare

Introduction

Integrating machine learning into heart disease detection enhances diagnostic accuracy by analyzing complex medical data to identify subtle patterns and risk factors. This enables the development of predictive models for early intervention and personalized treatment plans.

Such methods have been used extensively to show that their adaptability allows continuous learning from new data, improving predictive accuracy over time. Incorporating machine learning into clinical practice provides data-driven insights for informed decision-making, ultimately improving patient outcomes and reducing the healthcare burden of heart disease.

Logistic regression is a statistical method used to model the probability of a binary outcome based on one or more predictor variables. It estimates the relationship between the dependent binary variable and independent variables by applying the logistic function to a linear

combination of the predictors. This approach is widely used in various fields, including medicine, finance, and social sciences, to predict the likelihood of an event occurring.

A decision tree is a supervised learning model used for classification and regression tasks. It splits data into branches based on feature values, leading to decisions at leaf nodes. This structure allows for straightforward interpretation and handles both numerical and categorical data. However, decision trees can be prone to overfitting, especially with complex trees. Pruning techniques are often applied to enhance generalization.

Random forest is a supervised machine learning algorithm that constructs multiple decision trees during training and merges their outputs to improve predictive accuracy and control overfitting. For classification tasks, it outputs the class selected by most trees; for regression tasks, it averages the predictions of the trees. This ensemble approach enhances performance by reducing variance and bias, making it effective for both classification and regression problems.

A neural network is a machine learning model designed to process data by emulating the interconnected structure of the human brain. It consists of layers of nodes, or "neurons," each performing simple computations. These neurons are connected by weighted edges that adjust during training, enabling the network to learn patterns from data. Neural networks are fundamental to artificial intelligence applications, including image and speech recognition, natural language processing, and predictive analytics.

Naive Bayes is a supervised machine learning algorithm used for classification tasks. It applies Bayes' theorem with the "naive" assumption that features are conditionally independent given the class label. Despite this simplification, Naive Bayes classifiers perform well in various applications, including text classification and spam detection. They are efficient, requiring a small amount of training data to estimate the necessary parameters.

A Support Vector Machine (SVM) is a supervised machine learning algorithm used for classification and regression tasks. It works by finding the optimal hyperplane that best separates data points of different classes in a feature space. For cases where data is not linearly separable, SVMs employ the "kernel trick" to map input features into higher-dimensional spaces, enabling effective separation. SVMs are valued for their effectiveness in high-dimensional spaces and their robustness against overfitting, especially in cases where the number of dimensions exceeds the number of samples.

In this study, we provide a comprehensive accuracy analysis for six machine learning algorithms, namely, Logistic Regression, Decision Tree, Random Forest, Neural Network, Naïve Bayes, and SVM. Finally, we discuss the strengths and advantages of the best performing machine learning model on the dataset.

Literature Overview

Recent studies highlight the effectiveness of machine learning in detecting heart attacks. By analyzing complex medical data, these algorithms can identify patterns and risk factors that may not be evident through traditional methods. Such methods enhance early detection and diagnosis,

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potentially improving patient outcomes. In this part, we review some of the recent works in heart attack and healthcare anomaly detection using different machine learning algorithms.

Misra et al in (Misra, 2023), investigates the application of logistic regression to predict heart disease by analyzing various risk factors. By utilizing this approach, that study aims to identify significant predictors and assess the overall risk of cardiovascular conditions in patients. The study concluded that logistic regression show promising performance for detecting heart disease.

Sheta et al. (Sheta, 2024) utilizes a Decision Tree model with Feature Selection to enhance heart disease diagnosis, achieving 93.78% accuracy and a 0.94 ROC value showing very high accuracy in detecting heart disease.

Lutimath et al. (Lutimath, 2021) employed a Random Forest classifier to predict heart disease by analyzing patient data, including symptoms and physiological attributes. Utilizing Python for implementation, the Random Forest algorithm identifies the most significant features contributing to heart disease prediction, enhancing the accuracy of the model. This approach concluded that random forest models can help in early detection and intervention by effectively analyzing complex interactions among various risk factors.

Rojas-Albarracin et al. (Rojas-Albarracin, 2019) proposed an innovative approach to detect heart attacks by analyzing color images for characteristic postures associated with such events. Utilizing convolutional neural networks trained on a specially curated dataset of individuals simulating heart attack scenarios, the model achieved a classification accuracy of 91.75% and a sensitivity of 92.85%. This method aims to facilitate timely assistance for individuals experiencing heart attacks, especially when they are alone and unable to seek help due to incapacitating pain.

Kumari et al. in (Kumari, 2021) used a support vector machine classifier with Discrete Wavelet Transform to analyze Electrocardiogram signals for classifying cardiac arrhythmias. Utilizing data from the MIT-BIH and BIDMC databases, the model achieved a classification accuracy of 95.92% showing high efficacy for SVM models.

The Proposed Approach

The dataset, dating back to 1988, comprises four databases: Cleveland, Hungary, Switzerland, and Long Beach V. It includes 1025 patients and 76 attributes related to patient health metrics, although most published research focuses on a subset of 14 key attributes. The primary outcome of interest is the "target" field, which indicates the presence of heart disease in patients. This field is represented as an integer: 0 signifies the absence of heart disease, while 1 denotes its presence. The dataset has been widely used in medical research and machine learning studies aimed at predicting heart disease.

The 1025 patients' names and Social Security numbers were recently expunged from the database and substituted with placeholder data. Figure 1 shows the data distribution of 526 patients with heart disease (target =1) and 499 patients with no heart disease (target =0).

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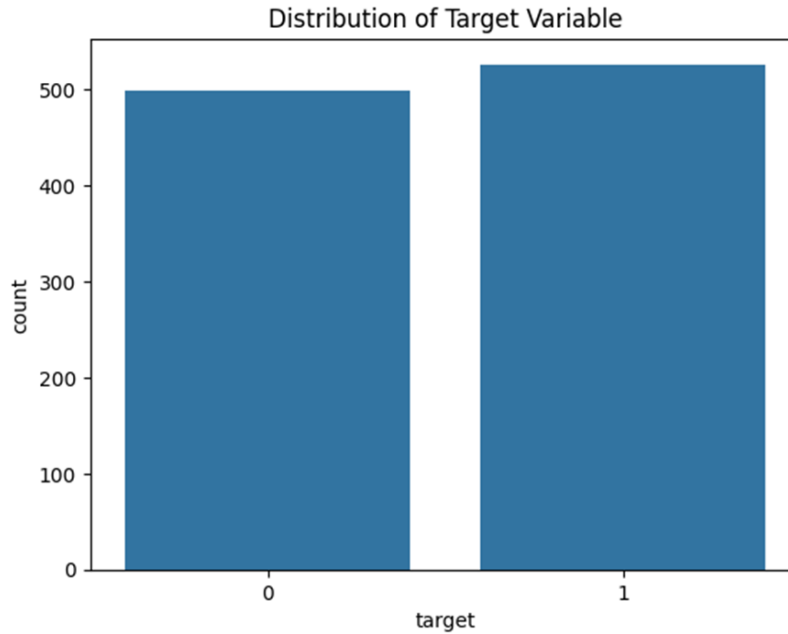


Figure 4: The Distribution of No Heart Disease ($target = 0$) and Heart Disease ($target = 1$)

Figure 5: Loan Status Distribution Chart (Charged off label = 0, Current loan label = 1.0, and Fully paid label = 2).

Outlier Detection and Deletion

To detect the remove outliers, we used the Boxplot outlier detection. In short, any values for a given column that fall beyond a certain value (interquartile range multiplied by 1.5) is considered an outlier and subsequently removed. We used this method for remove the outliers for the columns:

1. Resting Blood Pressure
2. Serum Cholesterol
3. ST depression induced by exercise relative to rest

Figures 2,3,4 depict the boxplot outliers for the three columns, where the empty circles denote values that are deemed outliers and therefore deleted from the data.

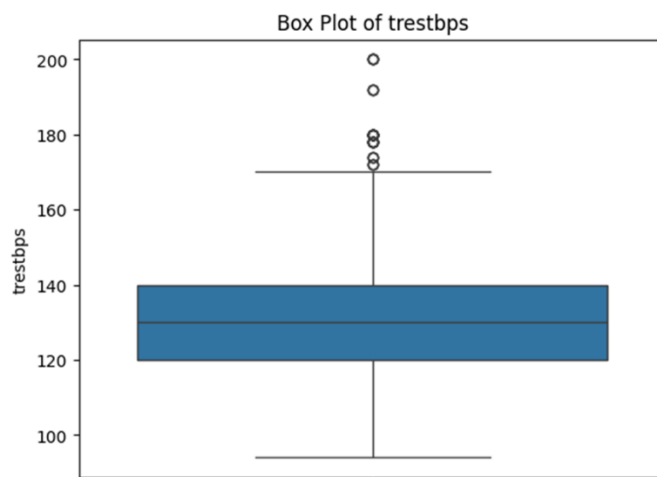


Figure 2: Outlier Detection for Resting Blood Pressure (trestbps)

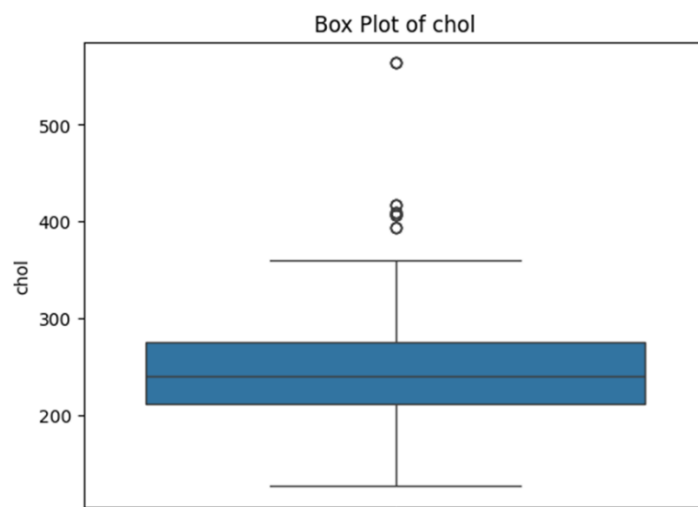


Figure 6: Outlier Detection for serum cholesterol in mg/dl (chol)

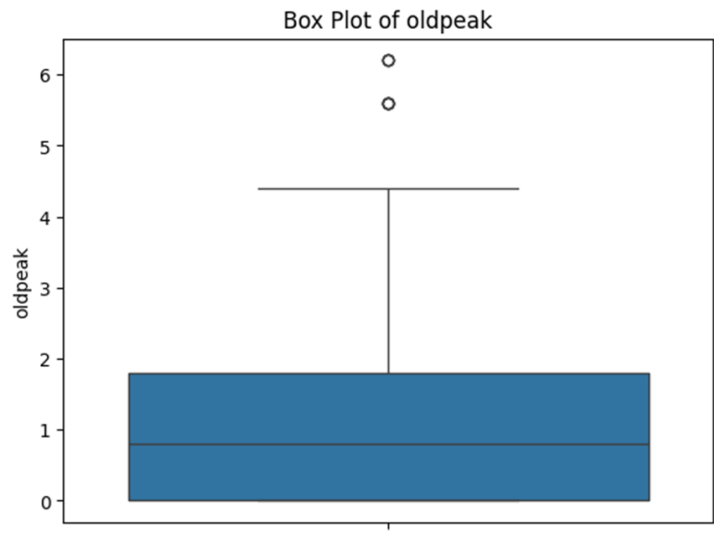


Figure 7: Outlier Detection for ST depression induced by exercise relative to rest (*oldpeak*)

After cleaning the outliers, we plotted all the cleaned columns and confirmed that there are no more outliers as shown by Figure 5.

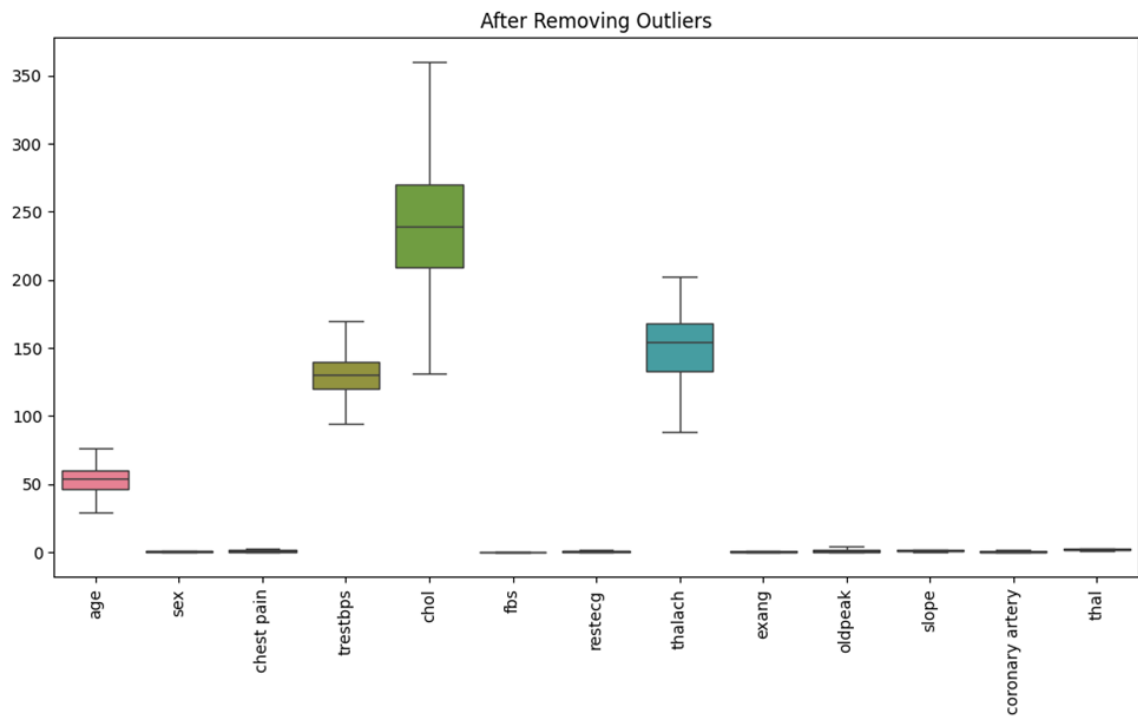


Figure 8: The Boxplots of the Dataset After Cleaning Outliers

Machine Learning Predictive Modeling

To construct a machine learning model, we need to split the data into a training part and a testing one. We chose the popular Test-Train Split of 80% training and 20% testing sets, following the standard practices

We trained six separate machine learning models using the following algorithms:

1. Logistic Regression
2. Decision Tree
3. Random Forest
4. Neural Network
5. Naïve Bayes
6. Support Vector Machine (SVM)

Results and Implications

To evaluate the accuracy of the proposed approach, we use the accuracy metric for six machine learning models.

The Logistic Regression algorithm achieved an overall accuracy of 86%. This algorithm was outperformed by Random Forest which achieved an accuracy of 94%. The Naïve Bayes algorithm achieved the lowest overall accuracy of 85%. The SVM algorithm achieving a very high accuracy (97%) on the dataset. The Neural Network (NN) achieved a near perfect accuracy on the dataset of 99%. However, the Decision Tree with feature selection achieve 100% accuracy in detecting heart disease. Figure 7 illustrates the overall accuracy of each of the six machine learning models achieved on the dataset.

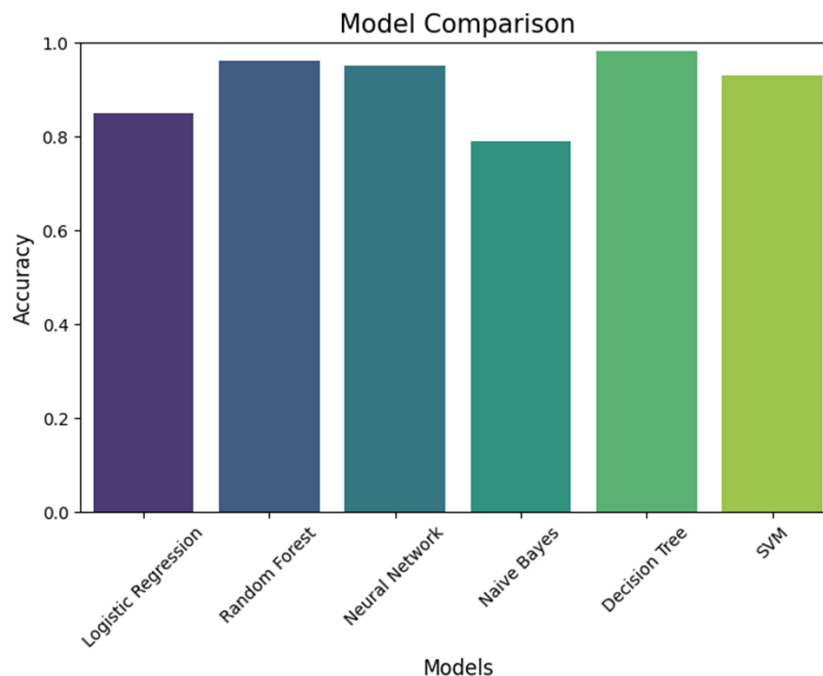


Figure 9: The Achieved Overall Accuracy of the Six Machine Learning Algorithms

Conclusion

In our recent study, we employed six machine learning algorithms to detect heart diseases using a specific dataset. The Logistic Regression algorithm achieved an overall accuracy of 86%, while the Random Forest algorithm outperformed it with an accuracy of 94%. The Naïve Bayes algorithm had the lowest accuracy at 85%. The Support Vector Machine (SVM) algorithm achieved a high accuracy of 97%, and the Neural Network (NN) reached a near-perfect accuracy of 99%. Notably, the Decision Tree with feature selection achieved 100% accuracy in detecting heart disease.

However, we recognize that such exceptionally high accuracies, especially the 100% accuracy of the Decision Tree model, may indicate overfitting. Overfitting occurs when a model learns the noise in the training data to the extent that it negatively impacts its performance on new, unseen data. This can lead to an overestimation of the model's true predictive capabilities.

