



**AUDIT TRANSITION IN THE AGE OF DIGITAL REVOLUTION:
TECHNOLOGY, PERFORMANCE, SUSTAINABILITY, AND TRANSPARENCY —
INSIGHTS FROM EMERGING MARKETS**

DOCTORAL DISSERTATION

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Budapest, 2026



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Doctoral School of Business Management

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Doctoral School of Business Management
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Table of Contents

List of Figures	iii
List of Tables	iv
Acknowledgment	vi
1. Dissertation summary	1
1.1. Research background and justification of the topic	1
1.2. Research frame.....	6
1.3. Overview of the studies	11
1.4. Usability of the findings for policymakers and the auditing profession.....	35
1.5. Potential research directions for future auditing research.....	40
1.6. List of own (and co-authored) publications related to the topic	45
Main references	47
2. Study I. Artificial intelligence and the future of the internal audit function	52
2.1. Introduction and motivation.....	53
2.2. Literature review	56
2.3. Research method.....	60
2.4. Main results.....	69
2.5. Discussion: Future research avenues	75
2.6. Conclusion and practical implication.....	79
References	80
3. Study II. Technology adoption in audit of information systems: Ethiopian audit firms' perspective	85
3.1. Introduction.....	86
3.2. Literature review and research hypothesis development	87
3.3. Research method.....	97
3.4. Study results.....	99
3.5. Discussion	105
3.6. Conclusions and future implications.....	108
References	109
Appendix A	115

4. Study III. Audit technology as a catalyst for improving non-financial performance in Ethiopian audit firms	117
4.1. Introduction.....	117
4.2. Literature review and hypothesis	119
4.3. Research methodology.....	124
4.4. Analysis and results	127
4.5. Discussion.....	130
4.6. Conclusion and implications.....	131
References	134
Appendix B	138
5. Study IV. Leveraging computer-assisted audit tools for corporate sustainability: Evidence from Ethiopia	139
5.1. Introduction.....	139
5.2. Literature review.....	142
5.3. Research method.....	151
5.4. Study results.....	155
5.5. Discussion.....	161
5.6. Conclusions and future implications.....	165
References	167
Appendix C	174
6. Study V. Key audit matters disclosure: Do they reveal construction firm’s risk of financial distress? Evidence from Ethiopia	176
6.1. Introduction.....	176
6.2. Review of the literature.....	179
6.3. Research method.....	181
6.4. Major findings.....	184
6.5. Conclusions and implications	193
References	195
Appendix D	198
Appendix E	200
Glossary	203

List of Figures

Figure 1. Relationship of research questions, publications, and results	9
Figure 2. Summary of Study II: Structural model with significant findings: CAAT adoption.....	19
Figure 3: Summary of Study II: Interaction effect between audit firm size and clients' AIS complexity on CAAT adoption	20
Figure 4. Summary of Study III: Interaction effect of OGR on OPE.....	24
Figure 5. Summary of Study IV: Structural model assessment – Fraud detection.....	29
Figure 6. Study I: Resolution of internal audit function under artificial intelligence.....	57
Figure 7. Study I: Selection scheme of publications.....	62
Figure 8. Study I: Publication distribution per year.....	70
Figure 9. Study I: Distribution of publications per research method.....	71
Figure 10. Study I: Distribution of publications per research method and year	72
Figure 11. Study I: Distribution of publications per framework used	72
Figure 12. Study I: The relation between the research method and the framework used.....	73
Figure 13. Study I: The CACS framework for artificial intelligence utilization in IAF	77
Figure 14. Study II: Research model using the TOE framework	96
Figure 15. Study II: Structural model with significant findings: Without a moderator.....	103
Figure 16. Study II: Structural model with significant findings: With moderator.....	103
Figure 17. Study II: Interaction effect between audit firm size and clients' AIS complexity.....	104
Figure 18. Study III: The research model	127
Figure 19. Study III: The interaction effect of OGR on OPE.....	129
Figure 20. Study IV: Research framework	150
Figure 21. Study IV: Structural model assessment without moderator	160
Figure 22. Study IV: Structural model assessment with moderators.....	161

List of Tables

Table 1. Summary of Study II: Structural model assessment summary for direct and indirect effect model: CAAT adoption	20
Table 2. Summary of Study III: Multivariate regression outcome	24
Table 3. Summary of Study IV: Structural model assessment – Fraud detection	29
Table 4. Summary of Study V: Pooled OLS regression model – Financial distress level	34
Table 5. Summary of research outcomes and stakeholder implications	39
Table 6. Study I: Summary of publications reviewed in the literature	65
Table 7. Study I: Distribution of publications per journal	69
Table 8. Study I: Top five most cited publications in 2023	70
Table 9. Study I: Distribution of publications per location	74
Table 10. Study II: Descriptive statistics	99
Table 11. Study II: Items loading, average variance extracted, composite reliability, and Cronbach’s alpha.....	100
Table 12. Study II: Fornell–Larecker test for discriminant validity	101
Table 13. Study II: HTMT test for discriminant validity.....	102
Table 14. Study II: Structural model assessment summary for direct and indirect effect model	102
Table 15. Study II: R ² Values and standardized root mean square residual (SRMR)	104
Table A1. Study II: Constructs and measurements used in the survey.....	115
Table 16. Study III: Multivariate regression outcome	128
Table B1. Study III: Variables and measurements	138
Table 17. Study IV: Kind of CAATs utilized.	156
Table 18. Study IV descriptive statistics.....	157
Table 19. Study IV: Mann – Whitney tests summary based on company characteristics.	158
Table 20. Study IV: Measurement model.	159
Table 21. Study IV: Discriminant validity.....	159
Table 22. Study IV: Summary of structural model assessment.	160
Table C1. Study IV: Indicators used for constructs in the survey.	174
Table 23. Study V: Sample selection procedure	182

Table 24. Study V: Key audit matters categorization	184
Table 25. Study V: Descriptive statistics of sampled company-year observations	185
Table 26. Study V: Descriptive statistics and univariate analysis of FIDT and NKAMs	187
Table 27. Study V: Correlation matrix	188
Table 28. Study V: Pooled OLS regression model	189
Table 29. Study V: Two-step-system generalized method of moments (GMM), Propensity score matching (PSM), and changes of the main independent variable model	193
Table D1. Study V: Variables and their definitions.....	198
Table E1. Summary of key peer reviewer feedback, revisions, and editorial outcomes	200

Acknowledgment

I express my sincere gratitude to God for guiding me throughout this journey. I am deeply grateful to my supervisor, Professor Lakatos László Péter, for his consistent support, professional guidance, and encouragement throughout my Ph.D. studies. I would also like to thank the reviewers of this dissertation for their valuable comments and constructive suggestions, which have significantly improved the quality of this work. Furthermore, I am grateful to the staff of the Doctoral School for their continuous administrative support and assistance during my studies. Finally, I extend my heartfelt thanks to my family for their unwavering support and constant belief in me.

1. Dissertation summary

1.1. Research background and justification of the topic

As a lecturer in accounting and finance with teaching and research experience at Debark University and Corvinus University of Budapest, I am deeply interested in exploring “*Audit Transition in the Age of Digital Revolution: Technology, Performance, Sustainability, and Transparency — Insights from Emerging Markets*” because it aligns closely with both my academic and research focus. My experience has strengthened my commitment to understanding how digital innovations transform audit practices, influence the quality of financial reporting, and enhance transparency in emerging markets. When I began this research, I envisioned it as an opportunity to bridge theory and practice, generate insights for curriculum development, guide practitioners, and contribute to a broader understanding of sustainable and technology-driven transitions in auditing. The thesis, developed as a compilation of interconnected publications, collectively examines how digital technologies reshape audit processes, auditor judgment, performance outcomes, sustainability assurance, and disclosure practices, positioning auditing as an evolving system influenced by innovation, sustainability expectations, and transparency demands. In addition to these quantitative and technological dimensions, the audit transition also involves important qualitative aspects, such as auditors’ perceptions of emerging technologies, professional judgment processes, trust in AI-supported systems, and behavioral responses to complex audit environments, which are increasingly recognized as critical components of modern auditing research.

The concept of “audit transition” emphasizes that the changes observed are not merely incremental improvements but fundamental shifts in how audits are designed, executed, and evaluated. Digital transformation acts as the primary driver of this transition, while audit transition represents its broader professional and methodological outcome. Traditional audit approaches (largely reliant on sampling, periodic testing, and retrospective verification) are increasingly being replaced by technology-enabled methods that allow auditors to examine complete datasets, perform continuous monitoring, and assess risks in real time. In the digital age, auditing is no longer primarily about selecting representative samples; it increasingly involves full-population testing, system-wide anomaly detection, and deeper analytical insight into organizational behavior. This evolution reflects the growing complexity of business

environments and the exponential increase in transaction volume and data sophistication (Allbabidi, 2021; Awuah et al., 2022). Advancing audit processes through technological innovation and enhanced disclosures has therefore become critical for maintaining confidence, ensuring regulatory compliance, and strengthening the efficiency and transparency of financial reporting. Recent studies further emphasize that this transition is not only technological but also organizational and behavioral, requiring auditors to adapt their cognitive processes and professional judgment in increasingly data-driven environments (Abdo-Salloum & Chehade, 2026; Sundarasan et al., 2026).

The inclusion of technology, performance, sustainability, and transparency as core pillars reflects the audit transition's multidimensional impact. Technology serves as the central catalyst, reshaping audit methodologies and tools through data analytics, automation, and artificial intelligence. Performance captures the growing recognition that technology-supported audits influence not only financial reliability but also broader organizational outcomes, such as operational efficiency, decision quality, and internal control effectiveness. Sustainability highlights the expanding scope of auditing beyond financial accuracy toward long-term value creation, ethical conduct, and effective corporate governance. Fraud and unethical practices undermine sustainability by eroding trust, damaging reputations, and weakening financial stability (Demirović et al., 2021). Consequently, governance mechanisms (such as internal auditing, risk management systems, skilled human capital, and the effective use of audit technologies) play a critical role in preventing fraud and supporting sustainable business practices. Transparency reflects the increasing importance of audit disclosures as communication tools that convey risk, uncertainty, and the usefulness of information to stakeholders. Emerging research also highlights that these dimensions are increasingly interconnected through digital technologies, particularly AI-enabled systems that simultaneously influence audit performance, governance quality, and transparency outcomes (Leocádio et al., 2024; Gu et al., 2024).

Recent technological advancements associated with the digital revolution have led to the development of specialized software and tools designed to enhance audit effectiveness and efficiency. Among these, computer-assisted audit techniques (CAATs) represent foundational technologies that enable auditors to gather, process, and evaluate large volumes of data more systematically (Mahzan & Lymer, 2014). The Information Systems Audit and Control

Association (ISACA) defines CAATs as tools and procedures used by auditors to perform data-driven audit tasks. In data-intensive environments, CAATs enhance accuracy, mitigate risk, and improve coverage by allowing auditors to analyze entire datasets rather than samples. Techniques such as data mining, pattern recognition, and statistical analysis facilitate the identification of anomalies and irregular trends that may signal heightened risk (Pedrosa et al., 2020). Tools such as Audit Command Language (ACL), Interactive Data Extraction and Analysis (IDEA), Excel macros, and automated workpaper software (e.g., CaseWare and AuditFile) have become increasingly common, streamlining audit workflows and enhancing integration with accounting systems (Al-Okaily et al., 2022).

Building on these foundational tools, artificial intelligence (AI) and automation represent the next stage of technological advancement in auditing. Automation substantially enhances audit efficiency by enabling the rapid execution of repetitive tasks such as data collection, sorting, and preliminary analysis (Smidt et al., 2021). AI-driven tools extend beyond traditional CAATs by incorporating learning capabilities, predictive analytics, and advanced pattern recognition. These systems can analyze vast numbers of transactions in real time, identifying complex anomalies and risk patterns that may remain undetected in manual or rule-based audits. As a result, auditors are increasingly able to focus on higher-level activities such as professional judgment, risk assessment, and strategic analysis. Research on AI-enabled auditing is therefore critical, as these technologies have the potential to enhance audit quality, reduce time and cost, and minimize human error and bias, thereby improving objectivity and reliability (Zhang & Song, 2022). At the same time, their adoption raises important challenges related to data security, system integration, and auditor competence. More recent studies highlight the emergence of AI co-piloted auditing and generative AI applications, which support auditors in complex decision-making, automated reporting, and advanced risk assessment while also raising concerns about explainability, overreliance, and auditor trust (Gu et al., 2024; Popa et al., 2024; Zhang & Zhou, 2025).

Beyond improvements in audit processes, the adoption of audit technologies increasingly influences organizational performance and sustainability outcomes. Prior research suggests that technology-enabled auditing contributes to improved operational efficiency, stronger internal controls, enhanced client confidence, and more informed decision-making (Errore et al., 2013;

Wang et al., 2022). In addition, as sustainability and ESG (environmental, social, and governance) reporting gain prominence, auditors are expected to provide assurance not only on financial information but also on non-financial disclosures related to ESG practices. Technology-supported audits play an increasingly important role in enhancing the credibility of such disclosures, thereby supporting long-term value creation and effective risk management (Samagaio & Diogo, 2022). Recent empirical evidence further confirms that AI-driven analytics can improve audit efficiency and support auditor judgment, while also introducing risks related to overreliance on automated outputs and the need for new competencies (Kokina et al., 2025; Li & Goel, 2025a).

Simultaneously, the digital transformation of auditing has heightened expectations regarding transparency and the quality of disclosure. Stakeholders increasingly demand clear, timely, and informative audit reports that provide insight into a company's financial position, key risks, and areas of judgment (Camacho-Minano et al., 2023). A significant development in this regard is the introduction of Key Audit Matters (KAMs), which require auditors to communicate the most significant issues encountered during the audit. KAMs enhance transparency by explaining how auditors addressed complex or high-risk areas, thereby improving users' understanding of audit processes and outcomes (Bepari et al., 2022). As reporting environments become more complex, research on enhancing the relevance, clarity, and timeliness of audit disclosures is essential for strengthening accountability and trust. In AI-enabled audit environments, transparency is further linked to issues of explainability and auditability of algorithms, which are critical for maintaining stakeholder trust and regulatory compliance (Li & Goel, 2025b).

The importance of these developments is illustrated by high-profile corporate failures such as the Wirecard scandal in 2020. Wirecard AG, a German payments company, collapsed after an investigation revealed that €1.9 billion purportedly held in trust accounts did not exist. The company's auditor, Ernst & Young (EY), failed to detect the fraud over several years, highlighting the limitations of traditional audit approaches reliant on sampling and legacy systems. Advanced audit technologies, including real-time data analytics and AI-driven tools, could potentially have identified inconsistencies and red flags earlier by enabling continuous monitoring and full-population analysis (Seethamraju & Hecimovic, 2022). Moreover, more

detailed and standardized disclosures across subsidiaries may have increased transparency and deterred misrepresentation. This case highlights the pressing need for refined audit methodologies and regulatory reforms in an increasingly digital and complex business landscape.

Motivated by these developments and personal research interests, this thesis examines how technological advancements are transforming auditing practices, performance outcomes, sustainability assurance, and transparency in emerging economies, with a particular emphasis on Ethiopia. While the empirical studies are grounded in "emerging market" contexts, their implications extend beyond these settings. Emerging economies are characterized by constrained resources, evolving regulatory frameworks, and uneven technological adoption, making them valuable contexts for observing how audit innovations unfold under practical limitations (Puthukulam et al., 2021). Ethiopia, in particular, shares key institutional, regulatory, and market characteristics with other emerging economies in Sub-Saharan Africa and parts of Asia, including developing auditing standards, limited technology adoption, resource constraints, and evolving disclosure frameworks, which allow for cautious generalization of the findings. The challenges identified in the literature, such as auditor competence, organizational readiness, trust in technology, and the effective use of full-population testing, are increasingly relevant across both developing and developed economies. Additionally, conducting empirical research in Ethiopia was facilitated by the researcher's access to data and professional networks (through scholarly associations) within the Ethiopian audit industry, which provided more practical opportunities than might have been available in other countries. Evidence from emerging markets further suggests that institutional constraints, resource limitations, and varying levels of technological readiness significantly influence the adoption and effectiveness of AI in auditing (Pérez-Calderón et al., 2025).

Accordingly, this research addresses three core questions:

RQ1 – Technology Adoption: How do emerging technologies reshape auditing practices?

RQ2 – Technology Impact: How does audit technology enhance organizational performance and sustainability?

RQ3 – Transparency: How do audit disclosures enhance transparency and risk assessment?

The study employs a combination of systematic literature reviews and empirical investigations to address these questions. By integrating evidence from multiple studies, the

thesis offers comprehensive insights into the ongoing audit transition in the digital age. Although rooted in an emerging market context, the findings contribute to a broader global discourse on how the auditing profession can adapt to digital complexity, heightened accountability, and expanding stakeholder expectations in an evolving regulatory and economic environment. At the same time, the study acknowledges that understanding the full implications of audit transformation also requires attention to qualitative dimensions, including auditor behavior, judgment processes, and interactions with emerging technologies, which remain important avenues for future research.

1.2. Research frame

My dissertation is grounded in a collection of published articles that examine the role of technology and disclosures in reshaping auditing practices and their broader contributions. Accordingly, the concept of "audit transition in the age of the digital revolution" captures a fundamental shift in the nature, scope, and expectations of contemporary auditing. Figure 1 illustrates the relationship between the research questions, publications, and the studies' findings. The foundation of the dissertation lies in systematic literature reviews (Study I), which examine the application of technology in auditing. Study I established the conceptual foundation by examining the transformative potential of artificial intelligence to shape the future of the internal audit function, offering theoretical insights into the ongoing digital transition in auditing. It outlines the technological and organizational shifts driving the transition in the digital era. More recent research further reinforces this transition by emphasizing the growing role of AI-enabled auditing frameworks and human–AI collaboration in shaping modern audit environments (Leocádio et al., 2024; Gu et al., 2024).

In addition to the studies included in this dissertation, I have authored a literature review on “Computer-assisted auditing techniques adoption for audit of information systems”, which has been accepted for publication in the *International Journal of Business Information Systems* (Wassie & Lakatos, 2025). Since 2023, AI auditing research has advanced rapidly, with emerging studies highlighting the integration of generative AI, large language models, and AI-driven analytics into audit practices. As presented in a separate subsection (see Section 1.3), the review offers additional theoretical and empirical insights into the significance of technology and disclosures in audit practice, complementing the dissertation’s focus on technology,

sustainability, and transparency in auditing. These reviews, along with a comprehensive categorization exercise, provide a valuable summary of the mechanisms and applications of technology and disclosures for interested readers, and help identify emerging research questions in the field that warrant further exploration. The literature reviews revealed the diverse modes and domains in which technology and disclosures can be effectively applied, highlighting opportunities for future research. Recent studies particularly emphasize the transformative impact of generative AI and advanced analytics on audit processes, professional competencies, and decision-making, highlighting the need for continuous adaptation in audit practices (Popa et al., 2024; Zhang & Zhou, 2025; Abdo-Salloum & Chehade, 2026).

When I began work on my dissertation, several influential studies had already examined the adoption of technology to improve auditing processes. Key contributions to the field include studies by Mahzan and Lymer (2014), Al-Okaily et al. (2022), and Samagaio and Diogo (2022), which examined the impact of individual and institutional factors on the adoption of technology in audit practices. Similarly, Camacho-Minano et al. (2023) investigated the relevance of audit disclosures, particularly their relationship with financial distress. While employing varied theoretical approaches and examining diverse contexts, these studies aimed to derive overarching conclusions. My focus in this study, however, was on understanding the specific effects of technology and disclosures within the current context and how they influence auditing processes and sustainability in the digital age. To achieve this, Study II utilized the Technological, Organizational, and Environmental (TOE) framework to examine six factors affecting technology adoption in external audits. It investigated the adoption of audit technologies among Ethiopian audit firms, identifying the key factors influencing the integration of information system tools within emerging market contexts (answers RQ1). More recent empirical evidence suggests that AI adoption in auditing is also influenced by factors such as auditor readiness, governance structures, and the need for explainable systems, particularly in technology-driven audit environments (Li & Goel, 2025a; Li & Goel, 2025b). Building on this, Study III analyzed how the use of audit technologies (CAATs) contributes to improved non-financial performance in audit firms (answers RQ2), underscoring technology's role as a strategic enabler of audit quality and organizational outcomes (see Figure 1). In line with recent findings, technology-enabled auditing not only improves efficiency but also supports auditor judgment and reduces

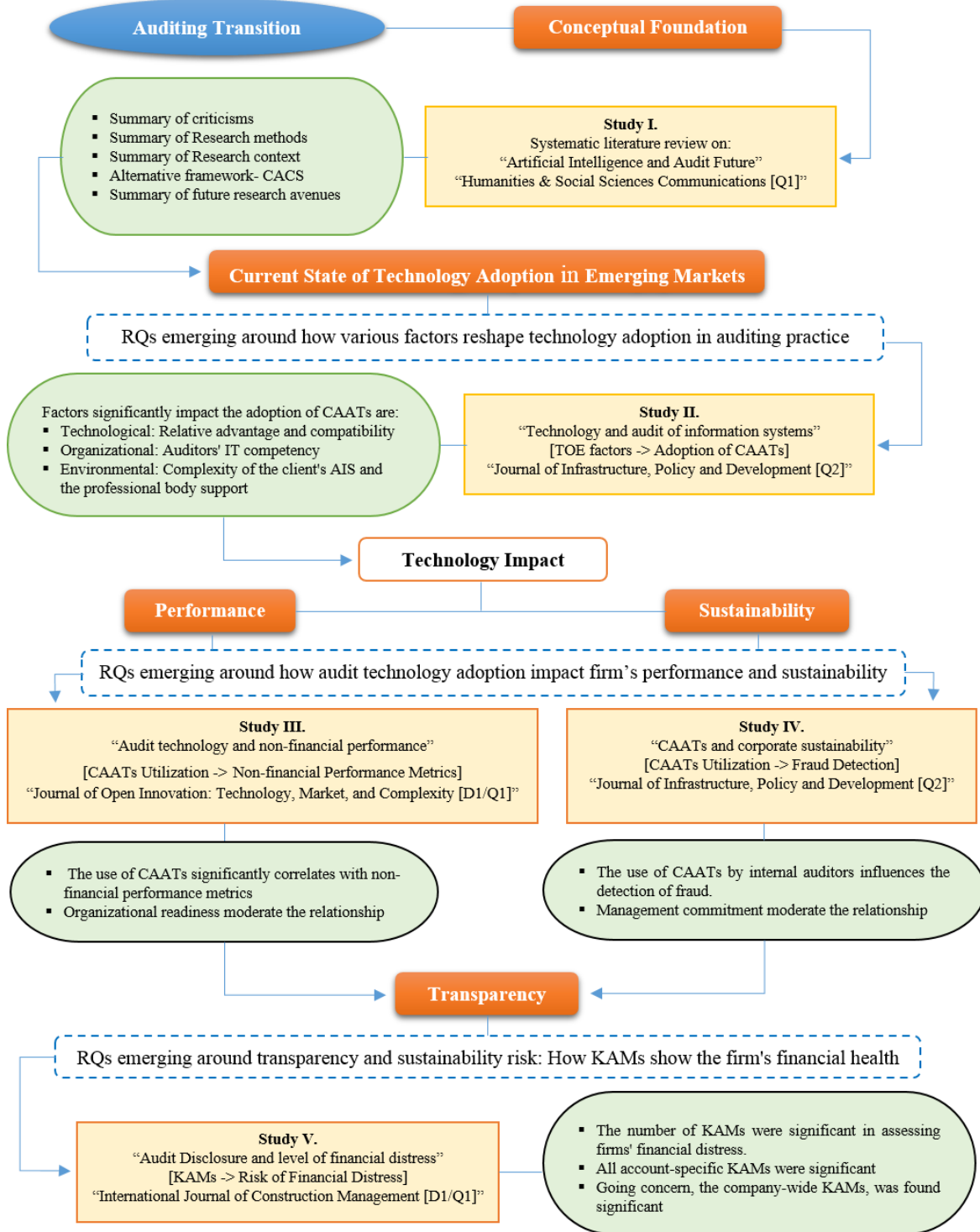
cognitive burden, while introducing new challenges related to overreliance on automated outputs (Kokina et al., 2025).

Additionally, Study IV extended the analysis to the sustainability domain, examining how computer-assisted audit tools and techniques can support corporate sustainability practices and reinforce the broader social responsibility of auditing within the context of developing economies (also answers RQ2), providing a unique lens for analysis. Sustainability, in general, refers to the ability of organizations or societies to meet current needs without compromising the resources and opportunities available to future generations (Ganesan et al., 2017). It involves balancing economic performance, social responsibility, and environmental protection, ensuring that current actions do not create long-term harm. In this thesis, sustainability is examined through the lens of the last two studies. In Study IV, it is proxied by the effectiveness of internal auditors in detecting fraud within business acquisition processes. This approach is supported by previous research, which shows that fraudulent activities can significantly weaken a company's ability to create value for shareholders and other stakeholders, posing a threat to long-term stability and responsible business practices (Amoako et al., 2023). In Study V, sustainability is represented through financial accountability, as evidenced by Key Audit Matter (KAM) disclosures. By promoting transparency, mitigating economic and operational risks, and supporting responsible financial practices, KAM disclosures help companies maintain sustainable growth (Kohler, 2020). Together, these approaches provide practical ways to assess sustainability, demonstrating how ethical governance and financial oversight contribute to long-term business success (answers RQ2). Recent literature also highlights that AI-enabled auditing contributes to sustainability by enhancing governance, risk monitoring, and fraud detection capabilities, particularly in complex and data-intensive environments (Sundarasan et al., 2026).

Finally, Study V explored the transparency dimension (see Figure 1) by investigating whether key audit matters (KAM) disclosures effectively reveal firms' financial distress risk, highlighting the communicative value of enhanced audit reporting and its implications for a company's sustainability risks (answers RQ3). Collectively, these studies provide a comprehensive understanding of how technology, sustainability, and transparency intersect during the audit transition in emerging economies and in the current digital revolution era. In contemporary audit environments, transparency is increasingly linked to the explainability and

auditability of AI systems, reinforcing the importance of clear communication and trust in technology-supported audit processes (Li & Goel, 2025b).

Figure 1. Relationship of research questions, publications, and results



Source: Researcher's own compilation

An emerging theme in the literature was the continued reliance on traditional auditing techniques, which often fail to detect material misstatements promptly (Rosli et al, 2013). Studies such as those by Seethamraju and Hecimovic (2022) have highlighted the low adoption rates of advanced technologies, including artificial intelligence (AI), in auditing processes. Recognizing this gap, I aimed to contribute to theoretical advancements in the adoption of AI within internal auditing. This effort culminated in Study I, in which a novel theoretical framework (Commitment, Access, Capability, and Skills Development (CACS)) was proposed to address AI adoption in internal audits. Study I and supplementary reviews also identified potential research areas and gaps, offering insights into how technology and disclosures upgraded audit practices, enhancing performance and sustainability (see Figure 1). These developments also underscore the importance of qualitative dimensions, such as auditor attitudes toward AI, trust in automated systems, and the interaction between human expertise and intelligent technologies, which are increasingly recognized as critical factors influencing successful technology adoption.

The literature review revealed a range of factors impacting technology adoption in auditing. In Study II, the researcher employed the TOE framework to investigate how the six different factors affect the adoption of Computer-Assisted Audit Techniques (CAATs). These factors included technological factors (relative advantage and compatibility), organizational factors (auditor IT competency and the size of the audit firm), and environmental factors (the complexity of client accounting information systems and support from professional bodies). Besides, Study III analyzed the impact of such technologies on audit firms' performance (non-financial), revealing how digital transformation (CAAT usage) enhances three non-financial outcome metrics (client relationships, employee engagement, and operational efficiency). Recent studies further indicate that these factors are complemented by emerging considerations, such as institutional readiness, regulatory support, and resource constraints, particularly in emerging-market contexts (Pérez-Calderón et al., 2025).

Furthermore, the literature highlights the potential of technology to enhance audit quality and corporate sustainability. Internal auditing, as part of enterprise risk management, plays a crucial role in controlling fraud risk (Demirović et al., 2021). According to Puthukulam et al. (2021) and Ahmi and Kent (2013), integrating human expertise with computer-based systems

can strengthen internal control mechanisms. Study IV extended the discussion to sustainability by examining the relationship between corporate sustainability (measured by the scope of fraud detection) and the adoption of CAATs in internal audits across government-owned and private entities, underscoring the broader societal value of audit technology. In line with recent research, the integration of AI into audit processes is increasingly viewed as a means to enhance both audit quality and long-term organizational sustainability through improved monitoring and risk assessment capabilities (Abdo-Salloum & Chehade, 2026).

Building on prior research on corporate sustainability and non-financial performance in external auditing, Study V shifted focus to enhanced audit disclosures. Rather than relying solely on initial literature reviews, this study examined the relationship between audit disclosures, such as Key Audit Matters (KAMs), and corporate sustainability, with a specific focus on their impact on firms' financial health. It highlights the role of enhanced audit disclosures (KAMs) in promoting transparency and signaling financial distress risk, underscoring how technology-driven audit practices contribute to greater accountability and trust in developing economies. The findings emphasized the importance of emerging technology and enhanced disclosures in supporting primary auditing functions, identifying this as an area for further exploration. Recent developments further suggest that technology-driven audit disclosures, supported by AI and data analytics, enhance transparency and stakeholder confidence by improving the clarity, relevance, and timeliness of audit reporting.

1.3. Overview of the studies

This section presents a synthesis of the researcher's work on advancing the audit process through the integration of digital technologies and enhanced disclosure practices. The research journey began with a comprehensive review of the literature, exploring the transformative impact of artificial intelligence on internal auditing and establishing a conceptual foundation for subsequent empirical inquiries. In addition to quantitative and technology-focused outcomes, the dissertation also recognizes emerging qualitative dimensions of audit transition, including auditor judgment quality, explainability of AI outputs, professional skepticism, trust in automated systems, and the interpretability of audit evidence in digital environments.

Building on the conceptual foundation, the researcher undertook a series of empirical studies to examine the adoption and impact of audit technologies within emerging market contexts. These studies employed survey methods and secondary data to assess how technological, organizational, and environmental factors shape the implementation of computer-assisted audit techniques in audit firms. The analyses further explored how technology adoption contributes to improved non-financial performance, strengthens corporate sustainability practices, and enhances audit transparency by disclosing key audit matters. Collectively, the studies demonstrate how digital transformation and transparent communication can reinforce audit quality and accountability. More recent literature (2024–2026) further strengthens these themes by showing that AI-enabled auditing is shifting from automation-focused applications toward governance, explainability, and human–AI collaboration in audit judgment (Gu et al., 2024; Leocádio et al., 2024; Kokina et al., 2025; Sundarassen et al., 2026; Abdo-Salloum & Chehade, 2026). The findings have significant implications for policymakers, practitioners, and academics seeking to understand the evolving roles of technology and disclosure in shaping the future of auditing.

Study I. “Artificial intelligence and the future of the internal audit function”

This study (in addition to the supplemental investigation) serves as a comprehensive summary that provides a foundational framework and inspiration for the researcher's subsequent investigations. The study aimed to systematically evaluate the use of artificial intelligence (AI) in the internal audit function (IAF), offering valuable insights for academics and industry professionals on this emerging topic. It also explored the implications of AI technology on the IAF. Subsequent studies have extended these early insights by emphasizing that AI adoption in auditing is no longer limited to efficiency gains, but increasingly involves issues such as explainability, auditor–AI interaction, and governance structures for AI-enabled decision-making (Gu et al., 2024; Li & Goel, 2025a; Kokina et al., 2025). The research employed a comprehensive approach, reviewing scholarly literature on AI in the IAF and organizing the findings into thematic clusters (Seethamraju & Hecimovic, 2022; Korol et al., 2022). This systematic literature review drew on 15 articles identified through a keyword search in the Web of Science database. The limited number of publications on the subject, as noted by Zhou (2021), underscores the scarcity of studies on AI use in IAF.

The systematic review involved a three-step search for relevant articles published between 2019 and 2023, using the keywords "artificial intelligence" and "internal audit." Initially, the study retrieved 62 publications, but two filtering criteria were applied to narrow down the results (given that the WoS database covers a wide range of disciplines). The criteria were document type (limited to articles and conference proceedings) and research area (business economics). As a result, 25 and 22 articles were excluded based on these criteria, leading to a final selection of 15 relevant papers for the review.

Study I was initiated in 2022 and designed as a foundational systematic literature review for the subsequent studies in this thesis. Although the article was published in 2024, the literature included (narrow sample) reflects studies available during the review and finalization period (between 2019 and 2023). Including recently published studies is methodologically appropriate for a systematic review, particularly in a rapidly evolving field such as audit digitalization, where excluding recent contributions could result in an incomplete or outdated synthesis. To ensure continued relevance, we incorporated recent studies aligned with the review themes as they became available in the subsequent empirical studies. These newer studies largely reinforce and extend established theoretical and empirical insights rather than altering the review's conceptual foundation, thereby strengthening the overall coherence and rigor of the thesis.

The researcher structured the review into three clusters of analysis to thoroughly examine the scholarly work on AI in IAF. The first cluster focused on assessing the relevance and novelty of the selected publications, using citation analysis and the frequency of publications over time. The findings revealed that not all publications had the same impact on the field, which supported the arguments of Puthukulam et al. (2021).

The second cluster evaluated the research methodologies employed in the selected papers, as understanding the application of theory is crucial. In line with the literature (Allbabidi, 2021), the study analyzed the theoretical contributions of each paper, categorizing them into three distinct sets. This analysis also explored how the research methods aligned with these theoretical contributions. This evaluation served as an indirect measure of the theoretical depth and methodological fit within the area of AI used in IAF. The review found that surveys were the most common research method, indicating a quantitative approach to studying the topic and highlighting the need for further theoretical development.

The third analysis cluster examined the research context, considering the temporal and geographical dimensions of the selected studies. This aspect provided insights into how the researcher can expand research on AI in IAF by linking it to theory, increasing geographical coverage, or conducting comparative studies. The review confirmed the findings of Zhou (2021), who noted that most research on AI adoption in auditing is conducted in developed countries, suggesting a need for further investigation in developing regions, such as Africa. Finally, the study recommended the adoption of the recently introduced Commitment, Access, Capability, and Skills Development (CACCS) framework (MetricStream, 2020) to facilitate the integration of AI in organizations' IAFs. This framework offers practical guidance for organizations while laying the groundwork for future research and theoretical advancements in internal auditing.

Updated research developments in AI and audit technology (2024–2026)

While Study I provides a systematic review of AI applications in auditing based on literature published between 2019 and 2023, the field has evolved significantly in recent years. Building on earlier contributions, recent studies have increasingly focused on developing conceptual frameworks, strengthening governance mechanisms, and addressing practical challenges associated with AI-enabled auditing. In addition, the literature has increasingly incorporated qualitative and behavioral perspectives, including auditor trust in AI systems, the interpretability of algorithmic outputs, and ethical concerns surrounding automated judgment (Kokina et al., 2025; Li & Goel, 2025b). Early advancements in this direction include the work of Minkkinen et al. (2022), who conceptualized continuous auditing approaches for AI systems and emphasized the importance of structured monitoring tools. More recent research has expanded this perspective, with Leocádio et al. (2024) proposing comprehensive conceptual frameworks for AI integration in auditing, and Gu et al. (2024) introducing the concept of AI-co-piloted auditing, which highlights collaborative interactions between auditors and intelligent systems to enhance audit efficiency and decision-making.

The rapid emergence of generative AI and large language models has further transformed the scope of audit technology. A study of Popa et al. (2024) developed a framework for integrating generative AI into the development of professional competencies, illustrating how such tools can support complex audit activities, including automated reporting and advanced risk assessment. Similarly, Zhang and Zhou (2025) emphasized the implications of generative AI for

audit practice and research, particularly in reshaping audit processes and professional roles. Complementing these developments, Sundarassen et al. (2026) provided a comprehensive mapping of AI-enabled auditing research, highlighting increasing attention to audit quality, ethical considerations, and the evolving skill requirements of auditors in technology-driven environments. Broader systematic insights are offered by Abdo-Salloum and Chehade (2026), who document the transformative impact of AI on accounting and auditing practices, reinforcing the growing importance of digital technologies across the profession.

Recent empirical and practice-oriented studies further demonstrate both the opportunities and challenges associated with AI adoption in auditing. The study of Kokina et al. (2025) shows that AI-driven analytics can enhance audit efficiency and support auditor judgment by reducing cognitive burden, while also cautioning against risks such as overreliance on automated outputs. In a similar vein, Li and Goel (2025a) examine the integration of AI into IT auditing, emphasizing the need for new competencies, governance frameworks, and effective audit procedures for AI-driven systems. Their subsequent work (Li & Goel, 2025b) further highlights issues of auditability and auditor readiness, stressing the importance of transparency and explainability in AI-based audit environments. Evidence from emerging markets, as reported by Pérez-Calderón et al. (2025), underscores the contextual nature of AI adoption, suggesting that institutional and resource constraints play a significant role in shaping implementation outcomes.

Additionally, Shivram (2024) demonstrates how machine learning techniques can be applied throughout the internal audit lifecycle, enhancing fraud detection, audit planning, and continuous monitoring. Collectively, these studies indicate that the adoption of AI in auditing extends beyond technological implementation and involves broader transformations in professional practices, organizational structures, and regulatory environments. They also point to critical challenges in ethics, interpretability, and compliance that stakeholders must address to ensure the responsible and effective use of AI technologies.

Incorporating these recent developments into this dissertation provides a more comprehensive and up-to-date understanding of the evolving AI and auditing landscape. This expanded perspective complements the findings of Study I. It establishes a strong foundation for subsequent studies that examine how emerging audit technologies influence performance and sustainability, as well as their role in enhancing transparency and professional practices.

Methodological approach for the following empirical studies

All of the subsequent four empirical studies employed a quantitative research method, as the researcher aimed to explore relationships between various variables and make independent judgments based on data described by precise procedures (Kothari, 2004). Except for Study V, the first three empirical studies used survey research to gather auditors' opinions and attitudes. The surveys were carefully designed, and the researchers meticulously planned the sampling process to minimize potential errors related to respondents or their answers (Al-Okaily et al., 2022). A key requirement for professional research is internal validity, ensuring that the research measures what it intends to measure. The researchers carefully selected each survey question item and adapted it from existing literature to achieve internal validity. The researcher also pretested the questionnaires with a sample of respondents, followed by brief interviews, to refine them and ensure clarity and consistency in the responses. The researchers obtained informed consent from all participants to use their responses in the study. The statistical methods used to analyze the results were tailored to each study's objectives, ensuring rigorous analysis. The surveys helped assess the impact of factors within the Technology-Organization-Environment (TOE) framework on the adoption of Computer-Assisted Audit Techniques (CAATs) for auditing information systems (Study II), the impact of CAAT utilization on non-financial performance metrics (client relationships, employee engagement, and operational efficiency) (Study III), and the effects of CAAT usage on corporate sustainability, as measured by the scope of fraud detection (Study IV). The question items for each factor were drawn from the existing literature, enhancing the study's validity and reliability (Kothari, 2004).

While surveys were the primary method for assessing auditors' opinions and attitudes, Study V employed secondary data analysis to examine relationships among variables. The researchers selected this approach because it best suited the nature of the variables, the longitudinal data, and the study's objectives. The researcher performed relevant tests, including robustness and endogeneity checks, to ensure the data met the necessary criteria for analysis (Hair et al., 2017). Overall, the representative sample used in Studies II, III, and IV, coupled with the longitudinal nature of Study V, strengthened the validity of the findings, making the results more generalizable and relevant to understanding auditing practices.

Study II. “Technology Adoption in Audit of Information Systems: Ethiopian Audit Firms’ Perspective”

Technological advancement is recognized as one of the most significant challenges in the corporate world (Ahmi & Kent, 2013). With the rise of information technology, both individuals and organizations, internally and externally, are increasingly engaging in fraudulent activities and misstatements for personal gain (Smidt et al., 2021). In response, auditors, especially external auditors, must perform thorough audits to identify potential misstatements and implement corrective actions. However, before auditors begin their work, it is essential to possess a solid understanding and expertise in using modern auditing technologies (Ahmi & Kent, 2013), such as Computer-Assisted Audit Techniques (CAATs), to reduce "information asymmetry." Despite the significant advantages CAATs offer in audit engagements, many audit firms worldwide still show limited adoption of these technologies (Awuah et al., 2022). As noted by the author, many firms continue to rely on "rudimentary (traditional) audit analytics techniques" in their audit processes.

Previous research on the adoption of CAATs in auditing has applied the Technology-Organization-Environment (TOE) framework across different countries. However, comprehensive studies on the use of CAATs in information systems auditing are lacking. Several gaps have been identified in the existing literature, including a scarcity of studies on the topic, limited geographic coverage, methodological inconsistency, an over-reliance on specific theoretical frameworks, and insufficient attention to various audit perspectives (such as internal and external audits). Furthermore, there is no empirical evidence to suggest that Ethiopian audit firms currently utilize CAATs in their audit work. As a result, this study aims to investigate the key factors influencing the adoption of CAATs in Ethiopian audit firms, utilizing the TOE framework.

The study gathered primary data by surveying qualified external auditors in Ethiopian audit firms registered with the Accounting and Auditing Board of Ethiopia (AABE), specifically Certified Public Accountants (CPAs) and members of the Association of Chartered Certified Accountants (ACCA). The survey was divided into two strata: auditors based in Addis Ababa (the capital) and those based outside the capital. Using G*Power (version 3.1), the study determined that the minimum required sample size for the PLS-SEM analysis was 89, and the

researcher successfully gathered 113 valid responses from the two strata. The data was collected using a self-administered questionnaire.

The extent of CAAT usage in the audit firms served as the dependent variable, following the methods of Siew et al. (2020). The adoption of various CAAT tools, including "Generalized Audit Software, Database SQL Search and Retrieval, Audit Automation Software, Test Data, Embedded Audit Modules, and Parallel Simulation Software", was evaluated on a scale ranging from (1) "Never use at all" to (7) "Extensively used." The overall score for the dependent variable was calculated by averaging the response scores across all the tools.

The study used closed-ended questions with a 7-point Likert scale (1 = "strongly disagree", 2 = "disagree", 3 = "slightly disagree", 4 = "neutral", 5 = "slightly agree", 6 = "agree", 7 = "strongly agree") to measure the independent variables. The researcher chose a 7-point scale to improve the accuracy of responses by offering a wider range of options, thereby enhancing the likelihood of capturing participants' genuine opinions (Venkatesh & Bala, 2012; Siew et al., 2020).

The study examined the impact of various factors on CAAT adoption by formulating seven hypotheses. These hypotheses suggested that technological factors (such as relative advantage and compatibility), organizational factors (such as auditors' IT competency and audit firm size), and environmental factors (such as clients' AIS complexity and support from professional bodies) would positively influence the adoption of CAATs in Ethiopian audit firms. Additionally, the study examined the moderating effect of audit firm size on the relationship between clients' AIS complexity and the adoption of CAATs.

The findings in Figure 2 and Table 1 revealed that two technological factors (relative advantage and compatibility) were significant determinants of CAAT adoption in Ethiopian audit firms. Moreover, auditors' IT competency, an organizational factor, significantly impacted the adoption of CAATs. Environmental factors, such as the complexity of clients' AIS and support from professional bodies, also played an important role in influencing CAAT adoption. These results aligned with previous studies (Siew et al., 2020; Daoud et al., 2021; Rosli et al., 2013; Al-Okaily et al., 2022).

The results concerning the impact of auditors' IT competency and clients' AIS complexity on CAAT adoption did not align with the researcher's initial expectation of a positive effect. Auditors' IT competency was found to have a significant, though negative, impact. This negative relationship could be attributed to several factors, including a limited understanding of CAATs, resistance to change, insufficient training, risk-averse behavior, and resource limitations. Addressing these challenges requires a concerted effort to enhance auditors' IT knowledge, provide extensive CAAT training, and allocate resources to support the installation and use of CAATs. Similarly, although clients' AIS complexity affects CAAT adoption, the relationship is also negative. This adverse effect may stem from resource constraints, regulatory concerns, integration challenges, and heightened risk perceptions associated with auditing complex AIS environments. Organized efforts are needed to overcome these obstacles, like allocating appropriate resources, developing robust regulatory frameworks, and enhancing technological capabilities that facilitate the integration of CAATs into the audit process.

