ACADEMIA MILITAR

Artificial Intelligence in Auditing Practices: A Conceptual Framework for the National Republican Guard

Aspirante de Administração da GNR Diogo José Saraiva Leocádio

Dissertação de Mestrado

Ciências Militares na Especialidade de Administração da GNR

Orientador: Tenente-Coronel de Infantaria João Carlos Gonçalves dos Reis

Coorientador: Major de Administração da GNR Luís Carlos Rodrigues Malheiro

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Presidente do Júri: Professor Auxiliar Manuel António Coelho do Carmo

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RESUMO

Esta dissertação de mestrado seguiu uma estrutura que compilou quatro artigos científicos. A investigação oferece diversos contributos no domínio da auditoria, com especial foco na adoção de tecnologias inovadoras. A Inteligência Artificial (IA) tem vindo a consolidar-se como uma ferramenta crucial em várias áreas, criando novas oportunidades para melhorar processos nas organizações. Nesta linha de pensamento, o objetivo geral do estudo visa compreender de que forma a Guarda Nacional Republicana (GNR) pode integrar tecnologias de IA nas práticas de auditoria. A capacidade de processar e analisar grandes volumes de dados otimiza o processo de auditoria, superando os métodos tradicionais. A metodologia utilizada foi de natureza qualitativa, incluindo estudos de caso e múltiplas fontes de recolha de dados, como entrevistas semiestruturadas, observação direta e documentação oficial da organização. Os resultados revelam que há uma mudança de paradigma nas práticas de auditoria, impulsionada pela transformação digital e pelos avanços tecnológicos. Neste sentido, são exploradas questões relacionadas com a integração de tecnologias de IA nas organizações e a necessária redefinição das competências do auditor na era digital. A fase final da investigação possibilitou o desenvolvimento de um modelo conceptual para a implementação de práticas de auditoria inovadoras. Foram analisados os desafios existentes e proposto um método, baseado em indicadores-chave, de modo a possibilitar responder eficientemente às exigências atuais da organização. Nesta ótica, a dissertação apresenta um quadro teórico e prático que visa expandir o conhecimento sobre as tendências emergentes no campo da auditoria e propor medidas concretas para a colaboração homem-máquina. Ao explorar as interações entre os modelos de auditoria e as particularidades da GNR, acredita-se que este estudo oferece uma contribuição de valor não só para a comunidade científica, mas também para a organização.

Palavras-chave: Auditoria; Guarda Nacional Republicana; Inteligência Artificial; Modelo conceptual; Tecnologias inovadoras

ABSTRACT

This master's dissertation followed a structure that compiled four journal articles. The research offers several contributions in the domain of auditing, with a particular focus on the adoption of innovative technologies. Artificial Intelligence (AI) has been consolidating as a crucial tool across various areas, creating new opportunities to improve organizational processes. In this regard, the main objective of the study is to understand how the National Republican Guard (GNR) can integrate AI technologies into auditing practices. The ability to process and analyze large volumes of data optimizes the auditing process, surpassing traditional methods. The methodology used was qualitative, including case studies and multiple data collection sources, such as semi-structured interviews, direct observation, and official documentation from the organization. The findings reveal a paradigm shift in auditing practices, driven by digital transformation and technological advancements. In this context, issues related to the integration of AI technologies in organizations and the necessary redefinition of auditors' competencies in the digital age are explored. The final stage of the research enabled the development of a conceptual framework for the implementation of innovative auditing practices. Existing challenges were analyzed, and a method based on key indicators was proposed, aiming to respond efficiently to the organization's current demands. From this perspective, the dissertation presents both a theoretical and practical approach intended to expand knowledge on emerging trends and to propose concrete measures for human-machine collaboration in the field of auditing. By exploring the interactions between auditing models and the specificities of the GNR, it is believed that this study offers valuable contributions not only to the scientific community but also to the organization.

Keywords: Auditing; National Republican Guard; Artificial Intelligence; Conceptual framework; Innovative technologies

INDEX

FIGURE INDEX

TABLE INDEX

LIST OF APPENDICES AND ANNEXES

APPENDICES

ANNEXES

LIST OF ABBREVIATIONS, INITIALS AND ACRONYMS

A	
AI	Artificial Intelligence
C	
CAQDAS	Computer-Assisted Qualitative Data Analysis Software
CASP	Critical Appraisal Skills Programme
D	
DL	Deep Learning
E	
EU	European Union
EUR	Euros
EY	Ernst & Young
G	
GNR	Guarda Nacional Republicana
I	
IoT	Internet of Things
IPSAS	International Public Sector Accounting Standards
IT	Information Technology
K	
KPI	Key Performance Indicator
M	
ML	Machine Learning
N	
NLP	Natural Language Processing
O	
OECD	Organisation for Economic Co-operation and Development
P	
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PwC	PricewaterhouseCoopers
Q	
Q	Quartile

R

RPA	Robotic Process Automation
RQ	Research Question

S

SLR	Systematic Literature Review

T

TEA	Triple-Entry Accounting

W

WP	Working Paper

INTRODUCTION

This dissertation, titled “Artificial Intelligence in Auditing Practices: A Conceptual Framework for the National Republican Guard”, is presented as the final requisite for the Master’s Degree in Military Sciences, with a specialization in Administration of the National Republican Guard (GNR), at the Portuguese Military Academy.