To address potential overfitting, we plan to implement techniques such as cross-validation, pruning (for decision trees), and regularization methods. Additionally, we will evaluate our models on an independent test set to obtain a more realistic assessment of their performance.

In future work, we plan to develop a voting ensemble system where each algorithm contributes to the final prediction. Ensemble methods like this often enhance predictive performance by combining the strengths of multiple models.

Furthermore, we plan to use a more recent and diverse dataset to improve the generalizability of our models, ensuring they perform well on various patient populations.

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By addressing potential overfitting and validating our models on new data, we aim to develop a robust heart disease prediction system.

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LEVERAGING A CYBERSECURITY CAPABILITY MATURITY MODEL FOR EFFECTIVE RISK MANAGEMENT IN AN OPERATIONAL TECHNOLOGY ENVIRONMENT

Jose C. Peña

Department of Computing, Business, & Technology
East Tennessee State University
Johnson City, TN 37604
penajc@etsu.edu
865.216.0904

Michael Lehrfeld

Department of Computing
College of Business and Technology
Johnson City TN 37604
lehrfeld@etsu.edu
423-439-5347

Key words: Cybersecurity, Operational Technology, SCADA, Self-Assessment Tool, Critical Infrastructure

Introduction

This work evaluated the perceived effectiveness of using a cybersecurity self-assessment tool to address the increased cybersecurity threats by seventeen respondents working in critical infrastructure environments, particularly those using Supervisory Control and Data Acquisition (SCADA) to manage the systems, and the feasibility of the tool to assess risk across ten domains that make up a modern Operational Technology (OT) computing environment.

OT and SCADA systems manage and control critical water, wastewater, gas, and electrical infrastructure environments for other industry purposes. Cybersecurity threat levels have increased in OT environments due to integrating interconnected “intelligent” devices that allow for better communication protocols and automation with legacy infrastructure. The technological upgrade also introduces limited visibility into security gaps, which threat actors can exploit.

The convergence of Information Technology (IT) and OT environments necessitates standardizing an effective cybersecurity risk management framework to address the increasing cybersecurity threats affecting both domains. The C2M2 provides a structured approach that assists organizations in evaluating their cybersecurity practices by leveraging tiered maturity indicator levels (MIL) and domain-specific practices to identify gaps, prioritize enhancements, and increase their cybersecurity posture. This research will gauge the C2M2 self-assessment tool’s perceived value in enhancing the cybersecurity posture in a production OT environment.

Literature Overview

The C2M2 framework has been recognized for its structured approach to enhancing cybersecurity maturity. Key literature highlights the model's applicability across various sectors, particularly in the energy industry (Department of Energy, 2023). Studies have shown that the C2M2 helps organizations identify gaps in their cybersecurity practices and prioritize improvements (Drivas et al., 2020). Comparisons and direct mapping with other models, such as the National Institute of Standards and Technology (NIST) Cybersecurity Framework and ISO/IEC 27001, underscore the C2M2's detailed focus on maturity levels and its practical guidance for implementation (NIST, 2023).

A recurring theme within the literature is the importance of specific cybersecurity controls across industrial control systems (ICS) and OT-specific SCADA infrastructures. Critical infrastructure is operated by complex SCADA systems that interact with field devices performing specific functions through network connectivity and control systems (Puys, Thevenon, & Mocanu, 2021). SCADA systems are vulnerable due to intermingling, differing communication protocols, network integration, and legacy applications that comprise most modern SCADA environments. A comprehensive cybersecurity posture for an organization includes multiple components such as intrusion prevention systems (IPS), intrusion detection systems (IDS), analytics, frameworks, standards, third-party assessments, and threat modeling, which form the Industrial Internet of Things (IIOT) (Puys, Thevenon, & Mocanu, 2021). The C2M2 can help organizations assess and improve these components, establishing a comprehensive cybersecurity framework for adherence.

In a hardware-specific study, Puys et al. (2021) created virtual labs connected to operational devices to simulate advanced persistent threat (APT) attacks, which provided hands-on training for students in penetration testing. The study concluded that virtualization with real-world controls assists in cybersecurity awareness in an ICS environment. Programmable Logical Controllers (PLCs) and Remote Terminal Units (RTU) are integral to most OT environments. Da Silva et al. (2023) examined PLC modifications that compromise integrity, using PLC logic to create a mathematical model defining PLC behavior and suggesting cybersecurity controls to minimize operational risks.

Prior analysis agrees on the importance of cybersecurity but differs in approach and subject matter. Approximately half of the research is technically oriented, focusing on ICS controls while touching on SCADA unless devoted explicitly to the topic. The second half is policy-oriented, focusing on policies, procedures, guidelines, and threat awareness. SCADA implementations are often complex due to the components involved and the technical ability necessary to understand interconnectedness and operability from a decentralized location (Gomez Rivera & Tosh, 2019).

The literature emphasizes the importance of emulating cybersecurity attacks and practicing responses. Coordinating technical and administrative disciplines from different areas strengthens understanding and promotes implementations of effective cybersecurity practices. Integrating security information and event management (SIEM) into a networked environment benefits the analysis of security threats before they occur. Axon et al. (2022) found that a SIEM instance can be managed internally or outsourced to a Managed Security Service Provider (MSSP), however, the location of the SIEM—whether in a cloud environment or with physical sensors—is important.

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Charilaou, Ioannou, and Vassiliou (2022) tested a tool to detect operational faults using datasets from real-world industrial processes. The tool detected modifications through machine learning and adaptation, with deep learning and adaptive techniques improving threat detection. The C2M2 can guide organizations in integrating detection tools into their cybersecurity program by assessing their applicability and correlation with the practice of the specific domain.

Zhang, Xu, and Xie (2019) examined the advantages of moving infrastructure to a cloud-based environment, creating a virtual environment to train cybersecurity professionals. The study concluded that the cloud-based approach improves awareness and responsiveness from decentralized locations.

The literature contributes to the field of cybersecurity in ICS and OT environments, demonstrating the importance of self-assessment tools, virtualized training environments, repeatable process controls, establishing baselines, setting achievable goals, and detection capabilities. It also addresses human error factors and geopolitical ramifications. However, the literature lacks a broadly adopted framework as an industry standard, and the complexity of environments contributes to the absence of a strategy to address cybersecurity concerns. The C2M2 can provide a structured approach to address these gaps, establishing a path forward for assessing and improving cybersecurity practices across diverse environments.

Methodology

The study employed a quantitative approach to evaluate the C2M2 tool in a production OT environment, focusing on SCADA infrastructure and personnel. Seventeen participants whose roles included cybersecurity, system administration, networking, and field device implementations within an OT environment were selected for the study. Participants were asked to complete the C2M2 Version 2.1(V2.1) online self-assessment via email, with a link to the HTML version. Upon completing the C2M2 self-assessment, a Microsoft Forms survey with ten questions was emailed to gauge the tool's perceived effectiveness in enhancing the organization's cybersecurity posture.

Data collection involved participants emailing their assessment results, including the PDF and JSON files to the primary researcher and completing the Microsoft Forms survey. A Python script aggregated the data from these files across each C2M2 domain. The follow-up survey results were analyzed using Microsoft Forms' built-in visualization tools to identify trends. Quantitative analysis included calculating response percentages and identifying trends from the assessment, while a qualitative review of responses to the survey helped identify common themes and experiences.

Results were visually represented to highlight the perceived value of the C2M2 tool across the following domains: Asset, Change, and Configuration Management, Threat and Vulnerability Management, Risk Management, Identity and Access Management, Situational Awareness, Event and Incident Response, Third-Party Risk Management, Workforce Management, Cybersecurity Architecture, and Cybersecurity Program Management (Department of Energy, 2023).

Results and Implications

The results are based on the evaluations provided by the C2M2 tool, which participants used to evaluate this SCADA environment. The results of this type of analysis are specific to the needs and risk appetite of the organization. The C2M2 assessment results in this OT-specific environment indicate that the Third-Party Risk Management domain is perceived to be the most mature and organizationally capable, with a score of 1.87. The Risk Management domain, which involves identifying risks to the organization's business operations, scored 1.82. The Identity and Access Management domain, which includes the ability of the organization to manage access control and identity governance effectively, received a score of 1.33, as demonstrated in Figure 1.

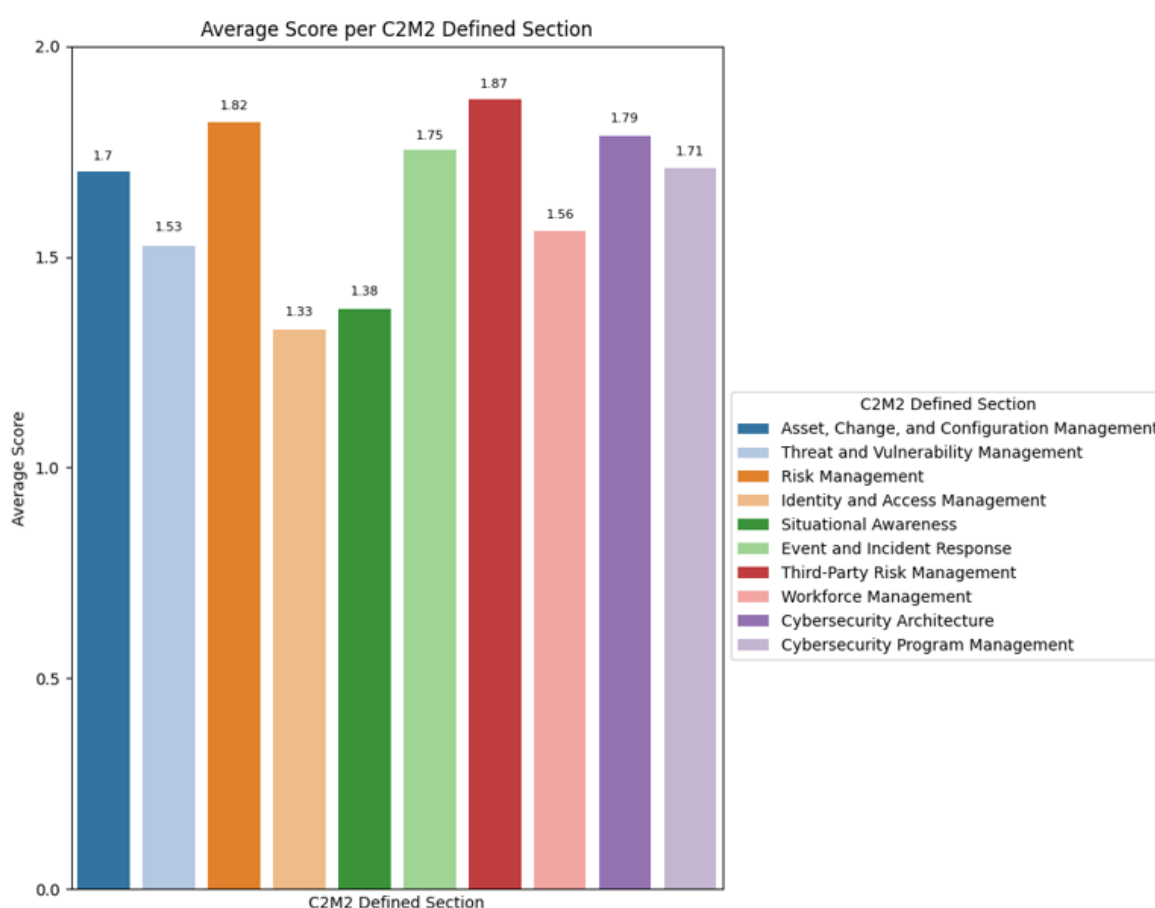


Figure 1. The average score for each domain as reported by the responses from the C2M2 assessment is represented on a scale of 0-2, where 0 is not implemented, 1 is partially implemented, and 2 is fully implemented.

The following are responses to the C2M2 survey questions.

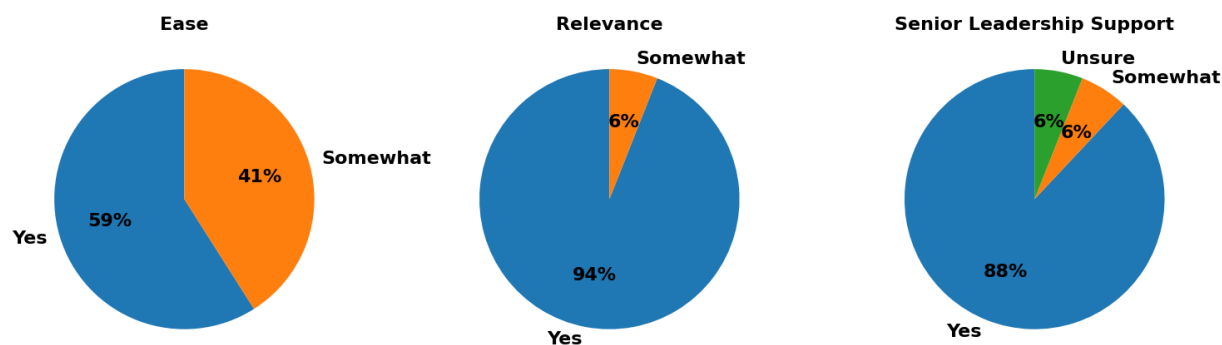


Figure 2.

Ease, Relevance, & Senior Leadership Support as reported by the survey respondents.

Most respondents (59%) found the tool easy to understand and use, while 41% indicated the tool to be somewhat easy to understand and use. Most participants (94%) considered the C2M2 tool relevant in improving the cybersecurity posture in the OT environment, whereas 6% felt as if the tool was somewhat relevant. Additionally, 88% of respondents reported strong support from senior leadership for using the C2M2 tool, 6% somewhat agreed, and the remaining 6% expressed uncertainty, as demonstrated by Figure 2.

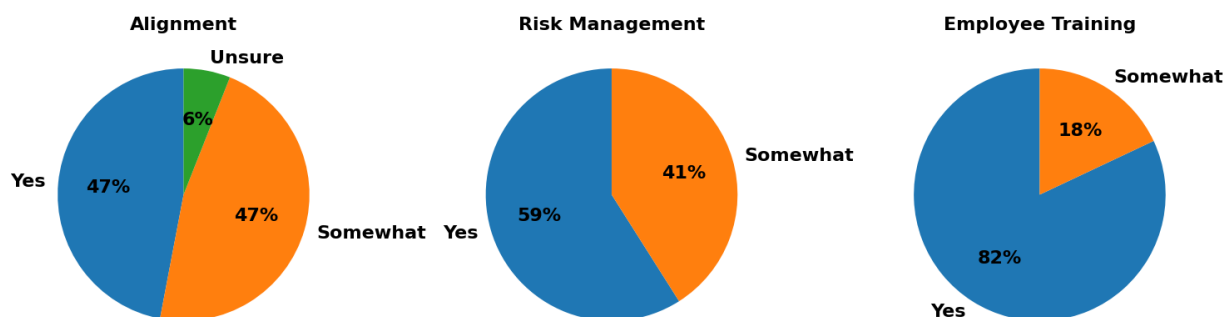


Figure 3. Alignment, Risk Management, & Employee Training as reported by the survey respondents.

Organizational policies aligned with proposed C2M2 standards according to 47% of respondents, while another 47% felt they were somewhat aligned, and 6% were unsure. The vast majority of respondents (59%) expressed confidence in the organization's risk management strategy after using the C2M2 tool, with 41% feeling somewhat confident. Employee cybersecurity training aligned with the standard suggested by the C2M2 tool according to 82% of respondents, and 18% felt the training somewhat aligned, as demonstrated in Figure 3.

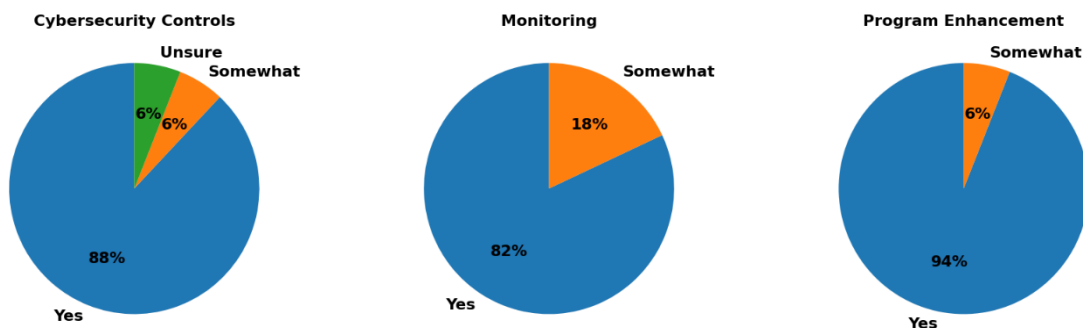


Figure 4. Cybersecurity Controls, Monitoring, & Program Enhancement as reported by the survey respondents.

As demonstrated in Figure 4, the cybersecurity controls recommended by the C2M2 tool were considered effective in mitigating risk by 88% of respondents, with 6% responding somewhat and 6% unsure. The C2M2 tool was felt to enhance the organization's ability to monitor and report cybersecurity incidents by 82% of respondents, while 18% felt the tool would somewhat enhance this capability. Adherence to the C2M2 tool standards was believed to positively affect the organization's overall cybersecurity posture by 94% of respondents, with 6% somewhat agreeing as demonstrated in Figure 4.



Figure 5. C2M2 Recommendation to Peers as reported by the survey respondents.

Adopting the C2M2 tool to other organizations or peers was recommended by 88% of respondents, with 12% answering they would somewhat recommend it as demonstrated in Figure 5.

Conclusion

Each organization must identify what works best in its unique environment. The research and feedback indicate that the C2M2 tool has the potential to serve as a valid cybersecurity framework for assessing and improving cybersecurity practices in OT environments.

The high scores in the Third-Party Risk Management (1.87) and Risk Management (1.82) domains demonstrate perceived confidence in these areas by those who participated in the study. The lower score in Identity and Access Management (1.33) highlights a need for improvement. The survey responses support these findings, with 88% of respondents agreeing that the C2M2 tool effectively

mitigates risks and 94% believing it enhances the organization's overall cybersecurity posture. 88% of respondents would recommend the adoption of the C2M2 tool to other organizations or peers.