Figure 2. Summary of Study II: Structural model with significant findings: CAAT adoption

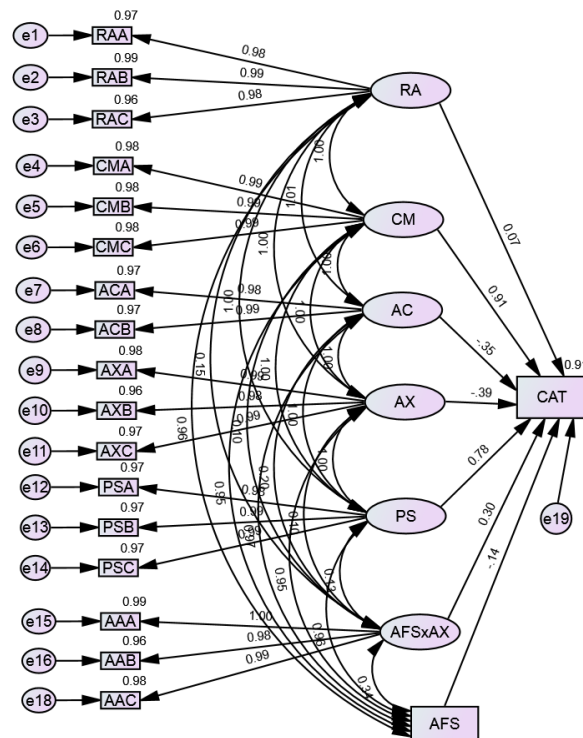


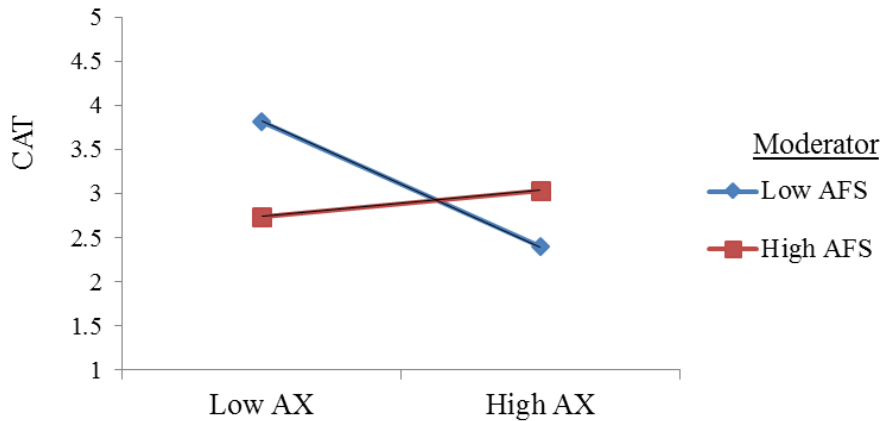
Table 1. Summary of Study II: Structural model assessment summary for direct and indirect effect model: CAAT adoption

Relationship			Path coefficient	SE	CR.	P	Finding
RA	-->	CAT	0.071	0.015	2.01	0.0712*	Significant
CM	-->	CAT	0.910	0.024	1.93	0.095*	Significant
AC	-->	CAT	-0.349	0.025	-2.807	0.037**	Significant
AX	-->	CAT	-0.393	0.026	-3.028	0.004***	Significant
PS	-->	CAT	0.783	0.023	2.961	0.026**	Significant
AFS	-->	CAT	-0.137	2.383	-1.048	0.962	Insignificant
AFSxAX	-->	CAT	0.297	0.785	0.553	0.581	Insignificant

Notes: *p-values <0.10; **p-values <0.05; ***p-values <0.01

Regarding the moderation effect, the study examined the interaction between audit firm size and clients' AIS complexity on the adoption of CAATs (see Figure 3 and Table 1). According to Hair et al. (2017), an effect is considered significant if the t-value falls between 0.9993 and 4.466.

Figure 3: Summary of Study II: Interaction effect between audit firm size and clients' AIS complexity on CAAT adoption



The analysis revealed that the moderating effect of audit firm size on the relationship between clients' AIS complexity and CAAT adoption was insignificant (t-value = 0.553). The result indicates that audit firm size does not significantly affect the negative relationship between clients' AIS complexity and the adoption of CAATs.

As a robustness check, the results were evaluated in light of the properties of PLS-SEM, which is variance-based and explicitly aims to maximize the explained variance of endogenous

constructs rather than reproduce a covariance matrix. Accordingly, the high R^2 values for CAATs adoption (0.91–0.92) fall within the "very substantial" range and are methodologically acceptable, particularly in a theory-driven technology adoption model with proximal predictors and a single-item, perceptual dependent variable measured on the same Likert scale, which is known to reduce measurement noise and increase explanatory power. The inclusion of the moderation term led to only a modest incremental increase in R^2 , suggesting added explanatory value rather than overfitting. We addressed Potential concerns related to common method variance through procedural remedies (anonymity, randomized items, and data collection in two rounds) and statistical tests. Harman's single-factor test showed that one factor accounted for 46.62% of the variance, which is below the 50% threshold. Measurement quality was further confirmed, as all constructs met convergent validity criteria (factor loadings, CR, and Cronbach's $\alpha > 0.70$; $AVE > 0.50$), and discriminant validity was supported by both the Fornell–Larcker criterion and HTMT ratios below 0.85. Taken together, these results suggest that the high explanatory power stems from a strong theoretical foundation rather than endogeneity, common method bias, or model misspecification.

Study III. "Audit technology as a catalyst for improving non-financial performance in Ethiopian audit firms"

The integration of technology into auditing, particularly through Computer-Assisted Audit Techniques (CAATs), has transformed how audits are conducted by improving efficiency, accuracy, and data coverage (Wang et al., 2022). While prior studies have emphasized mainly the financial benefits of adopting CAATs (Atta et al., 2024), there is a lack of knowledge about their non-financial implications, particularly in developing economies. Non-financial performance indicators such as client relationships, employee engagement, and operational efficiency, as highlighted by professional bodies like the American Institute of Certified Public Accountants (AICPA) and the International Federation of Accountants (IFAC), are crucial to an audit firm's long-term sustainability. Despite global advancements, Ethiopian audit firms have shown slow progress in adopting CAATs due to limited financial resources, insufficient technical expertise, and regulatory constraints. Nonetheless, the country's growing digital transformation presents a timely opportunity to investigate how CAAT adoption can enhance non-financial outcomes and strengthen audit effectiveness.

Guided by Contingency Theory (CT), the Resource-Based View (RBV), the Technology Acceptance Model (TAM), and the Technology-Organization-Environment (TOE) framework, this study examines the relationship between CAAT adoption and non-financial performance in Ethiopian audit firms. CT suggests that alignment between technological tools and client expectations enhances service quality and client retention. At the same time, RBV emphasizes the importance of human and technological resources in reducing turnover and improving employee satisfaction (Le et al., 2023). Drawing on TAM, the study posits that auditors' perceptions of CAAT usefulness and ease of use improve operational efficiency. The TOE framework highlights organizational readiness (financial capacity, leadership support, and infrastructure) as a moderating factor influencing successful implementation (Bigliardi et al., 2020). Accordingly, the researcher developed four hypotheses to test the effects of CAAT use on client retention, employee turnover, and operational efficiency, as well as the moderating role of organizational readiness. The study also controlled for firm characteristics, such as age and size (Siew et al., 2020), to account for contextual variations.

The study employed a quantitative, cross-sectional research design to examine the relationship between the adoption of Computer-Assisted Audit Techniques (CAATs) and non-financial performance among Ethiopian audit firms. This design was suitable for assessing existing conditions and relationships within a defined period, enabling efficient data collection across multiple firms simultaneously. As noted by Kothari (2004), cross-sectional designs are particularly suitable when investigating associations rather than temporal changes, especially in environments where limited resources and inconsistent record-keeping constrain longitudinal data collection. The design enabled the researcher to capture a snapshot of how CAAT usage correlates with key non-financial indicators, specifically client relationships, employee engagement, and operational efficiency, providing valuable insights into the technological transformation of the audit profession in an emerging market context.

The study targeted all 172 registered audit firms in Ethiopia as listed by the Accounting and Auditing Board of Ethiopia (AABE). Using Yamane's (1967) formula with a 5% margin of error and 95% confidence level, a minimum sample size of 120 firms was determined. To enhance representativeness, questionnaires were distributed to 150 firms, yielding 122 valid responses, which represents an 81% response rate. Data were collected electronically using a

structured questionnaire adapted from validated instruments in prior studies. The survey captured measures of CAAT usage, client retention, employee turnover, operational efficiency, organizational readiness, and demographic controls. To minimize social desirability and response biases (Kothari, 2004), the study ensured respondents' anonymity and confidentiality, used clearly worded items from previously validated scales, and conducted pretesting to refine clarity and consistency. The resulting sample was diverse and reflective of the Ethiopian audit industry, enhancing the generalizability of the findings.

The study assessed non-financial performance through three quantifiable indicators: client retention rate (CRR, calculated as the percentage of clients retained over a specific period), employee turnover rate (ERR, calculated as the proportion of employees who left the firm within a specific time frame), and operational efficiency (OPE, measured by the percentage of audits completed on time), following the operationalizations proposed by Errore et al. (2013). The independent variable, CAAT usage (CTU), was measured using a 5-point Likert scale, while organizational readiness (OGR, measured by the budget availability for audit technology adoption: 1 = yes or 0 = no) served as a moderating variable reflecting the firm's technological investment capacity (Le et al., 2023). Control variables included in the study were firm age and firm size. The questionnaire underwent expert review and pilot testing, resulting in Cronbach's alpha values ranging from 0.82 to 0.91, ensuring construct validity and reliability. The data analysis involved descriptive statistics and multiple regression models to assess the relationship between CAAT adoption and non-financial performance, while testing the moderating role of organizational readiness. Regression analysis was deemed appropriate because it allows for examining multivariate relationships and controlling for firm characteristics, thereby providing a robust statistical basis for interpreting the influence of CAAT usage on performance outcomes.

The preliminary analysis indicated a moderate level of technology use among Ethiopian audit firms, with a mean CAAT score of 3.4 (68%). Non-financial performance measures were generally positive, as indicated by high client retention (72%) and operational efficiency (84%), as well as a relatively low employee turnover rate (21%). The dataset satisfied the required regression assumptions: the Shapiro–Wilk test confirmed normality ($p = 0.072$), reliability was supported by Cronbach's alpha values above 0.70, and no multicollinearity was detected, with all Variance Inflation Factor (VIF) scores below 1.5. These diagnostic checks confirmed the

robustness of the dataset for regression analysis. As outlined by Kothari (2004), the study considered relationships statistically significant at the 5% level and highly significant at p-values below 0.01.

The regression results presented in Table 2 demonstrate that the adoption of Computer-Assisted Audit Tools (CAATs) has a significant positive effect on non-financial outcomes. Specifically, the study predicted that CAAT use would result in higher client retention, lower employee turnover, and improved operational efficiency. These findings supported all three primary hypotheses.

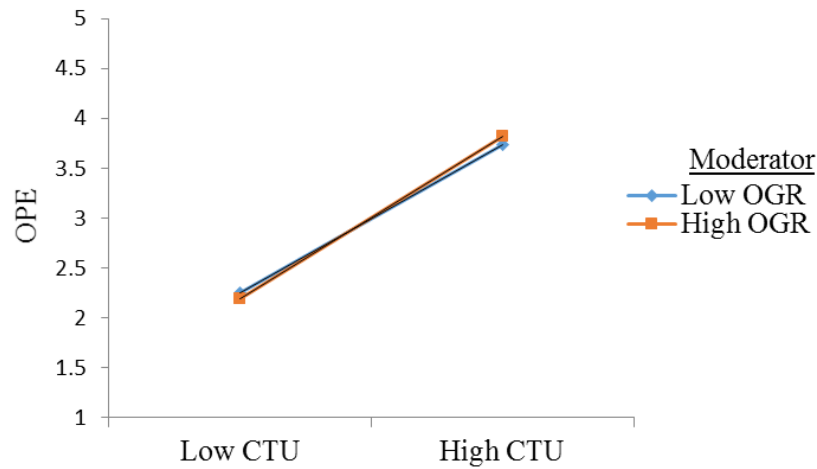
Table 2. Summary of Study III: Multivariate regression outcome

Model	Model 1	Model 2	Model 3
Dependent variable	<i>CRR</i>	<i>ERR</i>	<i>OPE</i>
<i>CTU</i>	1.311*** (0.031)	-0.966*** (0.029)	0.780*** (0.019)
<i>OGR</i>	0.763 (0.003)	-0.004 (0.003)	0.005** (0.002)
<i>FIG</i>	0.005** (0.002)	-0.003 (0.002)	0.000 (0.002)
<i>FIZ</i>	-0.003 (0.003)	0.003 (0.003)	-0.002 (0.002)
Observations	122	122	122
R-squared	95.1	92.8	95.1
F-Statistics	583.429***	389.744***	583.804***
Model VIF	1.311	1.311	1.311
Tolerance	0.763	0.763	0.763

*Notes: *p-values <0.10; **p-values <0.05; ***p-values <0.01*

Additionally, as illustrated in Figure 4 and Table 2, organizational readiness emerged as a significant moderator in the CAAT–efficiency relationship, indicating that firms with stronger technological infrastructure and internal capacity achieved greater operational benefits. The age of the audit firm was also significant in one model, implying that more established firms are better positioned to leverage audit technologies. However, other control variables did not show consistent effects across models.

Figure 4. Summary of Study III: Interaction effect of OGR on OPE



The findings underscore the central role of digital transformation in strengthening audit firms' non-financial performance, aligning with prior studies that highlight the strategic value of CAATs in enhancing audit quality, client trust, and employee engagement (Rosli et al., 2013; Wang et al., 2022). Consistent with international evidence, the use of CAAT was found to streamline audit processes, reduce manual workloads, and improve employee satisfaction and client loyalty (Atta et al., 2024). Moreover, the moderating role of organizational readiness supports prior research, which shows that firms with stronger resource bases and technological preparedness achieve higher efficiency gains (Bigliardi, 2020). The results also align with broader findings in developing economies, where challenges such as limited resources, cultural resistance, and weak institutional enforcement often hinder technology adoption (Errore et al., 2013). Nonetheless, individual and organizational enablers (particularly perceived usefulness and ease of use) remain crucial drivers of CAAT adoption (Le et al., 2023). Collectively, these results reinforce the growing consensus that integrating audit technology and organizational readiness is key to advancing operational excellence and sustainability in emerging market audit practices.

As a robustness check, standard model diagnostics were first assessed, with normality supported by the Shapiro–Wilk test ($p = 0.072$), acceptable internal consistency indicated by Cronbach's alpha values above 0.70, negligible multicollinearity evidenced by low VIF values (1.311), and homoscedasticity confirmed by the Breusch–Pagan test ($p = 0.241$). In response to feedback received during post-publication seminar presentations, particularly regarding the high explanatory power of the models ($R^2 = 95.1\%$, 92.8% , and 95.1%), we conducted additional

analyses to address potential endogeneity related to CAAT usage (CTU). Specifically, a control function approach was applied using six individual CAAT application scores as instruments; in the first stage, CTU was regressed on these scores, and firm-level controls (size, age, and organizational readiness), and the resulting residuals were included in second-stage regressions predicting client retention, employee engagement, and operational efficiency. The residual terms were statistically insignificant across all models, suggesting that endogeneity did not materially bias the estimates. At the same time, CTU remained a strong and stable positive predictor of all non-financial performance outcomes. Although reverse causality cannot be entirely ruled out in this cross-sectional study (because all variables are observed at a single point in time and we cannot definitively establish the direction of causality), these supplementary analyses strengthen confidence that the reported relationships reflect substantive effects of CTU rather than endogeneity-driven bias.

Study IV. “Leveraging computer-assisted audit tools for corporate sustainability: Evidence from Ethiopia”

In modern times, businesses face significant threats from fraud, which is often a key factor contributing to company failures and leading to economic, social, and environmental disasters (Ganesan et al., 2017). Fraudulent activities hinder a firm's ability to attain long-term sustainability. Kohler et al. (2020) argue that a lack of ethics in business diminishes accountability, fostering an environment where fraud can flourish, ultimately leading to harm to an organization's reputation, value, and public image. Samagaio and Diogo (2022) also noted the negative relationship between fraud and sustainable practices. According to Amoako et al. (2023), fraud in financial reporting can hinder the sustainable growth of businesses and markets. It underscores the importance of establishing a practical framework for detecting financial report fraud. Zhang and Song (2022) suggest that a robust corporate governance system is crucial for companies seeking to achieve genuine sustainability by ensuring the fulfillment of the triple bottom line. Internal auditing plays a crucial role in enterprise risk management (Demirović et al., 2021), particularly in managing fraud risks, as part of the internal control system. As such, internal auditors must possess the necessary skills and tools, such as computer-assisted audit techniques (CAATs), to effectively detect and prevent fraud.

The Institute of Internal Auditors (IIA) establishes professional standards for internal auditors, highlighting the importance of auditors' understanding of fraud risks (Standard 1210, A2) and incorporating technology and data analysis tools (Standard 1220, A2) into their auditing practices. Thus, adopting technology-based auditing techniques and skills is essential for preventing and identifying fraudulent activities. While existing literature (Ganesan et al., 2017) has focused on the factors influencing internal auditors' adoption of CAATs or the role of CAATs in fraud detection by external auditors, there is limited research on how CAAT adoption specifically impacts fraud risk assessments by internal auditors. Amoako (2023) suggested that CAATs positively affect fraud risk evaluation by internal auditors, though without providing empirical support. This study aims to enhance understanding of the impact of CAATs on fraud detection, contributing to corporate sustainability. The study hypothesizes that adopting CAATs has a positive impact on corporate sustainability, as measured by the extent of fraudulent scheme detection by internal auditors in Ethiopian companies. Additionally, the study examines the moderating effect of company characteristics, such as ownership, size, and management commitment.

The research used a survey method, gathering data through questionnaires developed based on existing literature. According to Hair et al. (2017), the survey method is suitable for collecting data on company-related attributes and professional experiences. The target population consisted of internal auditors in government and private companies in Ethiopia. The sample size was determined using G*Power (version 3.1), resulting in a minimum sample size of 74. Due to the lack of a comprehensive database of internal auditors in Ethiopia, participants were contacted via email through the Internal Auditing Institute of Ethiopia and on LinkedIn. Consequently, non-probability sampling was employed, specifically the convenience sampling method. The sample was relatively narrow due to limited access to the full population, reliance on available contacts, and practical constraints in reaching respondents. Additionally, data availability influenced the sampling approach, as only auditors whom we could contact and who were willing to respond were included. The survey gathered 83 valid responses, exceeding the minimum required sample size of 74.

Corporate sustainability, the dependent variable in this study, was represented by the scope of fraud detection activities carried out by internal auditors during the acquisition. Baader

and Kremar (2018) identified seven common fraud patterns in the acquisition cycle: double payments, bid rigging, pass-through schemes, private purchases, kickback fraud, non-accomplice vendors, and shell companies. These fraud types were used to assess the scope of tasks undertaken by internal auditors in detecting fraud within the acquisition cycle. The study used a five-point Likert scale to measure the significance of these items in audit activities, with 1 representing "Strongly disagree" and 5 representing "Strongly agree." The survey also included two exploratory questions to assess the general use of CAATs in internal auditing, with internal auditors rating the frequency of CAAT usage in their tasks on a five-point scale, where 1 represents "Never," 3 represents "Sometimes," and 5 represents "Always."

CAAT usage was considered the independent variable, measured according to previous studies (Pedrosa et al., 2020; Le et al., 2023), comprising 10 items related to the application of CAATs in audit tasks. Company characteristics were also assessed for their moderating effects, with company ownership (COSP) coded as 1 for private companies and 0 for government-owned companies, company size (CSIZ) coded as 1 for large companies and 0 for small companies, following the World Bank Group's criteria for small and medium-sized enterprises. Management commitment (MTCT) was coded as 1 for committed and 0 for non-committed companies (Daoud et al., 2021). The study evaluated the validity and reliability of the collected data to ensure the accuracy of the results and confirm that the study was free from common method variance (Fuller et al., 2016). The validity of the attributes was also checked through tests for Average Variance Extracted (AVE), Discriminant Validity, and Heterotrait-monotrait (HTMT) ratios (Hair et al., 2017; Ganesan et al., 2017).

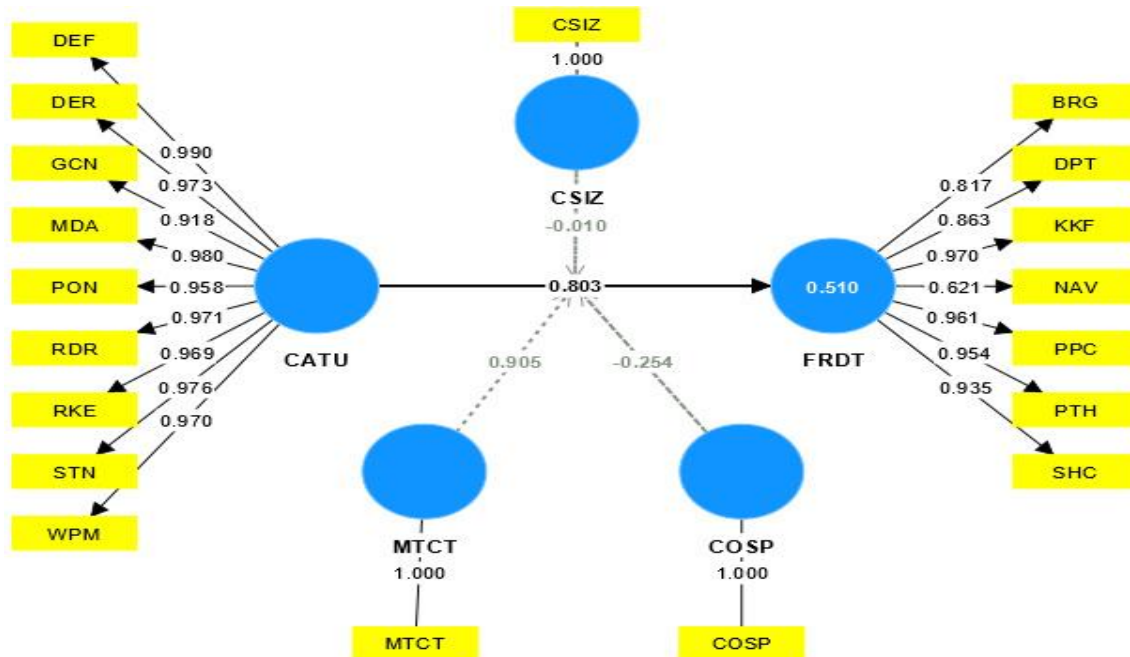
The analysis results, presented in Table 3 and Figure 5, showed that CAAT adoption enhances internal auditors' ability to detect fraud, consistent with previous research (Demirović et al., 2021; Zhang & Song, 2022). Companies are increasingly adopting business automation and data digitalization, making the effectiveness of internal auditing dependent on the effective use of information technology. These findings are consistent with Amoako et al. (2023), who assert that using CAATs is essential for companies to maintain a fraud-free environment. Thus, the practical application of CAATs is vital for reducing fraud incidents and enhancing corporate sustainability.

Table 3. Summary of Study IV: Structural model assessment – Fraud detection

Without moderator				With moderator			
Dependent variable	R ²	F ²		Dependent variable	R ²	F ²	
FRDT	0.491	0.963		FRDT	0.510	0.160	
Relation	Path coefficient	t-value	p-value	Relation	Path coefficient	t-value	p-value
CATU → FRDT	0.700	4.805	0.000	CATU → FRDT	0.803	4.834	0.000
				CATU*MTCT → FRDT	0.905	2.739	0.003
				CATU*COSP → FRDT	-0.254	-0.102	0.510
				CATU*CSIZ → FRDT	-0.010	-0.659	0.460

The study also examined the moderating effect of company characteristics on the relationship between CAAT utilization and fraud detection. The results indicated that neither company ownership nor size had a significant impact on this relationship. The findings showed that internal auditors in government-owned companies have access to tools similar to those used by their private sector counterparts, suggesting that both organizations leverage comparable technological resources for fraud detection.

Figure 5. Summary of Study IV: Structural model assessment – Fraud detection



The results align with previous studies, such as those by Samigo and Diago (2022) and Amoako et al. (2023). However, the study also reveals that management commitment plays a

significant moderating role in the relationship. This finding aligns with Mahzan and Lymer (2014) and Demirović et al. (2021), who emphasized the crucial role of management commitment in a company's technology adoption. Top management's commitment goes beyond merely providing resources to overcome resistance to using CAATs (Daoud et al., 2021; Smidt et al., 2021). It also includes actively endorsing new information systems and strengthening the legitimacy of CAAT adoption. As a result, management's support for integrating CAATs within the internal audit function is crucial in detecting a wider array of fraudulent activities, thereby contributing to the company's sustainability.

As a robustness check, preliminary analyses confirmed the reliability and validity of the measurement model and assessed potential differences across company characteristics. We evaluated the validity and reliability of the collected data to ensure the accuracy of the results and confirm that the study was free from common method variance (Fuller et al., 2016). The validity of the attributes was also checked through tests for average variance extracted (AVE), discriminant validity, and heterotrait-monotrait (HTMT) ratios (Hair et al., 2017; Ganesan et al., 2017). Both CATU and FRDT exhibited strong internal consistency, with Cronbach's alpha and composite reliability above 0.7, standardized item loadings above 0.7, and AVE values exceeding 0.50, which supports convergent validity. We confirmed discriminant validity via Fornell–Larcker criteria and HTMT ratios below 0.85. CATU remained a strong positive predictor of FRDT, explaining 49.1% of its variance in the base model ($R^2 = 0.491$) and 51.0% when company characteristic moderators were included ($R^2 = 0.510$). Following post-publication feedback from seminar presentations, we conducted additional analyses to address the potential endogeneity of CATU using a control function approach with ten individual CAAT applications as instruments. In the first stage, overall CATU was regressed on these instrument scores and control variables (firm size, ownership, and management commitment), and the researcher saved residuals. In the second stage, we included the residuals in the main PLS-SEM models predicting FRDT, together with CATU and controls. The residuals were not statistically significant, indicating no substantial endogeneity bias. Harman's single-factor test further suggested that common method variance was unlikely, as the largest factor explained only 38.7% of the variance. Overall, these results reinforce that CATU exerts a substantive positive effect on fraud detection performance rather than reflecting spurious associations, reverse causality, or measurement bias.

Study V. "Key audit matters disclosure: Do they reveal construction firms' risk of financial distress? Evidence from Ethiopia"

Assessing a client's operational and financial viability is a critical but challenging decision for auditors. Recent studies have highlighted that the usefulness of annual reports in terms of firm characteristics and audit risks depends on the disclosure of Key Audit Matters (KAMs) (Bepari et al., 2022). According to the International Auditing and Assurance Standards Board (IAASB), audit standards require auditors to evaluate a client's ability to continue as a going concern and provide an opinion when necessary. New approaches are needed to assess a client's viability, which has made going concern reports more significant (Kohler, 2020). Sierra-García et al. (2019) emphasized the need for further research on the advantages of comprehensive audit reporting. While the literature offers limited evidence on the perceived usefulness of KAMs for financial report users (Camacho-Minano et al., 2023), questions remain about the types and quantity of KAMs that effectively explain a firm's financial health and complexity, especially in many countries.

Moreover, no known studies have examined the relationship between the type of KAMs reported and the level of financial distress risk among clients in Ethiopia, creating a clear gap in research. Therefore, this study empirically investigates the connection between auditors' reports on the type and number of KAMs and the financial distress levels of client firms. The KAMs are analyzed in two ways: by risk level and financial impact category. The study posed three research questions to address its aim: (1) "Is there a relationship between the number of KAMs reported by auditors and the financial distress level of the client firm?" (2) "Is there a relationship between the risk level of KAMs reported by auditors and the financial distress level of the client firm?" (3) "Is there a relationship between auditors' reporting on KAM categorized by their primary impact and the client firm's financial distress level?"

A quantitative, explanatory research design was used, considering the nature of the variables and the study's objective to examine relationships. The initial sample comprised all construction companies (3,119) registered with the Ethiopian Ministry of Urban Development and Construction (EMUDC) from 2017 to 2021. A purposive sampling technique was employed to select the sample, focusing on recent periods to ensure the findings were current and relevant. The sample was then narrowed to include only grade-one construction firms, as these companies

are category-A taxpayers required to submit comprehensive audit reports. Most of these firms' financial audit reports were accessible through the Ethiopian Revenue and Customs Authority (ERCA). The researcher gathered additional KAM disclosures and auditors' data from the company's annual reports. The sampling process excluded 2,698 firms that did not meet the criteria of being grade-one construction companies and category "A" taxpayers. The process left 421 grade-one construction firms. The study removed an additional 334 companies because they did not provide complete data during the specified period. As a result, the final sample consisted of 87 grade-one construction firms, with 435 firm-year observations.

The study developed three pooled OLS regression models to address the research questions. The dependent variable, financial distress (FIDT), was measured using a revised version of Altman's (1983) Z-score model, a widely accepted method for predicting bankruptcy (Camacho-Minano et al., 2023). The independent variables were defined by the number of Key Audit Matters (KAMs) in each firm, measured using established methods (Bepari et al., 2022). These included the total number of KAMs (NKAM), the number of account-specific KAMs (AKAM), the number of company-wide KAMs (CKAM), the number of KAMs related to liquidity (FLQY), solvency (FSLY), and profitability (FPRY). The study also incorporated control variables, such as audit fee (ADFE), audit opinion (ADOP), and auditor change (ADCH), to account for auditor characteristics, as well as construction firm size (CFSZ) and the existence of financial restatements (REST) for client characteristics. Following Bepari et al. (2022), the study included fixed effects for year and industry categories to account for time-series trends and industry-specific factors. The following OLS regression models were then developed to analyze the data and answer the research questions.

Model 1: Examines the relationship between the number of KAMs reported by auditors and the client firm's financial distress level (RQ1)

$$FIDT_{it} = \beta_0 + \beta_1 NKAM_{it} + \sum \text{CONTROLS} + \varepsilon_{it}$$

Model 2: Examine the relation between the type of KAMs and financial distress level (RQ2)

$$FIDT_{it} = \beta_0 + \beta_1 AKAM_{it} + \beta_2 CKAM_{it} + \sum \text{CONTROLS} + \varepsilon_{it}$$

Model 3: Examined the effect of KAM by classifying the financial impact on financial distress level (RQ3)

$$FIDT_{it} = \beta_0 + \beta_1 FLQY_{it} + \beta_2 FSLY_{it} + \beta_3 FPRY_{it} + \beta_4 GOCN_{it} + \beta_5 OCWR_{it} + \sum \text{CONTROLS} + \varepsilon_{it}$$

The correlation test results reveal a statistically significant, medium-level correlation between financial distress (FIDT) and the independent variables in the models. Most of the relationships between KAMs and FIDT were negative, and the study detected no multicollinearity issues among the variables used in the regression models.

As shown in Table 4, the findings indicate that KAMs reported by auditors are valuable tools for predicting and assessing the financial distress risk of a firm. Specifically, the study demonstrates that as the number of KAMs disclosed increases, the risk of financial distress for construction companies also rises. The economic significance of this finding shows that the firm's risk of financial distress increases by 19.5% for every additional KAM disclosed. Based on this, the study suggests that construction companies experiencing financial distress disclose around four KAMs (rounded from $2.94 \times 1.195 =$ approximately 4), with the average number of KAMs per sample firm being 2.95.

Furthermore, the nature of KAMs plays a significant role in assessing a firm's level of financial distress (see Table 4). The findings reveal that account-specific KAMs are more influential in assessing financial distress than company-wide KAMs. The study suggests that, on average, three of the four KAMs disclosed by financially distressed construction companies are account-specific ($1.92 \times 1.347 =$ approximately 3). At the same time, the remaining one is company-wide ($1.02 \times 1.161 =$ approximately 1), with the average number of account-specific and company-wide KAMs being 1.92 and 1.02, respectively.

Additionally, account-specific KAMs, categorized by their primary impact on liquidity, solvency, and profitability, were particularly useful in assessing a firm's financial health and potential for distress (see Table 4). The results show that liquidity (-0.329), solvency (-0.330), profitability (-0.316), and going concern (-0.205) KAMs all have a significantly negative relationship with the firm's financial distress level (FIDT). Conversely, other company-wide KAMs (-0.05) exhibited insignificant negative relationships with FIDT. The result could be that identifying company-wide KAMs, aside from going concern, is more challenging for auditors, making their predictive power weaker than other types of KAMs. The results remained robust after conducting alternative financial distress measures and endogeneity tests.

Table 4. Summary of Study V: Pooled OLS regression model – Financial distress level

Model	Model 1	Model 2	Model 3
Dependent variable	FIDT	FIDT	FIDT
NKAM	-0.195*** (0.069)		
AKAM		-0.347*** (0.121)	
CKAM		-0.161*** (0.060)	
FLQY			-0.329** (0.125)
FSLY			-0.330*** (0.117)
FPRY			-0.316** (0.128)
GOCN			-0.205*** (0.060)
OCWR			-0.05 (0.064)
Observations	435	435	435
R-squared	99.68	99.71	99.74
F-Statistics	12384.01***	20194.89***	1686.83***
Fixed effects (industry category and year) and controls	Yes	Yes	Yes
Model VIF	5.29	6.24	6.02

Notes: *p-values <0.10; **p-values <0.05; ***p-values <0.01

The findings of GOCN align with previous research (Camacho-Minano et al., 2023), demonstrating a notable relationship. However, the link between FIDT and OCWR differs from that found in a previous study (Moroney et al., 2021), which reported no significant correlation. Additionally, the FLQY results are consistent with prior literature on financial distress (Bepari et al., 2022), indicating that liquidity measures are more effective in predicting bankruptcy than other financial indicators. However, this contrasts with the findings of Camacho-Minano et al. (2023), who concluded that firm liquidity does not significantly impact financial distress. Moreover, the FSLY results align with previous research (Kohler et al., 2020) on corporate bankruptcy, confirming that leverage measures are reliable predictors of company defaults. Lastly, the findings for FPRY are consistent with earlier studies (Sierra-García et al., 2019) on

financial distress prediction using ratio-based models, which confirmed that profitability measures are the best predictors of bankruptcy.

As a robustness check, the study employed three alternative financial distress measures (Z'' -Score (FIDTzsv), Charitou's score (FIDTch), and Charitou's score indicator (FIDTchv)) to validate the relation between KAMs and FIDT. Logistic regression using FIDTzsv shows a significant negative association with the number of KAMs (coefficient = -0.167), with a pseudo R^2 of 45.1% and an AUC of 0.724, indicating KAMs reliably reflect financial distress. Using FIDTch, higher financial distress is significantly associated with reports disclosing more KAMs. Similar results were found for KAM classifications, while FIDTchv also yielded comparable negative coefficients for both the number and classification of KAMs. Endogeneity was addressed using a two-step system GMM estimator, which corrected for unobserved variables, measurement errors, and simultaneity. The Diff-Hansen test showed no significant over-identification ($p = 0.226$). Propensity score matching confirmed a negative relationship between NKAM and financial distress (coefficient = -0.193), controlling for auditor characteristics (audit fee, audit opinion) and client characteristics (firm size). Finally, a change specification model using the change in NKAM between periods (NKAM_g) showed a significantly adverse effect (-0.015), demonstrating that KAM disclosures capture changes in financial distress beyond underlying firm fundamentals. Collectively, these results confirm the robustness of KAMs as indicators of financial distress.

1.4. Usability of the findings for policymakers and the auditing profession

The empirical findings presented across the five studies in this dissertation provide valuable insights not only for policymakers but also for the auditing profession and individual audit professionals operating in emerging markets. Collectively, the results demonstrate that clearly defining the objectives of audit technologies and enhanced disclosures can significantly improve audit efficiency, professional judgment, and accountability. For audit professionals, this implies a shift toward more technology-enabled, analytical, and risk-focused audit approaches, requiring auditors to move beyond traditional compliance-oriented practices. As the audit market continues to adapt to technological advancements, it becomes essential for audit policies and professional competencies to evolve in tandem with these changes (Camacho-Minano et al., 2023). The evidence underscores the importance of designing regulatory frameworks and

professional standards that facilitate the adoption of digital audit tools, promote transparent disclosure practices, and encourage continuous professional learning and the enhancement of auditors' judgment. Developing context-specific approaches to integrating advanced technologies and disclosures (particularly within both internal and external audit environments) can help ensure that innovation strengthens, rather than disrupts, audit quality and professional credibility. Recent literature further emphasizes that effective adoption of audit technologies also depends on the quality of auditor–technology interaction, including trust in AI systems, explainability of algorithmic outputs, and auditors' behavioral responses to automated decision-support tools (Gu et al., 2024; Kokina et al., 2025).

Technology adoption remains relatively new in emerging economies such as Ethiopia, where the role of professional bodies and audit firm leadership is pivotal to the successful implementation of advanced audit technologies and disclosure practices. The findings from Studies II and III highlight that institutional support, professional guidance, and structured capacity-building initiatives are critical enablers of technological advancement in the audit market. For audit professionals, this translates into a growing need for formal training in audit technologies, data analytics, and IT-related judgment skills. Such support should extend beyond awareness-raising to include continuous professional development programs, technology-oriented certification pathways, and practical implementation guidelines. The results further suggest that professional associations play a central role in shaping auditors' readiness for digital transformation by standardizing best practices and advocating regulatory updates that reflect the realities of technology-driven auditing. These findings provide a timely basis for policymakers to revise audit regulations to accommodate emerging technologies, such as Computer-Assisted Audit Tools (CAATs) and artificial intelligence (AI), ensuring that audit professionals remain competent, relevant, and aligned with international developments (Al-Okaily et al., 2022). Given that Ethiopia's audit market is predominantly composed of local firms without international network affiliations, tailored policies and professional development models that address the constraints faced by small and medium-sized audit practices are especially necessary. Recent studies also indicate that in emerging markets, institutional readiness, regulatory flexibility, and organizational learning capacity significantly shape the success of AI-enabled auditing adoption, highlighting the need for context-sensitive policy design (Pérez-Calderón et al., 2025).

Regarding technology adoption, the findings from Studies II and III reveal that CAATs play a vital role in streamlining audit procedures, optimizing resource allocation, and enhancing risk assessment and professional skepticism (Ahmi & Kent, 2013). Both technological factors (such as perceived relative advantage and system compatibility) and organizational factors (including auditors' IT competence and openness to change) significantly influence adoption decisions among Ethiopian audit firms. For audit professionals, effective CAAT utilization enhances audit planning, improves anomaly detection, and supports more evidence-based audit judgments. However, realizing these benefits requires targeted investments in technical training, infrastructure, and change management at both the firm and individual levels. The studies also highlight that environmental conditions (such as client system sophistication and the level of professional body support) shape the extent to which auditors apply CAATs in practice. To encourage wider adoption, audit firms should prioritize upskilling auditors, address system compatibility barriers, and actively educate clients on the value of data-driven auditing. These insights offer practical guidance for professional associations, such as the Ethiopian Professional Auditors Association, in designing competency-based training programs and assisting regulators in establishing realistic, technology-inclusive auditing standards. Beyond technical adoption factors, recent research highlights the importance of behavioral and cognitive dimensions of technology use, including auditors' judgment adaptation, cognitive load reduction, and interaction with AI-generated insights, which influence how effectively CAATs are translated into audit decisions.

Beyond improvements in audit efficiency and effectiveness, the adoption of audit technology carries broader implications for audit professionalism and organizational sustainability. Study IV demonstrates that leveraging CAATs enhances the accuracy and reliability of audit evidence, strengthens auditors' ability to evaluate internal controls, and supports more robust corporate governance assessments (Samagaio & Diogo, 2022). For audit professionals, this reinforces the evolving nature of the auditor's role, from manual verification toward interpretive, analytical, and advisory functions. Persistently low adoption rates, however, indicate the need for greater investment in digital infrastructure and continuous professional development. Audit firms must allocate sufficient resources to ensure that auditors can meaningfully interpret technological outputs and integrate them into audit judgments. Strengthened audit quality, in turn, enhances auditors' reputational capital and contributes to

greater public trust in the profession. These insights are particularly relevant for policymakers and professional bodies seeking to foster innovation in auditing while safeguarding professional independence and accountability. Recent literature further suggests that AI-enabled auditing enhances not only efficiency but also audit judgment quality through human–AI collaboration mechanisms, while simultaneously introducing risks such as automation bias and overreliance on algorithmic outputs (Abdo-Salloum & Chehade, 2026; Li & Goel, 2025a).

Finally, Study V focuses on the role of audit disclosures (specifically Key Audit Matters (KAMs)) in promoting transparency, professional accountability, and stakeholder awareness of audit risk. Audit disclosures enhance the informational value of financial statements by providing stakeholders with auditor-generated insights into areas of significant risk and judgment (Camacho-Minano et al., 2023). The findings reveal that both the number and nature of disclosed KAMs are significant predictors of financial distress, particularly in the construction industry. For audit professionals, this highlights the increasing importance of clear, well-justified, and professional judgment-based disclosures, as KAMs function not only as communication tools but also as indicators of auditors' risk assessments and ethical responsibility. A higher number of KAMs often signals elevated risk, reinforcing the role of audit reporting as an early warning mechanism and a reflection of a firm's sustainability profile. These results offer practical implications for regulators and standard setters by demonstrating how expanded audit reporting can enhance market discipline while simultaneously increasing auditors' accountability for their judgments. Recent developments in audit reporting also highlight the growing role of AI and data analytics in enhancing the clarity, consistency, and predictive value of audit disclosures, thereby strengthening transparency and stakeholder confidence in financial reporting.

Altogether, the five studies present a coherent progression from conceptual understanding to professional application, showing how technological innovation and greater transparency are reshaping auditing in developing economies. The findings highlight the need for coordinated action among policymakers, professional bodies, audit firms, and auditors to ensure that emerging technologies and disclosure reforms enhance audit quality while also strengthening the profession's long-term credibility and sustainability. Table 5 summarizes the key findings, their practical implications for stakeholders, and recommended actions to apply these insights effectively.

Table 5. Summary of research outcomes and stakeholder implications

Research Questions	Dimension	Key Finding	Practical Implication (Stakeholder-Specific)	Recommendation (Relevance Explained)	Stakeholders
RQ1: How do emerging technologies reshape auditing practices?	Technology Adoption	Technology such as CAATs and AI improves audit efficiency and coverage.	Auditors can perform full-population analyses rather than sampling, reducing audit risk and improving confidence in financial reporting.	Audit firms should invest in advanced audit tools and provide staff training to enable auditors to leverage technology effectively and enhance audit quality.	Audit firms Auditors Audit associations Regulators
RQ2: How does audit technology enhance organizational performance and sustainability?	Technology Impact	Technology improves operational and sustainability outcomes.	Auditors can use technology to provide more accurate and timely insights into operational and sustainability performance. Firms can enhance efficiency and monitor sustainability, supporting strategic decision-making and regulatory compliance.	Firms should integrate audit technologies into operations and reporting, while auditors should adopt these tools in practice to ensure accurate assessments and informed judgments.	Auditors Firm's management Regulators
RQ3: How do audit disclosures enhance transparency and risk assessment?	Transparency	Key Audit Matters (KAMs) enhance transparency and risk understanding.	Auditors can effectively communicate critical risks via KAMs, improving engagement quality. Investors and regulators gain clearer insights into audit risks, supporting trust and informed decision-making.	Regulators and firms should strengthen KAM disclosure practices, and auditors should ensure that disclosures clearly highlight key risks, enhancing transparency, stakeholder confidence, and compliance.	Auditors Audit firms Investors Regulators

1.5. Potential research directions for future auditing research

Based on the findings of the included studies and their identified limitations, several future research directions are proposed. Methodologically, all studies primarily adopt a quantitative approach, which, while effective in identifying relationships and testing hypotheses, may not fully capture the contextual and behavioral dimensions of auditing practices. In particular, the absence of qualitative methods, such as interviews or case studies, limits exploration of stakeholders' experiences, expectations, and perceptions regarding technological transformation, sustainability, and transparency in auditing. Recent literature increasingly emphasizes that these behavioral dimensions are critical for understanding AI-enabled auditing environments, particularly with respect to auditor trust, the interpretability of algorithmic outputs, and human–AI interaction dynamics (Kokina et al., 2025; Gu et al., 2024).

Future research could address this limitation by incorporating qualitative approaches, such as in-depth interviews with auditors, regulators, and industry stakeholders, to provide richer insights into emerging auditing practices. Case study methodologies may further enhance understanding by capturing real-world complexities that are difficult to quantify. In addition, follow-up studies using similar quantitative designs could track the evolving impact of technological advancements and sustainability considerations over time. Given the rapid pace of change in the digital era, longitudinal and mixed-method research designs would offer significant added value by combining empirical rigor with contextual depth. In line with recent developments in audit research, mixed-method approaches are increasingly recommended to better capture the interplay between technological systems and auditor cognitive processes in AI-driven environments.