This section introduces the importance of incorporating Artificial Intelligence (AI) into auditing practices, outlines the structure and alignment of this dissertation, and presents the research questions along with their related purpose. The main objective of this thesis is to explore “how” the GNR can integrate AI technologies into auditing practices. Both the opportunities and challenges in the institution’s audit process are emphasized, providing beneficial contributions that enhance our understanding of auditing in public sector organizations.

Based on current knowledge, this research establishes an effort in developing a conceptual framework designed to meet the particularities of the GNR, ultimately improving the efficiency of auditing practices. AI technologies arise as essential tools with the potential to redefine the way auditing practices are conducted. The focus of this thesis lies on financial auditing, which plays a fundamental role in safeguarding the integrity of the organization's processes. Advanced technologies extend beyond data analysis, enhancing both the accuracy and efficiency of financial statement evaluations and regulatory compliance. As a result, audits can achieve higher precision and comprehensiveness, ensuring improved awareness of operational performance (Kokina et al., 2025). Traditionally, audits conducted within the GNR, similar to many other public institutions, rely on manual methodologies and are mainly dependent on the experience of auditors. However, with the increasing volumes of data, a lack of human resources, and the complexity of daily routine tasks, these conventional approaches reveal considerable limitations.

The integration of AI in the domain of auditing represents a solid response to the challenges that traditional methods find difficult to overcome. AI technologies empower the identification of patterns and the detection of anomalies within extensive databases that might remain unnoticed in manual audits (Suarez et al., 2024). These tools streamline processes, mitigate errors associated with human intervention, enhance analytical accuracy, and enable continuous monitoring rather than relying solely on periodic audits (Hilario et al., 2024). AI also enables the development of predictive auditing systems that leverage

historical patterns of behavior to anticipate and prevent future irregularities (Seethamraju & Hecimovic, 2023). The capacity for early detection of failures or deviations ensures a more effective audit process, mitigating the risks, and fostering proactive management in alignment with the highest standards of public governance. However, despite the advantages of implementing AI into auditing practices, its application within the context of the GNR faces several challenges. It requires specialized training for auditors, who must be adequately prepared to operate these technologies and interpret their analyses accurately. Another critical aspect is ensuring that AI systems are subject to human oversight. AI should complement the work of auditors rather than replacing them entirely. Human supervision remains crucial, not only for validating the results generated by advanced tools but also for ensuring that decisions based on the analyzed data align with the institution's mission and core values.

As a public security agency, the GNR operates within a complex hierarchical structure, in which rigorous oversight of resources and procedures is crucial to its effectiveness. Innovative technologies provide a viable solution by automating routine processes, improving risk analysis, and ensuring compliance with regulations (Alsulami, 2025). Hence, this thesis highlights the potential of AI to modernize auditing practices in the GNR, advancing the literature within the context of the public sector.

In relation to the structure and alignment of this dissertation, it is the result of published journal articles, each subjected to a peer-review process (Annexes A, B and C) and approved by the respective editorial committees. Therefore, it comprises a portfolio of four articles: three already published in journals indexed in the Q2 category of Elsevier Scopus, and one currently “under review” by Heliyon (Q1). The integration of these manuscripts follows a comprehensive and coherent structure, characterized by an original introduction and conclusion. As presented in Table 1, the articles are included in the scope of “Business, Management and Accounting” and “Economics, Econometrics and Finance”. Their arrangement has been previously determined, ensuring a logical and chronological progression. This compilation encompasses both theoretical and technical studies, presenting an in-depth analysis of the subject matter, as well as empirical research grounded in fieldwork, designed to substantiate the initial findings.