The overall positive perception of the C2M2 tool's effectiveness and applicability in an OT environment suggests that it has the potential to serve as an effective benchmarking and roadmap application in SCADA environments. The survey results indicate that 59% of respondents found the tool easy to understand and use, while 94% felt it was relevant for improving cybersecurity in the OT environment, with 88% of respondents reporting strong support from senior leadership for using the C2M2 tool.

Organizations can choose to participate in the C2M2 assessment with the assistance of a facilitator to guide the process. A comprehensive walkthrough of the tool is available on the Department of Energy (DOE) website, addressing concerns about group participation (Department of Energy, 2023). This study relied on respondents' ability to navigate the tool without pre-assessment training, capturing their responses during their first use of the tool. The informal feedback received via email from the respondents regarding how the C2M2 assessment tool could be improved highlighted several areas. Many respondents suggested that the assessment could be made easier by reducing the number of questions and improving the wording and clarity of the questions. There was a sentiment to provide examples or more detailed descriptions to help understand the questions better. Some respondents felt that certain questions were repetitive and could be grouped to shorten the assessment. Including more specific examples of real-world controls corresponding to specific maturity levels was recommended. There were suggestions for a more OT-specific version of the tool, as some questions were not relevant to OT environments. Breaking the sections into more IT/OT focused questions could assist in identifying strengths and weaknesses more effectively. More explanations around the technologies discussed, as OT and IT environments sometimes use different terms for the same technologies, were also recommended. More detailed descriptions of the systems being asked about could help people from different work groups understand the questions better.

Though the findings were positive, the small sample size of the 17 respondents, assessing the OT environment individually, limits the conclusions we can draw when applying the C2M2 to every environment. The survey responses reflect the respondents' subjective perceptions, which may introduce bias. Expanding the sample size in future research may address the limitations of this study by including additional organizations that utilize SCADA systems to manage the OT component of their services.

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Cybersecurity Policies Aligned with NIST 800-53 for Small Medium Businesses

Michael Lehrfeld, PhD
Director, Institute of Cyber and Homeland Security
Department of Computing
College of Business and Technology
East Tennessee State University
1276 Gilbreath Dr., Box 70300
Johnson City, TN 37614
lehrfeld@etsu.edu
423.439.5347 (Contact Author)

David Asiamah | Ogechukwu Ada Lorretta Anoliefo | Wisdom Anagli | Emmanuel Somuah
Department of Computing
College of Business and Technology
East Tennessee State University
1276 Gilbreath Dr., Box 70300
Johnson City, TN 37614
asiamahd@etsu.edu
423.341.6667

Key words: NIST 800-53, Small medium business, GNS3, Security, Network

Introduction

In today's digital age, small businesses face growing challenges in maintaining secure and efficient networks, especially when operating across multiple locations. Our research, *Cybersecurity Policies Aligned with NIST 800-53 for Small Medium Businesses (SMBs)*, is an effort to tackle this challenge by developing a robust and scalable network infrastructure that meets the specific needs of a multi-location business. With the increasing importance of cybersecurity, this research focuses on creating a network that not only connects business branches seamlessly but also safeguards their operations against potential threats.

Using the network simulation tool, GNS3, we aim to and design a network environment that incorporates essential security measures, such as firewalls, access controls, and VPNs, alongside best practices for network management as outlined in the NIST 800-53 framework. The goal is to deliver a solution that ensures secure communication between branches while remaining scalable for future growth.

This project produced a fully documented and validated network design that meets business needs while addressing real-world cybersecurity challenges. It serves as both a learning experience and a valuable contribution to secure network design for small businesses.

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Literature Overview

This review section examines how NIST 800-53 influences cybersecurity policies and secure network design for SMBs. The framework offers essential guidelines for managing risks and implementing secure network practices, though its complexity sometimes challenges SMB adoption.

Ibrahim, Valli, McAteer, and Chaudhry (2018) highlight NIST 800-53 as a tool for enhancing secure network design through its core functions: Identify, Protect, Detect, Respond, and Recover. These functions ensure strong asset management, risk assessment, and access control. For instance, implementing controls like network segmentation and role-based access reduces vulnerabilities and strengthens security. A case study on local governments showed improvements in compliance tracking, incident response, and recovery planning, aided by tools like Microsoft Power BI (Ibrahim et al., 2018).

Lann and Carayannis (2010) argue that while NIST 800-53 provides a solid foundation, its rigid, checklist-based approach may limit adaptive responses to evolving threats. The lack of dynamic strategies can leave networks vulnerable, as demonstrated by the FAA data breach, where isolated control implementations failed to offer integrated defenses. They recommend frameworks like the Organizational Cognition Spiral (OCS) to foster dynamic learning and collaboration, which are essential for creating flexible and secure network designs (Lam & Carayannis, 2010).

Mierzwa (2023) highlights challenges SMBs face in adopting NIST 800-53 due to limited resources. Despite this, the framework boosts network resilience through asset inventory management and continuous monitoring. Tools like Cybersecurity Evaluation Tool (CSET) and CIS Controls help defend against ransomware and align cybersecurity with organizational goals (Mierzwa, 2023).

El-Hajj and Mirza (2024) emphasize simplifying NIST 800-53 to meet SMB needs. They suggest integrating tier-based solutions and practical tools like URL classifiers to address threats such as phishing and malware. These adaptations enable SMBs to scale their defenses while ensuring effective and efficient network security (El-Hajj & Mirza, 2024).

Nova (2024) highlights the benefits of combining NIST 800-53 with the Risk Management Framework (RMF), enabling continuous monitoring, system categorization, and reduced vulnerabilities. Scalable network designs help SMBs achieve compliance with regulations like GDPR and HIPAA while maintaining strong cybersecurity defenses (Nova, 2024).

Metin, Özhan, and Wynn (2024) critique the top-down nature of NIST 800-53, which can feel disconnected from SMB realities. They advocate for a bottom-up approach that integrates governance and culture into cybersecurity processes. Tailoring NIST 800-53 controls to align with SMB-specific risks fosters secure network designs by addressing vulnerabilities, ensuring compliance, and building trust with stakeholders. (Metin, Özhan, & Wynn, 2024)

Conclusively, Research shows that NIST 800-53 significantly impacts secure network design by improving risk management, reinforcing defenses, and ensuring compliance. However, its complexity demands tailored, resource-efficient adaptations for SMBs. By integrating practical tools and dynamic strategies, SMBs can fully leverage NIST 800-53 to create secure, scalable, and sustainable network designs.

Methodology

The methodology for this research focuses on the Cybersecurity Policies Aligned with NIST 800-53 for SMBs. By adhering to the NIST 800-53 security controls framework, this approach ensures a robust, scalable, and cost-effective solution. The methodology is divided into critical steps, each thoroughly detailed to capture the depth and rigor of the process.

Data Collection and Requirements Analysis

The research began with a thorough data collection to understand SMB operational needs, using the fictitious DOWE Tech Inc. as the primary case study. Stakeholder interviews provided insights into business operations, data sensitivity, and network performance requirements. These discussions clarified key aspects, including device diversity, user roles, and workflows across the three locations: Johnson City (headquarters), Asheville, and Greenville.

A comprehensive infrastructure analysis identified the need for 115 users and 190 devices, including desktops, servers, IoT devices, and VoIP phones. Additionally, provisions were made for 15 remote users requiring secure VPN access. High-priority applications like ERP, CRM, and cloud collaboration tools were also identified, guiding the design of a network that balances performance, security, and scalability.

Overview of GNS3

Graphical Network Simulator 3 (GNS3) was chosen to simulate and validate the network design. This open-source platform integrates virtual and physical devices into a software-based environment, enabling real-time testing without deploying physical hardware in the initial phase.

GNS3 offered several advantages, including replicating inter-branch connectivity via secure VPN tunnels and testing security protocols, redundancy, and failover mechanisms. Simulated scenarios like traffic surges and hardware failures validated the network's reliability, scalability, and data protection. It also allowed evaluation of remote worker integration while maintaining high security.

Network Design and Implementation

The network design consisted of logical and physical layouts. The logical layout used VLANs to segment the network, improving traffic management and security. Sensitive environments like development and IoT systems were isolated from general office traffic, and separate segments for guests and remote workers minimized internal exposure.

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The physical layout included Cisco ISR routers, Catalyst switches, firewalls, and Meraki wireless access points for robust connectivity. Each branch office had local infrastructure for independent operation during HQ downtime, with Greenville serving as the disaster recovery site, housing backup servers and redundant network paths.

Remote workers accessed the network via secure VPNs with multi-factor authentication (MFA), ensuring restricted access to sensitive systems and segmentation from internal resources using dedicated policies.

Application of NIST 800-53 Controls

The **NIST 800-53 framework** served as the foundation for implementing robust cybersecurity controls in DOWE Tech Inc.'s network infrastructure. This framework provided a systematic, scalable, and comprehensive approach to managing risks, emphasizing the principles of **confidentiality, integrity, and availability (CIA)**. The framework's extensive catalog of controls guided every aspect of the design and implementation process, ensuring compliance with industry best practices and enabling scalability for SMBs.

Access Control (AC)


NIST 800-53r5 FAMILY	OBJECTIVES AND POLICIES	NIST CONTROLS
 <p>Access Control (AC)</p>	<p>Objective: To ensure that only authorized employees can access sensitive systems and data, based on their roles and responsibilities.</p> <p>Policies:</p> <ul style="list-style-type: none"> o Role-Based Access Control (RBAC): We'll assign specific roles to all employees and adjust their access accordingly. We'll review access rights every quarter to ensure no one has more access than they need. o Multi-Factor Authentication (MFA): To protect critical systems, everyone will need to pass two-step authentication. This will be reviewed monthly to make sure everything is working properly. o Session Timeouts: If someone is idle for more than 10 minutes, they'll be automatically logged out to prevent unauthorized access. o Access Logs: Logs of system access will be reviewed every two weeks to spot any suspicious activity. 	<p>AC-2, AC-3, AC-6, AC-7</p>

Figure 1: NIST 800-53r5 family - AC (it's policies, controls & policy basis). For the main document, refer to the NIST 800-53R5 Family link in the reference section

AC in NIST SP 800-53 addresses resource protection against unauthorized access.

Role-Based Access Control (RBAC) was implemented per NIST's model (Ferraiolo et al., 2001), ensuring access was strictly role-based to minimize privilege misuse and insider threats.

- Administrative staff were granted limited access to general office systems.
- Developers were restricted to development servers, with no production access.

RBAC was enforced by configuring group-based policies using directory services, allowing scalable permission management and reducing manual account handling (Ferraiolo et al., 2001; Novriansyah, 2024).

MFA was employed to strengthen security, especially for sensitive roles. This ensured access required credentials plus a second factor, like time-based one-time passwords (TOTP), aligning with NIST SP 800-53 AC-2 and AC-3 controls.

Audit and Accountability (AU)


 <p>Audit and Accountability (AU)</p>	<p>Objective: To monitor and log system activity, ensuring we can detect and respond to security incidents quickly.</p> <p>Policies:</p> <ul style="list-style-type: none"> o Audit Logs: All systems will log activity automatically, and these logs will be checked every two weeks to catch anything unusual. o Alerts for Suspicious Activity: We will set up automated alerts for things like failed login attempts or access at odd hours. o Audit Log Storage: Logs will be kept for one year. Every quarter, we will archive older logs to free up space and ensure compliance. <p>AU-2, AU-6</p>
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Figure 2: NIST 800-53r5 family – AU (it's policies, controls & policy basis).

The AU family ensured transparency and traceability in the network. Logs from routers, firewalls, and servers were aggregated into a centralized SIEM system, enabling real-time analysis and long-term storage per AU-2 and AU-4 requirements.

Automated tools scanned logs for anomalies like unauthorized logins or unusual data transfers, flagging them for review. Regular audits were conducted to ensure compliance and identify vulnerabilities.

Incident Response (IR)


 <p>Incident Response (IR)</p>	<p>Objective: To detect, respond to, and recover from security incidents efficiently.</p> <p>Policies:</p> <ul style="list-style-type: none"> o Incident Response Plan: We'll review and update the plan every May and November. o Quarterly Incident Drills: Every three months, we'll simulate a cybersecurity attack to ensure we're ready to respond. o Incident Reporting: Any security incident must be reported within 24 hours and fully documented within 48 hours. <p>Incident Response Workflow:</p> <p>1. Incident Detected -> 2. Response Team Engaged -> 3. Containment -> 4. Recovery -> 5. Post-Incident Review</p> <p>IR-4, IR-6, IR-8</p>
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Figure 3: NIST 800-53r5 family – IR (it's policies, controls & policy basis)

Incident response mechanisms were implemented for proactive threat detection and rapid recovery. A hybrid IDS/IPS monitored network traffic in real-time, identifying malicious patterns and blocking unauthorized activities, adhering to NIST SP 800-53 IR-4, IR-6 and IR-8 controls.

Incident response playbooks, aligned with the RMF, outlined actionable steps for breach handling. Regular simulations, including penetration tests and mock breaches, validated these procedures.

System and Communications Protection (SC)


 <p>System and Communications Protection (SC)</p>	<p>Objective: To protect the confidentiality and integrity of our communications and systems.</p> <p>Policies:</p> <ul style="list-style-type: none"> o Encryption: All sensitive data with AES-256 both in transit and at rest will be encrypted. Encryption keys will be rotated annually. o Firewall and IDS Monitoring: We will review firewall rules and monitor IDS/IPS systems monthly to protect against threats. o Data Transmission: All data sent over the network will be encrypted to ensure security. <p>SC-8, SC-13, SC-23</p>
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Figure 4: NIST 800-53r5 family – SC (it's policies, controls & policy basis).

The SC family ensured data security in transit and at rest. IPsec for VPN tunnels and TLS for web applications were deployed, enabling end-to-end encryption and preventing interception. Firewall rules were configured to allow only authorized traffic, using stateful inspection and deep packet analysis, aligning with NIST SP 800-53 SC-7 and SC-13 controls.

The VPN infrastructure, designed for 15 remote users, employed dynamic encryption key generation for security and scalability, ensuring session isolation and least privilege access.

Tailoring and Continuous Monitoring

A tailored approach aligned NIST controls with DOWE Tech Inc.'s operational needs. Risk assessments identified critical areas, customizing controls to balance security, performance, and cost.

Continuous monitoring, integrated into the RMF, ensured resilience against evolving threats through:

- Regular vulnerability scans for timely patching.
- Automated compliance checks to uphold NIST standards.
- Periodic security policy and access control reviews.

This strategy adhered to NIST 800-53 CA-7, reinforcing ongoing security updates.

Testing and Validation

Testing and validation were key components of the methodology. The GNS3-simulated network topology underwent stress tests to assess peak traffic handling and scalability. Simulated cyberattacks evaluated the resilience of encryption, firewalls, and access controls. Failover mechanisms were tested by simulating headquarters server outages, confirming the disaster recovery site in Greenville could seamlessly maintain operations.

Reporting and Documentation

Extensive documentation was maintained to ensure transparency and replicability. The documentation covered all aspects of the network design, from initial configurations and security protocols to the results of testing scenarios. Recommendations for maintaining the network's security posture were also included, emphasizing regular audits, staff training, and proactive monitoring.

The final methodology offers a blueprint for SMEs aiming to establish secure, scalable network infrastructures. By leveraging GNS3 and adhering to NIST 800-53, this approach provides a cost-effective yet comprehensive solution to modern networking challenges.

Results and Implications

This section highlights the outcomes of our project, specifically focusing on how the NIST 800-53 security controls were mapped and how it was implemented in the Graphical Network Simulator 3 (GNS3). Using the NIST 800-53 framework, essential control families, and requirements were identified.

Key control families, including Access Control (AC), Awareness and Training (AT), Security Assessment and Authorization (CA), Identification and Authentication (IA), Risk Assessment (RA), and Privacy Controls (PC), were integrated into the GNS3 network design.

Critical elements implemented directly in the mapping included:

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- **Access management**, ensuring secure, restricted entry to sensitive systems within the network.
- **Audit processes**, tracking and analyzing network activity for breaches.
- **Continuous monitoring**, identifying and addressing vulnerabilities in real-time.

Although not all NIST 800-53 controls were applied, the system was simulated to ensure effective compliance, gap analysis, firewalls and intrusion detection systems, and the validation of real-life threats.

This research demonstrated how practical security policies for SMBs showcased their feasibility and effectiveness. By leveraging GNS3's flexibility, the project successfully highlighted strengthened cybersecurity policies, scalability, and public education on robust network security.

Conclusion

This project successfully demonstrated the application of NIST 800-53 cybersecurity controls in designing a secure, scalable network for small and medium-sized businesses (SMBs) using GNS3. By integrating critical security measures such as role-based access control, encryption protocols, and incident response systems, the network design ensures both operational efficiency and sturdy defense against potential cyber threats. The methodology provided a cost-effective and replicable framework for SMBs to enhance their cybersecurity posture while addressing real-world challenges.

For future endeavors, further work could focus on automating compliance monitoring and integrating advanced threat detection technologies, such as AI-powered intrusion detection systems. Additionally, exploring hybrid cloud solutions and zero-trust architectures could bolster the security and flexibility of the network. Lastly, conducting longitudinal studies to assess the long-term effectiveness of the implemented security measures in live environments would provide invaluable insights for continuous improvement. These advancements could help future researchers and practitioners build upon this foundation, ensuring SMBs remain resilient in an evolving threat landscape.