In terms of scope, while this research focuses on Ethiopia, the country shares key institutional, regulatory, and market characteristics with other emerging economies, particularly in Sub-Saharan Africa and parts of Asia. These include developing auditing standards, limited technology adoption, resource constraints, and evolving disclosure frameworks. Consequently, Ethiopia can serve as a representative context for understanding auditing practices in similar emerging-market settings, allowing for cautious generalization of the findings. Future research could examine other emerging economies, such as Kenya and Nigeria, and developing countries in Asia to further assess the generalizability of the findings and highlight contextual similarities

and differences. Comparisons with more developed auditing environments, such as Germany, the United Kingdom, or Central and Eastern European countries like Hungary, could provide additional insights into the impact of advanced technology adoption and mature disclosure frameworks on audit quality, transparency, and sustainability practices. Such cross-country analyses would help determine whether the observed patterns hold across different institutional, technological, and regulatory contexts, providing both academic and practical insights. Building on these methodological and scope considerations, the following subsections outline future research directions across the study's key dimensions (technology, performance, sustainability, and transparency). Recent cross-country studies further highlight that AI adoption in auditing is highly context-dependent, with institutional maturity, regulatory enforcement, and digital infrastructure playing a decisive role in shaping adoption outcomes (Sundarasan et al., 2026; Pérez-Calderón et al., 2025).

1.5.1. Technology

The integration of advanced technologies into auditing remains an evolving and underexplored research domain. Although scholars have increasingly examined the use of Computer-Assisted Audit Techniques (CAATs) and Artificial Intelligence (AI) in audit practices (Zhang & Song, 2022), the literature still lacks comprehensive conceptual frameworks and consistent theoretical foundations for understanding their implementation and long-term implications. Existing studies largely concentrate on adoption determinants, frequently relying on the Unified Theory of Acceptance and Use of Technology (UTAUT) or, to a lesser extent, the Technology–Organization–Environment (TOE) framework (Korol et al., 2022). While valuable, this narrow theoretical focus limits the ability to fully capture the multidimensional nature of technological transformation in auditing. Recent AI auditing literature further emphasizes emerging frameworks such as AI co-piloted auditing and generative AI integration, which shift attention from adoption alone toward collaboration between auditors and intelligent systems (Gu et al., 2024; Zhang & Zhou, 2025).

Building on the findings of Study I, future research could advance this stream by conceptualizing and empirically validating alternative frameworks, such as the Commitment, Access, Capability, and Skilling (CACS) model (MetricStream, 2020). This framework emphasizes the combined role of human capital, technological readiness, and institutional

commitment in successful technology implementation. Empirical testing of the CACS framework across diverse audit settings could deepen understanding of how these dimensions interact to influence adoption outcomes. Furthermore, as much of the extant literature is concentrated in developed economies (Allbabidi, 2021), comparative studies between developed and emerging markets (particularly in Africa and other developing regions) could reveal important contextual differences in technological readiness, resource constraints, and regulatory support structures. Recent studies also highlight that auditor readiness, explainability requirements, and governance structures are becoming critical determinants of AI adoption success in auditing environments.

Future studies should also extend beyond adoption decisions to examine how emerging technologies reshape audit methodologies, standards, and professional roles. Technologies such as AI, continuous auditing systems, and advanced analytics have the potential to fundamentally alter audit planning, evidence collection, and risk assessment. Accordingly, research that integrates technological innovation with auditing theory and institutional change perspectives would significantly enrich the literature. Furthermore, the findings suggest that, beyond technological advancements, organizational factors play a critical role in shaping audit practices. The findings highlight an important avenue for future research at the individual-organization level, which could be explored using qualitative methods such as interviews or case studies alongside quantitative approaches. Such qualitative inquiry is particularly important for understanding how auditors cognitively adapt to AI-generated insights and how trust in automated systems evolves.

1.5.2. Performance

Beyond adoption itself, a critical area for future research concerns the impact of audit technologies on audit performance. Studies II and III indicate that technologies such as CAATs and AI can enhance audit efficiency, effectiveness, and consistency by improving data processing capabilities and enabling more comprehensive risk assessments. However, empirical evidence on how these tools influence auditors' professional judgment, skepticism, and decision quality remains limited. Recent evidence suggests that while AI improves efficiency, it may also introduce behavioral risks, such as automation bias and reduced professional skepticism, warranting further investigation.

Future research could investigate the mechanisms through which technology affects audit performance outcomes, including audit quality, error detection rates, time efficiency, and resource allocation. Of particular interest is how auditors interact with technology-generated outputs and integrate them into professional judgments. While digital tools may reduce cognitive load and improve analytical accuracy, they may also introduce risks related to overreliance, automation bias, and diminished professional skepticism. Emerging AI auditing studies increasingly highlight the importance of human–AI complementarity in maintaining audit quality under complex decision environments.

Moreover, technological integration introduces new operational and ethical challenges, including system failures, cybersecurity risks, data integrity concerns, and escalating implementation and maintenance costs (Seethamraju & Hecimovic, 2022). Future research should adopt a balanced perspective by examining both the performance-enhancing potential and the unintended consequences of technology-enabled auditing. Experimental and behavioral studies could be particularly valuable in assessing how auditors respond to AI-generated recommendations under varying levels of complexity, uncertainty, and accountability. Recent studies in AI-enabled auditing emphasize the importance of experimental designs that capture behavioral responses to algorithmic decision-support systems.

1.5.3. Sustainability

As digital technologies increasingly shape corporate reporting and assurance practices, their implications extend beyond operational efficiency to encompass sustainability and long-term value creation. Studies III and IV highlight how the adoption of audit technologies contributes to broader organizational objectives, including improved governance quality and enhanced reliability of financial and non-financial reporting. This evolution suggests that audit technology should be viewed not merely as a technical innovation but also as a catalyst for sustainable and responsible business practices. Recent research reinforces this view by showing that AI-enabled auditing enhances ESG assurance quality and strengthens sustainability-related governance mechanisms.

Future research could explore how technology-enabled audits support sustainability by enhancing the credibility and assurance of environmental, social, and governance (ESG)

information. Advanced technologies such as AI, blockchain, and data analytics can improve the traceability, consistency, and verifiability of sustainability data, enabling auditors to provide more robust assurance over non-financial disclosures. In line with Korol et al. (2022), scholars could examine whether the use of digital audit tools influences the quality of sustainability reporting, stakeholder trust, and firms' long-term performance. Generative AI and advanced analytics are increasingly recognized as tools that may significantly improve ESG data assurance in future auditing systems.

Emerging-market contexts present particularly fertile ground for sustainability-oriented audit research. As noted by Allbabidi (2021), limited access to technology, training, and institutional support may constrain the sustainability benefits of audit innovation. Cross-country comparative studies could shed light on how regulatory environments, professional infrastructures, and cultural factors shape the sustainability outcomes of audit technology adoption. Integrating sustainability frameworks with auditing and information systems research also offers opportunities for interdisciplinary collaboration. Furthermore, the growing importance of sustainability in auditing underscores the need for future research to examine how non-financial reporting and assurance practices are interpreted and implemented in practice, particularly from different stakeholders' perspectives. Recent emerging-market studies also emphasize that sustainability assurance outcomes are strongly influenced by institutional capacity and digital maturity levels.

1.5.4. Transparency

Transparency through enhanced audit disclosures remains a cornerstone of audit quality and stakeholder confidence. Study V, which focuses on Key Audit Matters (KAMs), demonstrates that expanded audit reporting can serve as an early indicator of financial distress and heightened risk exposure. Nevertheless, the literature on the usefulness and interpretation of KAMs remains relatively limited. Prior evidence from Europe suggests that detailed KAM disclosures influence capital market reactions, suggesting that investors perceive them as informative signals (Moroney et al., 2021). Similarly, Camacho-Minano et al. (2023) find that firms with higher risk profiles (such as those experiencing losses, restatements, or high leverage) tend to disclose more KAMs, reflecting auditors' risk assessments. Recent developments further

indicate that AI-assisted audit reporting may enhance the consistency and predictive value of KAM disclosures in identifying financial distress signals.

Despite these contributions, important questions remain regarding how different stakeholder groups (including investors, regulators, creditors, and analysts) interpret and utilize KAM disclosures. Future research could explore the behavioral implications of audit transparency by examining how variations in the number, specificity, and tone of KAMs influence investment decisions, risk perceptions, and confidence, particularly in high-risk industries. Additionally, incorporating audit disclosures into financial distress prediction models could enhance their explanatory power by integrating non-financial indicators alongside traditional accounting ratios (Altman et al., 1983; Kohler et al., 2020; Sierra-García et al., 2019; Bepari et al., 2022). Behavioral audit research increasingly suggests that stakeholders interpret audit disclosures differently depending on framing, complexity, and perceived auditor credibility.

Emerging technologies offer further opportunities to advance audit transparency. The integration of AI and big data analytics into audit reporting processes could enable auditors to identify distress signals more accurately and communicate them more effectively through KAMs. Cross-sectoral and cross-country studies could examine how the relevance and predictive value of KAMs vary across regulatory regimes and institutional contexts. Finally, research examining the alignment of national auditing standards with international frameworks, such as ISA 701, could provide valuable insights into enhancing the consistency, comparability, and effectiveness of audit transparency globally. Future AI-enabled audit systems are expected to automate disclosure generation further, raising new challenges related to explainability and accountability in audit reporting.

1.6. List of own (and co-authored) publications related to the topic

1.6.1. Publications included in the dissertation

The studies are presented and ordered in original or planned form, without re-editing, as intended for publication (also see the summary of peer reviewer feedback and author responses for the published studies in Appendix E).

- Wassie, F. A., & Lakatos, L. P. (2024). *Artificial intelligence and the future of the internal audit function*. *Humanities and Social Sciences Communications*, 11(386), 1–13. <https://doi.org/10.1057/s41599-024-02905-w>
- Wassie, F. A., & Lakatos, L. P. (2024). *Technology adoption in audit of information systems: Ethiopian audit firms' perspective*. *Journal of Infrastructure, Policy and Development*, 8(13), 1–23. <https://doi.org/10.24294/jipd8819>
- Wassie, F. A., & Lakatos, L. P. (2025). *Audit technology as a catalyst for improving non-financial performance in Ethiopian audit firms*. *Journal of Open Innovation: Technology, Market, and Complexity*, 11, 100556. <https://doi.org/10.1016/j.joitmc.2025.100556>
- Wassie, F. A. (2024). *Leveraging computer-assisted audit tools for corporate sustainability: Evidence from Ethiopia*. *Journal of Infrastructure, Policy and Development*, 8(1), 1–26. <https://doi.org/10.24294/jipd.v8i1.2690>
- Wassie, F. A., & Lakatos, L. P. (2023). *Key audit matters disclosure: Do they reveal construction firms' risk of financial distress? Evidence from Ethiopia*. *International Journal of Construction Management*, 24(15), 1689–1697. <https://doi.org/10.1080/15623599.2023.2286882>

1.6.2. Other publications, conference presentations, and work-in-progress papers related to the topic

- Wassie, F. A., & Lakatos, L. P. (2025). *Computer-assisted auditing techniques adoption for audit of information systems*. *International Journal of Business Information Systems*. Advance online publication. <https://doi.org/10.1504/IJBIS.2024.10065904>
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2. Study I. Artificial intelligence and the future of the internal audit function

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Published in *Humanities and Social Science Communication*, 11(1). pp. 1–13.

<http://doi.org/10.1057/s41599-024-02905-w>

Abstract

Artificial intelligence (AI) can support the company's internal audit function (IAF) by delivering substantial strategic oversight, minimizing manual procedures, and making possible additional value added auditing services. Currently, there are research gaps in the literature, such as limited studies on the topic, low AI adoption rates in the IAF across different countries and regions, and a shortage of comprehensive frameworks for effectively using AI in the IAF. Hence, this review work aims to fill the research gap by offering an outline of research avenues on the topic in the literature and suggesting a new compressive framework for the effective use of AI in the IAF. This paper undertakes a systematic literature review (SLR) approach and aspires to highlight the state of research on the use of AI in the IAF, to deliver insight for scholars and industry experts on the issue, and to reveal the implications for IAF of the new AI technology. Moreover, to quickly make artificial intelligence work in internal audit functions, the CACS framework was recommended with attributes such as commitment, access, capability, and skills development (CACS). This work provides significant contributions for guiding future research directions and the development of theoretical foundations for the IAF field. On a practical level, the work will help internal auditors to assess and understand the potential advantages and risks of implementing AI in their organization's IAF. For regulators, this review should prove useful for updating regulations on internal auditing in the context of using advanced technology such as AI and for ensuring the compliance of internal auditing practices to the evolving technology. Organizations can also benefit from this review to decide whether AI investments in their IAF are justified. This review made an initial extensive SLR on AI use in the IAF as a basis for developing new research avenues in auditing and accounting.

Keywords: Artificial intelligence, CACS framework, Internal audit function, Internal auditors, Technology

2.1. Introduction and motivation

Business stakeholders want to confirm that organizational management makes proper decisions regarding, such things as risk management, the preservation of transparency, and the regularization of information with appropriate monitoring (Panda & Leepsa, 2017). To satisfy those motives, business organizations must have effective governance structures and guidelines. An effective governance structure and guidelines can support the attainment of objectives, the management of risk, and the improvement of corporate governance (Chowdhury, 2021). The organization's corporate governance system depends on the Internal Audit Function (IAF) to deliver an independent opinion, assist with every matter, and encourage and advance improvement and innovation (Tiron-Tudor et al., 2021). The contribution of Artificial Intelligence (AI) can be measured by those improvements and innovations (Goertzel, 2014) that help organizations to generate substantial competencies.

The introduction of AI holds the promise of delivering substantial improvements in the IAF's role by empowering the IAF to process dispersed and big data of the company instantly (Ghanoum & Alaba, 2020). Instead of only offering assurance on the sample data, with the support of AI, IAF can carry out audits on the total population. An autonomous and objective assurance task which is accessible within the company could then be considered to be an internal audit function (MacRae & Gils, 2014). This enhanced capability would deliver increasing satisfaction to the stakeholders regarding company operations and governance which is the responsibility of IAF (Florea & Florea, 2016). Governed by the International Professional Practicing Framework (IPPF), the IAF is one of the compulsory components of the Corporate Governance Code, and the Institute of Internal Auditors framework (Ergen, 2019). Looking back over the past decade, it is evident that the current audit profession has changed dramatically. Internal auditors need to be even more flexible and remain current with the changing technological environment. The spread of AI technology is highlighting the need for significant improvements in the functionality of IAF (Kozlowski, 2018). It is becoming increasingly clear that the aim of IAF needs to be transformed from sample-dependent and compliance audits to more sophisticated, comprehensive, practical, systematized, problem-resolving, predictive, and fraud-discovering audits (Ghanoum & Alaba, 2020). As one example, assessing smart controls and delivering advice for their improvement has become a requirements of IAF.

Empirically, the impacts of AI on the effectiveness of IAF have been rarely assessed (Lehner et al., 2023). Accordingly, this review may substantiate the literature shortage about AI used in IAF. Considering the overall importance of AI for organizations, the use of AI in IAF is a timely and relevant topic. The paper reviewed articles from the Web of Science (WoS) database that were published between 2019 and 2023. The review found that AI and IAF (separately) are extensively studied areas. However, there are limited studies on the use of AI in the IAF (Couceiro et al., 2020; Seethamraju & Hecimovic, 2022; Ghanoum & Alaba, 2020). Although the concept and application of AI are receiving wide acceptance, they have not yet been applied in some countries. Most studies focus on Australia, China, and Oman (Zhou, 2021; Khan et al., 2021; Rehmanand & Hashim, 2022). Besides, it was found that Asia and Europe are the most studied areas (Lehner et al., 2023). The review also revealed that most of the studies used the previously developed and common TOE (Technological Organizational Environmental) framework (Seethamraju & Hecimovic, 2022; Chen et al., 2021). The review highlights research gaps in the area under study, such as limited studies on the topic and low AI adoption rates in the IAF across different countries and regions. In addition, there is a shortage of comprehensive frameworks for effectively using AI in IAF. Hence, this review work tries to fill the research gap by offering an outline of research avenues on the topic and suggesting a new compressive framework (CACS) for the effective use of AI in the IAF.

Using the systematic literature review (SLR), this paper was designed to fill the research gap through a systematic analysis of research on the use of AI in the IAF. SLR is an appropriate method to deliver critical insight into this area, enabling the expansion of understanding of the use of AI in IAF, attaining an extensive view of the present situation, and looking for future research avenues. A thorough review of the prevailing field of knowledge is vital to highlight a reliable direction for future studies (Massaro et al., 2016). Therefore, the objectives of this paper are to identify, assess, and evaluate the present state of research, to give critical insights on the publications made on the issue, and to highlight future research avenues. In this way, the paper aims to expand the understanding of what has been published on the theme and suggest future research areas that can assist organizations in using AI in the IAF.

This review work provides essential contributions in both theoretical and practical aspects. For theory, it highlights the research areas which have not been investigated (research

gaps), thus guiding future research directions and the development of theoretical foundations. Moreover, this review contributes to developing a theoretical framework (CACS), assisting stakeholders to understand and conceptualize the use of AI in the IAF, which can be a basis for future investigations. For practice, this review helps internal auditors assess and understand the potential advantages and risks of implementing AI in their organization's IAF. It also helps internal auditors identify the new skills required to adopt and effectively use AI in their audit tasks, highlighting training and skill development areas. For regulators, this review is helpful for updating regulations on internal auditing in the context of using advanced technology such as AI and for ensuring the compliance of internal auditing practices to the evolving technology. Finally, organizations can benefit from this review to decide whether AI investments for their IAFs are justified. For this reason, the recently introduced CACS framework with four attributes was recommended for implementing AI in the IAF. Thus, organizations can benefit from the framework to quickly implement and utilize AI in their IAF.

In framing the intellectual area of study on the use of AI in the IAF, this review's research design is based on the procedure necessary to develop the SLR. Accordingly, the research questions in this work are informed by the requisites of the SLR and in the order of the study's analysis. The current state of research on the use of AI in IAF needs to be explored before developing directions for future research interests:

RQ1. *What is the current state of research on the use of AI in IAF?*

RQ2. *What are the future avenues of research on the use of AI in IAF?*

The research questions in this review work were developed as applied by Lehner et al. (2023), Silva et al. (2021), and Bracci et al. (2019). Thus, concerning the first research question (RQ1), the review aims to highlight which journals publish the most articles and the most prolific authors. Moreover, studies on the use of AI in the IAF were identified with geographic regions and countries to identify less studied regions. Therefore, in this review, it was also essential to identify the most used research method for the topic and the trends over the years. The second research question (RQ2) aims to provide insight for future research avenues on the use of AI in IAF by revealing the regions, topics and, and research methods that have been studied the least. Finally, this review will propose a framework for using AI in the IAF and elaborate the practical implications of this framework.

This review has five sections: literature review, research methods, major results, discussions, and conclusions. The first section provides a brief literature review of the arguments and existing frameworks for using AI in the IAF. The second section details the method applied (SLR) for this review work. The third section presents the major results of the SLR on the use of AI in IAF. Finally, the fourth and fifth sections discuss future avenues of research and a conclusion to summarize the results.

2.2. Literature review

2.2.1. Artificial Intelligence and Internal Audit Function

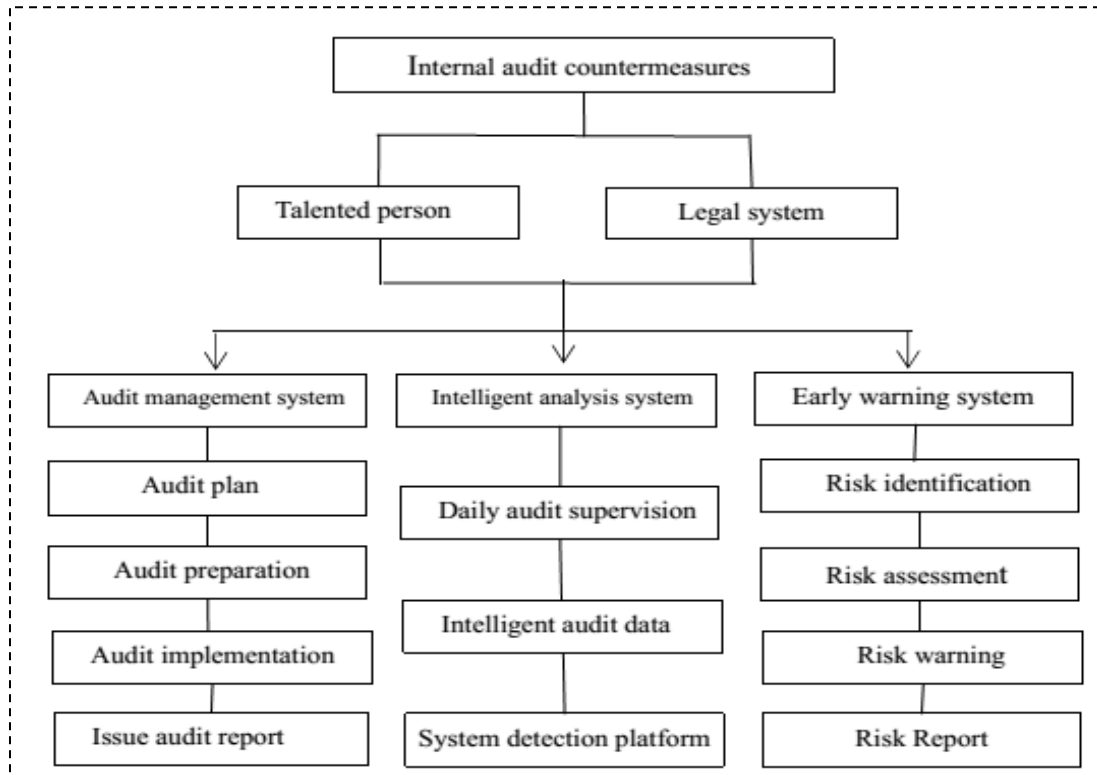
The way of doing business is getting more complex than earlier because of technological advances and real time operation improvements; hence, companies need to employ AI and remain updated every time there are new advances (Libert et al., 2017). Nevertheless, because of various barriers related to AI implementation, many companies are not utilizing it (Ammanath et al., 2020). Currently, only large companies have easy access to AI. By applying it to their internal audit function, they gain a more competitive advantage.

AI is a mix of software and hardware that performs similarly to the human brain. Based on the available data, it can assess, decide, and perform complex judgment procedures. (Moffitt et al., 2018). It analyzes, examines, and processes a considerable amount of data, and uses this data to further refine the algorithm. By combining technical knowledge with interactive interview skills, project management skills, responsive intelligence, and logical thinking, the IAF can support AI in the early data feed (Ghahramani, 2015).

A robust structure of internal audit functions, policies, and guidelines is necessary to gain the full benefit of AI (Rehmanand & Hashim, 2022). For organizations have extensive hierarchical data and AI, numerous automated businesses have benefited from their IAF. Here, an essential task of IAF is to audit the gathering, transformation, storage, control, and compliance of automated data to verify the audit requirement for a comprehensive examination and review of the usage of the data. AI also brings new difficulties and needs for the internal audit function of an organization; the resolutions of anomalies is conducted in different ways than the practice before, with AI following a strict procedure (see Figure 6). Thus, the State has to make official and comprehensive regulations and rules to control the legitimacy,

characteristics, transformation, and usage of automated data through AI in the IAF in order to offer the legal foundation for the legal improvement of the internal audit function (Zhou, 2021).

Figure 6. Study I: Resolution of internal audit function under artificial intelligence



Source: As applied by Zhou (2021)

Looking into the future, internal audit, staff will train AI to act without hesitation to peruse circumstances that need an extensive investigation or even forecast when the failed case on control will happen. But, AI could assist the internal audit function in additional ways as well, e.g., considering the role of AI in assessing the quality of data (Puthukulam et al., 2021). Improvements in low-cost data storage (like the cloud) have permitted the formation and accumulation of vast amounts of data subject to IAF, thus making tests of the completeness, faithfulness, accuracy, and reliability of the data difficult considering the complete due to the size of the big data. The future AI will be able to constantly manage this data and, warn internal auditors in the IAF about the condition of the data being transmitted and stored as well as the prospective fraud and related disclosures (Erb, 2018).

The AI's capability to understand and perform quicker than human beings will make it generally difficult to generate innovative methods of planning and testing controls to assess the effectiveness of AI (Seethamraju & Hecimovic, 2022). This circumstance will make it even more essential for consultants to collaborate in order to assist with the challenge of closing the knowledge gap (Erb, 2018). As each of the challenges are overcome, AI will positively impact the internal audit function by concurrently discovering risks and examining procedures and control design. The initial implementers of AI in various institutions may not be a cybersecurity section but rather the IAF. Thus, future internal auditors must be considered technical experts responsible for initiating this innovative and astonishing technology (Erb, 2018).

2.2.2. Does artificial intelligence replace internal auditors' jobs?

Many scholars have argued that AI would reduce job opportunities for internal auditors, while others have argued that it is an opportunity for them. According to Mach (2022), several companies and institutions do not utilize AI in their IAF due to the perception that AI will substitute actual employees. However, the evidence to date is that AI does not replace actual employees. It appears that internal auditors and AI can perform together to improve processes and effectiveness. AI will not replace the auditor's assessment of interviews, decisions, and judgment. Instead, it improves their performance by providing them with advanced tools and prospective outcomes.

Moreover, according to Muspratt (2018), although many have thought that AI would terminate internal auditors' jobs, however the truth is more complex than originally perceived. It turns out that AI helps to develop the market for the work of the internal auditors' by creating further advantages for workers to emphasize their work's complex matters that need human involvement. Moreover, AI has proven useful for managing the tedious and routine procedures that frequently take the most working days. Additionally, the paper demonstrates that the AI technology is intended to support creativity and provide assistance, thus allowing internal auditors to be more effective in the tasks that they have been given to perform. Generally, the view is optimistic for AI to become a useful tool for the internal audit profession in the long run. But the development path will not be smooth and occasional troubles can be expected along the way (Q.ai-Contributor-Group, 2022).

Conversely, according to Parker (2022), people-oriented work has diminished in some industries because of capital-oriented advanced technologies. If internal auditors in the IAF in the future do not advance their skills, there is a risk that AI-powered machines could replace their positions. In addition, as one scholar has demonstrated, many people have lost their jobs because AI has replaced almost all routine activities and further tasks with computers and robots. Since it has a high degree of accuracy, almost all companies desire to utilize AI-oriented robots in their IAF. Soon, this challenge will be extended to other industries, and the job loss caused by AI will become an existential matter for large classes of workers (Adhikari, 2021). Likewise, the health research funding (HRF, 2022) has argued that as AI-oriented machines are introduced to accomplish people's work faster and at lower costs, the level of jobs lost is rising with even the internal audit profession being at risk. Similarly, other scholars have contended that when AI becomes more common in organizations, it could reduce job openings because AI will be able to manage routine activities that previously were performed by employed staff (Tableau, 2021; Yakimova, 2020).

Generally, the message from the above arguments, is clear: - it is time for internal auditors to use their skills and talents in their jobs. In order to be prepared, it is essential that internal audit professionals remain up-to-date with the AI technology. By familiarizing themselves with this technology, the necessary skills and understanding will be developed. Otherwise, it will be a challenge rather than a prospect for them. In the era of AI, qualify for work in the internal audit function, a prospective employee will need to understand the technology better, to get proper training, and to acquire the necessary mindset that the use of AI is a competitive advantage.

2.2.3. Theoretical framework

Several explanatory frameworks have been introduced to assess technology adoption and its impact on organizations. According to Sadoughi et al. (2019) and Rad et al. (2018), some theories comprise the technology acceptance model, the theory of reasoned action, the innovation diffusion theory, the diffusion of innovation model, and the theory of planned behaviour. Above all, two well-known models were developed to measure the applicability of technologies in organizations. Those technology adoption models are the Unified Theory of Acceptance and Use

of Technology (UTAUT) model and the Technological, Organizational, and Environmental (TOE) framework.

The UTAUT framework was developed by Venkatesh et al. (2003). The model was developed to identify the common factors impacting users while undertaking technology adoption selection through various domains. The model established four significant factors that directly impact technology adoption intention and usage (performance expectancy, effort expectancy, social influence, and facilitating conditions).

The TOE framework is the combination and extension of the innovation diffusion theory (IDT) and technology acceptance model (TAM) (Hossain & Quaddus, 2011). In reaction to the criticisms and gaps in the diffusion of innovation (DOI) model in presenting the predictors of technology and innovation adoption at the institutional level and emphasizing the significance of circumstantial constructs in the adoption procedure, Tornatzky and Fleischer (1990) introduced the TOE framework. In the framework, technology adoption in organizations is projected by three symbiotic components: organizational features, external environment, and technological features (Tornatzky & Fleischer, 1990).

The CACS framework (commitment, access, capability, and skilling) was recently introduced by MetricStream (2020) and has also proven to be valuable in this review work. The framework was proposed explicitly for AI utilization in audit activities, it is also an alternative technology adoption framework. Since this framework was recently developed and takes into consideration the current technological changes and the concepts contained in previous theoretical frameworks, this review will suggest that companies implement it and that researchers consider it for use in their studies. The framework will be elaborated in the later section of the paper.

2.3. Research method

This part presents the methods used in this review to highlight the existing scholarly literature on the use of AI in IAF, explicitly using the systematic literature review (SLR). SLR is an organized and comprehensive study method that involves gathering, critically assessing, and integrating the prevailing academic literature on a particular topic or research question (Massaro et al., 2016). On a specific subject matter, it aims to deliver objective and evidence-based

highlights of the existing state of knowledge. According to Massaro et al. (2016), the SLR is a method complementary to a traditional literature review. The SLR method is vital for providing existing insights, critical views, and future research interests in emerging fields like AI in IAF. Massaro et al. (2016) also state that the SLR pursues to sustain replicability using a straightforward search and sampling strategy that document the data analysis and evaluation steps that were used. Applying the SLR method includes a step-by-step plan to identify the scholarly literature, as Massaro et al. (2016) suggested. Overall, this review aims to attain insights into the emerging research field of AI use in IAF and to understand future avenues of research in the field.

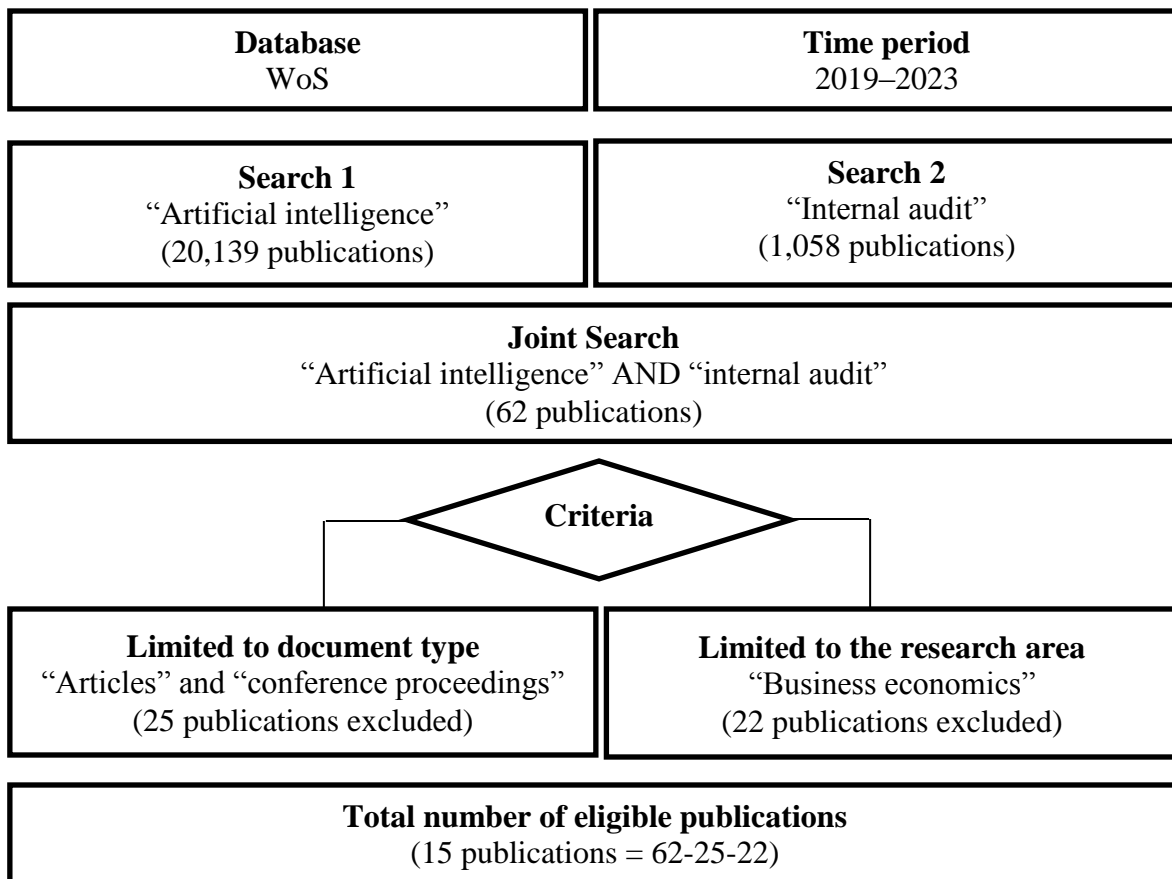
2.3.1. Database, search, and sampling strategy

Keyword search is more appropriate for an emerging field like a review work targeted to study AI use in IAF (Massaro et al., 2016). A similar approach was applied to sampling sources for two reasons. First, the joint use of AI in IAF has been highlighted recently in a limited number of journals. However, individually (AI and IAF), large body of publications across academic disciplines for a substantial amount of time was evident. Second, with AI use for IAF research, publications have expanded in numerous academic fields of interest (Lehner et al., 2023).

Moreover, published work quality is guaranteed through a peer-review process, the most accepted approach. Due to these reasons and to ensure the study's replicability, published works from recognized databases were considered for the primary analysis. Web of Science (WoS) is one of the most extensive databases comprising thousands of high-quality journals in arts and humanities, social sciences, and natural sciences. Using the database will allow all quality and reliable research undertaken in the study area to be considered for this work since it is a prominent source for books, articles, reviews, and conferences. In addition, government reports, websites, and blogs were used to support and demonstrate the primary analysis results. Government reports are helpful while making a study by providing authoritative and official data and insights on policy implications. Websites were also used to highlight current and up-to-date information and diverse perspectives on the topic (since the topic is volatile). Moreover, blogs were used to get insights from subject matter expertise and timely discussions on the topic (Wilson et al., 2015).

In three steps, the study undertakes the search and sampling process. The summary of the search and sampling process is presented in Figure 7. First, a keyword search for “artificial intelligence” and “internal audit” was executed. In the database (WoS), the filled "Topic" was used to perform the search, including title, abstract, and indexed publication keywords. Publications made from 2019 to 2023 (period) were considered to get insights on the quickly changing technological advancements (AI) and their use in organizations (IAF). As shown in Figure 7, the separate unrestricted search results were 20,139 and 1,058 publications for the keywords "artificial intelligence" and “internal audit”, respectively, from 2019 to 2023. Second, a joint search was executed using both keywords “artificial intelligence” AND "internal audit", resulting in 62 publications (only 0.3% of the total publication).^[1] This result supports the literature (Lehner et al., 2023), concluding that there are limited investigations made on the use of AI in IAF.

Figure 7. Study I: Selection scheme of publications



Note. As applied by Silva et al. (2021)

Third, restriction criteria were applied to filter out the relevant publications on the topic (since the WoS have wide-ranging journals in numerous disciplines). The restrictions are the document type (only articles and conference proceedings included) and research areas (business economics). Articles are the best categories for a review highlighting empirical insights (Lehner et al., 2023). Similarly, considering the suggestion of Massaro et al. (2016), conference proceedings are also included to capture future research insights. The research area restriction limited the search to business economics. The database (WoS) has one research area, "Business Economics", relevant to this review. After applying both restriction criteria, the joint search ("artificial intelligence" AND "internal audit") results in 15 publications, which are the sample units for this review (see Figure 7).^[2] Notably, 13 research articles and two conference proceedings were considered out of this paper's total selected publications (15). Then, all essential information (relevant to evaluate the output) of the selected publications was downloaded, such as publication year, author(s), document title, abstract, keywords, source title and type, and document type.

2.3.2. *Analytical framework*

The necessary step of SLR before data analysis is to outline the units of analysis included in the selected analytical framework. This study used the outlines and units of analysis as suggested by Massaro et al. (2016) and applied by studies like Bracci et al. (2019). Hence, this study addressed these units in three analysis clusters to comprehensively view the scholarly literature on AI use in IAF (addressing the first research question (RQ1)).

Firstly, the relevance and novelty of selected publications on the topic were identified, measured by citation analysis and frequency distribution of publications per year. The review observed that not all publications have a similar impact on the field, confirming the argument of Massaro et al. (2016).

Second, the review targeted the assessment of the research method of the publications encompassed in the sample since evaluating how the theory is used in the studies is necessary. Specifically, as applied by Bracci et al. (2019), the study assessed the theoretical contribution provided by the study in three different sets: no framework was proposed, applying a previous framework and proposing a new framework.. The review also assessed how the theoretical

contribution linked to the research method applied (interviews, historical analysis, case study, survey, and conceptual analysis). This analysis is used as a proxy for evaluating theoretical superiority and methodology fit within the research area (use of AI in IAF) (Bracci et al., 2019).

Finally, the research context considered in each selected publication was assessed since it previews the publications in time and location. It offers a way to forward suggestions on how AI in IAF research can be furthered (which also answers the second research question (RQ2)) through assessing the link with theory, enlarging geographical coverage, or undertaking comparative investigations. Table 6 shows the summary of the sampled publications used for this review with and a detailed analysis to be covered in the latter sections of this paper.

Table 6. Study I: Summary of publications reviewed in the literature

Publication Date /Author/ Country	Title	Journal	Framework	Method	Key Findings
07-12-2019 Jans and Hosseinpour Belgium	“How active learning and process mining can act as Continuous Auditing catalyst”	International Journal of Accounting Information Systems	Proposes a new model	Case study	<ul style="list-style-type: none"> ▪ The transaction verification framework was developed. ▪ Basic principles of continuous auditing were confirmed. ▪ Data mining could complement the approach.
12-06-2020 Westland US	“Predicting credit card fraud with Sarbanes-Oxley assessments and Fama-French risk factors.”	Intelligent Systems in Accounting, Finance and Management	Proposes a new model	Historical analysis	<ul style="list-style-type: none"> ▪ The most important predictors for credit card fraud are: ▪ Audit firm fees ▪ The Fama-French risk factors coefficient ▪ The Fama-French 3-factor model R^2
28-02-2021 Zhou China	“Research on the problems of enterprise internal audit under the background of artificial intelligence.”	Journal of Physics: Conference Series	Proposes a new model	Conceptual	<ul style="list-style-type: none"> ▪ The development of enterprise management that has contributed to a regularly optimized internal audit with an advanced intelligent system.
05-01-2021 Nonnenmacher et al. Germany	“Using Autoencoders for Data-Driven Analysis in Internal Auditing”	The 54th Hawaii International Conference on System Sciences	Applies previous models	Case study	<ul style="list-style-type: none"> ▪ The quality of internal auditing can be improved through autoencoders, which support auditors' engagement.

5-11-2021 Chen et al. China	“Enterprise’s internal control for knowledge discovery in a big data environment by an integrated hybrid model”	Information Technology and Management	Proposes a new model	Survey	<ul style="list-style-type: none"> ▪ The control environment is the top dimension in a big data environment. ▪ Information technology control construction is the top criterion in a big data environment.
5-11-2021 Mökande et al. UK	“Conformity Assessments and Post-market Monitoring: A Guide to the Role of Auditing in the Proposed European AI Regulation”	Minds and Machines	Applies previous models	Conceptual	<ul style="list-style-type: none"> ▪ Amendments are suggested in some aspects to: <ul style="list-style-type: none"> - Add verifiable criteria for vague concepts - Improve controls on conformity assessments
29-06-2021 Allbabidi Jordan	“Hype or Hope: Digital Technologies in Auditing Process”	Asian Journal of Business and Accounting	Applies previous models	Survey	<ul style="list-style-type: none"> ▪ Technology–organization–environment framework factors found significant in affecting the utilization of digital technologies ▪ Auditors' performance can be enhanced by utilizing digital technologies
10-07-2021 Khan et al. Australia	“AI-based audit of fuzzy front-end innovation using ISO56002”	Managerial Auditing Journal	Applies previous models	Interviews	<ul style="list-style-type: none"> ▪ The development of a Fuzzy front-end artificial intelligence audit tool results in a 92% enhancement in efficiency and 95% effective than the human auditor
17-11-2021 Puthukulam et al. Oman	“Auditors' Perception on the Impact of Artificial Intelligence on Professional Skepticism and Judgment in Oman”	Universal Journal of Accounting and Finance	Applies previous models	Survey	<ul style="list-style-type: none"> ▪ Machin learning-assisted, and AI-based audit systems have significant impact and relation with: <ul style="list-style-type: none"> - Professional judgment - Professional scepticism

28-02-2022 Korol et al. Ukraine	“Elaboration of recommendations on the development of the state internal audit system when applying the digital technologies”	Eastern-European Journal of Enterprise Technologies	Proposes a new model	Historical analysis	<ul style="list-style-type: none"> ▪ It was suggested to use indicators for overall financial control measures for state internal audit. ▪ The proposed mechanism is to establish the impact of digital technologies on the state's internal audit development.
07-07-2022 Seethamraju and Hecimovic Australia	“Adoption of artificial intelligence in auditing: An exploratory study”	Australian Journal of Management	Applies previous models	Interviews	<ul style="list-style-type: none"> ▪ The following technology–organization–environment (TOE) factors were found to be significant in influencing AI adoption: <ul style="list-style-type: none"> - Perceived benefits, compatibility, and maturity (T) - Organizational readiness, data quality, and trust (O) - Audit standards, regulation, and client readiness (E)
15-07-2022 Xavier et al. Brazil	“Tax evasion identification using open data and artificial intelligence”	Brazilian Journal of Public Administration	Proposes a new model	Historical analysis	<ul style="list-style-type: none"> ▪ A 98% prediction accuracy was attained in companies evading tax by validating after-fine improvements. ▪ They created a web-based solution for tax offices.
19-08-2022 Rehman and Hashim Oman	"Can internal audit function impact artificial intelligence? Case of publicly listed companies of Oman”	AIP Conference Proceedings	Applies previous models	Survey	<ul style="list-style-type: none"> ▪ IAF significantly affect AI since the organization's IAF offers the input data.

11-08-2022 Zhang et al. Australia	“Continuous monitoring with machine learning and interactive data visualization: An application to a healthcare payroll process.”	International Journal of Accounting Information Systems	of	Applies previous models	Case study	<ul style="list-style-type: none"> ▪ In continuous monitoring, information overload can be solved through machine learning and interactive data visualization technologies. ▪ The efficiency of irregularity detection, loss deterrence, and risk assessment can be improved through technological mergers.
19-02-2023 Lehner et al. Austria	"Artificial intelligence-based decision-making in accounting and auditing: ethical challenges and normative thinking."	Accounting, Auditing & Accountability Journal		No model proposed	Conceptual	<ul style="list-style-type: none"> ▪ AI-based decision-making in accounting faces the following five significant ethical challenges: <ul style="list-style-type: none"> - Objectivity - Privacy - Transparency - Accountability - Trustworthiness

2.4. Main results

2.4.1. Research area – Identifying the research novelty in time on the use of AI in IAF

As more and more journals continue to accept theoretical outcomes of articles published in this area, the research area's continuity and novelty will be confirmed. Table 7 shows the journals with sampled publications regarding the use of AI in IAF. Moreover, as Massaro et al. (2016) stated, field-level relevance is shown through the journal's impact factor. The review found that the International Journal of Accounting Information Systems (with a 1.159 impact factor) has published the most by contributing 2 (13.29%) publications.^[3] Considering the impact factor (based on Scimago Journal Rank (SJR) 2022), the Accounting, Auditing & Accountability Journal (with 1.729 impact factor) was found to be the second most published journal, contributing one article. Moreover, Minds and Machines (with a 1.232 impact factor) and the Australian Journal of Management (with a 1.132 impact factor) followed the third and fourth journals by contributing one article each. The result shows that publications are made in journals relevant to the topic (journals focusing on auditing and information systems).

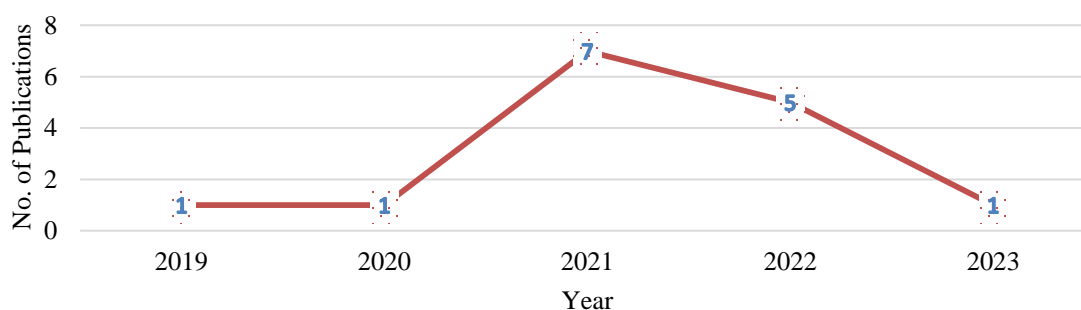
Table 7. Study I: Distribution of publications per journal

Publication source (Journal)	SJR Impact Factor 2022	No. of Publications	%
International Journal of Accounting Information Systems	1.159	2	13.29
Accounting, Auditing & Accountability Journal	1.727	1	6.67
Minds and Machines	1.232	1	6.67
Australian Journal of Management	1.132	1	6.67
Intelligent Systems in Accounting, Finance and Management	0.625	1	6.67
Managerial Auditing Journal	0.606	1	6.67
Information Technology and Management	0.534	1	6.67
Eastern-European Journal of Enterprise Technologies	0.283	1	6.67
Asian Journal of Business and Accounting	0.224	1	6.67
Journal of Physics: Conference Series	0.183	1	6.67
AIP Conference Proceedings	0.164	1	6.67
Brazilian Journal of Public Administration	-	1	6.67
The 54th Hawaii International Conference	-	1	6.67
Universal Journal of Accounting and Finance	-	1	6.67

In the sampled periods, the review found that the topic shows a substantial increment of publications in auditing and information technology research. The trend/distribution of sampled

publications from 2019 to 2023 is presented in Figure 8. It shows that in 2019 and 2020, the topic did not get substantial attention since only two publications (one publication for each year) were made. Surprisingly, in 2021 and 2022, the topic became more visible and contributed to 12 publications. In 2023, until this review was done, only one publication was found, and this may be due to the year not ending yet. However, the increment of publication over time varies significantly from year to year.

Figure 8. Study I: Publication distribution per year



The five most cited publications in the sample are presented in Table 8 (all self-citations were removed).

Table 8. Study I: Top five most cited publications in 2023

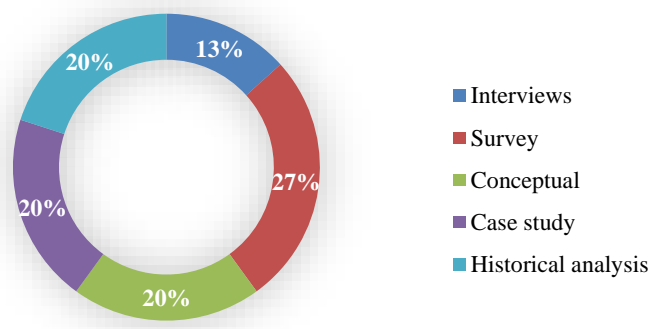
Year	Authors	Article title	Total citations
2021	Jakob Mökander; Maria Axente; Federico Casolari; Luciano Floridi	“Conformity Assessments and Post-market Monitoring: A Guide to the Role of Auditing in the Proposed European AI Regulation”	11
2019	Mieke Jans; Marzie Hosseinpour	"How active learning and process mining can act as Continuous Auditing catalyst."	10
2021	Jakob Nonnenmacher; Felix Kruse; Gerrit Schumann; J. Gómez	“Using Autoencoders for Data-Driven Analysis in Internal Auditing”	9
2023	Othmar Manfred Lehner, Kim Ittonen; Hanna Silvola; Eva Ström; Alena Wührleitner	"Artificial intelligence based decision-making in accounting and auditing: ethical challenges and normative thinking."	6
2021	Mohamad Hesham Adnan Allbabidi	“Hype or Hope: Digital Technologies in Auditing Process”	3

This analysis helps us understand the publication's importance (Massaro et al., 2016). In the database (WoS), the most cited publication in the sample is the one contributed by Mokander et al. (2021), having 11 citations^[4], followed by Jans and Hosseinpour (2019), with 10 citations. Three of the most cited papers were published in 2021. Except for the study made by Jans and Hosseinpour (2019), the other most cited studies used previous frameworks.

2.4.2. Research methods – Emerging theoretical superiority

The distribution of sampled publications per research method used is presented in Figure 9. The criteria to classify the research methods were used as applied by Bracci et al. (2019). Those methods include interviews, surveys, conceptual studies, case studies, and historical analysis. The result shows that most publications tend to be classified as surveys (27%). Hence, much of the research area is enriched with empirical evidence. Three methods with similar scores (20% each) were utilized in the study: conceptual, case study, and historical analysis. However, the review found that most studies were explanatory, indicating the need to study the research area further. Moreover, the result shows that it was easy to transform the concepts of the topic into variables, allowing us to undertake quantitative analysis (through a survey). The publications that applied conceptual methods used a qualitative approach to argue and debate the subject matter.

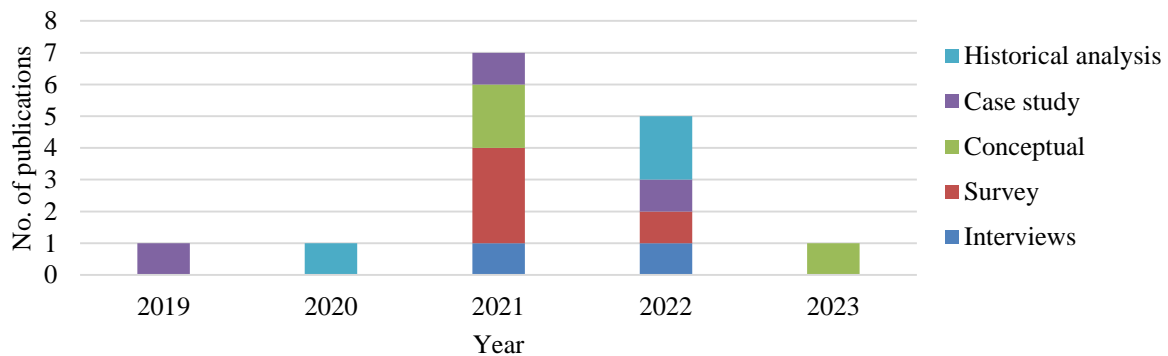
Figure 9. Study I: Distribution of publications per research method



The trends of the methods adopted over time are presented in Figure 10. This work recognized substantial phenomena from the trend. First, the review observed using different research methods during the peak periods (2021 and 2022). Four different methods were used during those periods. Moreover, most of the studies were empirical from the peak period publications. They are indicating that the authors contribute substantial empirical insights for

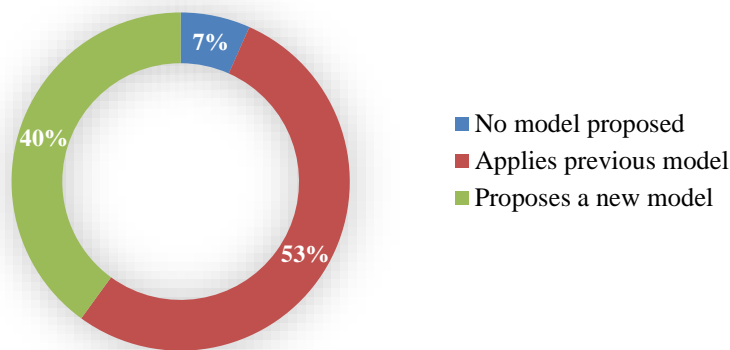
applying frameworks for using AI in the IAF (to real-world contexts). However, the limited publications made as conceptual work indicate that AI use in the IAF still needs more theory development and shared views (in definitions). The result confirms that a survey was the most adopted research method, as shown in Figure 10.

Figure 10. Study I: Distribution of publications per research method and year



Regarding the theoretical framework related to the use of IA in the IAF, the theoretical contribution of the studies in the sample was assessed (see Figure 11). As studies introduce new frameworks, it may confirm the research topic’s novelty and an emerging interest in the subject area. Similarly, applying the existing frameworks reflects the effort needed for the replicability and continuity of contributions on the topic (Lehner et al., 2023; Massaro et al., 2016). Both approaches are vital in further identifying the emerging state of theory and development of AI in the IAF (Lehner et al., 2023). Considering the recent and quickly changing technological advancement, this work expects a heterogeneous distribution of frameworks.

Figure 11. Study I: Distribution of publications per framework used



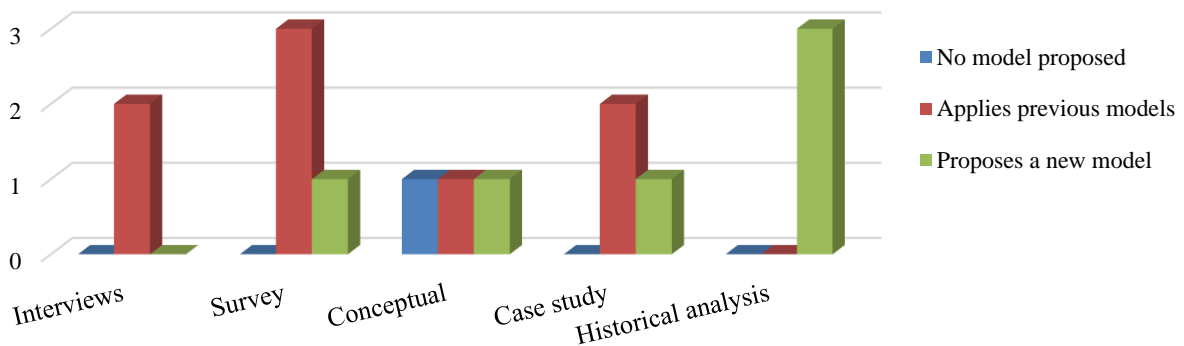
The review found that most studies (53%) included in the sample used previous frameworks to study the topic (see Figure 11). The technological–organisational–environment

(TOE) was the most utilized framework in the selected studies. For instance, the study of Seethamraju and Hecimovic (2022) used the framework to study AI adoption in auditing. They conclude that AI can enhance audit quality and provide value-adding services to the organization. However, the AI adoption needs to reconsider the audit practice with the expected lack of control in AI 'black-box', which may be exposed to extensive examination of the audit quality.

In contrast, only one study did not use any specific framework, representing 7% of the publications selected for this review. In addition, 40% of the sampled studies proposed new models to use AI in the IAF. Fortunately, these studies addressed the topic by investigating the adoption and use of AI in the IAF (Chen et al., 2021; Korol et al., 2022). Other authors also offered new insights on the use of AI in the IAF by pursuing to resolve the complexity of AI use holistically.

The relation between the research method and the framework used by the sampled publications is presented in Figure 12. It shows the relevance and expansion of methods on the topic. In the interview category, the two studies used the previous frameworks.

Figure 12. Study I: The relation between the research method and the framework used



Moreover, three studies used the previous frameworks in the survey category, while one proposed a new one. Likewise, three publications were found in the conceptual category with no model, used previous frameworks, and proposed a new model (separately). Two studies used the previous frameworks in the case study category, while one proposed a new one. Finally, all three studies proposed new frameworks in the historical analysis category. The results indicate the

quantitative nature of the research on the topic, and the area still needs further theoretical debate. In this review, it is also important to note that the interview is not a widely used research method.

2.4.3. *Research context – Placing publications in time and location*

The distribution of sampled publications per location (country and region) is presented in Table 9. This analysis is essential to get insight into the locations studied in the literature and identify the areas yet to be explored, thus assisting in identifying future research avenues (Massaro et al., 2016). This review analyses the location in two categories: country and region. Considering the country, most of the studies are located in Australia, representing 20 per cent of the sample, followed by China and Oman with the same score (13.32%). Considering the region, Asia and Europe have the most studies, representing 33.33 per cent of the sample. Australia was the second region, constituting 20% of the sampled articles. However, North America and South America are the least studied regions, each only contributing 7% of the publications. The review observed two phenomena from the results.

Table 9. Study I: Distribution of publications per location

Country	No. of Publications	%	Region	No. of Publications	%
China	2	13.32	Asia	5	33.33
Oman	2	13.32			
Jordan	1	6.67			
UK	1	6.67	Europe	5	33.33
Belgium	1	6.67			
Germany	1	6.67			
Ukraine	1	6.67			
Austria	1	6.67			
Australia	3	20.0	Australia	3	20.0
US	1	6.67	North America	1	6.67
Brazil	1	6.67	South America	1	6.67

First, the selected studies considered single-country cases, indicating no comparative analysis was made (between cases from two or more countries). A comparative analysis is vital for the topic (AI in the IAF) to measure and conceptualize it in diverse contexts. Second, most of the studies on the topic were conducted in developed countries and regions, indicating the shortage of research in other contexts. This phenomenon confirms the study of Allbabidi (2021), who stated that most of the studies on adopting and using AI for auditing are undertaken in

developed countries. Thus, studies must further investigate the topic in developing countries and regions (e.g. Africa).

2.5. Discussion: Future research avenues

This review generally highlights that, as a research field, the use of AI in the IAF has yet to reach a substantial level of consideration. The analysis reveals that there is a fluctuating contribution of publications per year. It shows that in 2019 and 2020, the topic did not get substantial attention, and in 2021 and 2022, the topic became more visible, contributing to most of the publications (12 articles). The limited number of publications may initiate debate on the relevance of the research interest in using AI in IAF. This review also found that 40% of sampled studies proposed new models to use AI in the IAF, and they investigated the adoption and use of AI in the IAF (Chen et al., 2021; Zhang et al., 2022).

The analysis demonstrated that the publications contribute to understanding AI's concepts, definition, and operation in different applications. Nevertheless, in an IAF context, the review revealed a lack of in-depth studies and fewer attempts to bring existing theories to AI implementation and auditing. The finding signals that additional investigations must be undertaken, although methodological and theoretical risks are expected. Future researchers can contribute to the field by conceptualizing the topic and use of AI in the IAF and investigating how to implement AI in the IAF. Moreover, they may contribute to how to measure the implementation level from theoretical and practical backgrounds. Research attention in such queries initiates insights built on the use of AI in the IAF topics and main arguments: How can AI contribute to developing IAF? What are the benefits, and how does AI affect the decision processes of IAF and policymakers? Similarly, how is AI affected by auditing concepts?

From the review, it was evident that several scholars believe that utilizing AI in the IAF will minimize human errors and provide efficiency. For instance, using AI for the organizational process minimizes human errors, assists the decision-making process, and provides more advantages for the company (Parker, 2022; Q.ai-Contributor-Group, 2022; Adhikari, 2021; Tableau, 2021; Opr, 2020; Couceiro et al., 2020). With the assistance of AI, judgements in IAF are made from the earlier information collected through employing a definite mix of algorithms—subsequently, a significant likelihood of attaining accuracy to a greater extent of

precision. Puthukulam et al. (2021) demonstrated ample usage of big data and analytics in the IAF of large companies. The robotics of IAF and the utilization of AI could get forward actionable predictions that could assist internal auditors in making the correct insights. AI could assist the IAF in auditing tasks efficiently and effectively (Muspratt, 2018; Seethamraju & Hecimovic, 2022).

Although AI creates opportunities for researchers on how to use it in the IAF and how it progresses the efficiency of IAF, it is also relevant to investigate the dark side of using AI. For example, in the application of AI technology, it is possible to experience information loss or damage for many reasons, such as (but not limited to) machine impairments or Cyber-attacks (HRF, 2022). Other scholars argue that AI's implementation and maintenance cost is another challenge (Edmondson, 2020). Such views call for additional investigations on the potential use of AI in the IAF.

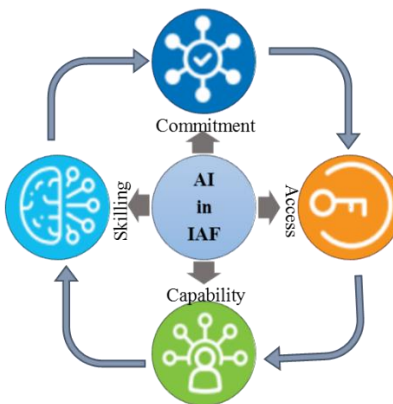
Methodologically, researchers may undertake comprehensive studies on how the use of AI in the IAF is conceptualized and may introduce new models for its measurement and application. In this context, this review finds that many researchers (Chen et al., 2021; Jans & Hosseinpour, 2019; Xavier et al., 2022; Westland, 2020; Zhou, 2021; Korol et al., 2022) tried to study the topic by introducing new models. The efforts of those researchers encouraged other scholars to contribute new insights into the theoretical frameworks in the field. In addition, it was found that measuring the use of AI in the IAF was not complex. Most studies in this review applied the survey method, indicating that quantitative approaches are the most utilized. However, the limited publications made as conceptual work indicate that AI use in the IAF still needs more theory development and shared views (in definitions).

Considering the locations in previous publications, this review found that no study was undertaken considering two country cases (comparative analysis). Moreover, it was found that most studies undertaken on the topic are based in developed countries, confirming Allbabidi's (2021) study. In those circumstances, future researchers can contribute by undertaking comparative analysis and covering different locations, especially developing regions (like Africa) and countries.

Overall, there are limited studies on the use of AI in the IAF (Couceiro et al., 2020; Seethamraju & Hecimovic, 2022; Ghanoum & Alaba, 2020). Although the concept and application of AI are getting wide acceptance, they have not yet been applied in some countries. Most studies are in Australia, China, and Oman (Zhou, 2021; Khan et al., 2021; Rehmanand & Hashim, 2022). Besides, it was found that Asia and Europe are the most studied areas (Lehner et al., 2023). The review also revealed that most of the studies used the previously developed and common framework, which is technological–organizational–environmental (TOE) (Seethamraju & Hecimovic, 2022; Chen et al., 2021). The review highlights research gaps in the area under study, such as limited studies on the topic and low AI adoption rates in the IAF across different countries and regions. Besides, there is a shortage of comprehensive frameworks for effectively using AI in IAF. Hence, this review work tries to fill the research gap by offering an outline of research avenues on the literature topic and suggesting a new compressive framework (CACS) for the effective use of AI in the IAF.

Accordingly, considering the review, this study suggests that future researchers can use and validate the newly introduced commitment, access, capability, and skilling (CACS) framework, which is a wide-ranging step in this direction (Metricstream, 2020). AI could let organizations and their internal audit functions grow quicker due to the difficulties of data analysis and management of risk. The journey of AI can be accelerated with the help of IAF, given the CACS framework displayed in Figure 13. Implementing the suggested CACS could be the turning point for internal audit, letting people move away and creating a method for AI to evaluate the big and disorganized data.

Figure 13. Study I: The CACS framework for artificial intelligence utilization in IAF



Source: As suggested by MetricStream (2020)

Using the CACS framework (see Figure 13), the advanced audit performance needs commitment and specific focus. The first step in the path of a technology-oriented mindset is the acceptance and recognition of innovative technologies to assist IAF (Khan et al., 2021; Zhou, 2021). The values of AI would be better recognized when there is an organizational commitment to discovering sections of IAF that could be brought under the fold of robotics. Moreover, cracking complex data sets using analytics could protect multimillion dollars (Metricstream, 2020).

Access is the second critical attribute for the effective utilization of AI in the IAF. Internal auditors face many difficulties, and one of the main challenges is related to access; this is because, in some periods, the process holders are open to allowing them in, and in others, they are not. This practice is a custom or association matter rather than a technological issue; however, it is very relevant for using AI in IAF (Seethamraju & Hecimovic, 2022). Access to the operating system that processes and analyses owners is undoubtedly an obstacle to internal auditors, which they have to pass before they begin the path to utilize intelligent technology, which is for monitoring continuously (Metricstream, 2020).

The other critical attribute essential for any IAF to utilize AI is system capabilities, as it is where the data reliability initiative commences. The exclusive feature of data storage and analysis begins with knowing the system's capability (Rehmanand & Hashim, 2022). In addition to AI's assessment of the performance of control systems and examination of financial or information systems in the IAF, the essential point is understanding how big data will be handled and processed in the system. For having and telling a material story, there should be the capability of IAF to join the data spots (Metricstream, 2020).

Finally, the successful utilization of AI in the IAF of a company is highly dependent on skilling. Providing training and development for internal auditors is critical since, from a firm viewpoint, it is essential to discover where employees with the necessary skills are seated in the internal audit team and then put them together for fair resource allocation (Nonnenmacher et al., 2021). In time, this could be a challenge since there might be associates in the audit group or team who started working when the technology was less used in their tasks. Making them acquire a technological mindset or training them might be difficult. The key is optional to hire new staff but rather leverage the prevailing talent (Metricstream, 2020). In general, the four

attributes are essential for implementing and utilizing AI in the IAF of an organization. One of the targets of this paper is to provide the practical implication and applicability of the subject matter. Thus, companies need to use those attributes in the framework to quickly implement and utilize AI in their IAF.

2.6. Conclusion and practical implication

A strong structure of internal audit functions, policies, and guidelines is necessary to gain the opportunities of AI. AI can support the company's internal audit function by delivering substantial strategic oversight, minimizing analysis based on manual procedures, and offering additional wide-ranging audits. The way of doing business is getting more complex than earlier, and it is because of the advances in technology and instant improvements in the manner of operations; hence, companies need to employ AI and update themselves continuously.

The present research on the use of AI in the IAF is in its emerging state. This review finds that many researchers tried to study the topic by introducing new models. The efforts of those researchers encouraged other scholars to contribute new insights into the theoretical frameworks in the field. However, there is a shortage of comprehensive frameworks for the use of AI in the IAF. In addition, it was found that measuring the use of AI in the IAF was not complex. Most studies in this review applied the survey method, indicating that quantitative approaches are the most utilized. However, the limited publications made as conceptual work indicate that AI use in the IAF still needs more theory development and shared views (in definitions). Besides, the review found that no study was undertaken considering two country cases (comparative analysis). Moreover, it was found that most studies undertaken on the topic are based in developed countries. Hence, future researchers can contribute by undertaking comparative analysis and covering different locations, especially developing regions (like Africa) and countries.

The findings of this review provide relevant theoretical and practical contributions for different stakeholders, including internal auditors, regulators, organizations, researchers, and the whole business community. Regarding theory, this review offers a comprehensive highlight of the prevailing research, contributing to formulating and arranging knowledge on the deeper understanding of how AI affects the IAF. Besides, it highlights the research areas which lack

investigations (research gaps), guiding future research directions and theoretical foundations. Moreover, this review contributes to developing a theoretical framework (CACS), assisting stakeholders to understand and conceptualize the use of AI in the IAF, and can be a basis for future investigations.

Regarding practice, this review helps internal auditors assess and understand the potential advantages and risks of implementing AI in their organization's IAF. It also helps internal auditors identify the new skills required to adopt and effectively use AI in their audit tasks, highlighting training and skill development areas. Besides, this review is helpful to regulators in updating regulations on internal auditing in the context of using advanced technology such as AI, ensuring the compliance of internal auditing practices to the evolving technology. Finally, organizations can benefit from this review to decide whether AI investments for their IAFs are justified. Considering the value of utilizing AI in the IAF of an organization, companies need to utilize AI and make it work in the IAF efficiently. For this reason, the recently introduced CACS framework with four attributes was recommended for implementing AI in the IAF. Thus, organizations can benefit from the framework to quickly implement and utilize AI in their IAF.

This review has some limitations, such as the data set used in the database (Web of Science), is limited to the selected keywords, and only includes research articles and conference papers. Although the researcher was aware of this limitation, it was believed that the Web of Science lets more replicable inquiries (a vital aspect of a systematic literature review). Moreover, the results are limited to the extent and depth of the data analyzed. Nevertheless, the reliability of the findings is ensured by the systematic literature review approach, yet the interpretations of the results are contingent on the beliefs and understanding of the researcher.

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Endnotes

1. The refined Web of Science research string is documented as follows: *Artificial intelligence* (Topic) and *internal audit* (Topic) and *Preprint Citation Index* (Exclude – Database) and *2019 or 2020 or 2021 or 2022 or 2023* (Publication Years)
2. The refined Web of Science research string is documented as follows: *Artificial intelligence* (Topic) and *internal audit* (Topic) and *Preprint Citation Index* (Exclude – Database) and *2019 or 2020 or 2021 or 2022 or 2023* (Publication Years) and *Article or Early Access* (Document Types) and *Business Economics* (Research Areas)
3. For additional information: <https://www.sciencedirect.com/journal/international-journal-of-accounting-information-systems>
4. Web of Science journal citation report 2023, for additional information: <https://www.webofscience.com/wos/alldb/full-record/WOS:000714864800001>

3. Study II. Technology adoption in audit of information systems: Ethiopian audit firms' perspective

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Published in Journal of Infrastructure Policy and Development, 8 (13). pp. 1–23.

<https://doi.org/10.24294/jipd8819>

Abstract

Today's automation of the audit process increasingly relies on electronic auditing, especially computer-assisted audit techniques (CAATs), and has become a global necessity. Therefore, this study aims to explore the influence of technological, organizational, and environmental (TOE) factors on audit firms' adoption of CAATs in developing countries, focusing on Ethiopia. The research employed a quantitative approach and gathered 113 valid responses from certified external auditors in Ethiopian audit firms. The data was then analyzed through the Partial Least Squares Structural Equation Modeling (PLS-SEM) method. The findings show that relative advantage and compatibility are the significant technological attributes influencing CAAT adoption in Ethiopian audit firms. Besides, auditors' information technology (IT) competency was a significant organizational attribute influencing CAAT adoption. Environmental attributes such as the complexity of the client's accounting information system (AIS) and the professional body support significantly impact the adoption of CAATs. Additionally, the size of an audit firm reduces the impact of clients' AIS complexity on the adoption of CAATs in Ethiopian audit firms. The findings underscore the significance of CAAT adoption in audit firms and offer valuable insights for policymakers and standard setters in crafting legislation for the Ethiopian audit industry. This study represents the first scholarly effort to provide evidence of CAAT adoption in audit firms in developing countries like Ethiopia.

Keywords: CAATs adoption; electronic auditing; Ethiopian audit firms; external auditing; information system

3.1. Introduction

Technological advancement is currently believed to be one of the most critical issues, causing many challenges for the corporate world (Skousen & Wright, 2006). Currently, countless businesses are performing their operations using information technologies, and many misstatements and frauds occur daily from an organization's internal and external parties. Using the knowledge of information technology, different parties within or outside of a firm are making misstatements and fraud acts for the best of their interest (Kee et al., 2013). Here, auditors, especially external auditors, are expected to do extensive audit work to identify those potential misstatements and take corrective actions. However, before auditors engage in audits, it would be better to have good knowledge and expertise in using current auditing technologies (Mao et al., 2016), such as CAATs, to avoid "information asymmetry." Despite the significant advantages of using CAATs in audit engagements, their adoption by audit firms worldwide remains inadequate (Lia et al., 2018). Lia et al. (2018) note that most audit firms continue to rely on "rudimentary audit analytics techniques (traditional auditing techniques)" to conduct their audit procedures.

Previous research on adopting CAATs for audit work has utilized the Technology-Organization-Environmental (TOE) framework across various countries. However, there has been limited exploration of CAAT adoption in information system auditing within the existing literature. Several research gaps have been identified: a scarcity of studies on the subject, limited coverage of geographical areas (regions and countries), methodological homogeneity, an overemphasis on specific theoretical frameworks, and a lack of studies addressing different audit perspectives (internal and external auditing). Furthermore, no empirical evidence indicates that Ethiopian audit firms currently use CAATs to support their audit procedures. Therefore, this study investigated the key factors influencing the adoption of CAATs by Ethiopian audit firms employing the TOE framework.

The study investigated the impact of various factors on CAAT adoption by developing seven hypotheses that propose a positive influence of technological factors (relative advantage and compatibility), organizational factors (auditor's IT competency and audit firm size), and environmental factors (clients' AIS complexity and support from professional bodies) on the adoption of CAATs in Ethiopian audit firms. Additionally, the study assessed the moderating

effect of audit firm size on the relationship between clients' AIS complexity and CAAT adoption. In the present study, to test these hypotheses, primary data were gathered through a survey of qualified external auditors, such as Certified Public Accountants (CPA) or members of the Association of Chartered Certified Accountants (ACCA), who work in Ethiopian audit firms. The findings reveal that relative advantage and compatibility are significant technological factors influencing CAAT adoption. Moreover, auditors' IT competency, an organizational factor, was also found to significantly impact the adoption of CAATs in Ethiopian audit firms. Moreover, environmental attributes such as clients' AIS complexity and professional body support significantly impacted the adoption of CAATs.

The study's findings have theoretical and practical contributions to the field, such as contributing to the advancement of audit theory by shedding light on the evolving role of technology in audit processes, especially in developing economies (like Ethiopia) where technological adoption might differ from developed countries. Besides, it provides a unique contribution by offering the first insight into how implementing CAATs can increase audit efficiency and effectiveness in Ethiopia. Moreover, the insights from CAAT adoption can help Ethiopian regulatory agencies understand the norms and standards needed to integrate technology into audit procedures (it can improve regulatory compliance and audit quality). Furthermore, the study helps audit firms by demonstrating how effectively implementing CAATs may lead to a competitive advantage in the market. Finally, external auditors working in various audit firms are expected to profit from the study, particularly those who do audit tasks on computerized processes and systems through CAATs.

The study is organized and presented in five sections: literature review and research hypothesis development in the second section, the research method in the third section, the study results in the fourth section, the discussion in the fifth section, and the conclusion and future implications in the sixth section.

3.2. Literature review and research hypothesis development

In many countries, the widespread adoption of CAATs began in the 1990s when firms increasingly integrated information technology (IT) into their business operations (Debreceeny et al., 2005). However, the responsibility for ensuring internal controls over IT-driven business

transactions rests with auditors, who are expected to provide opinions on the internal control procedures of these firms (Marei & Iskandar, 2020). It is widely recognized that businesses rely on IT systems, enabling them to continuously offer customer-oriented, advanced, and value-added products and services by leveraging technology effectively. Many opportunities for advanced control, "risk management framework," and improved business efficiency have been created since the application of IT to the business process. However, new risks face businesses' internal control and auditing due to advancements in IT, for instance, operational process termination, illegal access, and software control failures. Auditors should know that the conventional technique of relying on internal control and minimizing or increasing the scope of substantive control is no longer their issue. In modern times, the widespread use of computer-associated audit procedures needs many countries' provisions of audit guidelines. Hence, auditors must obtain knowledge of internal control over information technology during the audit processes (Marei & Iskandar, 2020).

Compared to modern auditing techniques, manual auditing might be suitable for some kinds of auditing, mainly when the client is small and has small transactions during the audit period. Nevertheless, spreading this to some complex audit procedures might be immaterial. The demand for valuable computer auditing systems is critical since conventional auditing cannot instantly identify material misstatements, unlike computer systems (Chang et al., 2011).

There is no specific set of international standards exclusively for Computer-Assisted Audit Techniques (CAAT). Instead, various international standards and recommendations address the broader field of audit technology and data analytics, which includes CAATs (Daoud, 2023). These guidelines provide auditors with strategies for effectively incorporating technology into the audit process, focusing on CAATs. According to the AICPA (2008), existing audit standards advocate using CAATs to enhance the effectiveness and efficiency of audit procedures.

Most importantly, CAATs support auditors by spontaneously obtaining complete data and performing analyses. Hence, it will reduce audit costs and time. Some of the essential standards and principles applicable to CAATs include the "International Standards on Auditing (ISAs)," the "International Framework for Assurance Engagements (IFAE)," the "Information

Systems Audit and Control Association (ISACA) Standards," and the "Institute of Internal Auditors (IIA) Standards" (Smidt et al., 2021).

Several studies on CAATs were conducted, considering various audit firms (from small to big 4) and audit experts (internal and external auditors). They evidenced a lack of adoption of CAATs, which means modern auditing techniques are still underutilized in many audit firms (Janvrin et al., 2008), and further research is needed to assess the adoption of CAATs. Therefore, this study aims to demonstrate and analyze the extent to which audit firms in Ethiopia use CAATs. As previously noted, there is a lack of research on adopting CAATs for information system auditing in various countries, with only a few regions and countries being examined. Additionally, there has been a limited variety of research methodologies, an overreliance on specific theoretical frameworks, and insufficient exploration of different audit perspectives (both internal and external) (Widuri & Gautama, 2020). These factors highlight a significant research gap in the field's literature.

Moreover, there is no empirical evidence that Ethiopian audit firms use CAATs to support their audit procedures. Thus, based on previous literature, the present study examined the factors that impact CAAT adoption by Ethiopian audit firms using the TOE framework. The technological, organizational, and environmental constructs are interdependent to provide insight into the determinants of technology adoption (Awuah et al., 2022). Adopting technologies like CAATs in organizations has an extended scope compared to personal user insights, and the organizational features and environmental aspects must be considered. In this study, the extended TOE framework was applied, and the elements and their relationships are represented in Figure 14.

3.2.1. Technological attributes

In the TOE framework, technological attributes specify the characteristics that can impact an organization's decision to adopt technology. In the literature (Sabherwal et al., 2006; Hameed & Counsell, 2014), many technological attributes were studied for their impact on technology adoption and usage. Most studies considered factors such as complexity, relative advantage, and compatibility since they have often been found to be significant in technology adoption (Thong,

1999). Hence, the two most significant factors (based on the literature frequency) have been included in the present study as technological attributes.

Relative advantage

According to Bertrand (2004), the relative advantage is the extent to which technological innovation is considered better than the notion that it supplants. It is an influential tool for gaining a maintainable relative advantage (Mao et al., 2016). Prior literature (Chandra & Kumar, 2018) highlights a direct association between the expected benefits of utilizing the technology (relative advantage) and its adoption. Hence, innovative technology adoption and practices commonly provide their users with a maintainable benefit (Chandra & Kumar, 2018). Audit firms must understand the advantages of utilizing CAATs in their audit process (Al-Hiyari et al., 2019) to distinguish themselves, simplify audit activities, and adopt innovative approaches to satisfy their stakeholders.

In addition, the outcome of Chandra and Kumar's (2018) investigation demonstrates that the relative advantage substantially affects adopting technology. In the context of CAAT adoption, Siew et al. (2020) found that relative advantage (a control variable) significantly positively affects the adoption of CAATs. Similarly, Daoud et al. (2021) and Rosli et al. (2013) also reported that relative advantage plays a substantial role in influencing the adoption of CAATs. However, Awuah et al. (2022) and Al-Okaily et al. (2022) argued that it has no significant impact on CAAT adoption. Therefore, as the audit firms start to understand the advantages of CAAT adoption, they will attain their relative advantage in the eyes of their stakeholders; they will invest in such technology and will have consent to adopt CAATs. Ethiopian audit firms may use CAATs if they see them as more efficient and effective than conventional audit procedures.

Furthermore, suppose Ethiopian audit companies feel that using CAATs would result in cost benefits, such as lower personnel expenses, audit time, or improved resource allocation. In that case, they may be more willing to invest in this technology. However, it is critical to consider the initial expenditure for software, training, and infrastructure. Therefore, the study suggests that the perceived relative advantage of CAATs will encourage audit firms to incorporate them into their audit processes, leading to the following hypothesis:

H1. In Ethiopian audit firms, relative advantage positively affects the adoption of CAATs.

Compatibility

Based on Rogers (2003), construct compatibility is perceived as the extent to which technological innovation is considered in line with prospective adopters' prior practices, "value relevance," and desires. As demonstrated by Ghobakhloo et al. (2011) and Rogers (2003), an audit firm's perspective regarding adopting CAATs is the degree to which CAATs suit the audit firms' prevailing technology infrastructure, organizational philosophy, values, and workplace experience.

The previous empirical literature has portrayed diverse outcomes regarding technology adoption and compatibility. Some of them (Daoud et al. (2021); Chiu et al., 2017) have concluded that CAAT adoption is not affected by compatibility, and others revealed that compatibility negatively influences CAAT adoption (Siew et al., 2020). On the other hand, Awuah et al. (2022), Al-Okaily et al. (2022), and Rosli et al. (2013) found that compatibility significantly and positively impacts the adoption of CAATs. Martínez et al. (2014) highlighted that compatibility can hinder technology adoption. Despite this, many earlier studies (Zhu & Kraemer, 2005; Tan et al., 2009) have identified compatibility as a critical factor influencing CAAT adoption.

Integrating CAATs with current audit systems and procedures in Ethiopian audit firms might be challenging. Compatibility concerns, data transfer obstacles, and customization to meet unique organizational requirements may occur. The difficulty of integrating CAATs into the existing process might hinder acceptance efforts and raise installation costs. Ethiopian audit firms may also face obstacles due to the complexity and quality of the data they work with, change management, and risk and security considerations. Hence, it is expected that audit firms tend to ponder CAATs if it is in line with the firm's philosophy, existing values, and critical desires, and the hypothesis was developed as follows:

H2. In Ethiopian audit firms, compatibility positively affects the adoption of CAATs.

3.2.2. *Organizational Attributes*

The organizational perspective is the second crucial component of the institutions' characteristics and resources within the TOE framework (Tornatzky & Fleischer, 1990). According to Siew et al. (2020), an auditor's IT competency is a defining characteristic of an audit firm's technology adoption constructs. However, in the context of CAAT adoption within audit firms, as noted by Siew et al. (2020) and Kee et al. (2013), the number of external auditors in a firm was used as a proxy for the firm's size.

Auditor's Competency in IT

Before any audit firm adopts the CAATs, external auditors must understand technical skills and their practice. Considering this, an auditor's competency in IT influences the adoption of CAATs (Janvrin et al., 2008; Axelsen et al., 2017). Additionally, Siew et al. (2020) highlight that CAATs require external auditors to possess adequate information technology skills to use these tools and interpret their results effectively. Axelsen et al. (2017) further assert that to explain the outcomes accurately, external auditors must be capable of understanding essential systems and recognizing overall computer controls. Moreover, Awuah et al. (2022), Al-Okaily et al. (2022), Sagar and Ramanathan (2022), and Siew et al. (2020) found that auditors' IT competency significantly and positively affects the adoption of CAATs. In Ethiopian audit firms, the compatibility of CAATs with auditors' skills, preferences, and procedures can significantly influence their adoption. User-friendly interfaces and intuitive features improve acceptance and shorten the learning curve for using CAATs. External auditors in audit firms need sufficient knowledge of technology-oriented audit techniques to execute their tasks. Therefore, an adequate degree of auditors' IT competency will make the adoption of CAATs more probable by audit firms, and this leads to formulating the hypothesis:

H3. In Ethiopian audit firms, the auditor's IT competency positively affects the adoption of CAATs.

Audit Firm Size

The prior empirical literature on information technology (Pedrosa et al., 2020; Chiu et al., 2017; Venkatesh & Bala, 2012) revealed that entity size is a precursor for technology adoption.

Large organizations, compared to small ones, have more economies of scale (Lowe et al., 2017; Siew et al., 2020), enabling them to employ more workers and invest in innovative technology systems to simplify new technology adoption. According to Lestari et al. (2020) and Rosli et al. (2013), large audit firms may have more financial and human capacity to ensure that new technology is successfully deployed. Accordingly, audit firm size has been confirmed to be a significant organizational attribute for adopting technology (Al-Okaily et al., 2022; Chandra & Kumar, 2018; Daoud et al., 2021) since large firms have the potential to make more investments in innovative technologies.

In Ethiopia, the size of audit firms can impact CAAT adoption due to resource availability, operational scale, risk management needs, client expectations, market demands, training and skill development, and audit engagement complexity. As the path of the empirical literature, the present study suggested that firm size has a substantial impact on the adoption of CAATs in audit firms and formulated the following hypothesis:

H4. In Ethiopian audit firms, audit firm size positively affects the adoption of CAATs.

Moderation Effect of Audit Firm Size

As stated by Janvrin et al. (2008) and Lowe et al. (2017) in their study, large audit firms are likely to have clients with a complex accounting information system. These companies (clients) have a probability of selecting more prominent audit firms (Ismail et al., 2006) because of their ability to audit complex accounting information systems and provide a better quality of audit services (Siew et al., 2020; Davidson, 1993; Francis & Yu, 2009). In contrast, smaller audit firms might struggle to adopt new technologies (Rosli et al., 2013; Lowe et al., 2017; Curtis & Payne, 2008) for auditing clients with complex accounting information systems. Axelsen et al. (2017) suggest that it may not be cost-effective for these firms to invest heavily in information technologies for their clients. Additionally, Lowe et al. (2017) and Axelsen et al. (2017) noted that smaller audit firms place minimal importance on information systems audits and view the use of information technologies in audits as having limited significance.

Therefore, in smaller Ethiopian audit firms with limited information technology capabilities, the complexity of the client's AIS may have minimal impact on the adoption of CAATs (Axelsen et al., 2017). In contrast, for larger Ethiopian audit firms with more advanced

IT capabilities, the complexity of the client's AIS could significantly influence the adoption of CAATs. Consequently, the hypothesis was formulated as follows:

H5. In Ethiopian audit firms, audit firm size moderates the effect of clients' AIS complexity on adopting CAATs.

3.2.3. Environmental Attributes

In the TOE framework, the environmental component constitutes the firm's setting, comprising its market connections with the government and contestants (Oliveira & Martins, 2011; Chandra & Kumar, 2018; Tornatzky Fleischer, 1990). The present study considers two exceptional environmental attributes important to audit firms: clients' AIS complexity, competitive pressure, and professional body support.

Clients' AIS Complexity

In the TOE framework, clients' AIS complexity refers to the level of intricacy in the accounting information systems of audit firm clients (Janvrin et al., 2008). This attribute encompasses the extent to which clients utilize computerized financial reporting systems (Ahmi & Kent, 2013) and the complexity and nature of the transactions managed by these systems within their organizations. Financial transactions are processed and kept electronically in computerized accounting information systems, improving "financial reporting quality" (Purnamasari et al., 2022). Furthermore, the industrial nature and clients' operational environment are other features of AIS complexity. For example, clients with large business operations in the banking industry may have complicated transactions that require improved and complex accounting information systems (Axelsen et al., 2017) to administer such business transactions. Prior empirical studies in developed countries (Siew et al., 2020; Al-Okaily et al., 2022; Ahmi & Kent, 2013) demonstrated that clients' IT complexity impacts the utilization of CAATs.

However, Daoud et al. (2021) argued in their study that this attribute has nothing to do with adopting CAATs. They contend that current CAATs are versatile and flexible enough to deal with various AIS difficulties. Audit firms may have access to CAATs with flexible functionality and customization possibilities, allowing them to efficiently manage a wide range

of client requirements and AIS difficulties. As a result, differences in clients' AIS complexity may not impede CAAT implementation substantially. Nevertheless, in emerging countries like Ethiopia, higher utilization of CAATs could occur when the environments of clients' AIS complexity changes in the manner audit processes are executed (Janvrin et al., 2008; Axelsen et al., 2017) and involves robust control over substantive testing. Hence, the hypothesis was formulated as follows:

H6. *In Ethiopian audit firms, the complexity of clients' AIS positively affects the adoption of CAATs.*

Professional Body Support

In the present study, professional body support is considered the extent to which audit bodies inspire Ethiopian audit firms to adopt CAATs by providing standards, guidelines, and assistance. Professional auditing bodies regulate the external auditing profession, and some emerging nations consider regulators seriously when alerting audit firms about innovative technologies. According to Mahzen and Lyman (2009), the endorsements of professional bodies are one of the means that an auditor seeks to choose and use CAATs. Additionally, the professional audit body is critical in distributing information regarding innovative technological improvements to its members (Siew et al., 2020; Awuah et al., 2022) and giving guidance, practical training, and assistance in utilizing technology. Nevertheless, according to Al-Okaily et al. (2022), professional body support has no substantial effect on adopting CAATs.