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UNDERSTANDING SME CYBERSECURITY: A LITERATURE REVIEW ON AWARENESS AND RISK EXPOSURE

Joshua Poteet
 Department of Computing
 College of Business and Technology
 East Tennessee State University
 PO Box 70711
 Johnson City, TN 37614
poteetjd@etsu.edu
 423.439.5328

Brian T. Bennett
 Department of Computing
 College of Business and Technology
 East Tennessee State University
 PO Box 70711
 Johnson City, TN 37614
bennetbt@etsu.edu
 423.439.5328

Key words: Cybersecurity, small business, awareness, risk, framework

Introduction

The world of business is a diverse one by many metrics—size, profit, good or service offered, reach—the list continues. The vast majority of businesses worldwide are small and medium-sized, defined generally as businesses with 500 or fewer employees, which accounts for 99.9% of those in the United States. This accounts for 44% of the US's GDP and 45.9% percent of employed Americans (US Chamber of Commerce, 2024).

Nevertheless, research indicates that these small and medium-sized firms lack proper cybersecurity practices (Junghans et al., 2024; OECD, 2021; Patterson et al., 2023; Remmele & Peichl, 2021; Tam et al., 2021). This common theme is shared across the body of cybersecurity research concerning small- and medium-sized businesses (referred to henceforth as SMEs). Much of the research concerns how best to adapt cybersecurity practices for the many different unique circumstances of businesses so small that adhering to the industry standard for cybersecurity is unfeasible, such as education of employees or crowdsourcing cybersecurity resources (Blancaflor et al., 2024; de Vicente Mohino et al., 2021; Emer et al., 2021; Klitis et al., 2024; Kocksch & Jensen, 2024; Rawindaran et al., 2022; Remmele & Peichl, 2021; Shojaiifar & Järvinen, 2021). This research is in response to an easily identifiable problem- in the U.S. alone, cyberattacks on SMEs comprised 43% of total data breaches in 2019. Many small business owners/employees report that they feel their organization is not worth targeting; clearly, this is not the case (Verizon, 2021).

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From this, it is easy to see that the research is correct in claiming that SMEs are under-protected. However, the current research needs more specific insights into where and how SMEs lack protection; are SMEs lacking in the awareness of cyber threats they need to adequately address their security? How cyber-aware are SMEs? What resources are available to SMEs to address this lack of cyber awareness?

The proposed research seeks to investigate these questions by conducting a survey on SMEs in the Appalachian region to obtain a cross-section of their current cybersecurity posture and comparing the data to industry-standard benchmarks for security. This survey will provide insights into how and where SMEs are more vulnerable to cyberattacks than other demographics.

This research specifically plans to ask and answer the following questions:

- What is the level of cybersecurity awareness among SMEs that use internet services in their daily operations?
- What is the cybersecurity risk level of SMEs who use the internet in their operations?
- To what extent do SMEs implement industry standard cybersecurity principles in their organization, as defined by the FFIEC framework?

Literature review

As a first step, this work reviews the key literature that addresses these questions. This review searched the ACM Digital Library, IEEE Database, and ProQuest Computer Science Database using key terms such as “Cybersecurity,” “Small Business/SME,” “Threat/Attack,” “Education,” and “Awareness.” The focus was primarily on research addressing people untrained in IT/Cybersecurity since a lack of awareness among employees is commonly identified as a cause of the high cyberattack rate.

This literature review aimed to investigate the gap in the body of research regarding how SMEs approach cybersecurity by searching for research on how closely they adhere to industry standard practices such as recognized frameworks, surveys of mandatory cybersecurity training for employees, or other related topics.

In all, 19 sources had sufficient connections between small businesses and cybersecurity to merit investigation. Only one source included similar research questions (Blancaflor et al., 2024), but did not specify its sample size. However, the number of SMEs in (Blancaflor et al., 2024)’s sample seems too small for an accurate representation because of the reported percentages; additionally, the results do not provide a comprehensive picture of its subjects’ cybersecurity posture.

Many of the studies reviewed noted that cybersecurity awareness was an area of weakness in small businesses when discussing weaknesses in SME cybersecurity posture (Douligeris, 2024; Emer et al., 2021; Kocksch & Jensen, 2024; Rawindaran et al., 2022; Shojaifar & Järvinen, 2021). Solutions to this problem were the focus of several studies, with the GEIGER and NERO initiatives being the largest (de Vicente Mohino et al., 2021; Klitis et al., 2024). Despite this, no survey details how ‘cyber-aware’ the SME population is in any of the reviewed research. Research also lacks data on how much risk of cyberattacks SMEs expose themselves to as a result of lack of cyber-awareness. One study found that few SMEs in its sample could fully implement industry standard procedures and addressed risk but did not provide specific

percentages (Kocksch & Jensen, 2024). As previously mentioned, only one study investigated SME adherence to industry standard frameworks (Blancaflor et al., 2024), but it may have included inaccurate results due to a small sample size.

Several other studies are closely aligned with the current research goals, but do not attempt to discuss any of the topics covered by the research questions. These studies provide insight into the SME ecosystem but do not match the stated goal of this literature review. Additionally, none of the case studies or surveys on SMEs (Blancaflor et al., 2024; Kocksch & Jensen, 2024; Patterson et al., 2023; Rawindaran et al., 2022; Rohan et al., 2023; Shojaifar & Järvinen, 2021; Tam et al., 2021) or the educational studies (de Vicente Mohino et al., 2021; Junghans et al., 2024; Klitis et al., 2024; Remmele & Peichl, 2021) were conducted in the United States, meaning the results may not compare.

From this review of the literature, we can confirm that there are few answers to the research questions this study asks. Many studies have enough information to hint at the state of cybersecurity awareness in SMEs, but none provide satisfactory answers. To find the answers to the questions put forward by this paper, this study proposes a methodology targeted at SMEs, taking the form of a survey.

Proposed Methodology

Instrumentation

The proposed research plans to use asynchronous surveys based on the FFIEC's cybersecurity assessment tool to gather data. While this survey was originally intended for use by financial institutions, the language in its questions is not exclusive to financial institutions. This survey maps to the NIST Cybersecurity Framework (FFIEC, 2015) and has been found to be effective and adaptable (Chourasia et al., 2024). The survey must be modified to fit the application, as SMEs have different structures and skillsets; the original survey is not designed with laypersons in mind. One or more pilot surveys will be conducted to collect feedback regarding the instrument before it is deployed at scale.

This survey will ask the user whether their organization utilizes a comprehensive variety of industry-standard practices in their operations via simple yes or no questions (FFIEC, 2024). The survey will have additional questions to identify the size of the organization's "attack surface," including social media accounts, computers/devices in the workplace, websites, or any avenue through which an external threat could access confidential data or damage operations. The project will use this modified tool to accurately capture an organization's cybersecurity posture, even if it does not have an official cybersecurity policy or dedicated cybersecurity staff.

Data Collection

This study will target a specific population—SMEs in the Appalachian region. Therefore, sampling must ensure that only subjects meeting these requirements would qualify. Since the target population consists of small and medium-sized businesses and not individuals, recruitment procedures must reach the largest number of those businesses as is feasible. Though these procedures are still in development, several have been identified as candidates, such as contacting local Chambers of Commerce for willing participants.

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The survey will be directed toward organizations that conduct a substantial amount of business operations online. These operations could include any action, internal or external, that requires internet access: emails, third-party services, internet-connected computers and systems, or online storefronts. Third-party credit card readers will not be considered; while connected to the internet, these connections are managed entirely by external entities. SMEs typically have no control over how credit card processing is secured. The survey will also cover phishing techniques, despite not necessarily requiring the internet or official company channels to operate.

The survey will be distributed via email to the organization's chief technology officer or equivalent. The survey will allow one month for recipients to submit responses. Reminders will also be issued twice—once at two weeks and another at three weeks—to increase the response rate. The sample size target will be 20 or more valid responses. After responses are received, another month will be allowed to analyze data.

The classification framework put forward in (Shojaifar & Järvinen, 2021) will be used to organize responses, and descriptive analysis will be carried out on the collected data to draw statistics that answer the research questions, as well as showing which areas of cybersecurity SMEs are weak points.

Limitations

The proposed research has several potential limitations. The first and most impactful is the sample size; as participation in the survey is voluntary and at the recipient's leisure, receiving fewer than expected responses may make for a poor representation of the population. Additionally, more technologically literate SMEs are likely to respond to the survey than less literate organizations, which may lead to skewed results in the study. Execution of the study will also require IRB review to ensure participants are protected.

Conclusions/Future Research

The proposed research would help fill a significant gap in the current understanding of SMEs and their use of cybersecurity. The proposed methodology is feasible and straightforward. This project will provide essential insight into an understudied sector seriously impacted by cybercrime in the United States. Cybersecurity in business is increasingly important, as more and more business operations occur online- many modern businesses even exist without a physical office at all. Cybercriminals take billions of dollars each year from a variety of victims, but like any other criminal, they prefer easy targets. Research suggests that SMEs are under-protected against cybercrime threats. While no data exists to disprove this belief, there is also little to prove it true, making this research essential for the field.

The specificity of this research brings additional functionality to the results this study, if successful, will create. Many government initiatives across the globe exist to try and address the problem of poor cybersecurity in SMEs, but without specific insight into where the problem is, those initiatives are unlikely to be fully effective. Many of these initiatives simply provide funding for SMEs to improve without proper guidance. SMEs that do not understand how to improve their cybersecurity posture may not make good decisions, even with the provided funding. This research will provide SMEs with the knowledge necessary to address their cybersecurity needs.

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AI IN THE APPALACHIAN HIGHLANDS SMALL BUSINESS ECOSYSTEM: A FRAMEWORK FOR SUCCESS

Mariatu Mahmoud
Department of Computing
East Tennessee State University
Johnson City, TN 37614
mahmoud@etsu.edu
(423) 773-7854

Dr. Chelsie Dubay, Faculty Advisor
Department of Computing
East Tennessee State University
Johnson City, TN 37614
dubayc@etsu.edu
(423) 439 -6959

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Introduction

Appalachia is no stranger to hardship. Most natives of the area grew up surrounded by the stories and struggles held within its mountains—the pride, the resilience, and the persistent stereotypes that often define it to outsiders. For some, there exists an unspoken charge to overturn these assumptions, but changing perceptions is not always an easy task. One such change agent, entrepreneurialism, embodies the region’s spirit of independence, resilience, and creativity. Small businesses, often family-run and rooted in tradition, serve as lifelines for their communities, offering economic stability and a sense of identity. Despite persistent hardships such as limited access to funding, economic volatility, and systemic neglect, Appalachian entrepreneurs continue to adapt and thrive. Their ability to persevere through challenges reflects the enduring strength of the region, where innovation and resourcefulness have always been necessary for survival. Small businesses in Appalachia are more than economic entities; they are symbols of hope and determination, keeping the culture alive in the face of adversity.

Small businesses are a driving force in the Appalachian economy. The region boasts of an impressive 2.4 million small businesses. In 2024, despite having the largest number of economically depressed counties, Central Appalachia touted an increase in loan dollars, signifying a renewed interest in the development and sustainability of small-town entrepreneurialism. Despite this renewed interest and capital investments, some small businesses cannot survive the volatile economic landscape. The Bureau of Labor Statistics (BLS) reports that, for the East South-Central region of the United States, over 22% of businesses created in 2022 failed to persist into the next year. The same report illustrated similar statistics for most years prior, with an average failure rating of 21%. While numerous factors may contribute to *Proceedings of the Appalachian Research in Business Symposium, Marshall University, March 27-28, 2025.*

small business failure, one study noted that too many entrepreneurs lack the ability to navigate all the complexities involved in starting and continuing to operate a business.

Artificial intelligence (AI) has changed how businesses function and profoundly affects how the tools used help increase sustainability. It has been demonstrated that AI-enhanced technologies minimize waste, ensure the best resource allocation, and help make decisions based on data. For example, Liu et al. (2023) stress these tools' economic resilience enhancement aspects, facilitating businesses to negotiate volatile markets using their advanced metrics.

Despite such transformative potential, the acceptance of AI has been quite patchy, particularly in economically disadvantaged regions like Central Appalachia. The obstacles are subsidization due to a lack of financial resources and the high implementation costs. Further, resistance to change within existing organizational cultures and structures complicates strategies for speedy integration. Capec and Counts (2019) cite these stumbling blocks as constraints to technology integration: low financing and doubts about AI's worth discouraging many businesses from integrating the technology. Ethical concerns, such as data privacy and algorithmic bias, are issues that exacerbate inertia.

Methodology

This study used a basic qualitative approach. The participants in this study were selected through purposive sampling, being careful with variation in industry type so that a full understanding of challenges and opportunities regarding AI integration could be gathered. The study used semi-structured interviews for flexibility regarding how many and in what nature conversations surrounding AI usage, benefits, and impediments of usage could take place. After interviewing subjects, data were analyzed thematically to code instances across the data that emerged regularly in repeating forms. The work presented in this short paper is an excerpt from an expanded thesis project.

Results and Implications

Participant responses congealed to inform a framework that can guide the success of AI integration in small business operations. This framework hinges on three core pillars: mentorship and training, financial accessibility, and operational efficiency. These factors create an ecosystem where businesses can harness AI for competitive growth and innovation.

Mentorship and Training: Cultivating AI Literacy

Businesses thrive when they receive structured guidance in AI adoption. Mentorship plays an important role in bridging knowledge gaps, offering both technical expertise and strategic insights. Participants consistently emphasized the influence of experienced mentors in navigating AI complexities. One business owner credited their mentor, stating, "Without Joe's help, it would have been incredibly difficult to get started with AI." These mentoring relationships demystify AI and enable business leaders to make informed decisions about AI tools and strategies.

Further, training programs reinforce this learning, equipping businesses with the skills necessary to integrate AI effectively. Task-specific workshops and continuous learning initiatives reduce resistance, boost confidence, and shorten the learning curve. One participant described their *Proceedings of the Appalachian Research in Business Symposium, Marshall University, March 27-28, 2025*.

training experience: “What would have taken me months to figure out, I learned in one session.” Such programs ensure that AI implementation is not just theoretical but immediately actionable, allowing businesses to streamline operations and maximize efficiency.

Financial Accessibility: Enabling AI Investment

Limited financial resources often hinder AI adoption, particularly in regions like Central Appalachia. Access to grants and low-interest loans allows businesses to experiment with AI without incurring significant financial risk. One participant shared, “I’m waiting for funding to pay for AI subscriptions before I can even set up workshops.” Grants support initial adoption, while long-term financing options enable businesses to scale AI investments strategically.

Participants emphasized the need for financial guidance, particularly in underserved regions. One business owner noted, “There aren’t many places here where people can get solid financial advice. Grants and low-interest loans could change that.” Structured financial support reduces entry barriers, allowing businesses to leverage AI for sustained growth and regional economic development.

Operational Efficiency: Driving Innovation and Growth

AI optimizes workflows, automates repetitive tasks, and enhances decision-making, increasing efficiency and productivity. Business owners in this study reported that AI-driven automation saved time and resources, allowing them to focus on higher-value tasks. One participant noted, “AI has immensely streamlined our marketing efforts.” Others highlighted improved customer engagement and content creation, with AI tools enabling businesses to maintain a consistent brand presence across digital platforms.

Beyond marketing, AI fosters better decision-making through data analytics. Businesses that leveraged AI-driven insights reported improved strategic planning and customer targeting. One participant shared, “AI analytics refine our marketing strategy, helping us tailor content to our audience more precisely.” These advancements position Appalachian businesses to compete in broader markets, enhancing both visibility and long-term viability.

Conclusion

The application of AI by small businesses throughout the Appalachian Highlands holds significant potential. These potential successes can only be fully realized by developing appropriate support systems and sufficient resource allocation. Key recommendations arising from this study include increasing AI literacy among business owners and employees, better access to financial resources for AI implementation, and the development of ethical, technological practices that align with Appalachian values. Future research into the long-term implications of AI on regional economic development within Appalachia is thus warranted, such as changes to job growth, business sustainability, and community welfare.

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THE SUCCESS FORMULA: INTRUSIVE ADVISING AS A GAME-CHANGER IN ACCELERATED COMPUTING EDUCATION

Christel Young, Ed.D.
Department of Computing
College of Business and Technology
East Tennessee State University
BlueSky Tennessee Institute
1 Cameron Hill Circle
Chattanooga, TN 37402
Youngcd1@etsu.edu
423.439.

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Introduction

The BlueSky Tennessee Institute, a pioneering educational partnership between East Tennessee State University (ETSU) and BlueCross BlueShield of Tennessee (BCBST), has been esteemed as one of the most innovative solutions for increasing the number of career-ready computing professionals in the state. The program is an accelerated Bachelor of Science degree in computing with a major in information systems. Students are enrolled in a cohort of around 30 students. The cohorts take their core classes together and finish their degree in 27 months. While in the program, students engage in a three-semester-long paid internship within the information technology department at BCBST.

One fundamental component of the program is the implementation of an intrusive advising model. A site director who serves as the academic advisor and the student success coach partner to provide support beyond what would be experienced in traditional computing programs. This has proven to be a crucial part of the educational program. For successful academic outcomes, implementing structured student support for high-intensity programs provides an additional layer of support required to increase the chances of success. Early results suggest this model could be adapted and scaled for similar corporate-educational partnerships.

This short paper aims to share the program's early successes, highlighting the pivotal role of the intrusive advising model, which is used to support student success. Included are a discussion of the accelerated computing educational program, an explanation of the intrusive advising model, program outcomes and early results, lessons learned and challenges the program has faced. Accelerated education offers a viable solution to the career-ready pipeline crisis when paired with structured support like intrusive advising.

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Accelerated Computing Education

Nationwide, it is projected that there will be around “47,500 openings for computer systems analyst positions” each year (TN Department of Labor and Workforce Development, 2025). BCBST was not immune to the problem. They launched the search to find the optimal partnership and develop career-ready professionals who could enter the workforce quickly.

The partnership between BCBST and ETSU was based on a tailored educational plan that maximizes students' opportunities to engage in coursework tailored to the corporation's direct needs. To maintain accreditation standards, an academic program of study was developed to accelerate the process while integrating targeted career preparation tailored specifically for BCBST.

Students attend classes year-round to complete the degree in 27 months, including Winter and Summer semesters. Students often have full course loads totaling 19-21 credit hours, sometimes more. With the shortened timeframe, students must engage in a prescriptive academic program to maintain an aggressive timeline to graduation.