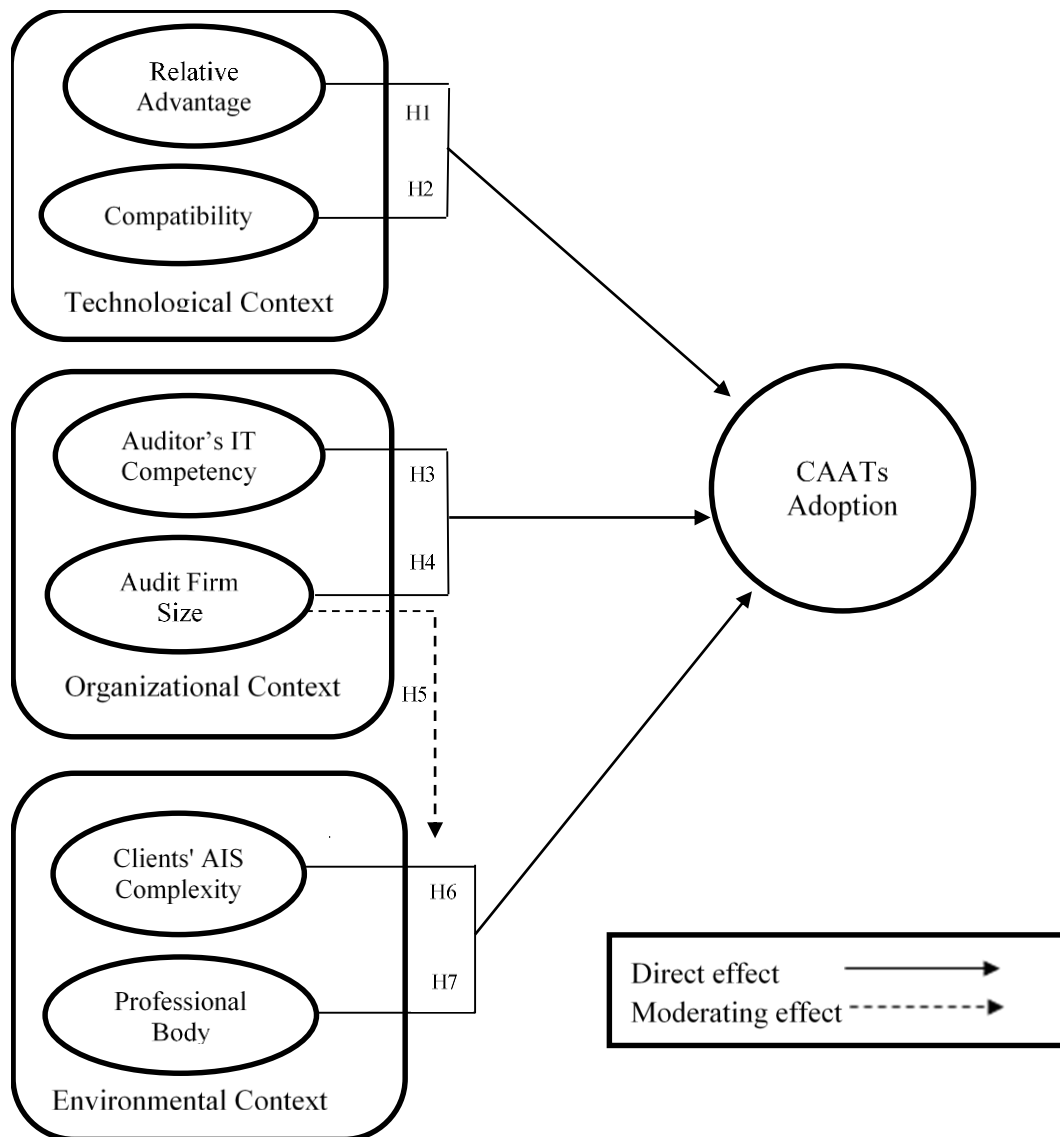
Although most of the prior empirical literature using the TOE framework ignored this environmental attribute, the present study considered it as a significant factor that can impact CAAT adoption. In emerging nations like Ethiopia, technology development is recent, and professional body support is needed for CAAT adoption. Professional bodies may support Ethiopian audit firms by providing guidance and standards, offering training and education, advocating for technology adoption, promoting research and thought leadership, and ensuring regulatory compliance and assurance. If external auditors observed that the professional audit bodies encourage Ethiopian audit firms to adopt innovative audit technologies, this would raise their acceptance and adoption of CAATs. Thus, the present study suggested that the proper

assistance from professional auditing bodies would upsurge the likelihood of CAAT adoption by audit firms, and the subsequent hypothesis was formulated as follows:

H7. In Ethiopian audit firms, professional body support positively affects the adoption of CAATs.

All hypotheses about the relationship between the dependent variables (in the TOE framework) and the dependent variable (CAAT adoption) are summarized and presented in Figure 14.

Figure 14. Study II: Research model using the TOE framework



3.3. Research method

3.3.1. Sample and data collection

This study primarily utilized primary data collected through a survey of external auditors from Ethiopian audit firms. The data sources were qualified external auditors (CPA or ACCA), as they better understand theory and practice within their firms. According to the Accounting and Auditing Board of Ethiopia (AABE, 2022), 172 registered certified audit firms are in the country. Given the homogeneous population of qualified external auditors, the study determined the minimum sample size needed for PLS-SEM analysis using G*Power (version 3.1) software (Faul et al., 2009; Al-Okaily et al., 2022; Siew et al., 2020). The software was set with the following parameters (Al-Okaily et al., 2022; Siew et al., 2020): $f^2 = 0.15$ (medium effect size), significance level $\alpha = 0.05$, power = 0.95, and number of predictors = 6. The software indicated a minimum sample size of 89. Therefore, to ensure adequate coverage, a total of 200 questionnaires were distributed for the study.

A stratified sampling technique was employed to select respondents for the study. The sample was divided into two strata based on the operational location of the audit firms: those based in the capital (Addis Ababa) and those located outside the capital (in 11 regional states). Of the 172 registered certified audit firms, 148 operate in the capital, while 24 are based outside. Consequently, the strata were categorized as "in the capital" and "outside the capital." The sample size was allocated according to the proportion of firms in each stratum, with 86% of the sample drawn from firms in the capital and 14% from firms outside the capital.

$$\text{Strata 1} = (148/172) \times 200 = 172$$

$$\text{Strata 2} = (24/172) \times 200 = 28$$

The questionnaires were distributed through an online survey method (using email). The researchers used external audit associations in the country to get responses from the respondents easily and promptly. A total of 113 valid questionnaires were collected and used for the analysis of this study. The total response rate was 56.5%, which is acceptable for studies on information technology at the institutional level. The responses were 101 from strata 1 (59%) and 12 from strata 2 (43%).

3.3.2. *Measurement*

The data was collected through a self-administered questionnaire, and it is a suitable instrument used in survey methods, especially to get a large amount of data (Kothari, 2004). In constructing the questionnaire and measuring the theoretical dimensions, the study adopted and used the validated and tested scales in the literature (Hair et al., 2019). Different measures were applied for the independent and dependent variables. The extent of CAAT usage in the audit firms was measured by the dependent variable and as applied by Braun and Davis (2011) and Siewet al. (2020). The adoption of popular CAAT applications such as Generalized Audit Software, Database SQL Search and Retrieval, Audit Automation Software, Test Data, Embedded Audit Modules, and Parallel Simulation Software were scaled from (1) "Never use at all" to (7) "Extensively used." Then, the average response score of all applications was considered to provide the overall score of the dependent variable (single-item variable) (See Appendix Table A1).

In addition, to measure the items of the independent variables, the study used close-ended questions with a measurement of 7 points Likert scale (1= strongly disagree, 2= disagree, 3= slightly disagree, 4= neutral, 5= slightly agree, 6= agree, 7= strongly agree). A 7-point scale is selected because the probability of attaining the objective reality of people will be increased since a variety of options are provided. The items (see Appendix Table A1) included each variable, and the scales were adopted from the previous studies in the literature (Venkatesh & Bala, 2012; Siew et al., 2020; Al-Okaily et al., 2022; Thong, 1999; Kee et al., 2013; Zhu & Kraemer, 2005; Ahmi & Kent, 2013; Janvrin et al., 2008).

3.3.3. *Common method bias*

The present study undertakes different ways to minimize common method biases, such as ensuring the anonymity of the respondents and collecting the data in two rolls. In addition, the items in the questionnaire were randomized to make the outcome variables and antecedents not easily guessed by the respondents. An exploratory factor analysis (unrotated solution) was also conducted to ensure no common method bias. Harman single-factor test statistics show that a single factor can explain about 46.62% of the total variance, indicating there is no standard method bias as it is less than 50% (Al-Qudah et al., 2021; Al-Okaily et al., 2022).

3.3.4. Data analysis

The present study used the PLS-SEM regression model to test the developed hypotheses and to validate measurements. It allows for estimating the relationships between variables without considering assumptions on the distribution of the data and with small sample sizes (Hair et al., 2019; Al-Okaily et al., 2022; Al-Qudah et al., 2021). Besides, considering previous empirical studies and the theoretical basis, PLS-SEM is a proper method for the present study since predicting the effect of independent variables on the dependent variable (exploratory) is the main aim of the present study, as the moderation effect (Pedrosa et al., 2020). The Amos 29 software was used to analyze and test the formulated hypothesis.

3.4. Study results

3.4.1. Descriptive statistics

The adoption of the popular and common CAAT applications was considered to determine the extent of CAAT adoption (CAT) as a variable. Table 10 shows that the average overall score of CAAT use was 3.24, indicating that the use of technology by the external auditors is not satisfactory. It confirms the insights in the literature (Ahmi & Kent, 2013; Al-Okaily et al., 2022) that most external auditors in developing countries have low usage of audit technologies for their audit works. In addition, most participants agreed that Generalized Audit Software (with a high mean value) is the common CAAT application they utilize for their work. However, the low mean values for all CAAT applications indicate that each software is not utilized sufficiently.

Table 10. Study II: Descriptive statistics

	Code	Mean	Std. Deviation	Skewness
Generalized Audit Software	GAS	3.94	1.915	0.090
Database SQL Search and Retrieval	DQL	3.57	1.856	0.350
Audit Automation Software	AUT	3.35	1.812	0.501
Parallel Simulation Software	PAS	3.32	1.858	0.577
Embedded Audit Modules	EAM	3.02	1.747	0.698
Test Data	TEA	3.24	1.838	0.615
Average response score of all applications	CAT	3.24	1.416	.642

3.4.2. PLS-SEM Model Analysis

Initially, the cross-loadings of all items on their respective variable were measured and checked. Items that scored lower than the standard loading (Hair et al., 2019), which is 0.70, were omitted. The omitted items are 1 item (RAD) from relative advantage, three items (ACC, ACD, and ACE) from auditors' IT competency, 1 item (AXD) from client's AIS complexity, and 1 item (PSD) from professional body support (See Table 10). The criteria for discriminant validity established by Hair et al. (2017) were applied, and the measurement and structural models were analyzed accordingly.

Measurement model

The convergent validity of the items with their respective variables was calculated and is presented in Table 11. According to Hair et al. (2017), for the variables to be included in the models, the cross-loadings of all items, composite reliability (CR), and Cronbach's Alpha (CA) should exceed 0.7. Additionally, each variable's average variance extracted (AVE) value must exceed 0.5. Considering the criteria, all variables met the conditions for validity of convergent (See Table 11).

Table 11. Study II: Items loading, average variance extracted, composite reliability, and Cronbach's alpha

Constructs	Items	Loading	AVE	CR	CA
CAT	Single item construct				
RA	RAA	0.992	0.971	0.990	0.989
	RAB	0.978			
	RAC	0.987			
	RAD*	0.573			
CM	CMA	0.987	0.975	0.991	0.992
	CMB	0.986			
	CMC	0.989			
AC	ACA	0.976	0.960	0.979	0.983
	ACB	0.984			
	ACC*	0.633			
	ACD*	0.513			
	ACE*	0.653			
AFS	Single item construct				

AX	AXA	0.982	0.968	0.991	0.990
	AXB	0.986			
	AXC	0.984			
	AXD*	0.566			
PS	PSA	0.984	0.970	0.989	0.989
	PSB	0.989			
	PSC	0.982			
	PSD*	0.356			
AFSxAX	AAA	0.995	0.986	0.995	0.971
	AAB	0.990			
	AAC	0.994			

Note: *The cross-loading is lower than 0.70

CAT = CAATs adoption; RA = relative advantage; CM = compatibility; AC = auditors' IT competency; AFS = audit firm size; AX = Client's AIS Complexity; PS = professional body support; AFSxAX = moderating variable

Besides, the separation of one variable from another was tested using discriminant validity. First, the Fornell-Larecker criterion test was used to see the variables' associations. As shown in Table 12, the square roots of AVE for all variables (on the main diagonal) are higher than the associations between the variables, indicating that all variables meet the standard for discriminant validity (Fornell & Larcker, 1981; Hair et al., 2017).

Table 12. Study II: Fornell–Larecker test for discriminant validity

	AFS	CAT	AFSxAX	PS	AX	AC	CM	RA
AFS	1.000							
CAT	0.706	1.000						
AFSxAX	0.578	0.587	0.993					
PS	0.731	0.560	0.359	0.985				
AX	0.737	0.576	0.381	0.438	0.984			
AC	0.788	0.659	0.438	0.539	0.641	0.980		
CM	0.706	0.550	0.313	0.590	0.387	0.438	0.988	
RA	0.690	0.571	0.318	0.433	0.539	0.691	0.433	0.986

Second, the Heterotrait-Monotrait (HTMT) criterion test was used as an alternative discriminant validity assessment (Rahi et al., 2018). According to Henseler et al. (2015), there is no discriminant validity if HTMT values are close to 1, and a threshold of 0.85 is used for this purpose. As shown in Table 13, the HTMT values are lower than 0.85, indicating that the standard for discriminant validity is met.

Table 13. Study II: HTMT test for discriminant validity

	AFS	CAT	AFSxAX	PS	AX	AC	CM	RA
AFS								
CAT	0.429							
AFSxAX	0.336	0.346						
PS	0.625	0.290	0.131					
AX	0.639	0.325	0.148	0.149				
AC	0.737	0.484	0.196	0.309	0.498			
CM	0.532	0.235	0.099	0.349	0.556	0.658		
RA	0.487	0.254	0.103	0.286	0.691	0.132	0.777	

Structural model

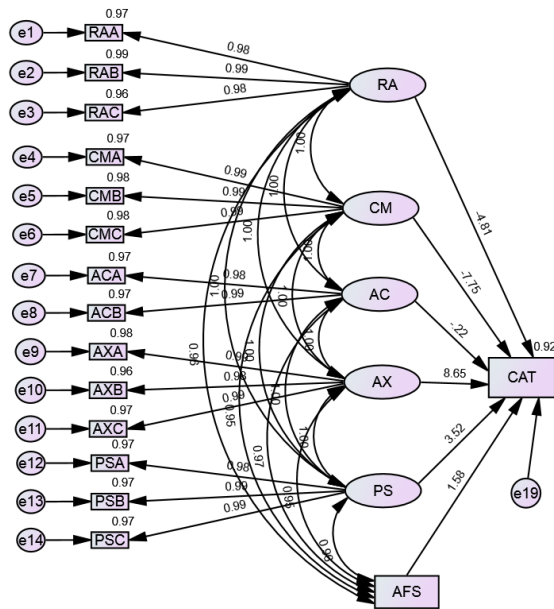
The statistical hypothesis test results for the structural model are summarized and presented in Table 14, Figure 15 and 16. The results show that the two technological constructs, which are relative advantage ($\beta = 0.071$, $p < 0.10$) and compatibility ($\beta = 0.910$, $p < 0.10$), have a significant impact on CAAT adoption (H1 and H2). Besides, the organizational construct, which is auditors' IT competency ($\beta = -0.349$, $p < 0.05$), has a significant impact on CAAT adoption (H3). However, it has a negative impact, and audit firm size has an insignificant impact on CAAT adoption (H4). Moreover, the environmental constructs, which are clients' AIS complexity ($\beta = -0.393$, $p < 0.01$) and professional body support ($\beta = 0.783$, $p < 0.05$), have a significant impact on CAAT adoption (H6 and H7). However, the complexity of clients' AIS has a negative impact on CAAT adoption.

Table 14. Study II: Structural model assessment summary for direct and indirect effect model

Relationship	Path coefficient	SE	CR.	P	Finding
RA --> CAT	0.071	0.015	2.01	0.0712*	Significant
CM --> CAT	0.910	0.024	1.93	0.095*	Significant
AC --> CAT	-0.349	0.025	-2.807	0.037**	Significant
AX --> CAT	-0.393	0.026	-3.028	0.004***	Significant
PS --> CAT	0.783	0.023	2.961	0.026**	Significant
AFS --> CAT	-0.137	2.383	-1.048	0.962	Insignificant
AFSxAX --> CAT	0.297	0.785	0.553	0.581	Insignificant

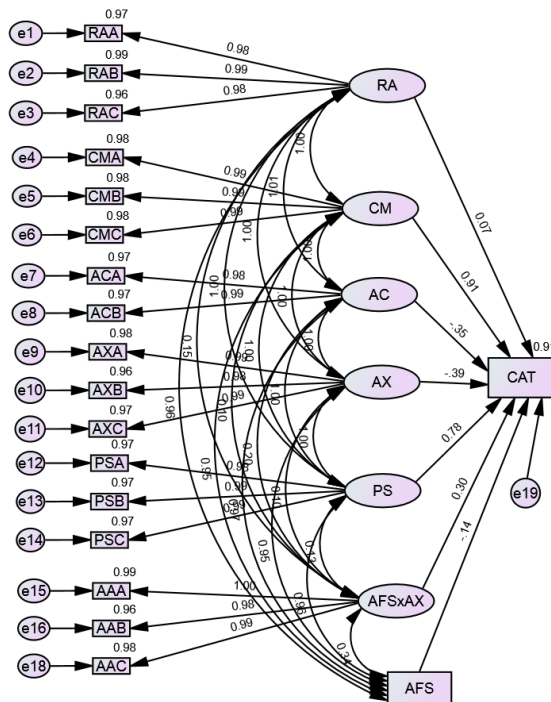
Notes: *p-values <0.10; **p-values <0.05; ***p-values <0.01

Figure 15. Study II: Structural model with significant findings: Without a moderator



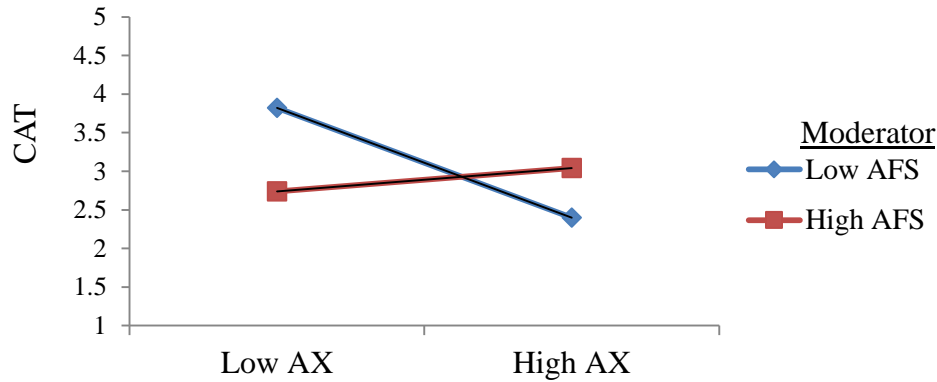
Considering the moderation effect, the interaction effect of audit firm size and clients' AIS complexity on the CAAT adoption was applied (See Figure 16). Following the recommendations of Hair et al. (2017), the statistical significance of the path coefficients was assessed using a bootstrap procedure with 5,000 resamples.

Figure 16. Study II: Structural model with significant findings: With moderator



According to the criteria, an effect is considered significant if the t-value falls between 0.9993 and 4.466 (Hair et al., 2017). Hence, the present study found that the moderating effect of audit firm size* clients' AIS complexity (H5) was insignificant (t-value = 0.553). The result implies that AFS dampens the negative relationship between AX and CAT (see Figure 17).

Figure 17. Study II: Interaction effect between audit firm size and clients' AIS complexity



The variance explained by the variables in a model is expressed in R^2 values, and Table 15 shows the R^2 values for each model. The values are considered weak, moderate, and substantial (0.25, 0.5, and 0.75, respectively) Hair et al. (2017). Hence, the R^2 in the direct model is considered substantial (see Table 14). It is a proper indicator for auditing and information technology adoption studies with PLS-SEM methods (Siew et al., 2020; Zhu & Kraemer, 2005). As shown in Table 15, the R^2 dampens from 0.92 to 0.91 when an indirect effect is added. Therefore, the effect of the interaction in this study has no substantial change on the model.

Table 15. Study II: R^2 Values and standardized root mean square residual (SRMR)

	Model			
	Direct effect	Indirect effect	Saturated	Estimated
R^2	0.92	0.91		
SRMR			0.0247	0.0068

Lastly, the standardized root mean square residual (SRMR) was calculated (see Table 15), which indicates that the model is best fitted as the value is close to zero. Due to size dependency and sensitivity of misspecified models, it is challenging to put cut-off values for best fit (Hu & Bentler, 1998). Hooper et al. (2008) noted that a large sample size and many parameters result in a lower SRMR. The standard rule of thumb value specified by Hu and

Bentler (1998) for a model to be acceptable is when the SRMR is lower than 0.05. Hence, the present study's SRMR value (0.0247) is acceptable.

3.5. Discussion

The issue of CAAT adoption was studied mainly in developed countries, and few studies have been made in developing countries (Samagaio & Diogo, 2022). However, the issue has not been addressed before in the Ethiopian context. Besides, the present study considered professional bodies' support as a significant environmental attribute that can impact CAAT adoption. Hence, it makes the study unique since most prior empirical literature using the TOE framework ignored this environmental attribute. Accordingly, technology development is recent in emerging nations like Ethiopia, and professional body support is needed for CAAT adoption. Moreover, little has been studied about the effect of interaction between the TOE framework's attributes (Lutfi & Alqudah, 2023). Therefore, this study aims to address the research gap by exploring the determinant factors within the TOE framework that influence CAAT adoption in Ethiopian audit firms.

The results of the present study confirm the relevance of various factors in the TOE framework within the context of Ethiopian firms. Specifically, two technological factors—relative advantage and compatibility—were identified as significant determinants of CAAT adoption in Ethiopian audit firms. Additionally, auditors' IT competency, an organizational factor, impacted CAAT adoption significantly. Furthermore, environmental attributes such as clients' AIS complexity and support from professional bodies also played a significant role in influencing CAAT adoption.

The results are discussed in the three contexts of the TOE framework. First, technological attributes, relative advantage, and compatibility play essential roles in adopting CAATs in Ethiopian audit firms (H1 and H2). The result confirms that as audit firms start to understand the advantages of CAAT adoption, they will attain their relative advantage in the eyes of their stakeholders; they will invest in such technology and will have consent to adopt CAATs. The finding implies that Ethiopian audit firms may use CAATs if they see them as more efficient and effective than conventional audit procedures. However, it is critical to consider the initial expenditure for software, training, and infrastructure. The positive impact of RA is consistent

with prior studies investigated by Chandra and Kumar (2018), Siew et al. (2020), Daoud et al. (2021), and Rosli et al. (2013). However, this is inconsistent with studies made by Awuah et al. (2022), Al-Okaily et al. (2022), and Maroufkhani et al. (2020), who revealed that RA does not affect the adoption of CAATs in different settings. The context of studies (country setting) could create inconsistent results with the literature.

Besides, CAAT's compatibility with the Ethiopian audit firm's work has a vital impact on its adoption. The impact is due to firms being anxious about how to audit technology tools relate to their prevailing procedures and practices. The result implies that the intention to use CAATs (then adoption) is more likely to occur when Ethiopian audit firms' beliefs, values, and IT experiences are congruent with CAATs. Contrary to prior literature (Al-Okaily et al., 2022; Ghobakhloo et al., 2011), this study highlights the distinctiveness of CAATs as an innovative advancement for audit firms. The findings reveal that technological contexts are crucial in driving the adoption of CAATs. This observation aligns with some earlier studies (Awuah et al., 2022; Al-Okaily et al., 2022; Rosli et al., 2013; Kim et al., 2020) that emphasize the importance of technological factors in motivating CAAT adoption. However, the findings are inconsistent with some studies (Daoud et al., 2021; Chiu et al., 2017), which concluded that CAAT adoption is not affected by compatibility, and others revealed that compatibility negatively influences CAAT adoption (Siew et al., 2020). This inconsistency could be due to the study's context (developing country).

Second, considering the organizational attributes, auditors' IT competency has an essential but negative impact on adopting CAATs in Ethiopian audit firms (H3). The results of the present study are inconsistent with studies in the literature (Abed, 2020; Janvrin et al., 2008) that state that effective CAAT adoption requires the auditor's IT competency. Besides, it contradicted the study of Siew et al. (2020), who demonstrate that CAATs demand external auditors to have sufficient information technology skills to use the tools and mainly describe the outcomes. Moreover, the result confronts with the study of Awuah et al. (2022), Sagar and Ramanathan (2022), Axelsen et al. (2017), and Al-Okaily et al. (2022) which concluded that auditor's competency in IT has a positive and significant influence on CAATs adoption. These inconsistent results and the negative relation may arise for several reasons, such as limited understanding of CAATs, fear of change, prevailing training needs, risk aversion behaviour, and

resource constraints. Addressing these difficulties requires a deliberate effort to increase auditor IT knowledge, provide extensive CAAT training, and invest resources to support its installation and utilization.

Furthermore, developing a continuous learning culture in audit firms can assist reduce resistance to change and promote the successful implementation of CAATs. Moreover, the other organizational construct, audit firm size, is insignificant in determining CAAT adoption (H4). The result is inconsistent with some previous studies (Pedrosa et al., 2020; Daoud et al., 2021; Venkatesh & Bala, 2012; Siew et al., 2020; Rosli et al., 2013), which concludes that firm size is a precursor for technology adoption. Nevertheless, the study of Lefebvre et al. (2005) supported the result. The inconsistent results on the impact of audit firm size on CAAT adoption may arise from the measures of the construct (such as the number of clients and the number of auditors), the context's nature, and the adopted technology type.

Third, considering the environmental attributes, clients' AIS complexity and professional body support have an essential impact on adopting CAATs in Ethiopian audit firms (H6 and H7). The nature of the client's industry, business environment, and activities are vital for the ease of use of technologies like CAATs. The implication is that audit firms may have clients with complex transactions requiring auditors to perform their tasks using advanced and complex CAATs. For example, clients with significant business operations in the banking industry may have complicated transactions that require improved and complex accounting information systems (Axelsen et al., 2017) to administer such business transactions. The results of the present study are consistent with previous empirical research from developed countries (Siew et al., 2020; Al-Okaily et al., 2022; Ahmi & Kent, 2013; Janvrin et al., 2008), which has shown that clients' IT complexity affects the use of CAATs. However, the direction of the impact is different as a negative relation was found. The negative impact may be raised from resource constraints, regulatory concerns, integration difficulties, and increased risk perception related to auditing complex AIS settings. Resolving these shortcomings requires organized efforts to devote suitable resources, create sound regulatory frameworks, and improve technological capabilities that enable the use of CAATs in the audit process. Furthermore, the findings of this study regarding the impact of professional bodies' support align with prior research (Mahzen & Lyman, 2009),

which supports the idea that such support is a critical factor in an auditor's decision to select and use CAATs.

Additionally, the result supports that the professional audit body is critical in distributing information regarding innovative technological improvements to its members (Siew et al., 2020; Awuah et al., 2022) and giving guidance, practical training, and assistance in utilizing technology. Nevertheless, the result is contradicted by the study of Al-Okaily et al. (2022), who state that professional body support has no substantial effect on adopting CAATs. This inconsistency may arise from the nature of the context and the period (internal auditing in the public sector and the COVID-19 period).

Unlike the prior studies using the TOE framework, they ignored professional body support as an environmental attribute, and the present study considered it a significant factor that can impact CAAT adoption. In emerging nations like Ethiopia, technology development is recent, and professional body support is needed for CAAT adoption. The result of the study showed that it has a positive and significant impact on CAAT adoption. Besides, the moderating effect of audit firm size on the impact of the client's AIS complexity was found to be insignificant (H5). This result contrasts with previous studies that indicate larger audit firms are more likely to have clients with complex accounting information systems (Janvrin et al., 2008; Lowe et al., 2017; Siew et al., 2020; Rosli et al., 2013; Curtis & Payne, 2008; Axelsen et al., 2017). This discrepancy may arise from differences in research contexts, as prior studies were conducted in countries with Big-4 audit firms, while in Ethiopia, the audit firms are predominantly local and relatively homogenous in size

3.6. Conclusions and future implications

In modern times, the widespread use of computer-associated audit procedures is influenced by many factors at individual and institutional levels. The present study found that institutional factors such as technological (relative advantages and compatibility) and organizational (auditors' IT skills) factors significantly influence the adoption of computer-assisted audit tools (CAATs) in Ethiopian audit firms. While CAATs can improve audit quality, competitiveness, and efficiency, achieving these benefits requires careful planning, integration, and training. Furthermore, environmental factors (complexity of clients' AIS and support from

professional bodies) significantly impact CAAT adoption. Hence, to enhance CAAT adoption, firms should invest in advanced training, address compatibility challenges, and educate clients on CAAT benefits. Professional bodies should also support this process to help firms implement technology-driven audit procedures effectively.

The present study offers both theoretical and practical implications. Theoretically, it contributes to auditing and accounting literature by showing that technological, organizational, and environmental factors significantly influence CAAT adoption in developing countries like Ethiopia. It highlights the evolving role of technology in audits, especially in regions where adoption differs from developed nations. These findings can guide future research on CAAT use in various contexts and further develop audit theory.

Practically, this study offers the first insight into how CAATs can enhance audit efficiency and effectiveness in Ethiopia. It shows that CAATs can streamline audit processes, improve resource allocation, and strengthen risk management. To leverage these benefits, audit firms should invest in robust IT infrastructure, provide targeted training for auditors, and establish clear guidelines for CAAT use. CAATs also give firms a competitive edge by offering advanced audit services, which can attract clients and open new business opportunities. Additionally, the study helps professional bodies (such as the Ethiopian Professional Auditors Association) develop training programs and assists regulatory agencies in setting standards for integrating technology into audit procedures.

The present study has limitations, including its focus on Ethiopian audit firms, which may affect the broader applicability of the findings. The sample size, while sufficient, may also limit the generalizability of the results. Future research should expand to include CAAT adoption in various-sized firms (local, national, Big 4) and across different industries (banking, trading, and manufacturing) with diverse accounting systems. Additionally, examining client firm characteristics like industry type and size could further elucidate factors influencing CAAT adoption.

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Appendix A

Table A1. Study II: Constructs and measurements used in the survey

Constructs	Measurement	Foundation
CAATs Adoption (Single item variable)	It is calculated as the total average score of CAAT applications. The average score for a particular CAAT application is determined by the extent of audit tasks carried out using generalized audit software (i), database SQL search and retrieval (ii), audit automation/ electronic audit working papers software (iii), parallel simulation (iv), embedded audit modules (v), and test data (vi). The extent was scaled from 1 to 7 as (1) “never used at all” to (7) “extensively used.”	Siew et al., 2020; Venkatesh and Bala, 2012); Al-Okaily et.al., 2022
Technological Context		
Relative Advantage (measured by 4 items)	<ol style="list-style-type: none"> 1. CAATs will improve audit efficiency through reduced paperwork 2. CAATs will increase audit firms' productivity. 3. CAATs will reduce the error rates in the audit process. 4. CAATs will help reduce costs in auditing operations. 	Venkatesh and Bala (2012); Siew et al., 2020; Al-Okaily et.al., 2022
Compatibility (measured by 3 items)	<ol style="list-style-type: none"> 1. CAATTs are compatible with our firm’s work procedures 2. CAATTs will fit in well with auditors' tasks in performing audits 3. CAATTs are compatible with our firm's current ways of doing an audit 	Venkatesh and Bala (2012); Siew et al., 2020; Al-Okaily et.al., 2022
Organizational Context		
Auditor’s IT Competency (measured by 5 items)	<ol style="list-style-type: none"> 1. Our auditors are IT literate 2. Our auditors’ understanding of CAATs is very good 3. Our firm has at least one auditor who is an expert in CAATs 4. Our employees know how to operate CAATs 5. Our employees have experience with CAATs 	Thong (1999); Siew et al., 2020; Al-Okaily et al., 2022
Audit Firm Size (Single item variable)	Number of external auditors in the audit firm scaled from 1 to 7 (1–3, 4–6, 7–9, 10–12, 13–15, 16–18, and more than 18)	Kee et al. (2013). Zhu and Kraemer (2005); Siew et al., 2020
Environmental Context		
Client’s AIS Complexity	1. The majority of our clients have complex accounting	Ahmi and Kent

<i>(measured by 4 items)</i>	<p>systems</p> <p>2. Most of our clients have highly computerized financial reporting systems</p> <p>3. The majority of our clients have complex business environments</p> <p>4. It is difficult to access audit evidence from clients' data manually</p>	(2013); Janvrin et al. (2008); Siew et al., 2020
<i>Professional Body Support</i> <i>(measured by 4 items)</i>	<p>1. Professional accounting bodies support CAAT usage</p> <p>2. Auditing standards that are set up by professional bodies support CAAT usage.</p> <p>3. Professional accounting bodies highly recommend CAAT usage</p> <p>4. Professional accounting bodies provide incentives to implement CAATs</p>	Zhu and Kraemer (2005); Siew et al., 2020; Al-Okaily et al., 2022

4. Study III. Audit technology as a catalyst for improving non-financial performance in Ethiopian audit firms

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Published in Journal of Open Innovation: Technology, Market, and Complexity, 11, pp. 1–8

<https://doi.org/10.1016/j.joitmc.2025.100556>

Abstract

Adopting computer-assisted audit techniques (CAATs) is transforming the auditing profession globally. As technological advancements continue to shape the audit landscape, understanding how CAATs influence non-financial performance outcomes is essential. However, little is known about their impact on non-financial performance in audit firms, particularly in developing countries like Ethiopia. This study investigates how CAATs influence non-financial performance metrics, including client relationships, employee engagement, and operational efficiency. A quantitative approach was adopted to analyze survey data collected from 122 audit professionals across Ethiopian audit firms in 2023. The findings reveal that the adoption of CAATs significantly correlates with client relationships, employee engagement, and operational efficiency, while its impact on operational efficiency is moderated by organizational readiness. The study highlights the need for strategic technological investments to enhance non-financial performance outcomes. This study offers original empirical evidence on the non-financial impacts of CAATs in the context of Ethiopian audit firms, filling a notable gap in the existing literature.

Keywords: CAATs; Non-financial performance; Auditing; Technological advancements; Non-financial performance metrics

4.1. Introduction

Technology integration into auditing, particularly through Computer-Assisted Audit Techniques (CAATs), reshapes audit practices worldwide. CAATs involve applying software tools and automated procedures to perform audit tasks more efficiently and accurately (Janvrin et

al., 2008; Vu et al., 2019). These tools enhance audit quality by reducing manual errors, increasing data coverage, and improving analytical capabilities.

Although the financial benefits of adopting CAATs have been well documented (Abdulaziz & Adebayo, 2021), their non-financial implications remain unexplored, especially in developing countries like Ethiopia. Understanding these non-financial outcomes is critical, as they contribute significantly to audit firms' overall effectiveness and sustainability. Non-financial performance in this context refers to performance indicators that do not directly relate to financial measures but are vital to an audit firm's long-term success.). Based on industry standards and best practices from professional bodies such as the American Institute of Certified Public Accountants (AICPA, 2017) and the (IFAC, 2016) International Federation of Accountants, good metrics for the non-financial performance of firms include the strength of client relationships, levels of employee engagement, and operational efficiency. These dimensions reflect how well an audit firm manages its internal capabilities and external service quality.

A key factor influencing the success of technology adoption is organizational readiness, which denotes how a firm is equipped structurally, financially, and culturally to embrace and implement technological innovations. It includes having sufficient budget, supportive leadership, skilled personnel, and appropriate infrastructure (Al-Omiri & Drury, 2021).

Despite global technological advances, Ethiopian audit firms have experienced a relatively slow pace of CAAT adoption, often due to limited resources and institutional constraints (Wassie & Lakatos, 2024). However, with growing interest in digital transformation across various sectors in the country, it is timely to investigate how CAAT implementation affects non-financial outcomes in this setting. Therefore, this study examines the impact of CAAT use on non-financial performance in Ethiopian audit firms, explicitly focusing on client relationships, employee engagement, and operational efficiency. Hence, the central research question guiding this inquiry is: How does using CAATs influence non-financial performance metrics in Ethiopian audit firms?

4.2. Literature review and hypothesis

CAATs include various tools and techniques, such as data analytics, continuous auditing systems, and automated audit software that enhance audit procedures (Li & Wang, 2024; Edison, et al., 2018). These tools help auditors perform data mining, sampling, and risk assessment more efficiently. They also improve audit processes by enhancing data analysis and decision-making. Internationally, studies have shown that CAATs improve audit quality by enabling more thorough and accurate evaluations (Omonuk & Oni, 2015). It has also been found that technologies enhance financial parameters such as profit margins, return on investment, and cash flows, which provide valuable quantitative insights into an organization's performance (Ahmed & Fakhr, 2022; Bigliardi et al., 2020). However, exclusive reliance on these metrics has several limitations. Firstly, they often overlook non-financial factors like customer satisfaction, employee engagement, and brand reputation, which are critical to long-term success. Secondly, financial indicators are backward-looking and may not fully capture future risks or growth opportunities. Additionally, accounting practices and short-term management decisions can influence these parameters to improve appearances rather than substance. Finally, focusing only on financial data may lead to ethical oversights, such as ignoring environmental or social impacts that do not immediately affect the bottom line but are essential for sustainable operations (Okoye & Nwoye, 2019).

Future technological advancements will likely significantly enhance non-financial performance in audit firms by improving the quality of client relationships, employee engagement, and operational efficiency. According to Financial Times (FT, 2025), emerging tools such as artificial intelligence, blockchain, and advanced data analytics will enable auditors to deliver faster, more accurate, and more customized services, fostering greater client trust and satisfaction. These innovations can also reduce repetitive tasks, allowing auditors to focus on complex, value-added work, increasing job satisfaction and reducing turnover (Chimweta & Matiza, 2020; Linåker & Wnuk, 2022).. Additionally, automation and smarter audit platforms will streamline workflows, leading to better time management and resource utilization. As technology evolves, firms that adapt effectively are expected to experience stronger organizational cohesion, improved stakeholder communication, and greater agility in meeting regulatory and market demands (Musau & Muathe, 2020).

Non-financial performance is typically assessed through factors such as operational efficiency, employee performance, customer satisfaction, and organizational culture (Kourtzidis & Tzeremes, 2019). According to Wang et al. (2022), in audit firms, these metrics are critical for long-term sustainability and growth. Prior research has shown that adopting new technologies, including CAATs, can improve these areas by reducing time spent on manual tasks, enhancing employee morale, and increasing client satisfaction (Said, 2014; Pedrosa et al., 2015; Deloitte, 2022). Non-financial performance indicators such as client relationships, employee engagement, and operational efficiency contribute to long-term organizational sustainability and competitive advantage. The firm's organizational readiness to adopt advanced technologies was also considered a vital element in the firm's non-financial performance (Selvam et al., 2016; Singh, 2022). According to the Technology-Organization-Environment (TOE) framework and Contingency Theory (CT), organizations that successfully align CAATs with their unique needs (e.g., operational complexity, industry regulations) may see improvements in process compliance and data quality (Al-Omiri & Drury, 2021). Enhanced data quality through CAATs can lead to better decision-making, client retention, and employee satisfaction due to reduced errors and redundancies (Li et al., 2018; Al-Okaily et al., 2022). In addition to organizational readiness, several other variables could moderate the relationship between innovation adoption and its outcomes. One such variable is leadership support, as top management's commitment and active involvement can significantly influence the effectiveness of innovation implementation (Dube & Ndlovu, 2021). Another important moderator is organizational culture, particularly the extent to which a culture supports risk-taking, learning, and open communication (Hassan & Mwangi, 2023). Besides, employee engagement and attitudes toward change could moderate outcomes, as a workforce that is motivated and receptive to innovation may be more likely to contribute to its success (Nasrah et al., 2023).

While extensive research exists on CAATs in developed countries, there is limited evidence of their impact in developing economies like Ethiopia. A study by Habtamu (2016) and Wassie (2024) highlighted the slow adoption of audit technology in Ethiopian firms due to resource constraints, limited technical know-how, and regulatory barriers. However, the growing trend towards technological adoption in various sectors in Ethiopia suggests a potential for positive changes in audit practices as well (Tesfaye, 2014). Ethiopian audit firms face several key barriers that hinder the full adoption of Computer-Assisted Audit Techniques (CAATs). A

primary challenge is the limited availability of financial resources, which restricts investment in necessary software and hardware (Wassie & Lakatos, 2024). Their study also shows that many firms struggle with a shortage of technically skilled personnel, making implementing and maintaining advanced audit tools challenging. Regulatory and institutional constraints also play a role, as existing frameworks have slowly adapted to digital auditing standards (Habtamu, 2016). Furthermore, practitioners often lack awareness and resistance to change, particularly in smaller or older firms that rely heavily on traditional audit practices (Tesfaye, 2014). These combined factors contribute to the slow and uneven integration of CAATs across the sector.

Focusing on Ethiopia as the context for this study is both timely and strategically important. As one of Africa's fastest-growing economies, Ethiopia is undergoing a gradual but notable digital transformation across multiple sectors, including finance and public administration. However, the auditing profession in the country still faces significant structural and technological challenges. These include limited access to modern audit tools, a shortage of adequately trained professionals, and regulatory frameworks that have only recently begun to adapt to international standards (Wassie & Lakatos, 2024). Despite these constraints, there is increasing recognition among policymakers and professional bodies in Ethiopia of the need to modernize audit practices to ensure transparency, accountability, and efficiency in both public and private institutions. This transitional landscape presents a unique opportunity to study how adopting audit technologies like CAATs can influence non-financial performance metrics in a setting marked by resource constraints, institutional reforms, and growing technological aspirations. The study addresses a critical gap in the literature by focusing on Ethiopia. It provides contextually relevant insights that could inform audit modernization efforts in other developing economies facing similar challenges.

4.2.1. Hypothesis development

The theories employed in this study—Contingency Theory (CT), the Resource-Based View (RBV), the Technology Acceptance Model (TAM), and the Technology-Organization-Environment (TOE) framework—were selected for their relevance in explaining how audit firms respond to technological change under varying internal and external conditions. Contingency Theory is well-suited for understanding how the alignment between CAATs and organizational context can influence outcomes like client satisfaction (Hussin et al., 2023). The RBV highlights

how leveraging internal capabilities, such as skilled personnel and digital infrastructure, can reduce employee turnover by enhancing job satisfaction (Nguyễn & Nguyễn, 2023). TAM provides insight into how perceptions of technology usability and usefulness drive operational improvements (Atta et al., 2024), while TOE emphasizes the role of organizational readiness in shaping successful implementation (Fülöp et al., 2024). Alternative frameworks such as Institutional Theory or Diffusion of Innovations Theory could also be applied, focusing respectively on how regulatory pressures or social influence affect technology adoption, or how innovations spread over time within professional communities (Ghani et al., 2024). However, the chosen theories offer a more nuanced explanation of firm-level behavior and performance, making them particularly appropriate for a study in a developing country context with diverse organizational capacities and technological constraints. Accordingly, considering the selected theories, the following hypotheses were developed to examine the relationships.

From the lens of Contingency Theory, organizations that adapt their technological infrastructure to fit external demands and client expectations are more likely to maintain competitive advantages. CAATs enable auditors to deliver more accurate and timely services, increasing client trust and satisfaction (Jayasena et al., 2024). When audit results are delivered with improved reliability and speed, clients are more inclined to maintain long-term professional relationships, thereby improving retention rates. Hence, CAATs are expected to strengthen client relationships by enhancing audit credibility and responsiveness. Hence, the first hypothesis was proposed as follows.

H1: CAAT use significantly impacts the client retention rate in audit firms

Besides, the Resource-Based View (RBV) theory posits that firms gain sustained advantage by effectively deploying internal resources, including human capital (Senan, 2024). CAATs can reduce repetitive, low-value tasks and allow auditors to focus on higher-order analytical and judgmental activities, which are more fulfilling and intellectually stimulating. This shift in task quality contributes to job satisfaction and retention, lowering turnover rates. Employees who perceive their work as meaningful and supported by technology are likelier to stay, particularly in firms that invest in upskilling and digital readiness. Hence, the second hypothesis was proposed as follows.

H2: CAAT use significantly impacts the employee turnover rate in audit firms

Furthermore, under the Technology Acceptance Theory, adopting new technologies increases efficiency when users perceive the technology as helpful and easy to integrate into their workflow (Abdulaziz & Adebayo, 2021). CAATs streamline audit procedures by automating data collection, risk assessment, and documentation processes. This automation reduces the time and cost associated with audits, improving the firm's overall operational efficiency. As firms increasingly rely on digital tools to manage complex tasks, CAATs are positioned to be key enablers of timely and cost-effective audit delivery. Hence, the third hypothesis was proposed as follows.

H3: CAAT use significantly impacts operational efficiency in audit firms

Moreover, the moderating role of organizational readiness can be understood through the Technology-Organization-Environment (TOE) framework, which emphasizes the importance of internal preparedness—such as infrastructure, financial resources, and managerial support—for successful technology adoption (Salleh et al., 2012; Chimweta & Matiza, 2020). Even when CAATs are available, their effectiveness depends heavily on whether firms have the capacity and willingness to implement them. Without adequate readiness, the benefits of technology may be delayed or unrealized. Thus, organizational readiness is expected to strengthen the positive effects of CAATs on non-financial outcomes, particularly operational efficiency. Hence, the final hypothesis was proposed as follows.