ETSU Department of Computing faculty provide core computing class instruction at the corporate campus. In contrast, general education course instruction is provided by other ETSU faculty through online asynchronous and synchronous class sessions. Smaller class sizes and immediate access to professors and mentors strengthen student-faculty relationships.

Intrusive Advising Model

Advising in traditional settings is often limited in scope, with students frequently engaging with advisement staff at the beginning and end of a semester or when problems arise. The intrusive advising model goes beyond the limited scope of the traditional advising model by engaging with students regularly, where discussions are not limited to only academic topics (Rose, 2023). These advising sessions are mandatory. The frequent touchpoints with students allow for early and frequent interventions to reduce attrition while increasing overall success.

The intrusive advising model incorporates individual one-on-one bi-weekly meetings with the program's Student Success Coach. During these sessions, students have the opportunity to discuss academic progress, challenges, and successes, as well as personal challenges that may threaten student success. Additionally, students may meet with the Site Director, who serves as the academic advisor for the program, to monitor progress and make adjustments to the educational program, if needed.

A key element that contributes to the success of the intrusive advising model is the unique partnership between the faculty of the program and the student success coach. Faculty members must update grades at least every three weeks and allow the Student Success Coach access to the grades. The Student Success Coach carefully reviews the grades. Information gathered from students' academic progress is used to develop strategic and targeted intervention plans for at-risk students proactively. The BlueSky program staff meets bi-weekly to discuss concerns openly and provide strategies that work for students experiencing challenges.

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Coupled with the efforts of the program staff is the availability of direct industry mentorship and networking support. Students are mentored by the corporate partner's executive leadership, supervisors, and assigned buddies who help students navigate the educational journey. This mentorship does not stop upon graduation and supports professional development and career satisfaction.

With the rigor of an accelerated computing program and the challenges college students may routinely face, additional wraparound support is critical and necessary for student success. Incorporating frequent touch points with students provides information and resources to minimize poor behavior choices, academic failure, and other situations that may threaten student success. The hallmark of the BlueSky intrusive advising model is the student, faculty, and staff collaboration, which provides support early and often, leading to increased persistence.

Program Outcomes and Early Results

Two critical areas, retention and job placement rates, have been positively impacted in part by implementing the intrusive advising model. The BlueSky program, for which intrusive advising is a foundational and non-negotiable component, touts a remarkable 91% retention rate for Cohort 1 and a 93% retention rate for Cohort 2 from year 1 to year 2 (AccelerateED, 2024; Emerson, 2022; Ford, 2024; B. Leon, personal communication, September 6, 2024). The National Student Clearing House (2024) shared that the national retention rate for students who start school and return to any school in the second year was 76.5% in 2022. While these are early figures, the numbers are promising and highlight a need to reconsider the role of advising in student success, especially for those enrolled in accelerated programs.

The first cohort to participate in the program graduated in December 2024. All Cohort 1 members graduated on time. Of those graduates eligible for employment in the United States, 100% accepted employment with BCBST. However, they were not obligated to do so as a condition of their enrollment in the BlueSky program. As a benefit to the corporate partner, the graduates who are now employees have had the opportunity to glean from their now coworkers. They have actively engaged with industry leaders and, even more specifically, with leaders within the organization. They have had the opportunity to adjust to the corporate culture and prepare for the rigor required of professionals in the fast-paced computing industry.

Lessons Learned and Challenges

With any program in its infancy stages, multiple lessons have been learned that inform efforts to scale and continue the program. From understanding the impact on student perseverance, choice, and agency to navigating transitioning to a corporate environment, students conquer challenges with the strategic support of the program's faculty and staff. The significant lesson learned is that the program works. The success, however, is attributed to the flexibility and willingness of the students, faculty, and staff to be transparent and collaborative, especially with the implementation of the intrusive advising model.

Understanding how to shape the program to meet students' needs is critical for its success. Students' needs extend far beyond the classroom. While part of the program addresses many of their basic

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needs, such as providing food and transportation stipends, intrapersonal needs—like a sense of belonging and connection—are also essential. This is best supported by the intrusive advising model in tandem with the other program elements that support student success.

While the early outcomes are promising, challenges remain in ensuring long-term program sustainability and student success. Students must navigate personal challenges while remaining fully engaged in the program. One significant challenge encountered and often discovered during the bi-weekly meetings with the Student Success Coach was the need for housing. Since the program is not located on a university campus, housing is not included as part of the program. Consequently, students are expected to arrange housing accommodations independently. Housing insecurity can often derail the students' academic plans (Young & Pentón Herrera, 2023). By meeting with students frequently and early, students facing housing insecurity were provided with support and community resources. This allowed students to focus on academic progress and less on challenges to their success.

Conclusion

A novel application of intrusive advising developed to support students in the BlueSky program has proven to be a foundational component contributing to the program's success. While no definitive plans are in the works to scale the BlueSky program beyond the current enrollment numbers, the program serves as a model of success for other workforce development programs. Higher education institutions should consider integrating intrusive advising (e.g. regular check-ins, faculty-staff collaborations, industry mentor partnerships) to improve student retention, graduation rates, and workforce readiness. This would require additional staff and smaller caseloads, but the increase would yield an increase in graduation rates and greater student connection and sense of belonging.

Workforce development programs and higher education institutional leadership should strongly consider implementing intrusive advising as a wraparound service component for students. Implications for the intrusive advising model are far-reaching. Not only is it essential to provide support for students, but institutions must be intentional, especially when supporting students enrolled in accelerated programs. This has proven especially helpful when the curriculum is accelerated, and the stress level students experience is more significant than in traditional education programs. Institutions should actively consider adopting intrusive advising to bridge the gap between academic preparation and workforce readiness. The BlueSky model offers a replicable framework for success, paving the way for scalable solutions in higher education and industry partnerships.

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BALANCING TRADITION AND MODERNITY: CEO AGE, MBA EDUCATION, AND THEIR EFFECTS ON SOCIAL COMPLIANCE IN GLOBAL SUPPLY CHAINS

Amir Naderpour
College of Business
Eastern Kentucky University
521 Lancaster Avenue
Richmond, KY 40475
amir.naderpour@eku.edu
859-622-1094

Ki-Jung Kim
College of Business
Eastern Kentucky University
521 Lancaster Avenue
Richmond, KY 40475
ki-jung.kim@eku.edu
859-622-8005

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Introduction

Global supply chains have become increasingly complex and scrutinized in recent years, particularly with respect to social compliance and ethical labor practices. Amid rising consumer awareness and regulatory pressures, firms are compelled to ensure that their supply chains adhere to internationally recognized standards of human rights and workplace conditions. However, despite these pressures, persistent social compliance violations continue to plague many organizations, often resulting in reputational damage, legal consequences, and adverse impacts on worker well-being (LeBaron, 2021).

The strategic decisions made at the top of a firm are widely recognized as pivotal in shaping organizational outcomes, including adherence to social and ethical standards. The Upper Echelons Theory (Hambrick & Mason, 1984) suggests that the characteristics of top executives—such as age and educational background—influence corporate strategies and, ultimately, performance outcomes. In this context, the present study investigates how CEO characteristics, specifically age and whether a CEO holds a graduate business degree (an MBA), relate to the incidence of social compliance violations within global supply chains. By linking executive demographic and educational attributes to labor practices in supplier factories, this research seeks to illuminate the extent to which personal attributes of leadership can serve as antecedents to ethical management practices in a globalized economic environment.

The importance of this study lies in its potential to inform both theory and practice. On the theoretical front, the research builds on established management theories to refine our understanding of how executive characteristics translate into strategic outcomes. From a practical perspective, the findings offer insights for firms and policymakers striving to enhance compliance monitoring and to mitigate risks associated with outdated managerial practices. Ultimately, this study adds to the expanding body of research that aims to integrate leadership dynamics with the evolving requirements of modern corporate governance and social accountability.

Literature Review and Hypothesis Development

Despite the increasing scholarly attention on executive characteristics and organizational performance, research examining the nexus between CEO attributes and social compliance in global supply chains remains sparse (Borghesi et al., 2014; Slater & Dixon-Fowler, 2010; Bear et al., 2010; Byron & Post, 2016). By integrating insights from Upper Echelons Theory with empirical evidence on risk management and contemporary leadership education, the present study addresses this gap. It contributes to the understanding of the role of leadership in managing global supply chain ethics.

This study investigates how CEO characteristics—specifically age and educational background (MBA)—influence social compliance violations in global supply chains. Upper Echelons Theory posits that the personal attributes of top executives shape corporate strategies and outcomes (Hambrick & Mason, 1984). While some research suggests that older CEOs may be more risk averse (Custodio et al., 2019), there is also evidence that longer-tenured or older executives may rely on established, legacy practices. Such practices might be less adaptive to evolving regulatory and ethical standards in today's global supply chains. Older CEOs might, therefore, be less inclined to update policies or embrace innovative approaches to address contemporary social compliance challenges. This reliance on legacy systems could result in a higher number of social compliance violations when compared to firms led by younger executives who may be more open to change and modernization. The persistence of outdated practices and a potential resistance to change among older CEOs can lead to a higher incidence of compliance issues. Thus, it is hypothesized that:

H1: There is a positive relationship between CEO age and the number of social compliance violations in the supply chain.

The educational background of a CEO significantly influences strategic decision-making and organizational practices. CEOs with an MBA are often exposed to advanced management concepts, including modern approaches to corporate governance, ethical leadership, and sustainability (Bertrand & Schoar, 2003; Lewis et al., 2014). Such training equips them with the skills necessary to integrate contemporary CSR and compliance practices into their strategic frameworks. As a result, CEOs with an MBA may be better positioned to implement and enforce robust social compliance systems, thereby reducing the number of violations within their supply chains.

Research indicates that a strong managerial education, particularly an MBA, is linked with improved monitoring practices and a more proactive approach to managing risks associated with

non-compliance (Chin et al., 2013). Accordingly, firms led by CEOs with an MBA are expected to exhibit fewer social compliance violations.

H2: Firms led by CEOs with an MBA degree experience a lower number of social compliance violations compared to those led by CEOs without an MBA.

Although older CEOs may be predisposed to adhering to legacy practices—which could lead to higher compliance violations—the presence of an MBA can introduce contemporary managerial insights and strategic rigor into their decision-making process. In this context, the MBA credential may serve as a moderating factor that mitigates the potential negative impact of age on social compliance. CEOs who combine extensive experience with modern management training are likely to be more adept at updating and refining compliance practices, thus offsetting the risks associated with the reliance on outdated systems. This interaction suggests that the positive relationship between CEO age and social compliance violations will be weaker among CEOs who possess an MBA. In other words, the adverse effects linked to older age—such as reliance on legacy practices—can be attenuated when the CEO also has advanced managerial training.

H3: The positive relationship between CEO age and social compliance violations is weaker for CEOs with an MBA degree than for those without an MBA.

Methodology

Data. We primarily use the Fair Labor Association's (FLA) audit data to assess labor conditions in supplier countries within global supply chains. The FLA is a non-profit collaborative effort involving universities, civil society organizations, and businesses. FLA member companies commit to subjecting their supply chains to independent assessments and monitoring as part of their organizational commitment to upholding fair labor standards through transparency. The FLA publishes these assessment results to foster open dialogue about worker conditions, ensure brand accountability, and help consumers make more informed purchasing decisions. We combined the FLA audit data with hand-collected CEO characteristics to investigate the relationship between CEO attributes and labor conditions in factories located in supplier countries.

Measurement. The dependent variable in this study is the number of labor violations in each factory. This measure captures the total count of violations across six categories: harassment or abuse, forced labor, child labor, freedom of association and collective bargaining, health, safety, and environment, and hours of work and compensation. The primary explanatory variables include CEO age, measured in years; CEO MBA, a binary variable coded as 1 if the CEO holds an MBA as their highest degree and 0 otherwise; and CEO tenure, measured as the number of years the CEO has served in their role. To account for other factors that may influence labor violations, we include several control variables. CEO sex is a binary indicator coded as 1 for male and 0 for female. CEO nationality is included as a categorical variable. We also control for the parent company (buyer firm), which is encoded as a categorical variable, and the factory's location, represented as a categorical variable indicating the country in which the factory operates. Factory size, measured by the number of workers, is log-transformed to account for skewness. Finally, we

control for the year in which the factory assessment took place to account for potential time-based effects.

Analytical Strategy. Given that the data structure is inherently hierarchical—with individual factories nested within larger buyer firms—we employ a multilevel mixed-effects modeling approach. This strategy is ideal for analyzing data where observations (i.e., factories) are grouped within higher-level units (i.e., buyer firms), as it allows us to account for both within-group (factory-level) and between-group (firm-level) variability.

Results

Table 1 presents the estimates from three multilevel mixed-effects regression models examining the relationship between CEO characteristics and social compliance violations in the supply chain. Model 1 is the baseest model without control variable. From Model 2, control variables were added. Consistent with Hypothesis 1 (H1), which predicted a positive relationship between CEO age and the number of social compliance violations, Model 2 revealed that increases in age were associated with more violations. Specifically, the coefficient for Age was .47 (SE = .16, $p < .01$), indicating that the expected number of violations increased significantly with CEO age.

Hypothesis 2 (H2) posited that firms led by CEOs with an MBA would experience fewer social compliance violations compared to those led by CEOs without an MBA. Although the simple main effect of MBA in Models 1 and 2 was negative (−4.37 and −6.24, respectively), these effects were not statistically significant, failing to support H2. However, Model 3 included an interaction term between Age and MBA, which provides additional nuance. The significant interaction (Age \times MBA: −2.07, SE = 0.40, $p < .001$) indicates that the effect of CEO age on social compliance violations is contingent upon MBA status. Specifically, the interaction suggests that while increasing CEO age is associated with a rise in violations among non-MBA CEOs, this positive association is significantly attenuated—and indeed reversed (Figure 1)—for CEOs with an MBA. For example, for MBA-holding CEOs the net effect of age on violations is $0.63 - 2.07 = -1.44$, indicating that as these CEOs age, the number of violations tends to decrease. This finding provides robust support for Hypothesis 3 (H3), which predicted that the positive relationship between CEO age and social compliance violations would be weaker for CEOs with an MBA relative to those without an MBA.

	Model 1	Model 2	Model 3
Age	.18 (.12)	.47** (.16)	.63*** (.14)
MBA	-4.37 (2.37)	-6.24 (4.04)	111.59*** (22.99)
Tenure	-.05 (.10)	.05 (.17)	.03 (.13)
Age × MBA			-2.07*** (.40)
Year		-2.34*** (.00)	-2.16*** (.54)
Factory size (log)		.97 (.78)	.89 (.76)
Factory nation		Yes	Yes
CEO sex		Yes	Yes
CEO nation		Yes	Yes
Random Effects			
Buyer Firm (Intercept) Variance	6.60 (13.87)	12.24 (7.86)	.00 (.00)
Residual Variance	115.26 (16.54)	57.76 (6.08)	57.97 (5.64)
ICC	.0542	.1757	.00
Model Fit			
AIC	1674.52	1557.85	1539.44
BIC	1694.83	1695.27	1680.22
Observations	218	211	211
Number of Groups	22	22	22

Table 1. The Results of Multilevel Mixed-Effects Regressions

*** $p < .001$; ** $p < .01$; * $p < .05$; Standard errors in parentheses. ICC = Intraclass correlation coefficient; AIC = Akaike information criterion; BIC = Bayesian information criterion

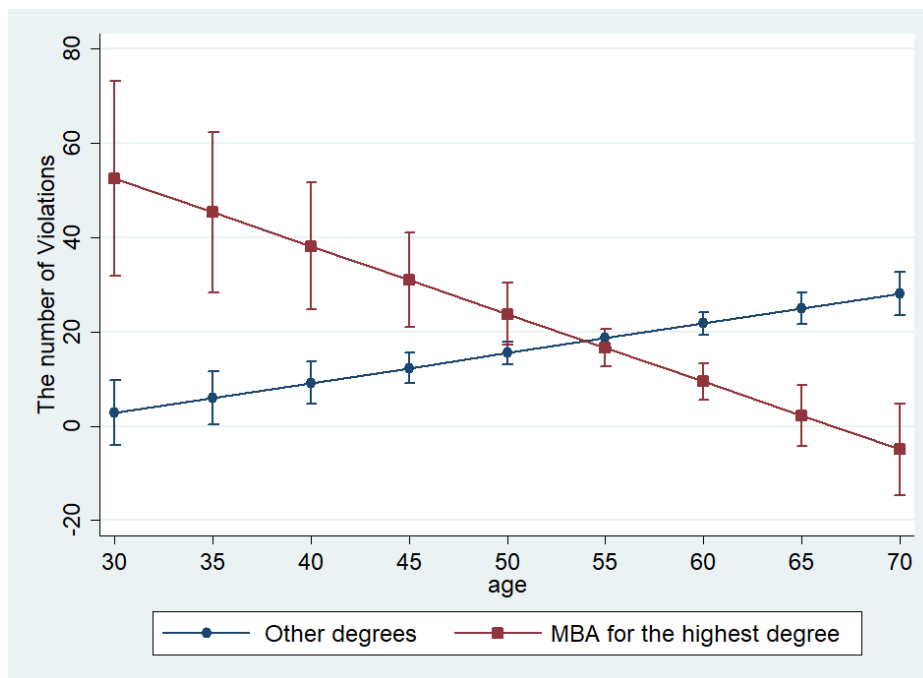


Figure 1. The Interaction between CEO ages and MBA degrees

Conclusion

Our results indicate that CEO age is positively related to the frequency of social compliance violations, supporting the hypothesis that older CEOs, potentially due to a reliance on legacy practices and a higher degree of risk aversion, may be less inclined to adopt innovative compliance measures. However, our study also uncovered a nuanced interaction effect: the presence of an MBA significantly moderates the relationship between age and compliance outcomes. Specifically, while older CEOs without an MBA tend to experience a higher number of violations, older CEOs with an MBA demonstrate a reversal of this trend, suggesting that contemporary managerial training can offset the risks associated with age-related adherence to outdated practices. These findings not only reinforce the importance of executive characteristics in shaping corporate behavior but also highlight the potential for advanced education to foster adaptive, ethically sound decision-making even among more experienced leaders.

Limitations and Directions for Future Research

Despite these contributions, the present study has several limitations that need consideration. First, the reliance on audit data from the Fair Labor Association (FLA) may introduce sample-specific biases, as the data is primarily drawn from firms committed to transparency and external review. This could limit the generalizability of the findings to firms or regions not covered by the FLA's monitoring framework. Future research employing longitudinal data could provide deeper insights into how changes in leadership attributes over time affect compliance outcomes.

Additionally, other unobserved factors—such as industry-specific regulatory environments, the role of board governance, or the influence of broader cultural norms—may also play a significant role in shaping compliance behavior. Expanding the scope of analysis to incorporate these variables could offer a more holistic view of the determinants of social compliance in global supply chains.

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A-Z: GENERATIONS AT WORK

Robles, Marcel (Marci)
College of Business
Eastern Kentucky University
521 Lancaster Avenue, BTC 214
Richmond, KY 40475
marcel.robles@eku.edu
859-622-1117

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Introduction

The world along with the population has changed dramatically over the last century. Technology is everywhere, social media has soared, artificial intelligence has entered society, and the workforce is more generationally diverse now more than ever before in history.

The current workforce is made up of multiple generations, with each significantly different from the others, having lived through dissimilar experiences and events. While the oldest generation, Traditionalists, make up the smallest number of employees in today's workplace, several continue to serve as volunteers. Generation Z has been entering the workforce as interns, co-op students, new hires, and college graduates.

The generational differences on the job have created some challenges for managers. With various personalities, attitudes, motivations, and other generational attributes comes the need for adaptable communication, leadership, and managerial strategies. By studying the characteristics of each generation, their desires, and their responses to discrete scenarios, employers can create a work environment that works towards (rather than hinders) increased and effective communication, productivity, and efficiency.

The purpose of this study was to determine managerial perceptions regarding generational differences and impact on communication, productivity, and efficiency in the workplace. The study addresses the following research questions:

1. What are the differences in generational characteristics?
2. What preferred communication methods work best for each generation?
3. What is the preferred leadership style for each generation?
4. What factors contribute to the motivation of each generation?

Literature Overview

While much research has been conducted on the older generations from Gen X to Traditionalists, research on the more recent generations from Beta to Millennials is more limited. This review of the literature discusses findings from past studies.

Generational Composition of the Current Workforce

With five generations eligible to work today, how many of these individuals are actively working, nearing retirement, choosing unemployment, not finding work, or beginning a new job search? The blend of generations has the ability to create great constructive interaction with the integration of varying experiences. Conversely, diverse generational interaction can bring challenges and conflicts among individuals (Dols, Landrum, & Wieck, 2020). Each generation contributes to a diverse and dynamic workplace, with organizations increasingly focusing on bridging generational gaps to foster collaboration. Understanding and adapting to the generational makeup in the workplace can help managers strategize to accommodate issues in managing a multi-generational workforce.

The number of Traditionalists (also known as the Silent Generation), born 1928-1945, has been dropping over the past 17 years (Sherman, 2008); although a small percentage of Traditionalists remain in the workforce, often in advisory or executive roles. Additionally, certain professions, such as nursing and business, continue to employ a considerable number of Traditionalists. Traditionalists are known for discipline, loyalty, and strong work ethic.

Baby Boomers were born between 1946 and 1964. While Baby Boomers were the predominant generation for several years, many are nearing or delaying retirement at this time in their lives. Boomers are valued in the workplace for their experience, leadership, and work dedication.

The second largest generation in today's workforce is Generation X, born 1965-1980. Gen Xer's characteristics include independence, adaptability, and work-life balance priorities. They are now often serving in mid-to-senior leadership roles.

The largest generation on the job today is the Millennials (aka Generation Y) who were born between 1981-1996. This generation is the largest segment of today's workforce. They are tech-savvy and purpose-driven, and they value flexibility.

Members of Generation Z, born 1997-2012, are the newest entrants into the workforce. They are known as digital natives who prioritize diversity, mental health, and career growth opportunities.

The number of members within each generation is constantly changing, and with the change, comes a difference in wants, values, work ethic, and work-life balance. Therefore, managers must be aware of and adaptable to the generational composition within their companies.

Professionalism

The meaning and representation of professionalism has changed immensely over the years. The definition of professionalism when Baby Boomers entered the workforce is no longer the same level of formality that it is now. Similarly, managers and supervisors are no longer assumed to be older than their employees; many managers may be even decades younger than their subordinates (Gleeson, 2017). Wanting to see if generations differed in their ideas and examples, Gleeson studied the beliefs of certain generations regarding professionalism in the workplace. The results indicated that each generation had the same core values when it came to professionalism such as being timely and dressing appropriately. The difference was what each consider to be timely and appropriate professional attire. Therefore, the generations agree in their values, but their overarching ideas vary. In our society where differences are accepted among customers, clients,

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and patients, we must also be mindful of differences among our colleagues, accepting and encouraging the diversity.

Older generations have seen and experienced more and can contribute ideas of what works in professional settings and what does not. So, either way, both generations can help when it comes to professionalism in the workplace.

Getting Along in the Workplace

Tensions arise from many places when different generations work together. Historical events that each generation has lived through is the biggest contributor (*Association of Equipment Manufacturers*, 2019), followed by individual preconceived notions of a generation. Hence, getting past the fixed ideas that each generation has about another and looking more towards what each generation can do for the other. Knight (2019) encouraged a series of cross-generation, cross-skill level projects for each generation to learn and see what the other has to offer.

Retaining Different Generations

Another challenge for companies is retaining employees. With an evolving generational workforce, managers must understand communication methods, leadership styles, and other strategic tactics that work for each generation. A big struggle for Gen Z currently is the transition from student to worker. These individuals have spent their entire lives in school, and now they are being thrust into the workforce. One theory for retaining the younger generation of workers and keeping them happy on the job is to create mentorships (Dols et al., 2020). Millennials and Gen Z thrive whenever they feel like they are being taught how to properly do their job. Knowing that they value feedback and happiness within their job, it is important to consider mentorship. Further, it is important to reward more experienced generations for effective mentorship. Letting individuals from these older generations know their sharing of knowledge and experience with these new generations have influence. However, employers must also realize that these generations are not as understanding when it comes to giving up their own time. If they must go in to work on a day off to help mentor, the program would not be as successful. Likewise, it is not only mentoring; for example, if employees of an earlier generation must go in to work on a day off for a meeting, they are more likely to be upset with their working conditions (Dols et al., 2020). If employees feel that their time is not valued, they will burnout and quit.

Knowing how to retain generations goes hand-in-hand with generational values. Having members of Generation X who enjoy flexibility means allowing them to take on projects that do not require constant supervision. Whereas Millennials enjoy leisure time and like to separate work from home, they can be attracted and retained by enhancing their relaxation time (Twenge, Campbell, & Hoffman, 2010).

What Can Managers Do?

Oftentimes, management would rather ignore the problem at hand or push it off until it becomes a bigger problem. Rather than ignoring age differences and their impact on job performance, managers should acknowledge and use generational differences to their advantage (Amayah & Gedro, 2014). Managers must also not assume that because of the age gap there will automatically be an issue. However, if a dilemma arises, the manager's role is to intervene and decide how to mediate.

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Along with knowing how to mediate problems, managers must also know how to prevent them. DelCampo noted that managers must consider each individual's values and determine how to track progress and productivity to rightfully appraise their employees (2011). Knowing how people respond to feedback is an effective way to retain employees and create a business environment with high morale. Tracking how a person is doing and giving them praises and criticism tailored to how they think, is a valuable method to keep employees happy and keep organizations running smoothly.

Methodology

This study used quantitative data collection. Seventy-four executives were surveyed regarding generational personalities, preferences, and actions of their workforce along with issues dealing with generational diversity. Executive responses were due February 1, 2025. After the responses were received, the data were analyzed to address the research questions, arrive at conclusions, and make recommendations.

Results and Implication

The results will describe the research and major findings of the study as well as the practical implications of the study.

Conclusions

The conclusions and implications of the study will be determined and presented at the Appalachian Research in Business Symposium (ARBS) after the data are collected and analyzed, limitations will be noted, and suggestions for future research will be offered.

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HEALTH, RETIREMENT AND UNIONS: SOCIOEMOTIONAL VIEWS ON OLDER WORKER RETENTION

Ki-Jung Kim
College of Business
Eastern Kentucky University
521 Lancaster Ave.
Richmond, KY 40475
ki-jung.kim@eku.edu
217.200.6800 (Contact Author)

Yonjin Suh
School of Labor and Employment Relations
University of Illinois Urbana-Champaign
504 E. Armory Avenue
Champaign, IL 61820
yjsuh2@illinois.edu

Key words: Socioemotional selectivity theory, health, intended retirement ages, unions, employer support

Introduction

The world of work is aging rapidly. This trend is projected to lead to severe labor shortages and talent gaps. One way to address these challenges is to retain older workers, who may otherwise retire (Heisler & Bandow, 2018; Kooij et al., 2020). Healthy older workers, in particular, are vital assets due to their physical and mental capacities, which enable them to continue contributing to workplace productivity (Barnes-Farrell, 2003). Paradoxically, however, some healthier individuals choose to retire early to enjoy their post-retirement lives (Cregan et al., 2023; de Wind et al., 2013). Addressing this loss of productive human resources requires a deeper understanding of the factors influencing healthy older workers' retirement decisions.

The retirement intentions of healthy older workers can be understood through the lens of socioemotional selectivity theory (SST). SST posits that as individuals perceive their remaining time in life as limited, they prioritize emotionally meaningful activities and relationships over long-term professional goals (Carstensen, 2006; Carstensen et al., 1999; Löckenhoff & Carstensen, 2004). For older workers, this shift in priorities can lead to retirement decisions aimed at maximizing personal fulfillment and socioemotional goals, even when their health allows them to remain employed (Fasbender et al., 2019; Griffin et al., 2012; van Solinge & Henkens, 2010). However, workplace context may alter these tendencies, offering organizations an avenue to retain healthy older workers.

Therefore, in this study, we examine the relationship between self-rated health and intended retirement age, focusing on two workplace contexts that may encourage healthy older workers to extend their careers. First, unions can create emotionally and socially meaningful work

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environments. In unionized workplaces, older workers can foster a sense of purpose, connection, and empowerment that aligns with their socioemotional priorities (Barling et al., 1992; Morgan & Pulignano, 2020; van der Meer, 2019). Second, employer support for older workers, particularly through tailored adjustments to work tasks and responsibilities, can make work more manageable and socioemotionally appealing to older employees (Wang & Huang, 2024). By investigating how unions and employer support contribute to creating supportive environments for older employees, we offer critical insights into addressing labor shortages and ensuring that older workers remain engaged and fulfilled in their roles.

Socioemotional Selectivity Theory (SST)

Individuals often undergo profound shifts in their behavior and priorities about life after experiencing critical events, such as a serious illness or the loss of a loved one. These behavioral and attitudinal changes can be effectively explained by SST. This theory posits that individuals' goals and priorities evolve as their perception of time changes (Carstensen et al., 1999, 2003; Löckenhoff & Carstensen, 2004). SST is particularly relevant for understanding older workers' motivation and decision-making on retirement (Charles & Carstensen, 2010; Cregan et al., 2023). When time feels abundant, individuals tend to prioritize goals tied to personal growth, career advancement, and financial security (Carstensen, 2006; Fasbender et al., 2019). Conversely, as people age or face experiences that highlight the brevity of life, they reevaluate goal priorities, shifting toward activities and relationships that provide emotional satisfaction and meaning in the here and now.

Health and intended retirement age

Most research that healthier individuals tend to stay longer in the workforce because they are more capable of fulfilling work-related responsibilities. However, some studies indicate that healthier individuals may choose to retire early. Von Bonsdorff & Ilmarinen, (2013) show that healthy individuals may decide to retire early to pursue leisure or nonwork activities while they are still in good health. Similarly, de Wind et al., (2013) find that good health can motivate individuals to retire early so they can enjoy life while they are physically able. Cregan et al., (2023) further highlight that good health may lead old individuals to prioritize early retirement by letting them recognize the diminishing time available to actively engage in leisure pursuits.

Based on SST, we argue that although better health might enable individuals to continue working, older individuals who perceive their remaining time in life as limited may view their good health as an opportunity to maximize emotionally meaningful experiences outside of work. Hence, they may prioritize such activities over professional obligations, even when their health supports continued employment. In this situation, retirement can become an increasingly appealing option because it enables old individuals to allocate their limited time and energy toward activities that align with their shifted priorities. Retirement can also become a means to focus on emotionally rewarding relationships with family members or loved ones. Healthier old individuals can have greater flexibility to prioritize their social and emotional needs; in contrast, less healthy individuals may be constrained by the need to maintain financial stability or access healthcare benefits through employment (Sargent et al., 2013).

Hypothesis 1: Healthier older workers are more likely to intend to retire earlier.

The Moderating Role of Unions

Unions are traditionally known as enhancing job security and stability (Freeman & Medoff, 1984), and this stability can reduce workers' stress and uncertainty (Wels, 2020). For older workers, this stability provides emotional reassurance that helps them focus on immediate social and emotional rewards rather than worrying about potential disruptions in their careers. Stable employment can also serve as a foundation for meaningful interactions in the workplace, reinforcing a sense of purpose that aligns with older workers' preference for emotionally rewarding experiences.

Unions can also create socially supportive workplaces by fostering solidarity and belonging through collective decision-making, advocacy efforts, and shared goals (Morgan & Pulignano, 2020; Rose, 1952). Union activities provide a platform for workers to engage in collective decision-making, share experiences, and work toward common goals, which collectively foster a shared identity (Kelly & Kelly, 1994). The workplace, in this context, becomes more than a job—it transforms into a community where older employees experience social satisfaction through camaraderie and mutual support (Budd, 2011; Budd & Spencer, 2015).

Hypothesis 2: Unions moderate the negative relationship between health and the intended retirement age, such that older workers at unionized workplaces are more likely to delay retirement as they perceive their health improves.

The Moderating Role of Employer Support for Old Workers

Employer support, particularly through tailored adjustments to work tasks and responsibilities, helps transform work into an experience that aligns more closely with the priorities of older adults, increasing the socio-emotional appeal of continuing to work. Moreover, employer support demonstrates an organization's commitment to inclusivity and respect for the diverse needs of older employees, thus creating a positive, age-friendly climate and environment that enhances collaboration and well-being for these workers (Boehm et al., 2014, 2021; Rudolph & Zacher, 2021). Furthermore, employer support in the form of task and role adjustments is likely to be perceived by healthier older workers as an opportunity to continue to work without compromising their well-being, as it provides reassurance that their health, abilities, and needs will be accommodated. Such practices and accommodations also help sustain a perceived fit at work by shaping the work environment, and sustained fit, in turn, should increase healthier older workers' intention to continue working (Boehm et al., 2021; Wang & Shultz, 2010; Wilckens et al., 2023).

Hypothesis 3: Employer support moderates the negative relationship between health and the intended retirement age, such that older workers are more likely to delay retirement as they perceive higher levels of employer support.

Methodology

We use the Korean Longitudinal Study of Aging (KLoSA), a nationally representative panel dataset from 2006 to 2022, with a sample of 8,669 actively employed individuals. Analyses employ multiple regression models with individual and year fixed-effects (Wooldridge, 2010). Intended Retirement Age is measured by asking respondents to indicate their intended retirement age. Self-reported health is measured using two identical items: "How would you describe your current health status?" Responses are recorded on a five-point Likert scale (1 = Very Poor to 5 = Very

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Good). Union presence is measured as a binary variable (0 = no union, 1 = union present). Employer support is assessed with the statement: “My employer would let older workers move to a less demanding job with less pay if they wanted to,” rated on a four-point scale (1 = Strongly Disagree to 4 = Strongly Agree). Controls include education, age, marital status, region, household assets (log), firm size, employment and job status, income (log), job satisfaction, job type, industry, and physical demands.

Results

Table 1 presents the results of the fixed-effects regression models. Model 1 is the basest model that only includes the main independent and moderating variables. In this model, health shows a statistically significant negative effect on the intended retirement age, supporting Hypothesis 1. Model 3 includes an interaction term between health and union to test Hypothesis 2. The interaction term is positive and statistically significant ($b = .88$, $p < .01$). To facilitate this interpretation, we plot the interaction in Figure 1. Healthier older workers in non-unionized workplaces are more likely to intend to retire earlier, reflecting a negative relationship between health and intended retirement ages. However, in unionized workplaces, this relationship reverses, with healthier workers intending to retire later. This finding corroborates Hypothesis 2. Model 4 introduces an interaction term between health and employer support to examine Hypothesis 3. However, the interaction term is not statistically significant, failing to support Hypothesis 3.