H4: Organizational readiness moderates the relationship between CAAT use and non-financial performance in audit firms

Finally, industry-specific factors such as audit firm age and size can influence the impact of Computer-Assisted Audit Techniques (CAATs) on non-financial performance. While older firms may have more experience and established processes that support technology integration, and larger firms may have more resources to invest in audit tools (Yang & Gabrielsson, 2017; Coad et al., 2013; Nasrah et al., 2023; Kee et al., 2013; Siew et al., 2020). It suggests that these characteristics may shape a firm's capacity to adopt technology. Hence, this study included these factors and controlled their effects.

4.3. Research methodology

4.3.1. Research design

A quantitative research design was adopted for this study, utilizing a cross-sectional survey method to collect data from Ethiopian audit firms. This design was chosen because it allows for measuring the relationship between CAAT adoption and non-financial performance in Ethiopian audit firms. A cross-sectional survey was chosen because it allows researchers to collect data simultaneously. It is suitable for assessing the current state of CAAT adoption and its relationship with non-financial performance across a sample of audit firms. This method is cost-effective and time-efficient, especially in contexts like Ethiopia, where longitudinal data may be complex to obtain due to limited resources, inconsistent record-keeping, or organizational instability (Kothari, 2004). Additionally, the goal of the study was to examine associations, not to track changes over time, making a cross-sectional design more appropriate for capturing a snapshot of how CAAT use correlates with client relationships, employee engagement, and operational efficiency at the present moment.

4.3.2. Sample of the study and data collection

The study targeted all registered audit firms in Ethiopia, and according to the Accounting and Auditing Board of Ethiopia (AABE, 2022), there are 172 registered certified audit firms in the country. In this study, the formula provided by Yamane (1967) was used to determine the sample size from the finite population (homogeneous, i.e., registered audit firms) by taking the acceptable magnitude of error (e) of 5% and confidence level (Z) of 95%. Where n is the Sample size, N is the Population size, Z is the confidence level, and e is the level of precision.

$$\frac{N}{1 + N(e)^2} = \frac{172}{1 + 172(0.05)^2} = 120$$

Considering the minimum sample size, a structured questionnaire based on validated formulas and scales from previous studies was developed and distributed to 150 audit firms. Data were collected over four months, from September to December 2023, and the questionnaire was distributed electronically through Email. The survey instrument included measures for CAAT usage, client relationship retention, employee turnover, operational efficiency, organizational readiness, and demographic and control variables. Out of 150 distributed questionnaires, 122 valid responses were collected, resulting in a high response rate of 81%. This broad coverage and

strong participation suggest that the sample reflects the characteristics and diversity of the audit industry in Ethiopia, enhancing the generalizability of the findings. Survey responses can be subject to several biases, including social desirability bias, where respondents may overstate positive behaviors (Kothari, 2004), like the extent of CAAT use, to present their firm in a favorable light. Response bias may also occur if participants misinterpret questions or provide inaccurate answers due to a lack of knowledge or attention (Kothari, 2004). To minimize these biases, the study used validated survey instruments from previous research to ensure clarity and reliability. It also assured anonymity and confidentiality to reduce the pressure on respondents to provide socially desirable answers. Additionally, a high response rate (81%) and structured, standardized questions helped improve the accuracy and consistency of the data collected.

4.3.3. Variable measurements

The key variables of interest include the dependent variable, non-financial performance proxied by various metrics such as client relationship (CRR, measured by client retention rate), employee engagement (ERR, measured by employee turnover rate), and operational efficiency (OPE, measured by the percentage of the number of audits completed on time) (Errore et al., 2013). Each non-financial performance metric in the study was operationalized using measurable, quantifiable indicators and calculated (Kourtzidis & Tzeremes, 2019) as follows:

Client Retention Rate (CRR) was used to represent client relationships and was calculated as the percentage of clients retained over a specific period, reflecting client loyalty and satisfaction.

$$CRR = \frac{\text{Number of clients at the end of the period} - \text{New clients acquired during the period}}{\text{Number of clients at the start of the period}} \times 100$$

Employee Turnover Rate (ERR) measures employee engagement, calculated as the proportion of employees who left the firm within a specific time frame, indicating job satisfaction and organizational commitment levels.

$$ERR = \frac{\text{Number of employees who left during the period}}{\text{Average number of employees during the same period}} \times 100$$

Operational Efficiency (OPE) was defined by the percentage of audits completed on time, which directly indicates the firm's productivity, planning, and process effectiveness.

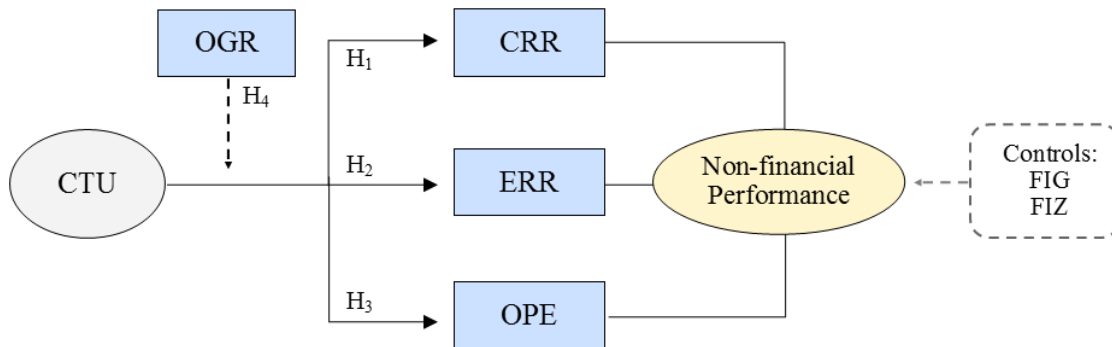
$$\text{OPE} = \frac{\text{Number of audits completed on time during the period}}{\text{Total number of audits during the same period}} \times 100$$

The independent variable was the extent of CAAT use (CTU, measured by a 5-point Likert scale (see Appendix Table B1). Organizational readiness was considered a moderation variable (OGR, measured by the budget availability for audit technology adoption: 1 = yes or 0 = no) (Salleh et al., 2012; Li et al., 2018). In addition, the study included audit firm age (FIG, number of years from establishment) and audit firm size (FIZ, small, medium, large) as control variables (see Appendix Table B1). The survey instrument was validated through a multi-step process to ensure reliability and relevance. Initially, the items were developed based on a thorough review of prior literature and theoretical frameworks pertinent to the measured constructs. To enhance content validity, the draft instrument was reviewed by subject matter experts in accounting and auditing, who provided feedback on item clarity, relevance, and completeness. Their input led to several refinements in wording and structure. A pilot test was conducted with a small sample from the target population to assess the instrument's clarity and internal consistency. Feedback from the pilot participants helped identify and correct ambiguous or confusing items. Finally, statistical analyses were conducted to confirm the reliability of the survey scales, with Cronbach's alpha values ranging from 0.82 to 0.91, indicating strong internal consistency.

4.3.4. Analysis method

The collected data were analyzed through descriptive statistics to summarize the extent of CAAT use and non-financial performance. As shown in Figure 18, regression analysis was also conducted to assess the relationships between CAAT use and non-financial performance metrics. Regression analysis was the best choice for this study because it allows for examining the strength and direction of relationships between CAAT use and multiple non-financial performance metrics while controlling for other variables like firm age and size. It also enables testing moderating effects, such as organizational readiness, clearly showing how different factors influence outcomes. Hence, regression is a suitable and powerful tool for analyzing complex, multivariable relationships in a quantitative study. All models included audit firm age (FIG, number of years from establishment) and audit firm size (FIZ, small, medium, large) as control variables.

Figure 18. Study III: The research model



4.4. Analysis and results

The mean score for CAAT use was 3.4 (68%), indicating moderate use of technology in the auditing process. For non-financial performance, the mean scores for client retention rate (72%), employee turnover rate (21%), and operational efficiency (84%) suggest generally favourable outcomes. In addition, 55% of audit firms have an available budget for audit technology adoption. The study's results were robust, and the data met all key assumptions required for regression analysis. Normality was assessed through visual inspections of histograms and the Shapiro-Wilk test, which produced a p-value of 0.072, indicating that the data did not significantly deviate from a normal distribution. Scale reliability was confirmed through Cronbach's alpha, with all constructs scoring above 0.70, demonstrating acceptable internal consistency. Multicollinearity was assessed using Variance Inflation Factor (VIF), with all model values scoring 1.311, far below the threshold of concern, and tolerance values well above 0.10, confirming no multicollinearity issues. The Breusch-Pagan test for heteroskedasticity returned a p-value of 0.241, suggesting that the assumption of homoscedasticity was met. Collectively, these diagnostic checks affirm the robustness and suitability of the data for subsequent regression analysis.

The multiple regression analysis in Table 16 revealed a significant relationship between CAAT use and improvements in non-financial performance indicators. Specifically, the results showed that CAAT adoption explained 95.1% of the variance in client retention (Model 1), 92.8% of the variance in employee turnover (Model 2), and 95.1% of the variance in operational efficiency (Model 3).

Table 16. Study III: Multivariate regression outcome

Model	Model 1	Model 2	Model 3
Dependent variable	<i>CRR</i>	<i>ERR</i>	<i>OPE</i>
<i>CTU</i>	1.311*** (0.031)	-0.966*** (0.029)	0.780*** (0.019)
<i>OGR</i>	0.763 (0.003)	-0.004 (0.003)	0.005** (0.002)
<i>FIG</i>	0.005** (0.002)	-0.003 (0.002)	0.000 (0.002)
<i>FIZ</i>	-0.003 (0.003)	0.003 (0.003)	-0.002 (0.002)
Observations	122	122	122
R-squared	95.1	92.8	95.1
F-Statistics	583.429***	389.744***	583.804***
Model VIF	1.311	1.311	1.311
Tolerance	0.763	0.763	0.763

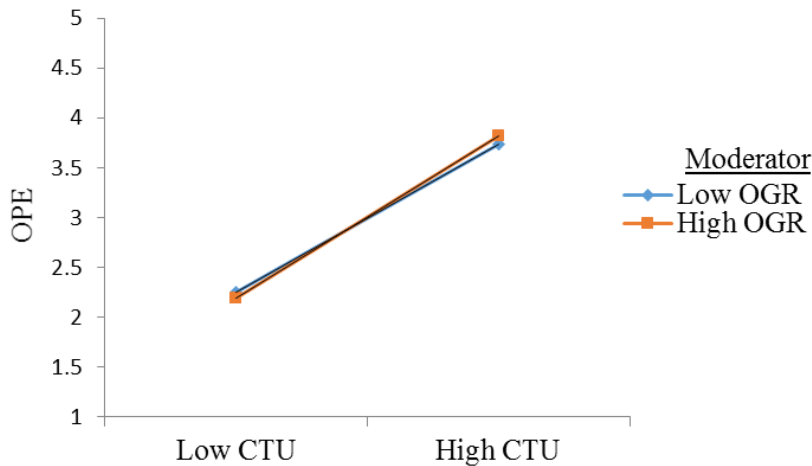
*Notes: *p-values <0.10; **p-values <0.05; ***p-values <0.01*

In this study, significance levels were set using conventional thresholds to determine the statistical validity of the findings. A p-value of less than 0.05 was used as the standard cutoff for identifying statistically significant relationships, indicating a less than 5% probability that the observed results occurred by chance (Kothari, 2004). In cases where p-values were below this threshold, the results were interpreted as providing sufficient evidence to reject the null hypothesis and support the existence of a meaningful effect or association. For more robust confidence, results with p-values below 0.01 were considered highly significant (Kothari, 2004). These thresholds guided the interpretation of the data, helping to assess the strength and reliability of the relationships between variables in the context of CAAT adoption.

Accordingly, CAAT use (CTU) significantly predicts client retention (CRR) ($\beta = 1.311$, $p \leq 0.01$), employee turnover (ERR) ($\beta = -0.966$, $p \leq 0.01$), and operational efficiency (OPE) ($\beta = 0.780$, $p \leq 0.01$) (supported H1, H2, and H3). Organizational readiness (ORG) emerged as a significant moderator only for the relationship between CAAT use and operational efficiency in Model 3 ($\beta = 0.005$, $p \leq 0.05$) (supported H4). The interaction effect presented in Figure 19 shows that OGR strengthens the positive relationship between CTU and OPE. Firms with higher levels of organizational readiness were more likely to use CAATs, increasing their operational

efficiency effectively. In addition, the control variable audit firm age (FIG) was found to be significant ($\beta = 0.005$, $p \leq 0.05$) in Model 1. However, both control variables (FIG and FIZ) were insignificant in almost all models.

Figure 19. Study III: The interaction effect of OGR on OPE



4.4.1. Main findings of the study

The study yielded clear evidence that Computer-Assisted Audit Tools (CAATs) are pivotal in enhancing key outcomes within audit firms. Specifically, CAAT use significantly predicted three critical organizational outcomes: client retention, employee turnover, and operational efficiency. Firms that integrated CAATs more extensively tended to retain clients at a higher rate and experienced lower employee turnover. Moreover, these tools contributed positively to improvements in operational processes, making day-to-day functions more streamlined and effective.

Another notable finding was the moderating effect of organizational readiness on the link between CAAT use and operational efficiency. While organizational readiness did not significantly influence all relationships, it played a crucial role in strengthening the connection between CAAT adoption and operational gains. Better prepared firms—in terms of infrastructure and internal capacity—were more successful in translating CAAT use into tangible efficiency improvements. Among the control variables examined, audit firm age emerged as a significant factor in one model, suggesting that more established firms might have structural advantages when implementing CAATs. However, overall, the control variables had limited influence across most models, reinforcing the central role of CAAT use and organizational readiness in shaping

performance outcomes. These findings underscore the importance of technological adoption and organizational preparedness in achieving operational excellence in the audit sector.del 3).

4.5. Discussion

This study highlights the limitations of relying exclusively on financial indicators for assessing organizational performance. It emphasizes the importance of incorporating non-financial metrics to understand value creation and sustainability better. The findings suggest that while financial parameters remain essential for short-term decision-making and accountability, they should be complemented with qualitative assessments, such as stakeholder engagement, innovation capacity, and long-term strategic positioning. By integrating financial and non-financial perspectives, organizations can achieve more balanced and forward-looking evaluations supporting sustained success.

The findings of this study support the hypothesis that CAAT use positively influences non-financial performance in Ethiopian audit firms. The significant positive relationship between CAAT use and client retention rate suggests that clients benefit from more accurate and timely audits, which could lead to improved trust and loyalty. The result indicates a healthy client relationship and satisfaction, which is critical to an audit firm's long-term success (Rosli et al., 2013). Similarly, the significant negative relationship between CAAT use and employee retention rate suggests that improvements in employee turnover rate are attributed to the reduction in manual tasks, allowing employees to focus on more complex and value-added activities. It shows that more experienced employees remain, contributing to consistent quality and service delivery (Said, 2014). Finally, the significant positive relationship between CAATs use and operational efficiency suggests that operational efficiency was enhanced as CAATs streamlined audit procedures, reducing time and resource expenditures (Wang et al., 2022). It shows that there are efforts to make good planning, resource management, and effective execution. However, organizational readiness regarding resources to support the use of CAAT is essential to achieve the firm's operational efficiency. It highlights the need for firms to invest in complementary resources, such as training and infrastructure, to leverage technological advancements fully.

The findings align with global studies emphasizing the benefits of CAATs for employee engagement and client relationships. For instance, studies by Selvam et al. (2016) found that CAATs improve audit quality and non-financial outcomes in firms. The findings also align with the views of Ethiopian auditors, who have highlighted the potential benefits of CAATs for improving audit practices and performance (Wassie, 2024). Besides, the study's findings align with existing research from other developing countries, particularly in highlighting the critical role of organizational readiness and technological infrastructure in adopting CAATs. Similar to prior studies (Abdulaziz & Adebayo, 2021; Senan, 2024; Jayasena et al., 2024), the results suggest that limited resources, lack of technical expertise, and insufficient management support are common barriers in developing contexts.

Additionally, the study reinforces the notion found in previous research (Okoye & Nwoye, 2019; Jayasena et al., 2024; Dube & Ndlovu, 2021; Atta et al., 2024) that auditors in these regions often face cultural and institutional challenges, such as resistance to change and minimal regulatory enforcement, which can impede technology adoption. However, the findings also support the literature by emphasizing the positive impact of individual-level factors, such as perceived usefulness and ease of use, echoing the relevance of models like TAM in these environments (Hassan & Mwangi, 2023; Fülöp et al., 2024; Nasrah et al., 2023; Ghani et al., 2024). The study supports and extends existing knowledge by confirming that while structural and systemic constraints persist across developing countries, individual and organizational enablers can still significantly influence CAAT adoption.

4.6. Conclusion and implications

This study provides empirical evidence that CAAT use positively impacts non-financial performance in Ethiopian audit firms. The findings underscore the importance of technological adoption in improving client relationships, employee engagement, and operational efficiency. However, the impact on operational efficiency depends on organizational readiness. This study makes a valuable theoretical contribution by linking the adoption of computer-assisted audit techniques (CAATs) to non-financial performance outcomes—a relatively underexplored area in audit technology literature, especially within the context of developing economies like Ethiopia. By empirically examining how CAATs affect client relationships, employee engagement, and

operational efficiency, the research broadens the conventional focus of audit technology studies, which often center on financial or compliance-related outcomes.

Furthermore, the study introduces organizational readiness as a moderating variable, adding depth to existing technology adoption models by illustrating how internal preparedness shapes the effectiveness of CAATs. This insight is particularly relevant for developing economies, where infrastructure, skills, and policy support disparities can significantly influence technology outcomes. The study refines and extends current theoretical frameworks by contextualizing these variables within the Ethiopian audit landscape, suggesting that non-financial benefits are key motivators and outcomes of technology adoption. This perspective encourages a more holistic understanding of audit technology's role in organizational development, offering a theoretical basis for future studies in similar settings.

Based on the study's findings, the following practical implications are posed for policymakers, audit firms, and regulators. Policymakers should prioritize investments in digital infrastructure and provide targeted support, such as training subsidies or tax incentives, to encourage the adoption of CAATs across the auditing sector. Audit firms are encouraged to assess their internal capabilities and invest in staff training and organizational readiness to fully leverage the benefits of CAATs, particularly in improving employee engagement and client service. Regulators should establish clear guidelines and frameworks that support the integration of audit technologies while ensuring that quality and compliance standards are upheld. Together, these actions can create an enabling environment for sustainable technological advancement in the audit profession within developing economies.

The findings of this study offer a foundation for future research beyond Ethiopian audit firms by highlighting the broader relevance of non-financial performance outcomes, such as client relationships, employee engagement, and operational efficiency, as key indicators of successful audit technology adoption. Future studies in other developing or emerging economies can build on this model to explore how cultural attitudes toward technology, varying levels of regulatory enforcement, and differences in organizational readiness shape these outcomes. Additionally, comparative research across countries or regions could deepen understanding of how local conditions mediate the relationship between CAAT adoption and firm performance, thereby refining global theories of audit technology implementation.

While this study highlights the role of CAAT adoption in enhancing non-financial performance, it is important to recognize that other factors could also improve client relationships, employee engagement, and operational efficiency. For instance, strong leadership and strategic management practices can drive better internal communication and employee motivation, independent of technology use. Similarly, ongoing professional development and training programs may enhance staff performance and client satisfaction regardless of the audit tools employed. Organizational culture, including openness to innovation and change, could foster a more engaged and productive workforce. External influences, such as market competition or regulatory pressure, might also push firms to improve service quality and operational processes. Therefore, while CAATs play a significant role, internal and external factors likely contribute to non-financial performance gains. Hence, the study paved the way for future research to consider those factors.

This study has some limitations that should be acknowledged. First, data availability posed a constraint, as the research relied on self-reported survey responses, which may be subject to bias or inaccuracies due to limited access to objective performance metrics. Second, the generalizability of the findings is limited, given that the data were collected solely from audit firms in Ethiopia; thus, the results may not fully reflect conditions in other developing economies with different regulatory, technological, or cultural contexts. Third, while the study focused on key variables like CAAT adoption and organizational readiness, potential omitted variables—such as leadership support, firm culture, or external competitive pressures—may influence non-financial performance outcomes but were not included in the analysis. Lastly, the study's exclusive reliance on a quantitative survey approach is another limitation, which may not fully capture the depth and complexity of auditors' experiences with CAAT adoption. While the survey provided valuable insights into patterns and relationships among key variables, it limited the exploration of contextual and subjective factors. A qualitative method, such as interviews with auditors, could have offered richer, more detailed perspectives on the practical challenges, organizational influences, and personal attitudes affecting CAAT usage. These limitations allow for more comprehensive future research to provide a more holistic view of adoption behavior.

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Appendix B

Table B1. Study III: Variables and measurements

Variable	Measurement	Source
Dependent Variables:		
<i>Client Retention Rate (CRR)</i>	Calculated as the percentage of clients retained over the specific period.	Kourtzidis & Tzeremes, 2019; Errore et al., 2013
<i>Employee Turnover Rate (ERR)</i>	Calculated as the proportion of employees who left the firm within a specific time frame.	Kourtzidis & Tzeremes, 2019; Errore et al., 2013
<i>Operational Efficiency (OPE)</i>	Calculated as the percentage of audits completed on time	Kourtzidis & Tzeremes, 2019; Errore et al., 2013
Independent Variable:		
<i>CAATs Use (CTU) (Single item variable)</i>	The overall score for CAAT usage is derived from the average of individual application scores. Each application's score reflects the degree to which specific audit tasks are performed using various tools, including: (i) generalized audit software, (ii) SQL database search and retrieval, (iii) electronic audit working papers or audit automation software, (iv) embedded audit modules, (v) parallel simulation, and (vi) test data. Usage is rated on a 5-point scale, where one indicates 'never used' and five signifies 'extensive use.'	Siew et al., 2020; Al-Okaily et al., 2022; Wassie & Lakatos, 2024
Moderating Variable:		
<i>Organizational Readiness (OGR)</i>	Dummy variable: the availability of budget for audit technology adoption (1 = yes, 0 = no)	Salleh et al., 2012; Li et al., 2018
Control Variables:		
<i>Firm Age (FIG)</i>	Number of years from establishment	Yang & Gabrielsson, 2017; Coad et al., 2013
<i>Audit Firm Size (FIZ)</i>	Number of external auditors (1–9, 10–18, and more than 18) in the audit firm scaled from 1 to 3 (1= small, 2= medium, 3= large)	Kee et al. (2013); Siew et al., 2020; Wassie & Lakatos, 2024

5. Study IV. Leveraging computer-assisted audit tools for corporate sustainability: Evidence from Ethiopia

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Published in Journal of Infrastructure Policy and Development, 8 (1). pp. 1–26.

<http://doi.org/10.24294/jipd.v8i1.2690>

Abstract

The existing ample literature studied the factors for adopting computer-assisted audit techniques (CAATs) by internal and external auditors, frequently ignoring their impact on the quality of audits and companies' efficiency. This study delivers new evidence on the kinds of CAATs utilized by internal auditors, examines their adoption impact on corporate sustainability, and studies the moderating impact of company characteristics. This study used data from internal auditors in Ethiopia gathered using a survey, and the study hypotheses were tested using the partial least squares-structural equation modeling (PLS-SEM) technique. The study found a moderate utilization of CAATs by internal auditors in executing their activities. The result also revealed a highly positive impact of internal auditors' CAAT utilization on fraud discovery in the acquisition process. The study found that the intensity of this relationship is impacted by the companies' characteristics of management commitment. However, the size and type of the company are not impacting it. This study finding complements prior studies and helps practitioners make decisions that can improve CAAT utilization in internal audit functions for a high level of companies' sustainability.

Keywords: *CAATs; CAATs utilization; corporate sustainability; fraud detection; internal audit*

5.1. Introduction

As time changes, firms' objectives have transformed substantially, which leads to theories being introduced (Zumente and Bistrova, 2021). The shareholder theory and the stakeholder theory that demonstrates the fundamental corporate objective were introduced by Friedman (1970) and Freeman (1984), respectively. The shareholder theory is a theory that

emphasizes financial goals as the means for shareholder worth maximization. On the other hand, a theory that elaborates more associated responsibility is a way to maximize company value, creating value for stakeholders. The main motives for a company's commitments to its stakeholders are sustainability and long-lasting value formation, as demonstrated by Zumente and Bistrova (2021). Thus, companies should play a role in the community's welfare and the environment.

The companies' ability or commitment to preserving resources, targeting to fulfill current demands and those of the upcoming generation, is considered sustainable (Issa et al., 2017). According to Elkington (1999), sustainability ensures that our current activities do not hinder the scope of social, environmental, and economic opportunities available to the upcoming generations. The author used a triple bottom line that constitutes three elements (economic, environmental, and social) to assess firms' performance. Hence, firms are being directed to harmonize these elements by concentrating on profit, the planet, and people (3Ps).

The business going concern faced significant threats from fraud, which was often found to be the reason for the failure of firms and economic, social, and environmental disasters (Margret and Hoque, 2016). Hence, fraudulent actions weaken the capability of firms to become more sustainable. According to Ramos Montesdeoca et al. (2019), a decline in responsibility arises from the absence of ethics in business, which opens the road to fraud to occur, which has a dangerous outcome for organizations, like loss of image, reputation, and value. The study of Martínez-Ferrero et al. (2013) confirmed that fraud and sustainability practices have a negative relationship. Based on the findings of Jan (2018), financial reports fraud harms the sustainable growth of businesses and financial markets. Thus, forming a practical framework to identify companies' financial report fraud is crucial.

Firms need to realize their objectives and fulfill all stakeholders' interests in corporate governance. The study of Elkington (1999) revealed that ensuring the effective attainment of the triple bottom line sound corporate governance system will allow the firm to play a role in a real, sustainable business. Some scholars (Leung et al., 2004) confirm the significance of internal auditing and its optimistic consequence for firm governance and management. Internal auditing is vital in enterprise risk management (Westhausen, 2017; Shapiro, 2014; Demirović et al., 2021) as a component of the internal control system, mainly in solid control of fraud risk. Human

capital is a fundamental driver of company performance, also revealed in auditing (Samagaio and Rodrigues, 2016). According to Shapiro (2014), mutual human capital and computer-based systems can advance the internal control system of companies. Hence, the internal auditor must be skillful to some extent and assisted by tools such as technology. In numerous pieces of literature (Meredith et al., 2020), technology has been seen as a means of decision support. Specifically, technology in this study denotes a handy tool called computer-assisted audit techniques (CAATs).

This study examines the relationship between corporate sustainability and adopting CAATs by internal auditors in government-owned and private companies in Ethiopia. The research has three specific objectives: identify the usage of CAATs by internal auditors, examine the impact of CAATs on corporate sustainability, and investigate the moderating impact of firm characteristics in the association between the adoption of CAATs and corporate sustainability.

The feature standards for the professional activities of internal auditing by the Institute of Internal Auditors (IIA, 2017) indicate that internal auditors shall have adequate understanding to examine fraud risk (standard 1210, A2) and that in practicing due professional care, they should ponder the implementation of technology-oriented audit and other data analysis methods (standard 1220, A2). Accordingly, adopting technology-oriented auditing techniques and skills might be necessary to perform effective work, explicitly in avoiding and discovering fraudulent activities. However, the existing pieces of literature (Henderson et al., 2016) focus on the determinants for the adoption of CAATs by internal auditors or the influence of CAAT usage on fraud discovery by external auditors. Conversely, few authors (Coderre, 2000) promote the positive impact of CAATs adoption on fraud risk examination by internal auditors, deprived of justifying this suggestion with empirical investigations. Hence, this study's key motive is to enlarge the knowledge about the impact of CAATs on fraud detection, which has a role in developing the sustainability of companies. With this context, the study hypothesized that CAAT adoption positively impacts internal auditors' fraudulent schemes detection scope. On this proposed relationship, three other hypotheses were developed to see the moderation effect of company characteristics attributes such as company ownership, company size, and management commitment.

In the survey, the data were obtained from 83 internal auditors working in government-owned and private companies in Ethiopia, and the study hypotheses were tested by employing the partial least squares-structural equation modeling (PLS-SEM). The outcomes of the study recommend that utilizing CAATs improves the capability of internal auditors to manage fraud risk in the companies' acquisition process. The study also found that the intensity of this association is impacted by the company characteristics, which is the top management commitment, but not by the company size or type. The following part of this study contains five sections: the literature review, research method, results, discussion, and conclusions section.

5.2. Literature review

5.2.1. Value creation for shareholders

With the rise of numerous theories like shareholder theory and stakeholder theory to assist businesses' mission statements, Zumente and Bistрова (2021) recommend that shareholder value creation be assisted by focusing more on a long-term orientation rather than a short-term one. Therefore, in the long run, the firm shall be concerned with its activities to guarantee its existence in the economy (Bistрова and Lace, 2012) by acting more responsibly and sustainably. At this point, two concepts are raised: sustainability and corporate social responsibility. Elkington (2006) demonstrated that developing and employing a solid corporate governance system is essential to guarantee shareholder value creation by acting more sustainably and responsibly. Weak corporate governance will encourage corporate fraud, deviation of resources, and, later, financial scandals (Atu et al., 2014). Unluckily, citizens have been seen harm through many cases of fraud all over the world. Ignoring the presence of corporate fraud and its impact has an advantage for cheaters, jeopardizing the stakeholders' needs and, sometimes, the community where firms are operating (Coderre, 2000). Even before these recent scandals, demand for non-financial information has increased, particularly in ethical, social, and environmental matters. Demand for non-financial reports has risen (Ramos Montesdeoca et al., 2019), mainly in ethical, environmental, and social issues. The scholars (Rossouw, 2005) demonstrate the significance of coordinating these areas because of their linking to corporate social responsibility, which is a potential main drive.

Furthermore, the European Commission 2021 presented its outline for a Corporate Sustainability Reporting Directive, which aims to review and fortify the non-financial reporting

directive and to get sustainability reporting in time, equally with financial reporting. Firms will have to report how sustainability matters impact their operations and the effect of their actions on the environment and society. Initiating well-organized corporate management is essential to ensure companies' growth and continuity. However, because of fraud, numerous companies fail, resulting in economic, social, and environmental disasters (Margret and Hoque, 2016). Due to the dangerous impact of fraud, firms' investors have been harmed by it (Ramos Montesdeoca et al., 2019), resulting in prospective investors losing their confidence. Besides, Jackson (2013) stated that fraud involves the loss of reputation, image, and value for private businesses. While in the public sector, it involves a decline in the quality of public services, loss of occupations, and value of money destruction.

According to Yu and Rha (2021), accounting fraud is a highly unethical management action that substantially impacts stakeholders negatively and can harm the prospects of companies' long-term sustainability. Accounting transparency is critical for most companies, and accounting ethics is related to corporate sustainability. According to Margret and Peck (2014), corporate social responsibility matters are gradually vital to firms and sustainable business operations (Lulaj et al., 2023) because of the consequences of fraud. Bernards et al. (2022) demonstrate that the current demands for advanced technologies spread the link between organizational operations (corporate governance) and audit culture. Hence, the application of technology like CAATs has to address the company's sustainability issues.

5.2.2. Corporate governance with internal auditing as a main component

According to Ramamoorti (2003), the benefit of companies having internal control systems (internal audit department) is highlighted in being aware of the impact of fraud, particularly internal fraud cases. Businesses need to generate internal auditing, which is becoming an essential part of contemporary business (Flesher, 1996). Massive businesses cannot escape from it; if they have not it presently, they will have it sooner or later.

In reinstating investors' confidence, corporate governance is needed to advance the consideration provided to internal audits and their role (Vadasi et al., 2019). Indeed, internal auditing has progressed into playing the role of supervision and advancing corporate governance and risk management procedures (Lin et al., 2011). Numerous studies (Vadasi et al., 2021; Lin et

al., 2011) revealed the significance of internal audits as a corporate governance tool. Based on J. Cohen et al. (2004), the interaction of corporate governance mixtures such as internal auditing and an audit committee, management, and external auditing is essential to enhancing the role played by internal audits in corporate governance. Usually, corporate governance procedures are associated with huge companies. However, they are vital to small and medium enterprises too. Effective corporate governance will assist small and medium enterprises in getting diverse resources in the decision process (Sarens et al., 2012).

5.2.3. Research hypothesis development

Internal auditors are optimistic about their purpose in corporate governance. However, they need more confidence while practicing their role (Leung et al., 2004). They are conscious of their role and have gotten advantages from improving information technology and its use in numerous organizations. A study by Ramamoorti and Weidenmier (2004) demonstrated the advantages of information technology since it assists several companies in attaining improved performance in their operations. Advanced technologies also improve the traceability and transparency of companies' sustainability (Zhang and Song, 2022). Internal auditors can perform better by using CAATs, which lets them continue playing their prominent roles in the corporate governance system of the companies. As stated by Singleton et al. (2006), the techniques offered by information technology to assist auditors in managing a company's information system to discover fraud are considered CAATs.

Because of their effectiveness, CAATs have gained importance in audit approaches (Coderre, 2000). Hence, it contributes to a robust corporate governance system and creates shareholder value. The previous literature revealed that, although internal auditors recognize the relevance of CAATs, the usage of CAATs in an internal audit function is less than anticipated (Li et al. 2018). Scholars such as Bierstaker et al. (2014) and Mansour (2016) demonstrated the same concern from the perspective of external auditing. CAATs are recommended by the IIA standards (IIA, 2017) for effectively practicing professional tasks. For audit tasks associated with forensic investigations, risk assessment in the planning phase, and testing internal controls, internal auditors can use CAATs (Coderre, 2000).

According to Singleton et al. (2006), CAATs have several benefits in the internal audit function. For instance, it could be employed to audit the entire data, letting a skilled auditor discover red flags. It also simplifies the process of creating reports by auditors, is flexible, and can transfer data in numerous formats. In the scope of auditing, the traditional method of auditing has been changed by big data technologies (like CAATs); however, they are introduced with new challenges in forming mega data audit platforms (Ma, 2023). In some CAATs, editing the data is impossible, maintaining its integrity and permitting auditors to run automated tests. Therefore, CAATs increase the effectiveness of internal audit functions (Coderre, 2000) and are necessary for companies' competitiveness and going concern. According to Power (2013), to discover fraud and recognize fraud risks, CAATs could be utilized. Fraud risk is manageable, while fraud is a disrupting incident. CAATs could be utilized by internal auditors to assess business transactions with features probably linked to red flags or fraudulent acts (Coderre, 2000; Smidt et al., 2018). Similarly, it could let the internal auditor detect fraud issues and their bases with better evidence, making it possible to have better audit quality (Cahyono et al., 2020; Christensen and Byington, 2003). However, an improved audit work environment is necessary to perform audits for detecting fraud using technology (CAAT), increasing the quality of audit findings to the maximum (Cahyono et al., 2020).

Usually, CAAT usage increases internal audit functions' effectiveness and efficiency (Singleton et al., 2006). Specifically, it increases the audit results' trustworthiness; internal auditors can frequently highlight the main risk areas and make more reliable, in-time, and material information (Li et al., 2018). Alex et al. (2022) indicated that the adoption of technology (CAAT) in auditing practice has many possible opportunities to optimize time and resources and increase investors' trust by improving the reliability and accuracy of financial information. Similarly, CAAT usage increases internal auditors' probability of discovering irregularities, like fraudulent actions. Hence, the quality of their performance is improving (Li et al., 2018). In utilizing CAATs, the contribution of internal auditing in fraud detection procedure is reflected in both the assessment of fraud risk and performing engagements (Demirović et al., 2021). Previous empirical investigations revealed that CAATs had improved the capacity of external auditors to discover fraudulent actions Henderson et al. (2016) and Olasanmi (2013). As internal and external auditors undertake oversight tasks, it is anticipated that CAAT's usage will upsurge the internal auditors' probability of recognizing fraudulent acts. Hence, CAAT usage will result in

minor losses and subsequently play a corporate sustainability role. Amoako et al. (2023) demonstrated that the sustainability of companies could be maintained through effective internal audit functions and risk management practices.

Moreover, internal auditing could impact the improvement of sustainability reports, and CAATs are the suitable information technology innovations for improving sustainability indicators disclosure (Ganesan et al., 2017). Considering the literature review, there is a positive link between corporate sustainability and the adoption of CAATs. Hence, the hypothesis is formulated as follows:

H1. The CAAT adoption positively impacts the fraudulent schemes detection scope.

In the internal audit function, the prospective advantages of implementing CAATs might be influenced by organizational perspectives, such as company ownership, size, and management commitment. Considering the ownership, government-owned and private companies have different objectives to realize. According to A. Cohen and Sayag (2010), the former is highly concentrated on effectively delivering public goods and services at reduced prices, while the latter focuses on creating shareholder value (via maximizing profit). Legal entities that perform commercial activities owned and controlled by the government are considered government-owned companies. The companies have a bureaucratic and highly rigid system in which tasks are enclosed by regulation. However, they consider unexaggerated profit in their objective, with the core objective of effectively delivering public goods and services at a reduced price to the people (Goodwin, 2004).

In addition, according to Lartey et al. (2019), private and government-owned companies have dissimilarities in financial reporting. In this study's scope, internal auditing is more accepted and recognized by government-owned companies than private businesses (Sprakman, 1985; Goodwin, 2004). Conversely, private companies give more value to management control systems because of their flexible and rugged atmospheres (Ahmi et al., 2014); hence, they expose themselves to risks in their business activities. Based on the findings of Goodwin (2004), compared to government-owned companies, the participation of internal auditors in financial risk management actions is higher in private companies. According to the report made by the

Common Body of Knowledge in 2005 (Araj, 2015), internal auditors in private companies prioritize fraud risk more than in government-owned companies.

Furthermore, the report made by the Association of Certified Fraud Examiners (ACFE, 2020) revealed that profit-oriented companies had more occurrences of fraud than government-owned companies. Several governments manage their provision of goods and services using e-government systems (Ahmi et al., 2014), and the data are kept digitally, too. Moreover, using appropriate automated detection techniques like CAATs, the subset of the data should be audited.

The growing utilization of information technologies in commercial activities provides companies in the public or private sector with a large amount of data that must be examined and processed. Thus, the internal audit function is expected to utilize data analysis software and techniques to avert fraud acts and provide more well-being to the company's stakeholders (Bănărescu, 2015). Nevertheless, the successful employment of CAATs has been sluggish to be improved in the public sector. According to the Common Body of Knowledge report in 2015 (Araj, 2015), internal auditors in government-owned companies are less responsive in utilizing data analysis and mining systems in fraud recognition and risk monitoring activities.

Government-owned companies vary from their private complements via environmental needs and organizational features, which are the components that may impact the CAAT's adoption decisions of internal auditors in fraud detection actions (Lee and Xia, 2006). The internal auditing functions in government-owned companies have high challenges in getting and retaining staff with information technology abilities (Araj, 2015), mainly in data quarrying and cybersecurity. Besides, government-owned companies need to devote their efforts to improving the competencies and skills of internal auditors for a successful reaction to fraud. Accordingly, investing in CAATs in private companies results in more efficiency, as they have highly skilled auditors capable of discovering fraudulent acts effectively (Lee and Xia, 2006).

According to Araj (2015), the practice of IIA standards by internal auditors in government-owned companies shows lower compliance. The utilization of CAATs is endorsed by these standards for successful and efficient professional performance. The lesser requirement for compliance might make internal auditors in government-owned companies less interested in

using CAATs to discover fraudulent activities. The internal audit functions in government-owned companies have a small extent of independence from the management. Auditors' independence impacts auditing phases, particularly the planning of the audit procedures, the decisions based on the audit evidence, and the final audit report (Araj, 2015). Internal auditors might be forced to utilize CAATs to a reduced level in government-owned companies due to their capability to expose irregularities.

According to the Common Body of Knowledge reports in 2015 (Seago, 2015), internal audit functions in government-owned companies are less dominant in some effectiveness assessment criteria, like in-time disclosure of audit matters. The lesser intent for performance assessment might result in less requirement for more advanced methods to increase audit efficiency in government-owned companies. Conversely, according to Telino et al. (2020), several private companies recognized information technology as fundamental to improving competitive advantages and efficiency. The ownership type of companies shall be taken as a moderator factor in information technology usage studies. A more substantial moderating impact can be expected in private companies, as suggested by Lee and Xia (2006). Thus, private and government-owned companies' diverse aims and functional perspectives can affect the association between CAAT usage and fraud discovery actions. Hence, the hypothesis is developed as follows:

H2. Company ownership moderates the impact of CAAT adoption on fraudulent schemes detection scope, such that in private companies, the impact is higher.

Company size is another vital factor mentioned by various literature (Li et al., 2018; Meredith et al., 2020; Bierstaker et al., 2014) that influences the adoption of CAATs. For instance, according to Daoud et al. (2021), the overall positive link between company size and the adoption of CAATs is commonly accepted. In addition, company size is expected to positively influence the adoption of CAATs since huge companies have the greatest likelihood of affording CAATs and have several transactions and processes compared to the smaller ones (Li et al., 2018). Based on the study findings of Pedrosa et al. (2020), Meredith et al. (2020), and Rosli et al. (2013), there has been a positive relationship between the usage of CAATs and company size since small companies investing in advanced technologies like CAATs is not assumed economically worthy.

According to Singleton et al. (2006), company size is an essential attribute to be considered in fraud control. Fraudulent financial statements are more likely to be produced in huge companies, while asset misappropriations happen widely in small companies. Huge companies have more capacities to advance their internal control system. They can invest in fraud aversion, discovery programs, and internal audit functions. In small companies, there is a lack of separation of duties, and control action is vital to avert fraud. The findings of Barnes and Webb (2007) revealed that company size impacts the vulnerability to fraud and the subsequent harms.

Company size could have a conditional impact on the unique association between CAAT usage and the scope of tasks internal auditors execute in fraud discovery. Investing in CAATs is a company decision (Widuri et al., 2016), not an individual's, since it requires a substantial cost. However, internal auditors can select the more suitable technique for their tasks. The usage of CAAT by internal auditors is not imposed on the IIA standards (Henderson et al., 2016); instead, they explain that they should consider using it. On the scope of tasks executed in discovering fraudulent actions, the relation of the delivery of CAATs to internal auditors and the understanding of their advantages in executing particular tasks might have an impact. In studies on information technology usage, scholars like Lee and Xia (2006) recommend that company size has a moderating effect. In the particular scope of fraud, the report by the Common Body of Knowledge in 2015 (Araj, 2015) shows that internal auditors in big companies utilize advanced data analysis and mining tools to discover fraudulent actions. The finding by Kummer et al. (2015) confirmed that huge companies use improved fraud discovery mechanisms, which leads to detecting more frauds. Thus, in internal audit function, the usage of CAATs to attain particular outcomes, like fraud detection, could be influenced by the size of the company; hence, the following hypothesis is developed:

H3. Company size moderates the impact of CAAT adoption on fraudulent schemes detection scope, such that in large companies, the impact is higher.

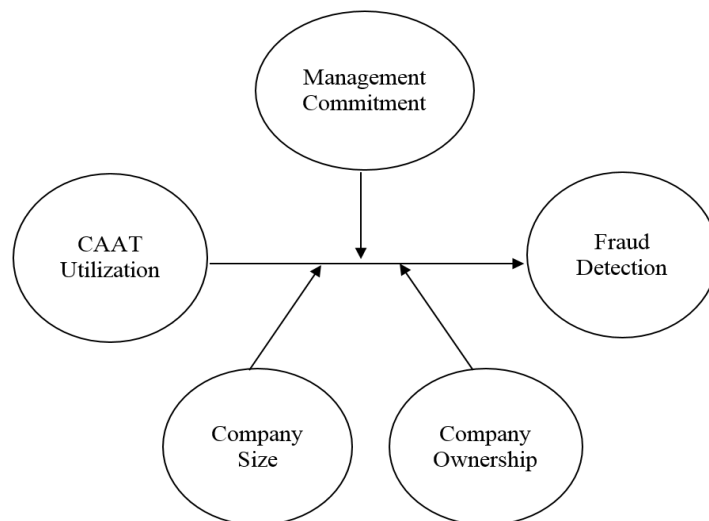
Management commitment is the other essential attribute from the organizational perspective. It is the extent of involvement of top management through providing assistance and direction to the adoption of auditing technology in the company's internal audit. In deciding a company's technology adoption, management commitment has been studied for its importance in

previous literature (Mahzan and Lymer, 2009) and found significant. In addition, the study by Rosli et al. (2013) highlighted that top management has the authority to organize and communicate with staff to design and adopt innovative technology. According to Curtis and Payne (2008), when top management inspires such adoption and utilization, internal auditors will intend to utilize the audit technology. This level of commitment from the top management inspires new technology utilization while assisting the adoption of information technology. According to Rosli et al. (2013), top management’s support also includes the willingness to provide financial resources for advanced technology adoptions. Besides, Chandra and Kumar (2018) revealed that top management commitment supports the delivery of hardware and software amenities with technical expertise improvement. Also, Salleh et al. (2007) demonstrated that, in the company’s information technology development, the participation of top management enhanced the decision-making related to the acquisition and implementation of technology. Thus, this study suggested that management’s commitment to supporting CAAT adoption in the company’s internal audit function is essential. Hence, the proposed hypothesis is:

H4. *Management commitment moderates the impact of CAATs adoption on fraudulent schemes detection scope, such that in committed management, the impact is higher.*

The relationship between fraud detection and CAAT utilization is displayed in Figure 20. Also, the moderating role of company size, company ownership, and management commitment are shown.