Variable	Model 1	Model 2	Model 3	Model 4
Health	-.66*** (.10)	-.27* (.11)	-.34** (.11)	-.43+ (.24)
Union (dummy; 0 = nonunion)	-1.80*** (.23)	-.14 (.28)	-3.04** (.94)	-.14 (.28)
Employer support	-.11 (.09)	-.16 (.10)	-.15 (.10)	-.47 (.39)
Health × Union			.88** (.27)	
Health × Employer support				.10 (.12)
Age		.35*** (.02)	.35*** (.02)	.35*** (.02)
Net asset (log)		-1.02 (.66)	-.99 (.67)	-1.03 (.66)
Monthly pay (log)		-.44* (.19)	-.44* (.19)	-.44* (.19)
Employer size (log)		-.56*** (.16)	-.56** (.16)	.56** (.17)
Job satisfaction		-.09 (.15)	-.09 (.15)	-.09 (.15)
Physical demands on the job		-.17+ (.09)	-.16+ (.09)	-.17+ (.09)
Categorical controls	No	Yes	Yes	Yes
Individual-year	12,760	8,669	8,669	8,669
Individuals	3,500	2,549	2,549	2,549
Individuals fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
R ² (within)	.0155	.1408	.1420	.1409
R ² (between)	.1642	.2925	.2929	.2924
R ² (overall)	.1095	.2309	.2315	.2307

Table 2. The Results of Fixed-Effects Regressions

***p < .001; **p < .01; *p < .05; +p < .10; Clustered robust standard errors in parentheses.

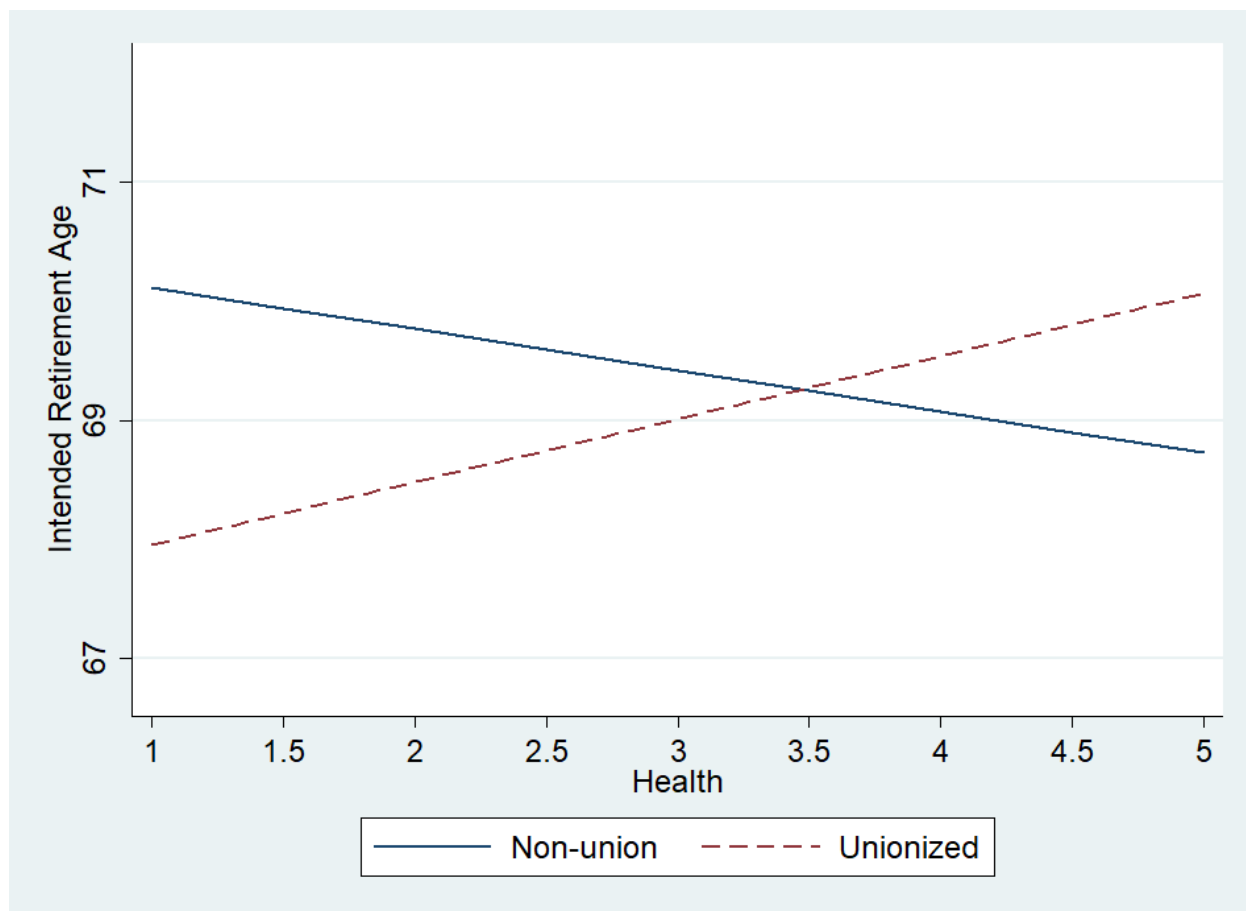


Figure 1. The Interaction between Health and Union on the Intended Retirement Age

Discussion and Conclusion

This study underscores the critical role of unions and employer support in shaping the relationship between health and retirement intentions among older workers. Leveraging SST and nationally representative data from South Korea, we reveal that while healthier individuals typically intend to retire earlier, unionized workplaces provide socially and emotionally meaningful environments that counteract this tendency. Although employer support did not receive statistical support as a significant moderator in our analysis, its marginal three-way interaction effects suggest potential nuances in how workplace adjustments influence older workers' decisions. These findings highlight the importance of examining factors across different levels and actors in promoting extended workforce participation and provide actionable insights for addressing labor shortages in aging societies. Practically, this study underscores the importance of retaining healthy older workers by prioritizing practices and support systems that align with older workers' socioemotional needs. Fostering positive labor relations is also a key as unions provide support and benefits that complement organizational and national initiatives.

While our research advances the understanding of retirement intentions among older workers, it has several limitations. Using archival data from KLoSA restricted the analysis to available items,

such as a single-item measure of employer support, which may have contributed to insignificant results. Future research should explore broader measures and mechanisms using primary or qualitative data. Additionally, findings based on South Korean data may lack generalizability; cross-cultural studies could provide deeper insights. Addressing these limitations would enhance understanding of retirement decision-making. Despite these limitations, our study provides a comprehensive analysis of the factors influencing retirement decisions, particularly among healthier older workers.

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AI IN RADIOLOGY: BRIDGING THE GAP BETWEEN TECHNOLOGY AND PATIENT CARE

Jordan Watts, MHA
Healthcare Administration Program
Management and Healthcare Division
Lewis College of Business
Marshall University
100 Angus E. Peyton Drive
South Charleston, WV 25303
watts172@marshall.edu

Jeff Larson, PhD, MBA
Assistant Professor
Department of Management and Health Care Administration
Marshall University
1425 4th Avenue
Huntington, WV 25701
larsonj@marshall.edu

Kasi Gorli, B.D.S, MSHIc
Healthcare Informatics Program
Management and Healthcare Division
Lewis College of Business
Marshall University
One John Marshall Drive,
Huntington, WV 25755
(304)-617-6601 gorli@marshall.edu

Alberto Coustasse D.PH., MD, MBA, MPH – CONTACT AUTHOR
Healthcare Administration Program
Management and Healthcare Division
Lewis College of Business
Marshall University
100 Angus E. Peyton Drive
South Charleston, WV 25303
304-746-1968
(304) 746-2063 FAX coustassehen@marshall.edu

Key words: AI, Radiology, Patients, Technology

Introduction

Artificial Intelligence (AI) integration in healthcare, particularly within radiology, has grown rapidly, with 400 out of 520 FDA-approved AI algorithms explicitly designed for radiological applications as of 2023. AI has shown significant potential for enhancing healthcare delivery and

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improving patient outcomes (AHA, 2023); however, understanding the barriers, facilitators, and implications of AI implementation in radiology remains fragmented across existing studies. This study investigates AI's impact on radiology in three critical areas: diagnostic accuracy, interpretation times, and clinical workflow efficiency. We synthesize key findings regarding AI's contributions to radiology practices through a comprehensive literature review of 29 articles published between 2015 and 2024, sourced from databases including PubMed, EBSCOhost, and Google Scholar.

AI applications in radiology have evolved from early computer-aided detection (CAD) systems to sophisticated deep learning models capable of detecting complex patterns beyond human perception (Pinto-Coelho, 2023). AI's ability to enhance diagnostic accuracy, expedite image interpretation, and optimize workflow efficiency is well-documented in literature. However, while AI has facilitated improvements in these areas, some radiologists have raised concerns about increased procedural complexity, requiring a nuanced understanding of AI's broader implications for clinical workflows (Hardy & Harvey, 2020). AI-based automation has further transformed radiology by optimizing image acquisition processes, reducing human error, and increasing the speed of image processing.

Literature overview

Numerous studies have highlighted AI's ability to increase diagnostic precision. One study found that AI achieved a sensitivity rate of 90% in diagnosing breast cancer with masses, surpassing the 78% sensitivity of radiologists (Alowais et al., 2023). Additionally, AI identified early-stage cancer at a remarkable 91% rate, compared to the 74% achieved by radiologists (Pacurari et al., 2023). The use of deep learning models and machine learning algorithms in radiology has also contributed to enhanced image quality by reducing noise and artifacts caused by patient movement, thereby allowing more precise diagnoses (Mazurowski et al., 2019). AI's role in predictive analytics has also been observed, enabling radiologists to forecast potential disease progression and tailor treatment plans accordingly.

AI has also proven beneficial in expediting radiological interpretation times. In digital breast tomosynthesis (DBT), AI implementation led to a 29.2% reduction in interpretation time, while mammographic evaluations saw a 34.7% decrease (Hsu & Hoyt, 2019). AI-based CAD systems have facilitated faster image analysis, reduced radiologists' workload and allowing for quicker clinical decision-making (Oren et al., 2020). These improvements are particularly crucial in emergency and trauma settings, where rapid diagnostics can significantly influence patient outcomes (Najjar, 2023). Additionally, AI-driven triage systems have allowed radiologists to prioritize urgent cases more effectively, reducing delays in critical diagnoses.

However, findings regarding AI's impact on clinical workflows have been mixed. AI has improved workflow efficiency by assisting technologists in selecting optimal imaging protocols and refining image acquisition processes (Cellina et al., 2022). Automated AI-based patient positioning in CT scans, for example, has reduced contrast dosage by 16% and saved radiographers 28% of the time required for patient repositioning (McCollough & Leng, 2020). On the other hand, AI has also introduced additional procedural steps, requiring technologists to verify AI-generated insights before proceeding with diagnoses, which in some cases has increased time spent on imaging acquisition (Newsome, 2024). Furthermore, ethical concerns have been raised regarding data

privacy, bias in AI training datasets, and regulatory compliance, necessitating ongoing evaluation of AI policies and frameworks.

Methodology

This study employs a qualitative research approach, with a literature review following a systematic approach. Peer-reviewed articles and reports were sourced from PubMed, EBSCOhost, and Google Scholar, with a focus on AI applications in radiology, diagnostic performance, and workflow efficiency. Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method, 8,349 citations were screened, with 29 studies meeting inclusion criteria.

Results and implications

The findings confirm AI's positive impact on patient care by enhancing diagnostic accuracy and interpretation efficiency. AI-enhanced radiology systems demonstrated a sensitivity range of 0.81 to 0.99 and specificity between 0.46 and 1.00, significantly improving disease detection rates (Pacurari et al., 2023). In mammography, AI-assisted imaging reduced false positives by 5.7% and false negatives by 5.9%, contributing to early cancer detection and reducing unnecessary biopsies (Alowais et al., 2023). Additionally, AI's role in diagnostic accuracy extended to prostate MRI lesion detection, where CAD improved detection accuracy by 4.4% (Winkel et al., 2021). AI-powered predictive models have also demonstrated potential in assessing disease prognosis and guiding personalized treatment strategies.

AI's ability to expedite interpretation times has also been widely documented. AI-assisted radiologists analyzing prostate MRIs reduced review time by 21% (Winkel et al., 2021), while AI integration in chest X-ray interpretation lowered turnaround time from 11.2 days to 2.7 days (Najjar, 2023). These improvements are instrumental in addressing radiology department backlogs and improving patient flow (Hosny et al., 2018). Furthermore, AI has been instrumental in reducing radiologist burnout by automating repetitive tasks and improving workload distribution.

Despite its advantages, AI integration in clinical workflows has introduced complexities. While AI algorithms have optimized image acquisition by enhancing image quality and reducing noise, radiologists and technologists have encountered workflow inefficiencies due to added procedural steps (Santos et al., 2019). Some radiologists have reported that AI requires additional verification processes, potentially slowing imaging acquisition. However, findings suggest that practical training can alleviate these challenges, allowing clinicians to integrate AI seamlessly into established workflows (Hardy & Harvey, 2020). Further research is needed to refine AI algorithms to ensure seamless interoperability with existing hospital information systems and electronic health records.

Conclusion

This study highlights AI's transformative role in radiology, demonstrating its capacity to enhance diagnostic precision, reduce interpretation times, and improve clinical workflows. While AI has introduced procedural challenges, ongoing education and training can mitigate these difficulties, ensuring smooth integration into radiological practices. As AI technologies continue to evolve, future research should focus on refining AI-human collaboration in radiology to maximize benefits while minimizing workflow disruptions. The findings underscore the need for a balanced approach

to AI adoption, where technological advancements complement rather than complicate radiological workflows.

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RANSOMWARE IN HEALTHCARE: THREATS, IMPACTS, AND MITIGATION STRATEGIES

Mackenzie Dotson, MHA
 Healthcare Administration Program
 Management and Healthcare Division
 Lewis College of Business
 Marshall University
 100 Angus E. Peyton Drive
 South Charleston, WV 25303 (304) 746-1968
dotson135@marshall.edu

Kasi Gorli, B.D.S, MSHIc
 Healthcare Informatics Program
 Management and Healthcare Division
 Lewis College of Business
 Marshall University
 100 Angus E. Peyton Drive
 South Charleston, WV 25303
gorli@Marshall.edu

Alberto Coustasse D.PH., MD, MBA, MPH – CONTACT AUTHOR
 Healthcare Informatics Program Director
 Management and Healthcare Division
 Lewis College of Business
 Marshall University
 100 Angus E. Peyton Drive
 South Charleston, WV 25303
 304-746-1968
coustassehen@marshall.edu

Keywords: Ransomware, Cybersecurity, Healthcare IT, Operational Disruptions, Patient Safety

Introduction

The growing digitalization of healthcare has exposed hospitals to significant cybersecurity threats, particularly ransomware attacks. The Health Sector Cybersecurity Coordination Center (HC3) reported that as of mid-2024, there were 730 cyber-attacks worldwide against healthcare institutions, with 530 targeting the U.S. (AHA, 2024). Half of these incidents involved ransomware, a type of malware that restricts access to critical data until a ransom is paid (HHS, 2021).

Hospitals are attractive targets for cybercriminals due to their essential role in patient care. Cybercriminals exploit vulnerabilities in hospital networks, often causing severe operational and financial damage. Factors such as understaffed IT teams, outdated security infrastructure, and the

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necessity of immediate patient care contribute to healthcare's susceptibility to these attacks. This paper examines the extent to which ransomware attacks have impacted healthcare facilities, including financial repercussions, patient safety risks, and operational disruptions.

Literature Review

Healthcare organizations continue to struggle with protecting sensitive patient data from cyber threats. Studies have shown that ransomware attacks significantly disrupt hospital operations, sometimes increasing patient mortality rates (Neprash et al., 2023). Research also highlights the economic burden of ransomware attacks, with hospitals losing millions due to operational shutdowns, remediation costs, and legal expenses (Diaz, 2023). Despite efforts to strengthen cybersecurity, attackers continue to refine their strategies, making healthcare institutions a persistent target.

A significant body of research explores the methods used by ransomware groups to infiltrate healthcare systems. Phishing emails, outdated software, and weak security protocols are common entry points for attackers (Siriwardana, 2024). The high-stakes nature of patient care increases the likelihood that hospitals will pay ransoms to restore access to critical data. However, paying ransoms does not guarantee data recovery, and hospitals often face additional demands from cybercriminals (Hut, 2024).

Methodology

This study employs a systematic review approach, utilizing peer-reviewed research articles, government reports, and industry analyses. The study focuses on data from 2015 to 2024, examining both direct and indirect impacts of ransomware attacks on hospitals.

The study follows PRISMA framework, ensuring comprehensive data collection and analysis. Studies were included if they provided empirical data on ransomware impacts on healthcare facilities, discussed cybersecurity resilience measures, or analyzed patient safety risks. Excluded studies were those that lacked relevance to U.S. hospitals or did not provide quantifiable findings.

Results and implications

Financial Impact

Ransomware attacks have led to severe financial losses for hospitals. For instance, the 2020 attack on the University of Vermont Medical Center resulted in over \$82 million in damages, with \$63 million attributed to recovery costs (Chiaradonna et al., 2023). Similarly, the 2021 ransomware attack on Scripps Health incurred losses exceeding \$112.7 million, including legal fees and lost revenue (Paavola, 2021). More recently, the 2024 Change Healthcare ransomware incident had an estimated monetary impact of \$870 million, with expected direct costs surpassing \$1 billion (Hut, 2024).

These financial burdens extend beyond direct ransom payments. Hospitals often experience prolonged downtime, leading to revenue losses, legal repercussions, and the need for extensive cybersecurity enhancements. Research indicates that cyber insurance coverage has become crucial in managing financial risks, yet policies do not fully cover ransomware-related losses (Neprash et al., 2022).

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Operational Disruptions

Unlike other forms of cyberattacks, expert hackers planned ransomware to paralyze hospital operations. From 2016 to 2021, 44.4% of healthcare ransomware incidents resulted in significant operational disruptions, including ambulance diversions and canceled procedures (Neprash et al., 2022). A survey in 2022 found that 47% of hospitals had to transfer patients to nearby facilities due to system failures (Petrosyan, 2023a). Furthermore, healthcare organizations reported an average downtime of 18.71 days following ransomware attacks, a substantial increase from previous years (Petrosyan, 2023b).

During downtime, hospitals revert to manual record-keeping, leading to inefficiencies and an increased risk of medical errors. Many hospitals lack robust contingency plans, further exacerbating delays in patient care. Moreover, emergency services are often the most affected, as rerouted ambulances strain nearby hospitals, creating system-wide bottlenecks (Siriwardana, 2024).

Patient Safety Risks

While the link between ransomware attacks and patient mortality remains debated, research suggests a correlation between cyber incidents and adverse patient outcomes. A 2022 study indicated that 53% of affected hospitals reported increased mortality rates, while 37% observed worsening patient conditions due to delayed treatments and diagnostic procedures (Petrosyan, 2023a). Additionally, cybercriminals have targeted hospital equipment, causing failures in life-supporting devices such as ventilators and defibrillators (Siriwardana, 2024).