Figure 20. Study IV: Research framework



5.3. Research method

5.3.1. Study sample and data collection

This study's target population encompasses internal auditors (a homogenous population) working in government-owned and private companies in Ethiopia. An individual unit of measurement was considered, and G*Power (version 3.1) software was used to determine the minimum sample size required for PLS-SEM analysis (Al-Okaily et al., 2022). The software results in a minimum sample size of 74, applying the following settings. The conventional effect size values of 0.1, 0.3, and 0.5 for small, medium, and large effect sizes are provided in the G*Power software, respectively (Verma & Verma, 2020). The medium effect is deemed appropriate in social science study, and the researcher in this study calculates the sample size using a medium effect size (0.15) as applied by prior studies (Al-Okaily et al., 2022; Verma & Verma, 2020; Siew et al., 2020). Thus, the settings are as follows: $F^2 = 0.15$ (medium), significance level $\alpha = 0.05$, the power = 0.95, and the number of predictors = 4 (including the moderating variables). The absence of a database regarding internal auditors' identification leads to contacting the target population by e-mail, through the Internal Auditing Institute of Ethiopia with its members, and using the LinkedIn social network. Therefore, getting a sample frame was challenging in this case, and this study applied a non-probability sampling technique, particularly the convenience sampling method. In the survey, 110 questionnaires were distributed considering the minimum required sample size (74), and 102 questionnaire responses were collected. However, 19 replies were removed because of too much missing data and straight-line responses. Design features influence non-response items in online surveys since they are rejected and rashly filled. The study's forced replies to the query strategy may also motivate some respondents to stop replying to the survey (Hair, Hult et al., 2017). Consequently, a total of 19 invalid responses were collected. Finally, it gives a valid response of 83, which is appropriate for the analysis since it is above the minimum required sample size.

The internet-based survey was used with questionnaires developed from the literature review to gather the data. Based on Hair, Hult et al. (2017), the survey approach is appropriate for gathering data when the attributes studied are related to companies and professional experience.

The data collected through a survey must be ensured for validity and reliability to confirm that the studied phenomenon accurately reflects the results (Kothari, 2004). Thus, the present study undertakes the following steps to improve the validity and reliability of survey data. First, the study utilized validated survey instruments tested for reliability and validity in previous similar studies (Pedrosa et al., 2020; Samagaio and Diogo, 2022; Baader and Kremer, 2018). In addition, the study implemented a strategy to minimize non-response bias through follow-up reminders, producing a more representative sample. Furthermore, the translation methods of the scales and the pre-test with five auditors were undertaken in addition to the questionnaire's accessibility on the Qualtrics platform (helps to recognize any ambiguities or biases in the questions). Besides, the Mann-Whitney test was used to compare the prompt and delay replies for all items applied to measure the predicting and predicted factors. The result shows no significant differences in the assessments, revealing no potential non-response bias in the data (Armstrong and Overton, 1977). Moreover, the study used the Cronbach's alpha test to assess the internal consistency and reliability of the survey instrument. The test statistics resulted in a 0.939 scale reliability coefficient (greater than 0.7) (Kothari, 2004), indicating that reliable instruments were used for the study.

In addition, the study has implemented the following techniques (Fuller et al., 2016) to decrease the common method variance. First, the questionnaire enclosed an opening note clarifying the aim of the investigation, guaranteeing the confidentiality of replies, notifying respondents that involvement was voluntary, offering accessible contacts for any queries, and motivating them to reply with integrity based on their experience. Secondly, no logic was not followed in the enclosure of the attributes in the questionnaire, and the measurement items were mixed with averting illusive associations. Thirdly, the points of the scale were labeled to minimize agreement bias. Lastly, the study used five-point Likert scales and nominal measures to decrease the anchoring impact. Then, Harman's test for single-factor was used to test the total variance accounted by the factor below 50% (Fuller et al., 2016). With an unrotated factor solution, the exploratory factor analysis results in two factors having greater than one eigenvalue. Together, they explain 94.2% of the total variance, with 85.3% of the variance contributed by the first. From the outcome, we can understand that there is no common method variance.

Most of the participants are men (59%), and the age interval of most of the respondents is greater than 35 (47%). Also, the qualification of the majority of participants is auditing (42%), followed by accounting (34%), and most of them are bachelor's degree holders (36%). The work experience of the majority of participants falls in the interval between 5 to 10 years (40%).

5.3.2. *Measurement*

Two exploratory questions were used in the survey questionnaire to examine the general use of CAATs in the internal audit units. Initially, sampled internal auditors were requested to specify the degree of CAAT usage in their internal audit function. Then, they provided their point of view on the use frequency of 10 CAATs in the internal audit tasks. Following numerous studies (Mahzan and Lymer, 2009; Singleton et al., 2006; Mansour, 2016; Serpeninova et al., 2020), the CAATs list was developed. A five-point Likert scale was used to measure items in both questions, where 1 represents “never”, 3 represents “sometimes”, and 5 denotes “always”.

The predicted variable of this study, corporate sustainability, is proxied by the performance of the fraudulent schemes detection scope of internal auditors in the acquisition cycle of the businesses (FRDT). According to Margret and Peck (2014), economic, environmental, and social disasters could result from fraudulent acts, which can collapse businesses. Thus, fraud impacts the capability of companies to generate shareholders' value and other stakeholders, bringing danger to the company's sustainability. Araj (2015) stated that internal auditors recognized that fraud is one of the main five company risks affecting internal audit function. In the company's acquisition process, a list of seven general fraud patterns was formulated by Baader and Kremar (2018), such as double payment, bid rigging, pass-through, private purchases, kickback fraud, non-accomplice vendor, and shell company. This study used all seven items to denote the scope of tasks executed by internal auditors to discover fraud in the acquisition cycle. The significance of these items was assessed by internal auditors for their audit activities through a five-point Likert scale (1 represents “strongly disagree” to 5 represents “strongly agree”).

In this study, CAAT utilization (CATU) is the predicting variable. Information technology usage is vague and can be explained and measured in various techniques. Accordingly, internal auditors used multi-item measures to measure the CAAT usage, letting the

researcher assess the variety of use (Henderson et al., 2016). Thus, internal auditing tasks respondents were queried whether they apply CAATs. Based on previous literature (Ahmi et al., 2014; Li et al., 2018; Pedrosa et al., 2020), the study scale developed and includes 10 items and adjusted some to fit the requirements of this study. A five-point scale was used to measure these items, with 1 representing “strongly disagree” to 5 “strongly agree”.

The company characteristics’ moderating impact was measured distinctly using the two dichotomous attributes. Company ownership (COSP) was represented by 1 private and 0 government-owned. Company size (CSIZ) was represented as 1 big and 0 small companies. The categorization of companies follows the World Bank’s (WB) grouping criteria for small and medium-sized enterprises. A company is considered small when it has less than 50 employees, total assets, and annual sales of less than \$3 million. Hence, the companies that do not fulfill these criteria are categorized as big companies (World Bank Group, 2019). Finally, Management commitment (MTCT) was represented by 1 committed and 0 not committed. In this study, for the attributes of CAAT utilization and fraud detection, all the measurement items utilized are presented in Appendix Table C1 with their sources. The respondents’ information of demographic characteristics was also incorporated in the questionnaire, such as gender, age, professional qualification, education, and experience.

5.3.3. Data analysis

The summary of the characteristics of respondents and the descriptive analysis was made through IBM SPSS Statistics 27. PLS-SEM was utilized with SmartPLS 4.0 to test the developed hypotheses and validate the measurements. According to Hair, Risher et al. (2019), PLS-SEM is a second-generation regression method that permits the causal relations among one or more predicting and dependent variables to be estimated simultaneously without any assumption on the data distribution. This technique distinctly evaluates the structural and measurement models by merging ordinary least square regressions with the principal component analysis (Hair, Risher et al., 2019). PLS-SEM is preferable for understanding difficult measurement and structural models, though it is practically and theoretically similar to multiple regression analysis (Hair, Ringle et al., 2011). Based on Cachón-Rodríguez et al. (2021), it is an appropriate technique when the aim is to execute a causal–predictive study in exploratory research with small samples and where many items with diverse measurement scales measure factors. The PLS-SEM method

was used in many social science disciplines, including studies examining the drivers for auditors' CAAT usage (Pedrosa et al., 2020; Henderson et al., 2016). Accordingly, for this study, PLS-SEM is a proper model to predict the impact of the explanatory variable on the explained variable and the moderation impact.

The PLS-SEM model involves two phases (Hair, Ringle et al., 2011); the measurement model's validity and reliability will be estimated in the first step. Then, the structural model will be evaluated, and the study hypotheses will be concluded. This study used the reflective model, as all measured items indicate particular attributes (Hair, Hult et al., 2017). Discriminant validity, individual indicator reliability, convergent validity, and internal consistency reliability examinations are encompassed in the assessment of the measurement model. This study used the direction and significance of the structural path coefficients, the effect size (F^2), and the coefficient of determination (R^2) to assess the structural model. With 5000 samples, a bootstrapping process was utilized to estimate the significance of the path coefficients (Hair, Hult et al., 2017).

5.4. Study results

5.4.1. Descriptive analysis

Identifying the CAATs utilized by internal auditors was the initial objective of this study. As shown in Table 17, the mean usage of CAATs was 3.01, which reveals that there is no intensive utilization of the technology by internal auditors. This outcome confirms the report of the Common Body of Knowledge in 2015 (Seago, 2015), which demonstrates that the utilization of CAATs by most internal auditors is very little or no use at all for the audit procedure. More than 20% of internal auditors rely mainly on manual procedures and systems. Participants in this study stated that generic personal productivity tools, Active Data for Excel, and online public databases are primarily utilized by CAATs. Conversely, most of the CAATs listed in the questionnaire scored a mean value of less than three, indicating that the companies' internal auditors rarely utilize these techniques. Besides, the outcome of the Mann–Whitney test of mean differences shows that the utilization of 10 CAATs by internal auditors working in government-owned and private companies was similar. Except for program analysis techniques, internal auditors working in huge and small companies have the same level of CAAT usage. Likewise, all CAATs except program analysis techniques and Active Data for Excel have similar

utilization levels by internal auditors in companies with committed and not committed management.

Table 17. Study IV: Kind of CAATs utilized.

	Code	Mean	SD	Skewness
General—CAAT	GCAAT	3.01	1.444	-0.046
Specific—CAATs:				
Generic personal productivity tools, like Word and PowerPoint	GPPT	3.31	1.431	-0.343
Active Data for Excel	ADEX	3.20	1.446	-0.195
Online public database	OPDB	3.13	1.395	0.006
Program analysis techniques, like process mapping software and flowcharts	PATQ	2.95	1.296	0.023
Database SQL search	DSQL	2.92	1.363	0.126
ACL—Audit Command Language	ACDL	2.90	1.358	0.059
Statistical software like SPSS	STSW	2.83	1.430	0.099
Database management system	DMSM	2.80	1.412	0.267
Working Papers software like CaseWare Working Papers	WPSW	2.76	1.445	0.211
Microsoft Access	MSAC	2.75	1.521	0.250

The three primarily utilized tools (CAATs) and their relation to fraud detection in the acquisition process are presented as follows. First, numerous personal productivity tools are utilized by internal auditors to improve efficiency in detecting fraud. In this study, common personal productivity tools such as Microsoft Word and PowerPoint were found to be commonly utilized by internal auditors to undertake their tasks. The result was consistent with Serpeninova et al. (2020), who concluded that generalized CAATs are the most utilized types by auditors. The tools are used to create audit reports, document the audit process, and present audit outcomes to stakeholders. In fraud detection, these tools are vital in presenting and organizing information and evidence about potential fraud risks and mitigation approaches in the acquisition process. Organized documentation enables a comprehensive understanding of fraud risks in the acquisition process (such as vendor, invoice, and purchase order frauds) (Araj, 2015). It supports suggesting actionable recommendations to improve the control environment (Serpeninova et al., 2020). Secondly, internal auditors use Active Data for Excel tool to analyze financial data of acquisitions. The tool will assist them in detecting irregularities (anomalies) and perform trend and ratio analysis for identifying potential frauds in the acquisition process. It is also valuable for

internal auditors in extracting, importing, validating, analyzing, profiling, and visualizing data within the acquisition process (Samagaio and Diogo, 2022). Thirdly, several online public databases are used by internal auditors to assist the fraud detection process in the acquisition cycle. By utilizing the databases, internal auditors can improve their fraud detection abilities throughout the acquisition process, confirming compliance, reducing risks, and upholding the integrity of the procurement function in companies. Business registries, internet search engines, social media, government, supplier, and public legal databases are found to be the common online public databases used by internal auditors to assist their audit tasks in the procurement function of companies (Samagaio and Diogo, 2022).

The essential statistics for the attributes and their measures applied to test the study's hypotheses are summarized in Table 18, and see Appendix Table C1 for the items. The construct CATU has a mean score of 3.47, and its items scored between 3.34 and 3.55. Generally, it indicates that internal auditors occasionally utilize CAATs in the main tasks, while there was heterogeneity in the data reflected by the standard deviations of items. Mainly, three items have the highest agreement level, such as the utilization of CAATs to identify and assess fraud risks, to identify the risks of errors, and to sort transactions. However, CAATs are only sometimes utilized to perform analysis of relationships between variables.

Table 18. Study IV descriptive statistics.

Items and attributes	Code	Mean	SD	Skewness
CAAT Utilization	CATU	3.47	1.290	-0.368
Item 1	RKE	3.55	1.150	-0.333
Item 2	RDR	3.64	1.235	-0.307
Item 3	DER	3.45	1.318	-0.518
Item 4	DEF	3.42	1.260	-0.362
Item 5	WPM	3.48	1.338	-0.477
Item 6	GCN	3.42	1.389	-0.184
Item 7	STN	3.53	1.243	-0.402
Item 8	PON	3.41	1.371	-0.461
Item 9	MDA	3.48	1.263	-0.275
Item 10	RSP	3.34	1.337	-0.364
Fraud detection	FRDT	3.42	1.295	-0.425
Item 1	SHC	3.34	1.355	-0.430
Item 2	PTH	3.42	1.354	-0.420

Item 3	DPT	3.34	1.213	-0.429
Item 4	BRG	3.37	1.134	-0.372
Item 5	PPC	3.34	1.355	-0.249
Item 6	KKF	3.48	1.319	-0.401
Item 7	NAV	3.66	1.337	-0.672
Company ownership	COSP	0.51	0.503	-0.025
Company size	CSIZ	0.59	0.495	-0.374
Management commitment	MTCT	0.28	0.450	1.014

The summary in Table 19 shows the Mann–Whitney tests on the latent factors CATU and FRDT and their corresponding items, considering the company characteristics (company ownership, size, and management commitment). The outcome indicates that the distribution of the participant’s assessment of the items of the latent factors CATU and FRDT was almost indifferent to the ownership and size of the companies. However, there were substantial differences for most of the items of FRDT between participants working in companies with committed and not committed management, but not for CATU.

Table 19. Study IV: Mann – Whitney tests summary based on company characteristics.

Attribute	Hypothesis	COSP	CSIZ	MTCT
CATU	Same distribution	All remaining items	All remaining items	All items
	Different distribution	RKE	WPM, RDR	
FRDT	Same distribution	All items	All items	BRG
	Different distribution		NAV, PPC	All remaining items

5.4.2. PLS-SEM model analysis

The output in Table 20 displays the parameters applied to assess the measurement model, such as Cronbach’s Alpha, composite reliability, and average variance extracted. In both attributes, the value of Cronbach’s Alpha and composite reliability were above 0.7 (Hair, Ringle et al., 2011), indicating adequate internal consistency reliability. In addition, the standardized loadings of all items were above 0.7 (Hair, Hult et al., 2017) (Figures 21 and 22), which confirms the individual indicator reliability.

Table 20. Study IV: Measurement model.

Attribute	Cronbach's Alpha	Composite reliability	Average variance extracted
CATU	0.991	0.992	0.936
FRDT	0.995	0.960	0.778

The validity of the attributes was assessed by testing the average variance extracted (AVE), discriminant validity, and the heterotrait-monotrait (HTMT) ratio. First, the average variance extracted values of the constructs (CATU and FRDT) were above 0.5 (Hair, Risher et al., 2019), which is the minimum required threshold value, implying that the attributes explained a significant proportion of the variance of items. Hence, the conclusion is that the attributes had convergent validity. Second, based on the results in Table 21, the study verified that the attributes had discriminant validity. The criteria of Fornell and Larcker (1981) were also confirmed since the square root of the average variance extracted values of both attributes were more than their correlation values. Furthermore, the heterotrait-monotrait (HTMT) ratio was below 0.85 (Hair, Risher et al., 2019), the minimum threshold value.

Table 21. Study IV: Discriminant validity.

Attribute	Panel A: Correlation matrix		Panel B: HTMT	
	CATU	FRDT	CATU	FRDT
CATU	0.967			
FRDT	0.699	0.882	0.596	

Note. The diagonal values in Panel A denote the square root of AVE.

Two steps were undertaken in the assessment of the structural model. First, the CATU and FRDT (Hypothesis 1) relationship was emphasized. Secondly, the entire structural model was assessed by introducing moderation (Hypotheses 2, 3 and 4). The summaries of structural models assessment for both with and without moderation are presented in Table 22, Figures 21 and 22.

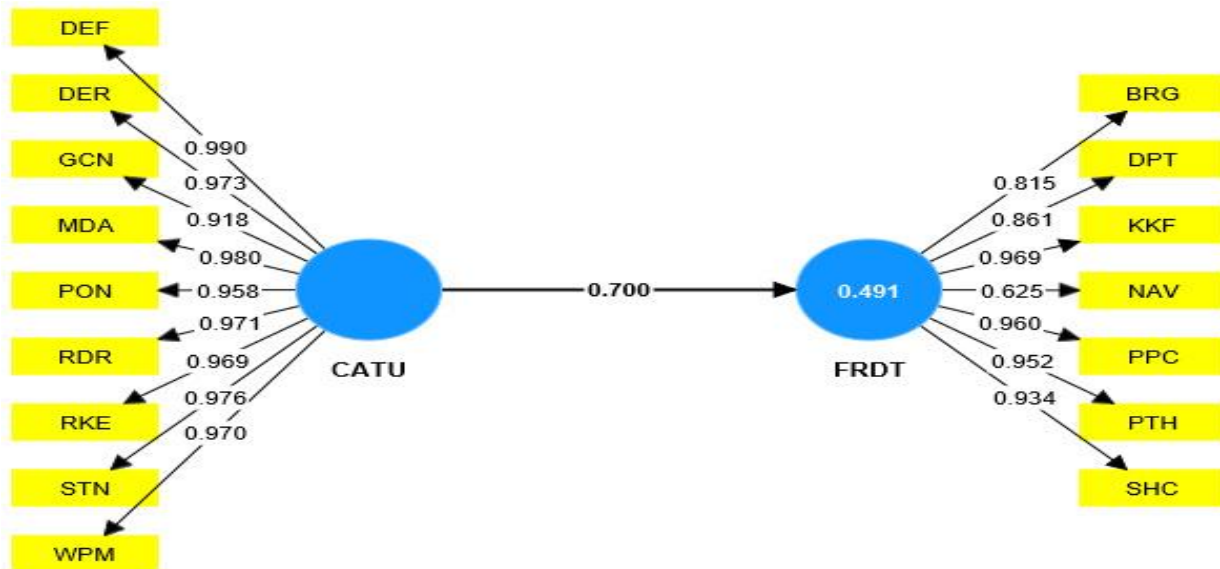
Without moderation, the R^2 value of the variable FRDT was 0.491 (Table 22 and Figure 21), indicating an explanatory model has moderate power since the value is close to the threshold of 0.50 (Hair, Risher et al., 2019). The F^2 value of 0.963 is above the effect size threshold of 0.35 (J. Cohen, 1988), indicating the large effect of CATU on FRDT. The value of the estimated path coefficient ($\beta = 0.700$; $p < 0.01$) revealed a positive impact of CATU on FRDT (also see Figure

21), which confirmed the first hypothesis (H1). The outcome indicates that CAAT utilization impacts internal auditors in executing tasks that can reduce the risk of fraud in the acquisition cycle.

Table 22. Study IV: Summary of structural model assessment.

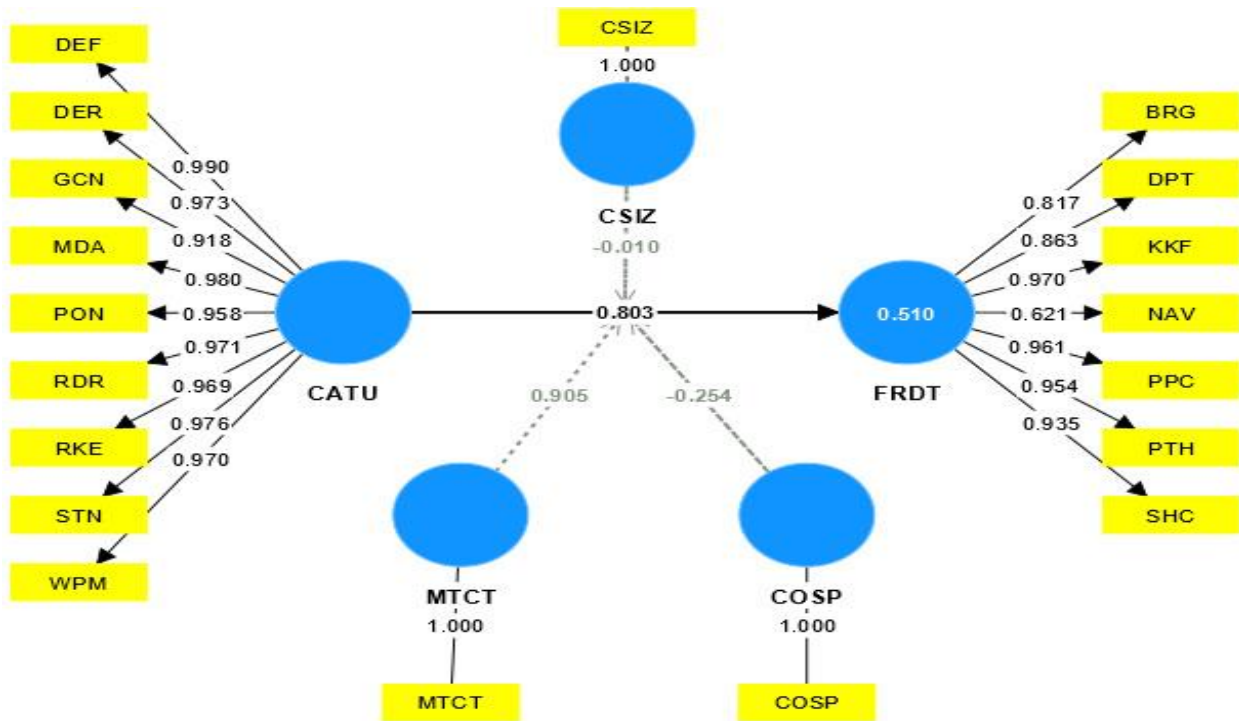
Without moderator				With moderator			
Dependent variable	R ²	F ²		Dependent variable	R ²	F ²	
FRDT	0.491	0.963		FRDT	0.510	0.160	
Relation	Path coefficient	t-value	p-value	Relation	Path coefficient	t-value	p-value
CATU → FRDT	0.700	4.805	0.000	CATU → FRDT	0.803	4.834	0.000
				CATU × MTCT → FRDT	0.905	2.739	0.003
				CATU × COSP → FRDT	-0.254	-0.102	0.510
				CATU × CSIZ → FRDT	-0.010	-0.659	0.460

Figure 21. Study IV: Structural model assessment without moderator



With moderation, the structural model was assessed by including the three moderating factors separately and collectively. As presented in Table 22, the model's predictive accuracy explained by the R² (0.510) is above the threshold of 0.5 but near it, indicating a moderate level (Figure 22).

Figure 22. Study IV: Structural model assessment with moderators



Also, the F^2 value of 0.160 is above the medium effect size threshold of 0.15 (J. Cohen, 1988), indicating the medium effect of CATU on FRDT. The outcomes also display that the positive impact of CATU on FRDT remained significant, with a path coefficient ($\beta = 0.803$; $p < 0.01$) more than without moderation estimated model (also see Figure 22). The moderating impact of management commitment (MTCM) on the relationship between CATU and FRDT was found to be statistically significant with a positive path coefficient ($\beta = 0.905$; $p < 0.05$), confirming the fourth hypothesis (H4). However, the impacts of company size (CSIZ) and company ownership (COSP) on the relationship between CATU and FRDT were not found to be statistically significant; thus, the second (H2) and third (H3) hypotheses were not supported. When the moderating factors are introduced into the model separately and collectively, the statistical values (R^2 , F^2 , path coefficients, and p -values) are almost similar or close, which did not change the interpretations.

5.5. Discussion

This study was started by identifying the kind of CAATs utilized by internal auditors in the companies' internal audit functions. The outcome revealed that information technology is not

intensively used in the internal audit processes, corresponding to other studies' findings (Pedrosa et al., 2020; Lulaj et al., 2023; Bernardis et al., 2022; Alex et al., 2022). Internal auditors know they can use technology better and admit its adoption has challenges (Cachón-Rodríguez et al., 2021). From a general audit perspective, the literature (Pedrosa et al., 2020; Zhang and Song, 2022) shows that there are factors that can boost resistance to the adoption of CAATs. For instance, some factors include the shortage of information technology training and knowledge, complexities in implementing it in actual circumstances, and the risk related to its usage. Hence, the efforts made to identify the factors for adopting information technology resulted in the rise of many theories. For example, the technology acceptance model (Venkatesh et al., 2003), the technology–organization–environment framework (Tornatzky and Fleischer, 1990), diffusion of innovation (Rogers, 2003), the theory of planned behavior (Ajzen, 1991), the unified theory of acceptance and use of technology (Venkatesh et al., 2003) and empirical studies in the area of CAATs in internal audits (Mahzan and Lymer, 2009; Henderson et al., 2016; Smidt et al., 2018) are some of the theoretical models.

This study proposed the positive impact of utilizing CAATs on the fraudulent schemes detection scope of internal auditors, the first hypothesis (H1). The outcome of the analysis revealed that the data support this hypothesis. This study shows empirical evidence consistent with the literature (Ma, 2023; Christensen and Byington, 2003; Coderre, 2000), revealing that CAAT adoption improves internal auditors' ability to detect fraud. Moreover, the magnitude of the effect of the predicting variable on the predicted variable is shown by the estimated path coefficients: A one-unit change of CATU changed the extent of FRDT between 0.700 and 0.803 (see Tables 22, Figures 21 and 22). Companies are showing a rising process of business automation and data digitalization in which the effectiveness of the internal audit role is conditioned to information technology adoption. Thus, a study by Henderson et al. (2016) recommended that for companies to function in a fraud-free environment, CAATs should be encouraged. According to ACFE (2020), companies lose 5% of their annual revenues due to fraudulent actions. The loss signifies a confounding drain on the overall economy (ACFE, 2020), adversely impacting producing goods, providing services, and creating jobs. Hence, effectively utilizing CAATs is vital to minimizing fraud incidents, confirming information technology's role in improving corporate sustainability.

The moderating impact of company characteristics on the relationship between CATU and FRDT was proposed in Hypotheses 2, 3 and 4. The outcome shows that the second and third hypotheses were not supported. However, the fourth hypothesis was supported by the data. Previous literature (A. Cohen and Sayag, 2010) demonstrates variations in the difficulties between government-owned and private companies, which could affect the role played by internal auditing in the companies' internal control. Compared to government-owned companies, a report by the Common Body of Knowledge in 2015 (Araj, 2015) states that attention to fraud risk, prevention, and detection is higher in private companies. In addition, according to Lee and Xia (2006), the moderating impact of the type of company was more noticeable in profit-oriented companies. This study delivers empirical evidence that company ownership does not impact the relationship between CATU and FRDT. This outcome indicates a homogeneity of views on the contribution of CAATs to improving corporate sustainability. Fraudulent actions often result in company failure, creating economic, environmental, and social disasters. The disasters finally harm the company's sustainability (Margret and Hoque, 2016). Any company faces a contemporary reality: fraud risk (Araj, 2015). Based on Ramos Montesdeoca et al. (2019), fraud involves the loss of reputation, image, and value for private businesses. While in the public sector, it involves a decline in the quality of public services, loss of occupations, and value of money destruction (Jackson, 2013). As a result, in the 21st century's corporate governance, fraud risk management has a profound position (Power, 2013). Integrating more information technology into internal audit functions to improve sustainability has become a worldwide challenge recognized by government-owned and private companies (Amoako et al., 2023). Also, the outcome revealed that internal auditors in government-owned companies have similar tools as their complements in private entities; hence, similar technological potential is utilized in detecting fraud.

The outcomes also revealed that company size is not moderating the association between CAAU and FRDT. This result confronts the study of the Common Body of Knowledge in 2015 (Araj, 2015), which concludes a higher level of information technology use in larger companies for fraud detection. The company size scope can explain the moderation effect's impact. According to the recommendation of Lee and Xia (2006), the size of the information technology department could be an alternate proxy for the company size. Considering this, the outcome of the robustness test that used the internal audit department dimension kept the previous

conclusion (the number of employees in the internal audit department was a proxy for company size). With the proxy factor of the internal audit department, the moderation model results in the following structural model measurement indicators: $R^2 = 0.483$, $F^2 = 0.447$, and path coefficient = -0.086 with t value = -0.709 and p -value = 0.478 .

Moreover, the outcomes of this study show that management commitment significantly moderates the association between CAAU and FRDT. The outcome is consistent with the findings of Mahzan and Lymer (2009) and Demirović et al. (2021), who conclude that management commitment has a significant role in a company's technology adoption. The top management commitment is not limited to supplying essential resources to resolve resistance to CAAT use (Smidt et al., 2018; Maroufkhani et al., 2020); it also includes championing the new information systems and advancing the legitimacy of CAAT adaptation. The result also corresponds with Curtis and Payne (2008), who found that top management commitment impacts the internal auditors' intent to utilize the audit technology. According to Rosli et al. (2013), top management's support includes the willingness to provide financial resources for advanced technology adoptions. Besides, Chandra and Kumar (2018) revealed that top management commitment supports the delivery of hardware and software amenities with technical expertise improvement. Also, Cahyono et al. (2020) and Salleh et al. (2007) demonstrated that, in the company's information technology development, the participation of top management enhanced the decision-making related to the acquisition and implementation of technology. Thus, the outcome of this study confirms that the management's commitment to supporting CAAT adoption in the company's internal audit function is essential. Hence, it results in the effective utilization of CAATs, which enables the discovery of numerous fraud actions and, in return, contributes to the companies' sustainability.

The findings of this study endorsed the internal audit departments' perception of the kinds of information technologies that are primarily utilized for the prevention and detection of fraud (see Table 21). The outcome revealed that the most widely used kinds of CAATs are generic personal productivity tools (GPPT) and Active Data for Excel (ADEX). These types of technologies do not need substantial financial resource allocation (Serpeninova et al., 2020). This outcome corresponds to the finding of Araj (2015) and Serpeninova et al. (2020), who states that internal auditors do not have the necessary knowledge to react to fraud risk effectively. Other

literature also demonstrated that company size correlates with fraud (Lou and Wang, 2009); hence utilizing advanced CAATs may be essential for internal auditors to react appropriately.

5.6. Conclusions and future implications

Information technology provides opportunities for improved performance, assisting companies to be more sustainable. This study's outcome revealed a positive impact of CAAT utilization by internal auditors on fraud detection in the acquisition process. The intensity of this association is impacted by the company characteristics, which is the top management commitment, but not by the company size or type. In addition, participants in this study stated that generic personal productivity tools, Active Data for Excel, and Online public databases are primarily utilized tools (CAATs) by internal auditors. Conversely, most of the CAATs listed in the questionnaire scored a mean value of less than three, indicating that the companies' internal auditors rarely utilize these techniques.

The outcome of this study delivers both theoretical and practical implications. Theoretically, the first contribution of this study is to the area of research on CAAT utilization and its impact on efficiency. The outcomes correspond with studies (Pedrosa et al., 2020; Henderson et al., 2016) made on external auditors' perspective, starting by concentrating on the matter from the internal audit perspective and sustainability. Second, the study recognized the kind of CAATs utilized by internal auditors in executing their activities, using the list of CAATs assumed by Samagaio and Diogo (2022) in their study. Different from previous studies, the present study found that generic personal productivity tools, Active Data for Excel, and Online public databases are primarily utilized tools (CAATs) by internal auditors. Third, compared to the prior studies that applied regression models (Mansour, 2016), this study's usage of the multivariate methods of PLS-SEM enables a more robust analysis to be undertaken in exploratory research (which makes it differ from previous works). Fourth, compared to preceding studies (Henderson et al., 2016), the CAATs utilization in core audit tasks was differently measured by a more general scale in this study, with the CATU attribute measurement model signifying nine items with an acceptable degree of reliability. Fifth, most previous studies were made on the adoption of CAATs in organizations; however, they did not investigate the impact of their adoption on the sustainability of firms. The new finding on using CAATs in the internal audit function for sustaining the company's operation might shed light on

emerging fraud risks in existing controls. The findings also validate prevailing audit methodologies (types of CAATs) and highlight areas for improvement. It contributes to refining internal audit processes by utilizing CAATs for efficiency and effectiveness. When findings reveal the effective utilization of CAATs in internal audit tasks, the information can be used to update industry best practices, improve the general quality of audits, and ensure corporate sustainability. Finally, findings may argue or extend prevailing theoretical frameworks in internal auditing, improving theoretical developments and academic investigations.

In addition, the association between CAAT utilization and fraud detection has practical implications for internal auditors and companies. The study's finding on the companies' internal auditors' low (rare) utilization of CAATs implies the need to invest in technology and auditors training. In addition to investment in CAATs, companies must provide required training and resources for internal audit teams. The effective use and interpretation of results from CAATs can be possible if internal auditors obtain the required skills. Utilizing information technology improves the analytical capability of internal auditors, which is considered an expected gain, like discovering anomalies in accounting records, operational inefficiencies, or asset misappropriations. Accordingly, corporate governance will be positively influenced by improving the internal auditors' quality, assisting companies to attain a higher degree of sustainability. The present research helps to know the impact of utilizing CAATs to improve internal audit efficiency and its advantages in reducing fraud risk. Internal auditors can use the findings to enhance fraud risk management approaches, ensuring that companies are well organized to alleviate emerging fraud risks. The CAAT's advanced way of detecting fraud acts (using algorithms and analytics) is essential in offering assurance to the companies and their stakeholders about the integrity of financial statements.

Lastly, the finding of this study also differs from previous studies since it considers a significant (moderating) factor, top management commitment, for the adoption of CAATs and its impact on corporate sustainability. The top management's commitment to supporting the utilization of CAATs for detecting fraud has practical implications. In the company's information technology development, the participation of top management enhanced the decision-making related to the acquisition and implementation of technology. Hence, the management's commitment results in the effective adoption and utilization of CAATs, which

enables the discovery of numerous fraud actions and, in return, contributes to the companies' sustainability. Ultimately, leveraging CAATs can assist the accuracy and reliability of financial statements (identify potential fraud risks) and improve corporate governance, resulting in a significant role in maintaining corporate sustainability.

There are some limitations in this study to be considered by future researchers, such as the size of the sample may impact the scale reliability procedure of the CATU attribute. According to Hair, Risher et al. (2019), the sample size influences statistical tests, though this study fulfills the minimum size for using the PLS-SEM model. Also, due to the sensitivity of the fraud matters, political precision may affect its measurement. The FRDT attribute was measured only on the fraudulent schemes in the companies' acquisition process. Future research may expand the tasks executed by internal auditors in discovering fraud in economic, environmental, and social aspects. In addition, the direct impact of company size on CAAT utilization could also be investigated. The moderating impact of company size could be analyzed by future research using other measurements, such as financial resources and output measures, including sales and net assets. The study's limited geographical focus must also be considered in future studies. Studying diverse cultural settings in common-law countries has more extension. Finally, other company characteristics, such as industry, may also be considered in future studies.

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Appendix C

Table C1. Study IV: Indicators used for constructs in the survey.

Attributes	Code	Items/Indicators	Source
CAAT Utilization (CATU)	RKE	1. Identify and assess the risks of errors in the audited information and processes	Pedrosa et al., 2020; Samagaio and Diogo, 2022
	RDR	2. Identify and assess fraud risks in the audited information and processes	Pedrosa et al., 2020; Samagaio and Diogo, 2022
	DER	3. Detect errors in the audited information and processes	Pedrosa et al., 2020; Samagaio and Diogo, 2022
	DEF	4. Detect fraud in the audited information and processes	Pedrosa et al., 2020; Samagaio and Diogo, 2022
	WPM	5. Prepare the audit work programs in the planning phase	Pedrosa et al., 2020; Samagaio and Diogo, 2022
	GCN	6. Assessment of going concern assumption	Pedrosa et al., 2020; Samagaio and Diogo, 2022
	STN	7. Sort transactions with specific characteristics	Pedrosa et al., 2020; Samagaio and Diogo, 2022
	PON	8. Test an entire population instead of a sample	Pedrosa et al., 2020; Samagaio and Diogo, 2022
	MDA	9. Match data across files	Pedrosa et al., 2020; Samagaio and Diogo, 2022
	RSP	10. Perform analysis of relationships between variables, such as linear regression	Pedrosa et al., 2020; Samagaio and Diogo, 2022
Fraud detection (FRDT)	SHC	1. Shell company—fictitious companies or companies with reduced activity with which the company is suddenly connected (e.g., company data coincide with employee data)	Baader and Kremar, 2018; Samagaio and Diogo, 2022
	PTH	2. Pass-through—manager/employee has a company that sells goods and services to the entity where	Baader and Kremar, 2018; Samagaio and

	he/she works at inflated prices (e.g., high-volume purchases from a new or unauthorized supplier)	Diogo, 2022
DPT	3. Double payment—payment is often made twice (e.g., a given purchase was invoiced at several points in time)	Baader and Kremer, 2018; Samagaio and Diogo, 2022
BRG	4. Bid rigging—vendors who pay to influence a competitive bidding process in their favor (e.g., influence the specifications in their favor)	Baader and Kremer, 2018; Samagaio and Diogo, 2022
PPC	5. Personal purchases—making private purchases at the expense of the company (e.g., receipt of unjustified goods)	Baader and Kremer, 2018; Samagaio and Diogo, 2022
KKF	6. Kickback fraud—collusion between suppliers and managers/employees for fictitious or inflated purchases (e.g., placing multiple purchase orders for small amounts for the same product)	Baader and Kremer, 2018; Samagaio and Diogo, 2022
NAV	7. Non-accomplice vendor—involvement of innocent suppliers in the embezzlement of company funds or assets (e.g., overpayment of an invoice, requesting the return of the difference)	Baader and Kremer, 2018; Samagaio and Diogo, 2022

6. Study V. Key audit matters disclosure: Do they reveal construction firm's risk of financial distress? Evidence from Ethiopia

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Published in International Journal of Construction Management, 24(15), pp. 1689–1697

<http://doi.org/10.1080/15623599.2023.2286882>

Abstract

Recent studies have provided insights into key audit matters (KAMs) disclosure content and their determinants. While conducting this study, no known study examined the relation between the type of KAMs reported and the level of clients' financial distress risk in Ethiopia, which is a clear research gap. Hence, this study aimed to examine the disclosure of KAMs' (in number and nature) usefulness in assessing a client construction firm's financial distress risk (FIDT). A quantitative method with five-year (2017–2022) secondary data of KAMs disclosure in the audited financial reports of grade one construction companies in Ethiopia was used to study the relationship. The pooled OLS regression analysis shows that KAMs reported by auditors are valuable in predicting and assessing a firm's risk of financial distress. The number of KAMs and all account-specific KAMs were useful in assessing firms' financial distress. However, from the company-wide KAMs, going concern was found to be significant. Results were found robust to financial distress, using alternative measures, and tests of endogeneity. Overall, this study suggests construction firms contemplate auditor disclosers (KAMs) as one of the financial health assessment approaches.

Keywords: Construction companies, financial distress, key audit matters, nature of KAMs, number of KAMs

6.1. Introduction

The benefits of KAMs recently have gotten attention from various studies and made diverse conclusions on their usefulness for the users of financial reports. Recent studies demonstrated that annual reports' usefulness regarding the characteristics of the firm and audit

risks specific to the client rely on KAM disclosure (Seebeck & Kaya, 2022; Smith, 2022; Moroney et al., 2021). Providing judgment on the degree to which the client is operationally and financially viable is the main decision but is difficult to make. The audit standards require auditors to examine clients' going concern ability and provide their opinion when they find it significant to report (IAASB, 2015). However, some studies (Pincus et al., 2017; Geiger et al., 2021; Read and Yezegel, 2018) revealed that auditors frequently misreport the going concern classifications. The viability of the client to remain as an entity needed new approaches, and the going concern report became significant (Laitinen & Laitinen, 2020). According to Franzel (2017), the issue calls for more studies on the benefits of comprehensive audit reporting.

The usefulness of audit disclosures in examining companies' financial condition has been studied recently by some scholars (Gutierrez et al., 2020; Munoz-Izquierdo et al., 2020; Liu et al., 2022). According to Munoz-Izquierdo et al. (2020), the classification accuracy of Spanish non-financial firms improved by 10% using bankruptcy forecast models when accounting and traditional auditing data were combined. Using the traditional audit report format, Gutierrez et al. (2020) also conclude that the models' predictive ability improved as the going concern opinions are added to different business default models.

The literature has limited evidence regarding KAMs' perceived usefulness for financial report users. However, the type and number of KAMs' usefulness in explaining the level of a firm's financial health and complexity remain an open query in many countries. While conducting this study, no known study examined the relation between the type of KAMs reported and the level of clients' financial distress risk in Ethiopia, which is a clear research gap. The literature inspires this study with the new concept of KAM disclosure, which may show the degree of the firm's financial distress risk that it may face. This study aims to examine the degree to which KAM disclosers (recent and compulsory expanded audit reports) are important in evaluating the existing degree of firms' financial distress. The study, in particular, empirically examined the relationship between auditors' reports on the type and number of KAMs and the financial distress degree of client firms. The KAMs are examined in two ways: by level of risk and financial impact category. Considering the context, this study posed three research questions to examine the relationship between KAMs and FIDT:

RQ1. *Is there a relationship between the number of KAMs reported by auditors and the level of the client firm's financial distress?*

RQ2. *Is there a relationship between the risk level of KAMs reported by auditors and the level of the client firm's financial distress?*

RQ3. *Is there a relationship between the auditor's report on KAMs classified by their primary impact and the client firm's level of financial distress?*

A quantitative method with five-year (2017–2022) secondary data of KAMs disclosure in the audited financial reports of grade one construction companies in Ethiopia was used to study the relationship. The study regresses the proxies for the level of financial distress of client firms on different KAM categories and their occurrence frequencies. The results of Pooled OLS regression analysis revealed that there is a significant explanatory power of KAM disclosed by an auditor in evaluating the presence of a firm's financial distress level. As the number of KAMs increases, the risk of financial distress level in the firm becomes higher. This result is consistent when using alternative financial distress level measures. Furthermore, various endogeneity tests were made to confirm that KAM disclosures are not only determined by poor financial ratios as a measure of the level of financial distress (Singh et al., 2022), and the results are robust.

This study has contributed to the literature with its findings on expanded audit reports and financial distress. In prior literature, most of the studies have investigated the degree of incremental usefulness of expanded audit reports from a financial report users' perspective. However, this study advances its investigation by examining KAMs' usefulness (assessed by the number and risk-level categories) for the users of financial reports to undertake decisions on the viability of firms. The finding of this study has wide-ranging implications for construction firms and their stakeholders, such as investors, auditors, and regulators. It promotes accountability and transparency within construction firms, developing a financial responsibility culture. It also sheds light on the specific financial operations of construction firms with high distress risk, eventually improving the industry's sustainability. It can also provide directions for regulatory changes to confirm that auditors properly examine critical areas through audits. Auditors may also benefit from this study by assessing potential clients' engagement risk and providing audit report disclosers for users as an alternative going concern signal about the firm. The following section of the paper includes a literature review, methodology, major findings, and conclusions.

6.2. Review of the literature

During the audit of a firm's financial reports, external auditors address the most significant matters referred to as Key audit matters (KAM) in their report (Sierra-García et al., 2019). Auditors determine and provide reports on these matters for transparency and to highlight the audit process. The purpose is to improve the audit report's usefulness and relevance by targeting the areas which need more audit attention. Auditors may consider factors in communicating their KAMs, such as complex accounting estimates, significant risks, new accounting policies, materiality, legal or regulatory compliance, transactions with related parties, and unusual transactions (Camacho-Minano et al., 2023). Most importantly, auditors may use KAMs to publicly communicate material risks related to the client's going concern, which signals the risk of financial distress and minimizes the client's possibility of getting going concern opinions.

The firm's experience of significant financial difficulties and yet working to address its financial obligations is referred to as financial distress (FIDT) (Altman et al., 2017). Several factors cause it, and it is a condition in which the firm's financial health is declined. In identifying the FIDT condition of a firm, auditors may use signals such as decreasing profits (revenue), inability to raise capital, high debt values, liquidity concerns, downgraded credit ratings, unfavourable cash flow, and legal and regulatory difficulties. Business closure, bankruptcy, restructuring, or asset liquidation are the severe consequences of FIDT. Firms apply different strategies to resolve their FIDT problems, such as enhancing operational efficiency, cutting costs, looking for new revenue streams, restructuring debt, looking for financial support, or renegotiating payment contracts (Altman, 1983).

In revealing the FIDT conditions of firms, KAMs are now gaining new attention from the auditors' and researchers' side. The informative usefulness of KAMs has been investigated by some studies from the users' perspective. A recent study by Seebeck and Kaya (2022) in the U.K. regarding the informative usefulness of KAMs using various proxies shows that KAMs with detailed descriptions have a significantly positive relationship with capital market reactions. This relation shows that KAMs are useful to investors for informed judgments. Previous studies (Camacho-Minano et al., 2023; Chen et al., 2023) show that clients get more KAMs as they have

losses, prior accounting restatement, and higher leverage ratios (risk from the auditor's viewpoint).

In addition, emerging studies have recently delivered empirical insights on assessing the risk of financial distress using the type of disclosures in audit reports (KAMs). Most studies used well-known assessment models (Altman et al., 2017) to evaluate the risk of financial distress using financial report data (by computing accounting ratios). Nevertheless, numerous studies (Bellovary et al., 2007; Laitinen & Laitinen, 2020) have doubted accounting-dependent assessment models' predictive ability; they suggest advancing those models to include non-financial and market-based factors. According to Munoz-Izquierdo et al. (2020), information gathered from external auditing data showing the nature of the audit opinion and disclosure content can be considered a non-financial factor.

Generally, there is limited evidence in previous literature regarding KAMs' perceived usefulness for financial report users. However, the type and number of KAMs' usefulness in explaining the level of a firm's financial health and complexity remain an open query. While conducting this study, no known study examined the relation between the type of KAMs reported and the level of clients' financial distress risk in Ethiopia. The identified research gap inspires this study to be undertaken with the new concept of KAM disclosure, which may show the degree of the firm's financial distress risk that it may face. The study, in particular, examined the relationship between auditors' reports on the type and number of KAMs and the financial distress degree of client firms. The KAMs are examined in two ways: by level of risk and financial impact category.

By providing transparency on matters impacting the general audit strategy and demanding hard audit decisions, regulators aim to upsurge audit reports' benefits (PCAOB, 2018; IFAC, 2016). International audit regulations, both PCAOB and IAASB, require auditors to evaluate the client's material risk in their audit, including issues demanding subjective and solid judgments (Kohler et al., 2020; Porumb et al., 2021). However, both regulations let the auditor's judgment determine the number of KAMs. Moreover, based on the audit standards, determining the significance of a matter to be classified as a KAM still relies on the auditor's judgment. The KAMs reflect the risk that can affect the firm's comprehensive financial report generally (company-wide) or specifically (account-specific) (Burke et al., 2022; Gutierrez et al., 2022).

In Ethiopia, the International Standards on Auditing (ISA) are used for financial auditing of firms in various industries (including the construction industry). Auditors focus more on specific matters while auditing construction firms, such as cost estimation, contract terms, revenue recognition, compliance with industry-specific regulations, contingencies, and project completion (AABE, 2014). Within the country's legal and regulatory environment, auditors use local accounting and auditing regulations aligned with International Financial Reporting Standards (IFRS) and ISA. Accounting and Auditing Board of Ethiopia (AABE) is the country's regulatory body for auditing standards and regulations. According to Ethiopian Financial Reporting Proclamation No. 847/2014, Article No. 32 (AABE, 2014), auditors must report material risks to a client firm in any industry before bankruptcy.

6.3. Research method

6.3.1. Sample and data collection

A quantitative method with an explanatory research type was applied, considering the nature of variables, data, and the aim of the study (examining relationships). The initial sample of this study encompasses all construction companies (3,119) registered in the Ethiopian Ministry of Urban Development and Construction (EMUDC) from 2017 to 2021. A purposive sample selection procedure was followed in determining and selecting the sample. Those recent periods were fixed to highlight recent and relevant findings for readers' interest and considered the availability of necessary data. Then, the sample was narrowed to grade-one construction firms since those companies are category-A taxpayers and required to report a comprehensive audit report (but not for other categories). Regardless of the company's annual turnover, category “A” taxpayer is any company (which includes construction firms) incorporated under the laws of Ethiopia. Most of their comprehensive audit reports on financial statements are accessible from the Ethiopian Revenue and Customs Authority (ERCA). Additional data on KAM disclosure and the auditor were also collected from the firm's annual report. Ensuring the consistency of coding of KAMs through categories and level of risk was emphasized more during this research. In the sampling process, 2,698 construction firms were excluded because they are not grade-one construction companies and category “A” taxpayers (no requirement for a comprehensive audit report). The process results in 421 grade-one construction firms. Then, another criterion was set for the accessibility of audited financial reports within the period, and 334 grade-one

construction companies were dropped due to not having all necessary data in the specified period. The reason is that some of those firms were established after 2021, and some quit or stopped operations due to litigation issues during the period. The sample selection process is summarized in Table 23, and the final sample encompassed 87 grade-one construction firms and 435 firm-year observations.

Table 23. Study V: Sample selection procedure

The sample: Construction companies and company-year observations	
Initial sample: All construction firms registered in EMUDC in 2017	3,119
Less: Construction firms not registered as grade one	(-) 2,698
Grade one construction firms	421
Less: Construction firms with no required data of the consolidated annual statement (2017–2021)	(-) 334
Total construction firms of the sample: Firms with all consolidated annual statement data in ERCA (2017–2021)	87
Firm-year observations total (87*5)	435

6.3.2. Regression models

This study has developed three pooled OLS regression models to examine the issue. Definitions for all variables included in the model are presented in Appendix Table D1. The first research question (RQ1) examines the relationship between the number of KAMs reported by auditors and the client firm's financial distress level. Hence, the following OLS regression model was developed to answer it considering each client's firm-year observations.

Model 1:

$$FIDT_{it} = \beta_0 + \beta_1 NKAM_{it} + \sum \text{CONTROLS} + \varepsilon_{it}$$

The total number of KAMs in each sampled firm for the periods was calculated as applied by previous literature (Lennox et al., 2022; Sierra-García et al., 2019). As a measurement for the dependent variable (FIDT), Altman's eZ''-Score model was applied (continuous variable). The revised version of Altman's (1983) Z-score model, which is accepted by various studies (Habib et al., 2020; Altman et al., 2017; Balcaen & Ooghe, 2006) and practice as a main bankruptcy prediction technique, was used. The following four-factor model was used to calculate the Z''-Score.

$$Z''\text{-Score} = 3.25 + 6.56Z_1 + 3.26Z_2 + 6.72Z_3 + 1.05Z_4$$

The following four most accurate financial ratios for bankruptcy prediction are included in the top ten ranks made by Bellovary et al. (2007). The working capital to total assets ratio (Z_1), retained earnings to total assets ratio (Z_2), earnings before interest and taxes to total assets ratio, and book value of equity to total liabilities ratio. Generally, the threshold value for financial distress is 2.6; a Z'' -Score above this value indicates a safe. If a firm has a Z'' -Score below the threshold value, it is in the distress or grey zone, meaning it is more likely to have financial problems in the short term. In this study, the Z'' -Score value measures FIDT (increasing FIDT means a lower risk of financial distress)

Based on the suggestions of previous studies (Sierra-García et al., 2019; Lennox et al., 2022), this study included control variables (CONTROLS) such as client and auditor characteristics that can impact KAM disclosure. The study included audit fee (ADFE), audit opinion (ADOP), and auditor change (ADCH) for auditor characteristics. It also included construction firm size (CFSZ) and the existence of a restatement (REST) for client characteristics. As Lennox et al. (2022) suggested, this study also included the fixed effect of year and industry categories to capture issues regarding time-serious trends and industry characteristics.

This study's second research question (RQ2) was posed to examine the relation between the type of KAMs and financial distress. The relationship of KAMs to the level of risk, such as account-specific (AKAM) or company-wide (CKAM), with the firm's financial distress was examined using the following OLS regression (Model 2). For a given year, the sum of the client firm's account-level and company-wide KAMs are represented by AKAM and CKAM, respectively (see Table 23).

Model 2:

$$FIDT_{it} = \beta_0 + \beta_1 AKAM_{it} + \beta_2 CKAM_{it} + \sum \text{CONTROLS} + \varepsilon_{it}$$

Considering the last research question (RQ3), the study examined the effect of KAMs by classifying the financial impact on financial distress levels. Account-specific KAMs were classified by liquidity, solvency, or profitability. Similarly, company-wide KAMs were classified by going concern (GOCN) or other company-wide risks (OCWR). The following OLS regression model was developed to study the relationships.

Model 3:

$$FIDT_{it} = \beta_0 + \beta_1 FLQY_{it} + \beta_2 FSLY_{it} + \beta_3 FPRY_{it} + \beta_4 GOCN_{it} + \beta_5 OCWR_{it} + \sum \text{CONTROLS} + \varepsilon_{it}$$

The number of KAMs regarding doubts about the viability of a firm is represented by (GOCN), and the number of company-wide KAMs other than going concern is represented by (OCWR). (Restructuring and discontinued operations, Merger and acquisition (M&A) accounting, Tax-related, Litigation etc). The number of KAMs primarily impacting a firm's liquidity, solvency, and profitability is represented by FLQY, FSLY, and FPRY, respectively. Generally, the sampled construction firms' KAM disclosures reported by auditors and the classifications made to each KAM (based on the previous literature) are presented in Table 24.

Table 24. Study V: Key audit matters categorization

Risk-Level	Classification	Variable code	Variable description	Source
Account-specific KAMs (AKAM)	Liquidity	FLQY	Number of KAMs disclosed related to liquidity	Bellovary et al. (2007) and Camacho-Minano et al. (2023)
	Solvency	FSLY	Number of KAMs disclosed related to solvency	Bellovary et al. (2007) and Camacho-Minano et al. (2023)
	Profitability	FPRY	Number of KAMs disclosed related to profitability	Bellovary et al. (2007) and Camacho-Minano et al. (2023)
Company-wide KAMs (CKAM)	Going concern	GOCN	Number of KAMs disclosed related to going concern	Camacho-Minano et al. (2023)
	Other than going concern	OCWR	Number of KAMs disclosed other than going concern	Camacho-Minano et al. (2023)

6.4. Major findings

6.4.1. Descriptive statistics

The summarized descriptive statistics of sampled company-year observations and reported KAMs are presented in Table 25. The company-year observations distribution in the year and industry categories are presented in Panel A. The most represented construction

industry category is building construction (BDC) (62.1%), followed by general construction (GLC) (34.5%) and road construction (RDC) (3.4%). Moreover, the number of KAMs distributed in the year is presented in Panel B. The number of client firms reported KAMs ranges from 1 to 5 annually. The overall mean is 2.94, declining slightly throughout the sample from 3.14 to 2.94 in 2017 and 2021, respectively. The number of KAMs distributed by risk level and classification in the year is presented in Panel C (Table 23). Across the sample of 435 firm-year observations, 1277 KAMs are distributed. Considering KAMs' risk level in years, the number of reported company-wide KAMs (34.6%) is lower than account-specific KAMs (65.4%). From the reported account-specific KAMs, the most disclosed KAMs are concerning solvency (31.7%), followed by profitability (20.5) and liquidity (13.2%). From the reported company-wide KAMs, 86 KAMs (7.6%) are concerning the company's going concern, and 339 KAMs (27.9%) are other company-wide KAMs.

Table 25. Study V: Descriptive statistics of sampled company-year observations

Panel A. Company-year observation distribution in the year and industry category							
<u>Construction industry category (CINC)</u>	2017	2018	2019	2020	2021	Total	%
General construction (GLC)	24	34	42	25	25	150	34.5
Building construction (BDC)	61	53	41	59	56	270	62.1
Road construction (RDC)	2	0	4	3	6	15	3.4
Total	87	87	87	87	87	435	100

Panel B. Summary of KAMs reported in the year						
<u>KAMs reported (NKAM)</u>	2017	2018	2019	2020	2021	Means
Mean No. of KAMs	3.14	2.86	2.74	3.00	2.94	2.94
Std. Dev. No. of KAMs	1.36	1.43	1.43	1.32	1.27	1.36
Min. No. of KAMs	1	1	1	1	1	1
Max. No. of KAMs	5	5	5	5	5	5

Panel C. Number of KAMs distribution by risk level and classification in year								
<u>KAMs Classification</u>		2017	2018	2019	2020	2021	Total	%
AKAM	FLQY	39	30	31	38	30	168	13.2
	FSLY	84	83	70	87	81	405	31.7
	FPRY	57	48	55	45	57	262	20.5
	Sub-total AKAM	180	161	156	170	168	835	65.4
	%	14.1	12.6	12.2	13.3	13.2	65.4	
CKAM	GOCN	18	22	19	18	9	86	6.7
	OCWR	75	66	63	73	79	356	27.9

	Sub-total CKAM	93	88	82	91	88	442	34.6
	%	7.3	6.9	6.4	7.1	6.9	34.6	
Total		273	249	238	261	256	1277	
NKAMs								
%		21.4	19.5	18.6	20.4	20.0	100	
Panel D. Summary of averaged audit fees (,000 ETB) in year								
		2017	2018	2019	2020	2021	Total	
Audit fees (ADFE)		12019.08	12776.55	12948.37	12119.33	12203.94	62067.291	
Panel E. Summary of the nature of opinion issued in the year								
Audit opinion (ADOP)		2017	2018	2019	2020	2021	Total	%
Unqualified and non-going concern		75	74	70	77	77	373	85.7
Qualified for going concern		12	13	17	10	10	62	14.3
Panel F. Summary of firms' auditor change in the year								
Auditor change (ADCH)		2017	2018	2019	2020	2021	Total	%
Not occurred		61	69	65	67	66	328	75.4
Occurred		26	18	22	20	21	107	24.6
Panel G. Distribution of firm size in the year								
Construction firm size (CFSZ)		2017	2018	2019	2020	2021	Total	%
Small		15	15	14	12	11	67	15.4
Medium		49	38	31	52	51	221	50.8
Large		23	34	42	23	25	147	33.8
Panel H. Distribution of existence of restatement in year								
Restatement (REST)		2017	2018	2019	2020	2021	Total	%
Not existed		64	63	60	64	57	308	70.8
Existed		23	24	27	23	30	127	29.2

Besides, the average yearly total audit fees (in thousands of Ethiopian Birr) of firms in the sample are presented in Panel D. The average audit fees show a slight increment across the sample period (2017 to 2021). In addition, the summary of the nature of the opinion issued in the year is presented in Panel E. 85.7% (373) of company-year audit reports are an unqualified and non-going concern. Qualified for going concern, audit reports accounted for 14.3% (62) of the total audit reports. This result is consistent with previous literature (Feldmann & Read, 2010), highlighting that qualified audit reports for going concern are rare. In this study, the result about going concern doubts has to be noted; hence, 14.3% of the sample received KAMs paragraph regarding going concern. Based on this evidence, the firm's future viability may be disclosed by auditors, preferably in the KAMs paragraph rather than the extremely going concern opinions.

The descriptive statistics and univariate analysis of FIDT and the number of key audit matters are presented in Table 26. The link between the values of FIDT and the number of KAMs is displayed in Panel A. Client construction firms have a mean of 13.145 and 3.872 FIDT, as they have one and five KAMs in their audit report, respectively. The result reflects that construction companies with one KAM are financially healthier than companies with five KAMs based on Altman (1983). Hence, as the number of KAMs increases, the mean value of FIDT (representing the firm's financial distress level) decreases; hence, the risk of financial distress increases.

In addition, the sample of this study was divided into two subsamples, such as firm years having a lower number of KAMs (less than three) and a higher number of KAMs (greater than or equal to three). The t-test of means deference is presented in Panel B (Table 26). The result shows a significant mean difference between the two groups, and the FIDT means differ. Generally, this result of univariate analysis partly answers the first research question since construction firms having greater than or equal to three KAMs disclosed are more likely to be financially distressed than construction firms having less than three KAMs disclosed.

Table 26. Study V: Descriptive statistics and univariate analysis of FIDT and NKAMs

Panel A. Descriptive statistics					
<u>NKAM</u>	<u>Obs.</u>	<u>Mean FIDT</u>	<u>Std. Dev. FIDT</u>	<u>Percentile 5</u>	<u>Percentile 95</u>
1	85	13.145	1.266	11.832	15.254
2	89	10.936	.485	10.178	11.671
3	105	8.954	.656	7.996	10.055
4	81	6.898	.597	5.864	7.772
5	75	3.872	1.383	1.008	5.628
Total	435	8.919	3.217	3.187	13.633
Panel B. Univariate analysis					
<u>NKAM</u>	<u>Obs.</u>	<u>Mean FIDT</u>	<u>Std. Dev. FIDT</u>	<u>p-value</u>	<u>t-test</u>
>= 3	261	6.86	2.27	0.000	-26.507***
< 3	174	12.02	1.46		

6.4.2. Correlation and regression outputs

The test result in Table 27 show, overall, there is a statistically significant and medium correlation between the FIDT and the independent variables included in the models. However, the correlations of FIDT with company characteristics, such as restatement (REST), and auditor

characteristics, such as auditor change (ADCH), are low. Most of the relationships between KAMs and FIDT are negative and significant. FIDT and NKAM have a significant correlation value of -0.955 , which shows that as the number of KAM increases, the value of FIDT decreases (the risk of financial distress increases). The study also found a significantly negative correlation between AKAM and CKAM. The FIDT correlation with AKAM and CKAM classifications is also significantly negative. Besides, the correlation result revealed no multicollinearity problem among the variables included in the regression models.

Table 27. Study V: Correlation matrix

	FIDT	NKAM	AKAM	CKAM	FLQY	FSLY	FPRY	GOCN	OCWR	ADFE	ADOP	ADCH	CFSZ	REST
FIDT	1.000													
NKAM	-0.955	1.000												
AKAM	-0.922	0.087	1.000											
CKAM	-0.448	0.622	0.155	1.000										
FLQY	-0.426	0.384	0.449	0.056	1.000									
FSLY	-0.464	0.460	0.494	0.136	-0.192	1.000								
FPRY	-0.444	0.410	0.504	0.022	0.033	-0.268	1.000							
GOCN	-0.372	0.486	0.257	0.567	0.093	0.143	0.128	1.000						
OCWR	-0.203	0.309	-0.042	0.687	-0.016	0.036	-0.088	-0.210	1.000					
ADFE	0.996	-0.094	-0.090	-0.472	-0.420	-0.451	-0.432	-0.350	-0.252	1.000				
ADOP	0.589	-0.579	-0.347	-0.610	-0.179	-0.190	-0.134	-0.160	-0.583	0.641	1.000			
ADCH	-0.061	0.051	0.008	0.089	0.032	-0.016	0.004	0.041	0.069	-0.067	-0.126	1.000		
CFSZ	0.901	-0.089	-0.082	-0.496	-0.375	-0.407	-0.407	-0.416	-0.222	0.089	0.492	-0.139	1.000	
REST	0.003	-0.012	0.029	-0.070	0.066	-0.035	0.028	-0.059	-0.031	0.008	0.080	0.057	0.016	1.000

This study used three regression models to address the research questions (RQ1, RQ2, and RQ3). The results of the first model (Model 1) in Table 28 display that there is a significantly negative relationship (-0.195) between the number of KAMs (NKAM) and the level of financial distress (FIDT). The result indicates that the risk of financial distress rises as the number of KAMs reported increases (RQ1). Considering the economic significance, the firm's risk of financial distress is increased by 19.5% with an increase in KAMs. From this result, the study suggested that financially distressed client construction companies get, on average, about four KAMs ($2.94 \times 1.195 \approx 4$) disclosures. The value is rounded, and the mean number of KAMs per sample firm, 2.95, was considered (see Table 25, Panel B).

The relationship between the firm's financial distress and KAM type was also examined using two different regression models (to answer RQ2 and RQ3). The results of the second model (Model 2) in Table 28 display that both the number of account-specific KAMs (AKAM) and company-wide KAMs (CKAM) have a significantly negative relation with FIDT (firm's Z'' Score value). The higher coefficient of AKAM over CKAM indicates that the overall account-specific KAMs capture more structural risks (financial distress) than company-wide KAMs. Considering the economic significance, the firm's risk of financial distress is increased by 34.7% and 16.1% for an increase in AKAM and CKAM, respectively (RQ2).

Table 28. Study V: Pooled OLS regression model

Model	Model 1	Model 2	Model 3
Dependent variable	FIDT	FIDT	FIDT
NKAM	-0.195*** (0.069)		
AKAM		-0.347*** (0.121)	
CKAM		-0.161*** (0.060)	
FLQY			-0.329** (0.125)
FSLY			-0.330*** (0.117)
FPRY			-0.316** (0.128)
GOCN			-0.205*** (0.060)
OCWR			-0.05 (0.064)
Observations	435	435	435
R-squared	99.68	99.71	99.74
F-Statistics	12384.01***	20194.89***	1686.83***
Fixed effects (industry category and year) and controls	Yes	Yes	Yes
Model VIF	5.29	6.24	6.02

The average number of AKAM and CKAM per firm is 1.92 and 1.02 (835/435 and 442/435), respectively (see the distribution in Table 25, Panel C). From the results, the study

suggests that, on average, out of the four KAMs disclosed by financially distressed client construction companies, about three KAMs ($1.92 \times 1.347 \approx 3$) are AKAM, and one KAM ($1.02 \times 1.161 \approx 1$) is CKAM (the values are rounded).

The third model (Model 3) separates the going concern (GOCN) from other company-wide KAMs (OCWR) and groups account-specific KAMs by their primary impact on the construction company's liquidity (FLQY), solvency (FSLY), and profitability (FPRY). The results in Table 28 display that liquidity (-0.329), solvency (-0.330), profitability (-0.316), and going concern (-0.205) have a significantly negative relation with the firm's level of financial distress (FIDT). However, other company-wide KAMs (-0.05) have insignificant and negative relations with FIDT. A likely reason for this result is that identifying company-wide KAMs other than going concern is more challenging for the auditor; hence, OCWR could have less predictive power than other KAM classifications.

The result of GOCN corresponds with previous literature (Camacho-Minano et al., 2023; Munoz-Izquierdo et al., 2020; Basioudis et al., 2008; Gutierrez et al., 2020) examining the relationship between the level of firms' financial distress and going concern, that shows a significant relation. Although the sign of the relationship between FIDT and OCWR is supported by previous literature (Camacho-Minano et al., 2023; Alexeyeva & Sundgren, 2021; Balcaen & Ooghe, 2006., 2006) made considering mergers and acquisitions as company-wide KAMs, the significance has not corresponded.

In addition, the result of FLQY is supported by some previous financial distress literature (Bepari et al., 2022; Altman et al., 2017), evidencing that liquidity measures better predict a firm's bankruptcy. However, the result contradicts the recent study of Camacho-Minano et al. (2023), which concluded that firm liquidity has no substantial impact on a firm's financial distress. The studies mentioned above included KAMs on inventory, earnings management, accrual, deferral, cash, and receivable as liquidity-related KAMs. Besides, the result of FSLY is supported by previous literature (Bepari et al., 2022; Camacho-Minano et al., 2023; Munoz-Izquierdo et al., 2020; Altman et al., 2017; Carson et al., 2013) made on firm's bankruptcy and confirming leverage measures are perfect company default predictors. Those studies included KAMs on intangible intensity, leverage, liabilities, contingencies, leases, long-term debt, and

pension as solvency-related KAMs. Finally, the result of FPRY is also supported by previous literature (Camacho-Minano et al., 2023; Jansen et al., 2012; Habib et al., 2020; Li et al., 2020; Altman, 1983; Altman et al., 2017; Lukason & Laitinen, 2019) examining financial distress using ratios-based business failure prediction models and confirmed that measures of profitability best predict a firm's bankruptcy. Those studies included KAMs on revenue accounts and earnings management as profitability-related KAMs.

6.4.3. Tests of robustness

This study employed three alternative financial distress measures to examine the robustness of the outcomes and the dependent variable (FIDT). Those are the Z''- Score (FIDT_{Zsv}) indicator variable, the Charitou's (2004) Score (FIDT_{ch}), and the Charitou's Score (FIDT_{chv}) indicator variable (see Appendix Table D1 for definitions). Firstly, the untabulated results of the logistic regression model show there is a significant relation (−0.167) between FIDT_{Zsv} and the number of KAMs, which supports the findings of the study's main model. The pseudo R² of the model is 45.1%, and the area under the curve (AUC) of the model is 0.724, indicating the level of financial distress can efficiently be explained by the number of KAMs variables and their classification. Secondly, the FIDT_{ch} measure was also employed, and the study's main findings were supported since the untabulated results show that a high likelihood of financial distress can be reflected by expanded audit reports having a high number of KAMs and similar results found for KAMs classification (see Table 28). Thirdly, a logistics regression for the indicator variable FIDT_{chv} (Charitou's score indicator) was made, and the outcomes (untabulated) for the number of KAMs variables and thier classifications are similar to the results of FIDT_{Zsv}.

6.4.4. Endogeneity tests

Two-step system GMM estimator

This study used this approach to address concerns regarding unobservable omitted variables and measurement errors that influence FIDT. It is also used to address issues on simultaneous causality since the client construction companies' weak financial health may determine the disclosure of KAMs. Compared to a one-step GMM estimator, this estimator is more accurate in correcting measurement errors (Roodman, 2009). The results of the GMM

estimator are presented in Table 29, Model 4. The issues regarding the proliferation of instruments and serial autocorrelation of errors are addressed in this test.

Propensity score matching (PSM)

The study used the PSM test to alleviate the specification dependency of the relation between NKAM and FIDT. The study created treatment and control groups to analyze the NKAM variable. The indicator variable TRMT was coded as 0 for audit reports having less than three KAMs and 1 otherwise (the auditor and client construction firm characteristics were controlled). The first-stage regression results of Model 5 in Table 29 show a significant relationship between the control variables and TRMT. Auditor characteristics such as audit fee (ADFE) and audit opinion (ADOP) and client firm characteristics such as construction firm size (CFSZ) are significantly related to the disclosure of KAMs.

The second-stage regression of Model 6 in Table 29 used the propensity score (Mypscore) to assess each audit report's low and high number of KAMs. Audit reports that disclosed less than three KAMs were considered low and coded as 0, while 1 represents high (having three or more KAMs). The result shows that the relation between FIDT and NKAM is still significantly negative (-0.193), confirming the study's main results, which show that KAMs accurately reflect financial distress.

Change specification model

The study further applied a change specification model to see if KAMs are not simply driven by the firms' poor fundamentals. KAM disclosure may primarily rely on the financial condition of firms because of the calculation of Z''-Score in the main model (FIDT). This endogeneity concern was addressed using change specification models. This study created an indicator variable NKAM_g, which is the change of NKAM between t and $t-1$. The regressions were re-estimated, and the result of Model 7 in Table 29 show similar results to Table 28 (significantly negative coefficient of -0.015); hence, construction firms' financial distress level can accurately be assessed with KAMs.

Table 29. Study V: Two-step-system generalized method of moments (GMM), Propensity score matching (PSM), and changes of the main independent variable model

Model	Model 4	Model 5	Model 6	Model 7
	Two-step	First stage	Second stage	Change
Robustness tests	GMM	PSM	PSM	specification model
<u>Dependent variable</u>	<u>FIDT</u>	<u>TRMT</u>	<u>FIDT</u>	<u>FIDT</u>
FIDT _{ln}	-0.063* (0.050)			
NKAM	-0.323** (0.171)		TRMT -0.193*** (0.064)	
NKAM _g				-0.015** (0.008)
ADFE	0.022*** (0.007)	-0.005*** (0.001)	0.064*** (0.001)	0.065*** (0.001)
ADOP	-0.526*** (0.140)	0.225*** (0.050)	-0.684*** (0.052)	-0.721*** (0.047)
ADCH	-0.011 (0.033)	-0.034 (0.033)	0.088 (0.025)	0.013 (0.025)
CFSZ	0.110 (0.069)	0.164*** (0.041)	0.205** (0.082)	0.158** (0.073)
REST	-0.060 (0.048)	0.004 (0.028)	0.029 (0.033)	0.024 (0.035)
Observations	348	435	435	435
R-squared			99.65***	99.64***
Wald test	68.32***			
F-Statistics				9698.28***
Fixed effects (industry category and year)	Yes	Yes	Yes	Yes
Model VIF	6.05		4.18	3.35
AR (1) (p-value)	-2.07 (0.038)			
AR (2) (p-value)	-1.45 (0.209)			
Hansen test (p-value)	2.20 (0.333)			
Diff-Hansen test (p-value)	4.35 (0.226)			

6.5. Conclusions and implications

This study was focused on examining the usefulness of improved transparency of the audit process through KAMs in assessing client construction firms' financial distress risk. Recent calls for further investigations were considered from the literature (Minutti-Meza, 2021;

Camacho-Minano et al., 2023; Chen et al., 2023). The relationship between KAMs and financial distress was examined by filtering grade-one construction firms registered in the Ethiopian Ministry of Urban Development and Construction from 2017 to 2021, resulting in 435 firm-year observations.

The result of this study shows that KAMs reported by auditors are valuable in predicting and assessing a firm's risk of financial distress. The finding evidenced that the risk level of financial distress in construction companies rises as the disclosed number of KAMs increases. The number of KAMs and the nature of KAMs are also found to be substantial in assessing a firm's financial distress level. The finding shows that account-specific KAMs are more substantial in assessing a firm's financial distress than company-wide KAMs. Account-specific KAMs grouped based on their primary impact as liquidity, solvency, and profitability were useful in assessing a firm's financial distress. However, in the company-wide KAMs, only going concern was found significant in assessing the extent of the firm's financial distress. The results were found robust after being checked by alternative financial distress measures and endogeneity tests.

The finding of this study is highly pertinent and has wide-ranging implications for construction firms and their stakeholders, such as investors, auditors, and regulators. Firstly, it promotes accountability and transparency within the construction firms, developing a financial responsibility culture. It also sheds light on the specific financial operations of construction firms with high distress risk, eventually improving the industry's sustainability. Secondly, the findings can assist regulators in assessing the cost-benefit of new regulations on expanded audit reporting (auditor's requirement for KAM disclosure) for the construction industry. It can provide directions for regulatory changes to confirm that auditors properly examine critical areas through audits. Thirdly, auditors may benefit from this study by assessing potential clients' engagement risk and providing audit report disclosers for users as an alternative going concern signal about the firm. Finally, this study is also beneficial to users of financial reports as the study conducted a new approach to evaluating the financial health of firms using public auditor (independent) data.

Acknowledging the study's limitations is essential, and the following are limitations which may guide future research and researchers. The number of construction firms included in

the sample and the data availability may constrain the generalizability of the findings. The time frame may limit the relevance of the study's findings since regulatory frameworks and economic conditions may change over time. The distinctive features (regulatory, economic, and cultural) of Ethiopia's construction industry (regulatory, economic, and cultural) may also limit the generalizability of the findings to other countries.

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Appendix D

Table D1. Study V: Variables and their definitions

A. Dependent variables

In the main analysis:	
FIDT	Altman's Z'' - Score of sampled grade one construction companies and calculated as: $3.25 + 6.56 \times Z_1 + 3.26 \times Z_2 + 6.72 \times Z_3 + 1.05 \times Z_4$ Z_1 = (Current assets minus current liabilities) divided by total assets Z_2 = Retained earnings divided by total assets Z_3 = Earnings before interest and taxes divided by total assets Z_4 = Book value of equity divided by total liabilities
In the test of robustness and endogeneity:	
FIDT _{zsv}	Altman's Z'' -Score classification and coded as: 1 if score ≥ 2.6 (safe zone) and 0 if score < 2.6 (grey and distressed zone)
FIDT _{ch}	Charitou's score of sampled grade-one construction companies was calculated as follows:

	$1/1 + \text{EXP}\{-7.1786 + [12.3826 \times (\text{TL}/\text{TA})] - [20.9691 \times (\text{NI}/\text{TL})] - [3.0174 \times (\text{OPCF}/\text{TL})]\}$
FIDT _{chv}	Charitou's Score classification and coded as follows: 1 if the score ≥ 0.2 (Non-distressed) and 0 if the score < 0.2 (Distressed)
FIDT _{ln}	The lagged value of FIDT used for the endogeneity test

B. Independent variables

In the main analysis and test of endogeneity:

NKAM	The number of disclosed KAMs by an auditor
NKAM _g	Change of number of disclosed KAMs between period t and t-1
AKAM	Account-specific KAMs
CKAM	Company-wide KAMs
FLQY	KAMs on liquidity
FSLY	KAMs on solvency
FPRY	KAMs on profitability
GOCN	KAMs on going concern
OCWR	KAMs on other company-wide risks
ADFE	The amount of total audit fees
ADOP	Audit opinion coded as 1 if qualified for going concern, 0 otherwise)
ADCH	Auditor change coded as 1 if occurred, 0 not occurred)
CFSZ	Construction firm size is coded as 1 if small, 2 if medium, and 3 if large
REST	Restatement coded as 1 if existed, 0 not existed)

Appendix E

Key comments from reviewers, the corresponding author responses, and the final editorial and defense decisions are summarized below.

Table E1. Summary of key reviewer feedback, author responses, and editorial and defense outcomes

Study	Journal	Key Reviewer Comments Summary	Author Responses Summary	Final Editorial Decision Letter Summary
I	HSSCOMMS	“Clarify research gap and objectives; strengthen methods; restructure discussion and conclusion; improve references and language; highlight contributions.”	Revised introduction and gap; clarified SLR methodology; added theoretical and practical contributions; reorganized discussion and conclusion; updated references and language.	Accepted; “Your manuscript (HSSCOMMS-13608R2) has been accepted for publication in Humanities and Social Sciences Communications. Reviewer comments were addressed satisfactorily. Publication is expected within 4–6 weeks, pending completion of required documents and approval of typeset proofs. You will be notified by email once it is published.”
II	JIPD	“Strengthen originality; clarify sampling and data collection; link hypotheses to theory; expand implications; state limitations; improve coherence.”	Emphasized novelty and context; detailed sampling and survey method; grounded hypotheses in TOE; expanded implications and limitations; improved structure and clarity.	Accepted; “Your manuscript (JIPD-8819) has been accepted by the Journal of Infrastructure, Policy and Development. All reviewer suggestions have been incorporated. Please carefully review the attached galley proof and return it within 48 hours. This is the final opportunity for textual changes; subsequent proofreading will be limited to typographical and layout corrections, and all authors must confirm the final version, including names, affiliations, and funding acknowledgments.”

III	JOITMC	“Define key constructs; justify context; strengthen theoretical grounding; detail methodology and analysis; update literature; address limitations.”	Defined concepts; justified study context; grounded hypotheses in Contingency, RBV, TOE, and TAM; detailed methodology and regression analysis; updated literature; strengthened discussion.	Accepted; “Your manuscript (JOITMC-D-25-00485R1) has been accepted for publication in <i>Journal of Open Innovation: Technology, Market, and Complexity</i> . It will now enter production, during which you will review proofs and complete required forms. Reviewer feedback indicates that your revisions addressed their comments. You have also been added to the journal’s reviewer pool.”
IV	JIPD	“Clarify sampling and sample size; ensure validity and reliability; expand CAAT and sustainability literature; highlight originality; explain CAATs used.”	Explained sampling and power analysis; addressed reliability and bias; expanded literature; clarified contributions and novelty; detailed CAAT tools and fraud detection role.	Accepted; “Your manuscript (JIPD-2690) has been accepted by the Journal of Infrastructure, Policy and Development. All reviewer comments have been addressed. Please proceed with the Article Processing Charge (APC) payment as detailed in the attached invoice.”
V	TJCM	“Clarify gap and objectives; separate literature review; explain methodology and sample; address missing data; improve references; discuss implications and limitations.”	Clarified objectives; added standalone literature review; detailed methodology and sample selection; addressed missing data; standardized references; expanded implications and limitations.	Accepted; “Your manuscript (TJCM-2023-0696R1) has been accepted for publication in the International Journal of Construction Management as of November 19, 2023. Reviewer comments indicate that your revisions satisfactorily addressed their concerns.”
I–V	Dissertation (multiple studies)	“Incorporate qualitative methods (interviews, case studies) and follow-up research in future directions; link research questions more directly to findings and use diagrams/tables to clarify stakeholder relevance	Added discussion of qualitative and follow-up approaches in future research directions; added a summary table linking research questions, findings, implications, and recommendations for stakeholders; expanded and proposed comparative	Acceptable with minor revisions. Both reviewers agree that the dissertation makes a significant and methodologically rigorous contribution to auditing research in emerging economies, meets the standards required for a Ph.D., and is recommended for acceptance with minor revisions.

and recommendations; propose study discussion across emerging comparative studies across and developed countries; and similar or different countries to updated Chapter 1 by adding a new test generalizability with clear subsection incorporating recent justification; update AI auditing (2024–2026) AI auditing literature, literature beyond 2021, reflected also in the research including generative AI, LLMs, framework. and regulatory frameworks.”

Glossary

Account-Specific Key Audit Matters (AKAM): Issues highlighted by auditors that relate directly to individual financial statement items, such as inventory balances, revenue accounts, or receivables.

Age of Digital Revolution: The current period is characterized by rapid technological change, where digital tools have a profound influence on business and economic activity.

AI Adoption: The process by which audit departments begin using AI-based systems within routine audit work.

Altman's Z-Score: A composite financial indicator that estimates a company's likelihood of bankruptcy using a mix of profitability, leverage, and efficiency ratios.

Analytical Framework: A systematic outline describing the stages of a study, from gathering data to analyzing results and ultimately reporting findings.

Artificial Intelligence (AI): Computer systems designed to perform tasks that generally require human reasoning, such as identifying patterns or supporting decisions.

Audit Committee Expertise (ACEX): The combined financial, accounting, and oversight competence of audit committee members, shaping the strength and effectiveness of corporate monitoring.

Audit Fees (ADFE): The total compensation a company pays its external auditor for performing the annual audit and related assurance work.

Audit Opinion (ADOP): A coded indicator representing whether an auditor issued a clean opinion or raised qualifications about the financial statements.

Audit Tenure (ATTR): The number of consecutive years the same client has engaged an audit firm.

Audit Transition: The shift from one audit method, standard, or approach to another, requiring changes in procedures and overall audit practices.

Auditing Practice: The systematic process through which auditors examine, verify, and evaluate an organization's financial and operational information to ensure accuracy, compliance, and accountability.

Auditor Change (ADCH): A signal of whether the client replaced its external auditor during a particular period.

Auditor Rotation (ATRO): A binary measure marking whether the audit firm responsible for a client changed in the current year.

Auditor's IT Competency: The degree to which an auditor is proficient in using technology, especially tools designed to support automated or data-driven audit procedures.

Binary Classification of Financial Distress (FIDTzsv / FIDTchv): Variables that divide firms into distressed or non-distressed categories based on Z-score criteria or Charitou's financial distress model.

CAAT Utilization (CATU): A measure of how frequently and thoroughly auditors employ Computer-Assisted Audit Tools during their engagements.

Charitou Score (FIDTch): A financial distress measure derived from a model that incorporates leverage, profitability, and cash-flow-related factors.

Client Retention Rate (CRR): The portion of clients that an audit firm retains over a defined time horizon.

Company Age (COAG): The number of years a firm has been in existence since its founding.

Company Size (COSI): An indicator of an organization's scale, commonly captured through total assets, revenues, or workforce size.

Company-Wide Key Audit Matters (CKAM): Audit issues that affect the entire organization, highlighting significant risks or complexities relevant across all company operations.

Computer-Assisted Audit Techniques (CAATs): Digital tools and methods that help auditors analyze data, perform tests, and enhance the efficiency and reliability of audit procedures.

Construction Firm Size (CFSZ): A classification system grouping construction companies into small, medium, or large categories based on operational magnitude.

Dependent Variable: The core outcome in a study that is being explained, predicted, or influenced by other variables.

Digital Revolution: A significant shift driven by widespread digital technologies that reshape how information is produced, shared, and used.

Emerging Markets: Economies transitioning toward higher industrialization and investment, characterized by rapid growth, expanding infrastructure, and increasing technology adoption, traits observed in several fast-growing East African nations.

Error Detection (DER): The application of CAATs to identify inaccuracies or irregularities in audit evidence or accounting systems.

Explanatory Research: Research designed to uncover the underlying reasons or mechanisms that link variables in a study.

Financial Distress (FIDT): A condition indicating that a firm may struggle to meet its obligations, often quantified using models like Altman or Charitou.

Financial Performance (FIPR): Measures reflecting how effectively a company operates, such as profitability, liquidity, or return metrics.

Financial Restatement (REST): A revision of previously released financial statements due to discovered errors or omissions.

Fraud Detection (FRDT): The process of identifying suspicious or intentionally misleading activities within financial records.

Going Concern Opinion (GOCN): An auditor's statement indicating whether significant doubt exists regarding a company's ability to continue operating in the near future.

Industry Category (CINC): A classification of firms based on the primary sector or market in which they operate.

Internal Audit Function (IAF): The internal department tasked with providing independent evaluations of risk management, governance, and internal controls.

Internal Control: Systems and procedures intended to safeguard assets, ensure reliable reporting, and support efficient operations.

Key Audit Matters (KAMs): Topics that auditors judge to be most significant in the audit due to complexity, estimation uncertainty, or risk.

Lagged Financial Distress (FIDT_In): The prior period's financial distress measure used to reduce bias and capture temporal effects in analysis.

Leverage (LEVR): The extent to which a company relies on borrowed funds, typically expressed as a ratio to equity or total assets.

Non-Financial Performance: Organizational outcomes that are not directly measured in monetary terms, such as client retention, employee turnover, operational efficiency, service quality, innovation, governance, and social impact.

Number of Key Audit Matters (NKAM): The count of significant audit issues disclosed in the auditor's report.

Organizational Readiness (OGR): The degree to which a firm is prepared (structurally and culturally) to adopt new audit technologies.

Performance: A broad measure of how effectively an organization achieves its financial, operational, or strategic objectives, usually evaluated through predefined indicators.

Professional Certifications: Designations auditors earn through examination and training, such as CPA, ACCA, or CA.

Regression Analysis: A statistical technique used to examine how one variable changes in response to one or more predictors.

Resource-Based View (RBV): A theory asserting that unique internal assets (tangible or intangible) can give an organization lasting competitive advantages.

Restatement (REST): A binary variable marking whether a company has issued corrected financial statements.

Risk Assessment: A structured process used by auditors and managers to identify, analyze, and evaluate potential risks that may affect an organization's objectives, performance, or compliance.

Risk of Errors Assessment (RKE): An evaluation, often supported by CAATs, that identifies areas in the audit where mistakes or irregularities are more likely.

Sustainability Reporting: The communication of a company's environmental, social, and governance practices and their outcomes.

Sustainability: The practice of managing economic, environmental, and social resources in ways that meet present needs without compromising future generations—often assessed through ESG (Environmental, Social and Governance) metrics.

Systematic Literature Review (SLR): A structured approach to identifying, evaluating, and synthesizing research evidence on a defined topic.

Technology Acceptance Model (TAM): A framework that explains user adoption of new technology based on perceived usefulness and ease of use.

Technology Adoption: The integration and implementation of new technological tools within an organization's audit practices.

Technology-Organization-Environment (TOE) Framework: A model describing how technological characteristics, organizational conditions, and external factors collectively influence adoption decisions.

Transparency: The degree to which an organization openly communicates its processes, decisions, and performance information.

Trustworthiness: The confidence auditors have that technological tools will function reliably and deliver accurate, dependable results.