Patient data security is another primary concern. Ransomware attacks often involved data exfiltration, where hackers steal sensitive patient records before encrypting systems. The attackers sold Stolen medical records on the dark web, leading to identity theft and financial fraud. Research indicates that healthcare data breaches cost an average of \$10.93 million per incident, making the industry one of the most financially vulnerable to cyberattacks (Neprash et al., 2023).

Implications

Ransomware attacks in the healthcare sector present significant risks that necessitate comprehensive strategies extending beyond traditional measures. Bolster cybersecurity resilience, hospitals should implement regular training programs for staff to enhance their ability to recognize phishing attempts, thereby establishing a well-informed front line of defence. Additionally, conducting incident simulation drills can effectively prepare healthcare facilities for real-world scenarios, improving response times and better coordination.

Investing in specialized cyber insurance is critical for providing financial protection against ransomware-specific risks. Collaborating with cybersecurity firms can also facilitate access to advanced threat detection technologies and strategies tailored to evolving cyber threats. It is essential to manage supply chain risks by thoroughly vetting third-party vendors to ensure that potential entry points are monitored and effectively mitigated.

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A determined cybersecurity response team can significantly enhance recovery efforts and reduce operational downtime. Maintaining an updated inventory of critical systems enables quicker recovery and response, while a stringent patch management policy can proactively address vulnerabilities. Developing clear patient communication plans ensures transparency during an incident, maintains trust, and provides necessary updates.

Moreover, it is important to consider policy implications. Healthcare organizations should advocate for stronger federal and state regulations concerning cybersecurity standards, ensuring that all facilities uphold a baseline level of security measures. Policymakers could also introduce funding incentives for hospitals to invest in cybersecurity infrastructure and training.

Finally, investing in innovative technologies that enhance operational resilience during attacks, such as decentralized data backups, can significantly improve recovery capabilities. By adopting these multifaceted approaches and engaging in proactive policymaking, healthcare organizations can better safeguard themselves against the pervasive ransomware threat.

Conclusion

Ransomware attacks present a severe and growing threat to U.S. hospitals, causing financial strain, disrupting operations, and potentially compromising patient safety. This study suggested that hospitals face rising costs and operational challenges due to these cyber incidents. To effectively fight the pervasive threat of ransomware in the healthcare sector, organizations must adopt comprehensive strategies that include staff training, incident simulations, investment in cyber insurance, and initiative-taking engagement with policymakers to strengthen cybersecurity resilience. While evidence links ransomware attacks to increased patient mortality, further research is needed to quantify these risks comprehensively. Future efforts should focus on enhancing cybersecurity resilience, improving incident response strategies, and implementing stronger regulations to mitigate the impact of ransomware in the healthcare sector.

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DEVELOPING A NEIGHBORHOOD-LEVEL RISK ANALYSIS USING GOESPATIAL TECHNOLOGIES IN CHARLOTTESVILLE, VA

Lucas Lyons, Systems Analyst
Charlottesville Fire Department
Community Risk Reduction Division
2420 Fontaine Ave.
Charlottesville, VA 22903
lyonsl@charlottesville.gov
423.360.7076

Key words: GIS, risk analysis, data analytics, emergency response, community development

Introduction

The Charlottesville Fire Department (CFD) is an all-hazards fire department serving the City of Charlottesville and the University of Virginia. Using GIS technologies, apportioned census data, and analysis of historical emergency incident data, CFD developed a neighborhood risk assessment as a framework to tailor risk prevention programs and services to meet the needs of a small city adjacent to the University of Virginia in the foothills of the Blue Ridge Mountains.

Literature Overview

This project was a collaboration between the Deputy Chief of Community Risk Reduction and CFD's Systems Analyst. It was informed by the collective body of knowledge of about 100 sworn firefighters who respond to emergencies in the community and know its risks inherently. The first-of-its-kind granular risk analysis built in an interactive hub (ArcGIS Hub) won a Special Achievement in GIS award from ESRI in 2022. It has been used as a template for community risk planning and response by fire departments across the country since its release.

Methodology

CFD started the project by analyzing approximately 30,000 emergency incident records documented over a five-year period to build custom risk profiles for each of the city's nineteen neighborhoods. One of the primary goals of CFD's community risk reduction (CRR) division is to analyze risks in the community and work with governmental, non-profit, and public health partners to design and implement programs to proactively address risks before they result in a 911 call for an acute emergency.

Neighborhoods are a strong identifier for Charlottesville's 48,000 residents, with active neighborhood associations in all 19 and neighborhoods used as reference points in local conversations. Analyzing risk data at a neighborhood level would have required sophisticated geospatial apportionment techniques a decade ago but was possible for CFD's small administrative staff with advanced geographical enrichment tools provided by the Environmental Systems *Proceedings of the Appalachian Research in Business Symposium, Marshall University, March 27-28, 2025.*

Research Institute (ESRI), the primary GIS software used by local governments. These tools apportioned 2020 census block data to each of the custom neighborhood polygons that did not align neatly with census-designated geographies.

Historical incident data was used to create rankings for exigent community health and safety concerns to tailor prevention and support programs for each neighborhood. 66% of CFD's annual responses are for emergency medical incidents and that dataset contains invaluable insights into specific health challenges in city neighborhoods. A separate dataset containing emergency response data more traditionally associated with fire departments like structure fires, hazardous materials incidents, and service calls for non-medical issues like lift assists was also analyzed and used for risk prioritization. Opioid overdoses, cardiac arrests, strokes, diabetic emergencies, cooking fires, and structure fires all were calculated on a per capita basis using 5-year averages of the incident dataset summarized at neighborhood geographies.

In addition to quantitative data sources, project principals printed maps of the city and traveled to each of its three fire stations to engage with crews' firsthand knowledge gained on the ~8,000 runs they make into the community annually. Firefighters discussed call hot spots, apparatus access challenges, and known hazards like home hoarding conditions in their first-due response zones that were then digitized and considered alongside quantitative analyses.

Results and Implications

CFD's neighborhood risk assessment, built in an ArcGIS online Hub environment, went live in 2021 and has become an indispensable tool for understanding the unique risks of each city neighborhood and designing targeted programs to address them. It continues to be updated on a biennial basis with demographic and rolling five years of historical incident data. City management, partners such as the University of Virginia's community health program, harm reduction non-profits, and a range of other city departments regularly use the application for strategic development and targeted community programs. The broad scope of the risks analyzed and published for the public proved the utility of the tool far beyond the traditional response focus of a city fire department.

Fire departments from across the country have contacted CFD about the process of building similar risk assessments, some of which cover populations and areas many times larger than that of Charlottesville. CFD staff have shared our time and development roadmap freely so that other communities can create similar projects to reduce risks and enhance the health and safety of their residents.

Some risks identified in the assessment proved prescient and action was only taken to address them after tragic accidents, a common response when local governments with limited budgets receive an earful from constituents after a preventable accident occurs. For example, an adult engagement focus for the Belmont neighborhood was improving crosswalk and pedestrian safety. After a pedestrian death in that neighborhood in fall 2024, significant resources and attention were dedicated to pedestrian safety in response.

Community Development Block Grant funding received shortly after publishing the assessment was used to install fire prevention devices in nearly 1,000 homes in the city. Data from the neighborhood risk assessment helped the department identify pockets of older and lower income citizens overlaid with high per capita incidences of cooking fires to strategically deploy those devices where they would most likely alert occupants of those fires or extinguish them before they spread.

The focused strategies developed for each neighborhood continue to guide the work of addressing existing and evolving risks in our city.

Conclusion

CFD's development of a granular neighborhood risk assessment was a successful demonstration of the impact a small team in a small city department can have by creatively utilizing enterprise software common in local government like ESRI products to design upstream programs addressing urgent community health and safety issues.

While staff capacity has limited frequency of data and demographic updates to a biennial basis, progress has been made recently with data analytics interns developing Python scripts to automate per capita incident calculations and other time-consuming analytical components.

The original assessment included an overview of historical weather events and known threats to Charlottesville. An expansion of that section to focus on specific climate threats expected (and increasingly observed) to become more common as climate change intensifies was developed in fall 2024. As Hurricane Helene devastated mountain communities across western North Carolina in October, a flood risk assessment was being finalized and shared with our city's emergency manager. Continuous development of this assessment is a top priority of CFD's analyst and supporting interns to continue to track evolving community risks and prepare for those to come.

References

Charlottesville Fire Department's Neighborhood Risk Assessment can be accessed at the following URL: <https://neighborhood-risk-assessment-charlottesville.hub.arcgis.com/>

21st CENTURY COMMUNITY ECONOMIC DEVELOPMENT: LESSONS FROM EASTERN KENTUCKY

Peter Hille
Chief Executive Officer
Mountain Association
433 Chestnut Street
Berea, KY 40403
peter@mtassociation.org
859.986.2373

Key words: Economic development, community development, downtown revitalization, Eastern Kentucky

Introduction

The content of this paper was initially developed as a follow-on to MDC's State of the South regional initiative which conducted regional fora in 2023, including one in Central Appalachia (<https://www.mdcinc.org/resources/truesouth/>). The author was a presenter at the Berea forum and was invited to write a blog post based on comments delivered there. Subsequently, that post was further developed in the form presented here and published by MDC as part of its True South series.

Literature Overview

While the overall thrust of this short paper is observational and based on deep professional experience, some of the data sources are listed in the references below.

Methodology

The primary source for this paper is 35 years of extensive field work, participatory research, case studies and professional engagement in Eastern Kentucky and Central Appalachia, including decades of discussion and debate with experts in the field of community economic development, state and national agency personnel, thoughtful colleagues and observation and shared experiences from generous and wise community leaders. Some of the specific sources of data include are in the references below.

Results and Implications

The paper and the examples cited make a case for shifting away from a focus on industrial recruiting and job creation and instead recognizing that the future of Eastern Kentucky relies on addressing the demographics of the region's communities which have suffered a devastating loss of population—mostly workforce—over 75 years. Successful economic development in deeply economically distressed communities can and should be grounded in communities recreating themselves as places where people can live and will chose to live.

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Conclusion

Change is visible today as a result of decades of investment in leadership and community development. Downtowns are coming back to life and storefronts are filling up. Quality of life is key to making communities in Eastern Kentucky attractive and viable for young people growing up there, for those who left for college or work, or for retirees who left in the decades-long Appalachian diaspora. Those same qualities will encourage visitors to explore the potential to relocate to these places as well. Both returning and new residents will bring assets and resources, and many will bring their jobs with them via remote work opportunities. This regrowth of communities will drive economic development that is grounded in small, locally owned businesses that contribute to quality of life while also building more diverse and sustainable local economies.

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Appendix

It's time to embrace a new approach to economic development that is grounded in the realities of the 21st century, not the economies of the past. We must look beyond resource extraction, and beyond the industrial revolution, to create economies that are more diverse, resilient, sustainable, and equitable. Appalachia provides a stark example of how the old economy didn't work. The persistent poverty of this region is a harsh illustration of that failure, and we see many of the same dynamics in rural places across America and around the world.

The expulsion and erasure of Native Americans and the immeasurable crime of slavery set the economic and moral stage for the extractive industries that have characterized the economic history of this place, from salt to timber to coal to oil and gas. And we see the result of what economists call the resource curse: places that are rich in resources become impoverished.

For more than 100 years, coal was king in Appalachia. Coal camps were built to house workers. Some had modern conveniences with everything a family needed at the company store. But others offered only a meager existence and the miners were typically paid in scrip that could only

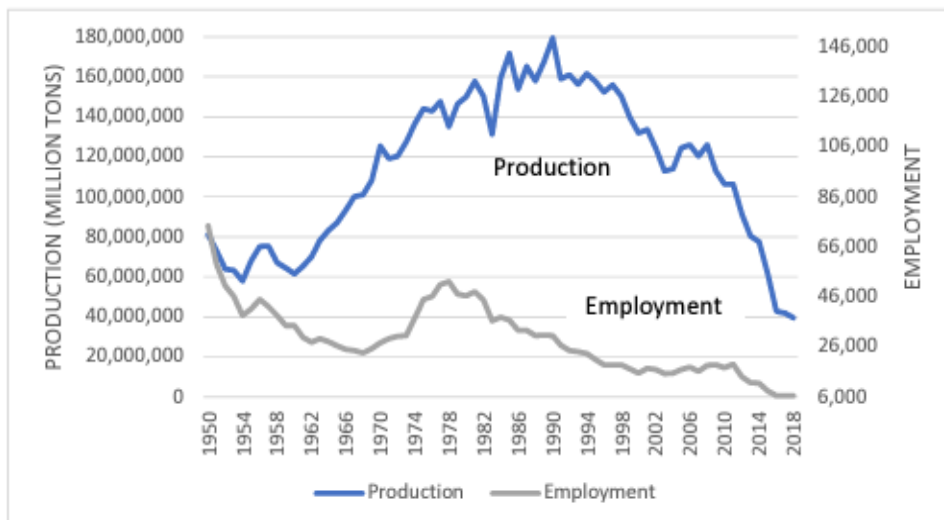
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be spent at those company stores. As the miners organized for better pay and working conditions, the companies fought the unions with private guards to put down strikes, often with great violence. Coal brought jobs, but at a great cost to the people and places where it was mined.

Kentucky began losing coal jobs in the 1950's with the mechanization of the mines and continued to lose jobs for the next 70 years, even as production increased. The jobs became more technical, and paid better, but with each boom-and-bust cycle more workers left, and each time coal rallied fewer jobs came back. The result is a hollowed out demographic where generations of workers left to find jobs elsewhere and many communities lost half of their population.

Now we face the daunting task of building a new economy amid the ruins of an old economy that extracted the coal, extracted the wealth, and ultimately extracted the workforce. Building a new economy in Appalachia will take more than just bringing in a new industry to replace the old one. We have to rebuild entire local economies with all the elements of community that are needed to support that—schools, healthcare, childcare, housing, infrastructure.

Kentucky Coal Production and Employment 1950-2018



Kentucky began losing coal jobs in the 1950's and continued to lose jobs for the next 70 years, even as production increased. Despite its promise, the old economy didn't work. Now Appalachia, [much like other Southern economies built on extraction](#), must build a new economy—one that is more diverse, resilient, sustainable and equitable. *For more about the economic history of coal in Appalachia and the need for a different future, see Peter Hille's [2019 Congressional testimony](#).*

Best Practices for Strengthening Economic Resilience in Appalachia – and rural communities throughout the South

1. Invest in education, technology, infrastructure, and broadband.
2. Engage the community over the long term.
3. Create communities where people want to live.
4. Grow youth engagement and next-generation leadership.
5. Identify and grow the assets in the community and region.
6. Build networks and foster collaboration.
7. Move multiple sectors forward for economic development and grow value chains.
8. Cultivate entrepreneurs and develop resources for business start-ups.

[Strengthening Economic Resilience in Appalachia: A Guidebook for Practitioners](#) includes case studies and best practices for enhancing economic prospects of coal-impacted communities in Appalachia, but the lessons apply to other Southern, rural communities historically dominated by one industry.

Local leaders have stepped up to the challenge of recreating their communities as places where people can live, and will choose to live. They understand that [all the services and amenities that make a place livable are themselves economic drivers](#)—grocery stores, coffee shops, bookstores, restaurants, recreation opportunities, health clinics and childcare centers.

Remarkably, we now stand at an exciting moment in this long trajectory. An April 2023 article in the Lexington Herald Leader headlined [“Thriving Business Climate”](#) described the growth of retail businesses in several Eastern Kentucky downtowns. The article cited places where the old downtown store fronts are filling up, where it’s become hard to find a place to open another business, and one town where occupancy has gone from 80% vacant to 100% full. This feels like a tipping point in the long work of community economic development here.

How did we get here? These communities are growing again because of decades of investment in local leadership and community development. Seeds of hope have been sown through countless small projects carried out by local leaders—a park cleanup, a new farmers market, an after school program for kids, or a walking trail. These seeds have been watered by resources like community mini-grants programs, support from community foundations, and local fundraising that unearthed untapped assets. The saplings that have taken root are now bearing fruit as young people look at the changes and begin to imagine a future for themselves that doesn’t require them to leave; as those who have left consider coming home; and where a visitor looks around and wonders if they might set down roots here too.

This tipping point in our journey of community revitalization coincides with a sea change in the world of work. In the past, jobs were tied almost exclusively to physical locations. Much of the old-school language of economic development spoke of this in well-worn phrases like “bringing in jobs” or “landing a factory.” The world of online work has been shifting that paradigm for many years, but today, in the post-pandemic economy, we have learned the true extent to which many jobs need not be tied to a physical location at all.

For Appalachia, this bodes well for an approach to community economic development that is grounded in the idea of communities where people want to live and can afford to live. Our re-awakening downtowns, combined with the natural beauty of this area, provide an attractive quality of life. The opportunity for people to live here and not have to sacrifice the potential of a world-class job is a bright light at the end of a long tunnel.

Coal communities literally fueled the growth of our nation's economy, but despite their sacrifices, they did not participate in the prosperity they helped to create. They are owed a debt, and that debt can be paid by investing in growing this new economy. The federal government has recognized that debt with a breathtaking range of new funding programs for energy communities, but it is critical that we ensure these resources are not squandered in outmoded approaches like building industrial parks to recruit industries—industries that are not likely to locate in the small, economically distressed counties of this region.

Instead, government policy makers and private philanthropy should hearken to voices close to the ground, align their investments with the good work that is already underway in many places, and help communities that are just getting started to begin their own revitalization. Many of our towns have fine old buildings that have sat vacant too long—invest the money needed to bring them forward into this moment of rebirth. Our schools are struggling for funding—put solar panels on their roofs to reduce their energy burden. We have a long-standing housing crisis, made worse by climate-driven storms—put new federal dollars into meeting that need so as our population rebounds, people have decent homes to live in.

Our communities are indeed coming back to life and we can see the results. People are returning, and many of them are bringing their jobs with them. The new economy we are building here in Eastern Kentucky can be an example for rural places everywhere. When local leaders and local entrepreneurs take control of their own economic future, and create communities where people want to live, the people will come, and the jobs will follow.

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<https://www.report.stateofthesouth.org/>