Table 1 - Structure and alignment of the dissertation

Original Title	Research Question (RQ)	Journal
Trends and Challenges in Auditing and Internal Control: A Systematic Literature Review	RQ1: "What trends and challenges are expected in the domains of auditing and internal control?"	Heliyon (Q1)
Auditors in the digital age: A systematic literature review	RQ2: "How do auditor competencies evolve in response to innovative challenges within the digital age?"	Digital Transformation and Society (Q2)
Artificial Intelligence in Auditing: A Conceptual Framework for Auditing Practices	RQ3: "What is the impact of AI on auditing practices?"	Administrative Sciences (Q2)
Exploration of Audit Technologies in Public Security Agencies: Empirical Research from Portugal	RQ4: "How can AI improve auditing practices in a public security agency?"	Journal of Risk and Financial Management (Q2)

RQ1: "What trends and challenges are expected in the domains of auditing and internal control?" (see Table 1 – sourced from Chapter 1). Based on the examination of prior research, understanding trends in auditing and internal control is essential as AI and Big Data redefine practices. To ensure data remains trustworthy and actions stay ethical, we must be aware of new challenges and combine automation with human oversight. The evolution of different types of technology demands continuous learning and adaptation to safeguard integrity, enhance risk assessment, and align with industry standards, as well as to confront ethical dilemmas and the constraints of automated decision-making.

RQ2: "How do auditor competencies evolve in response to innovative challenges within the digital age?" (see Table 1 – sourced from Chapter 2). A comprehensive analysis of the current knowledge indicates that technological advancements shape auditor skills. This process is influenced by regulatory frameworks, institutional policies, and professionals' capacity to adapt to new demands. In fact, the increasing integration of AI and data analytics into auditing practices has dictated a redefinition of skill sets, prompting both regulatory bodies and audit firms to rethink training standards and professional development strategies. This emphasizes the importance of adapting institutional strategies in developing the competencies auditors need to address the complexities of the digital era.

RQ3: “What is the impact of AI on auditing practices?” (see Table 1 – sourced from Chapter 3). In the context of auditing, the integration of AI is redefining traditional auditing methodologies. Auditors have concentrated on the review of financial records, typically evaluating compliance after the fact. However, AI has introduced a paradigm shift by enabling real-time monitoring and proactive decision-making. This transition significantly enhances the accuracy of audits, increasing the overall value and responsiveness of the audit process. Additionally, the incorporation of AI into auditing practices fosters improved decision-making, mainly in areas such as risk analysis, financial management, and regulatory compliance. This accentuates the potential for organizations to enhance their competitive edge and adaptability in the current dynamic environment.

RQ4: “How can AI improve auditing practices in a public security agency?” (see Table 1 – sourced from Chapter 4). In the public sector, AI technologies have the potential to enhance audit processes by optimizing tasks such as data extraction, analysis, and verification. The use of customized algorithms, incorporating key indicators, reduces manual workloads, and reinforces compliance with regulatory standards. This results in more reliable audits and well-informed decision-making. Moreover, a foundation is established to support the strategic adaptation of AI models to various public administration contexts, with an emphasis on organizational transformation as a means to integrate emerging technologies.

CHAPTER 1 – TRENDS AND CHALLENGES IN AUDITING AND INTERNAL CONTROL: A SYSTEMATIC LITERATURE REVIEW

Executive Summary[1]

This introductory article sets the stage for the exploration presented in this thesis, providing an in-depth theoretical analysis of the relationship between auditing, internal control, and technological advancements. Digital technologies, particularly Artificial Intelligence (AI) and Big Data Analytics, are revolutionizing these areas by streamlining diverse operations, enhancing risk evaluation, and supporting more informed decision-making. The rapid advancement of new possibilities and solutions should not overshadow the importance of critically addressing the challenges they entail.

It was conducted a Systematic Literature Review (SLR) to explore these interactions, selecting high-impact articles from the Elsevier Scopus database. The analysis focuses on identifying key trends, assessing the implications of AI integration in auditing, and evaluating the balance between technological precision and human expertise. Findings indicate a paradigm shift, with AI technologies increasingly automating audit procedures, improving risk identification, and enhancing the accuracy of audit reports. For all these advancements, challenges remain, such as ethical considerations, data reliability issues, and the necessity for consistent professional adaptation.

This research provides valuable contributions into the future of auditing, focusing on the opportunities and challenges posed by technological advancements. It emphasizes the importance of continuous learning, ethical awareness, and the evolution of auditing methodologies to adapt to a progressively automated field. It also highlights the need to preserve human expertise as new technologies are integrated, ensuring that auditing practices evolve without compromising their accountability, transparency and integrity.

Keywords: Auditing; Challenges; Internal Control; Trends

[1] This executive summary serves as an expanded version of the initially published abstract, providing a comprehensive understanding and ensuring alignment among the thesis articles. For citation guidance, please refer to the APA standards. For chapter citation: Leocádio, D., Malheiro, L., Reis, J. (2025). *Trends and Challenges in Auditing and Internal Control: A Systematic Literature Review* [Manuscript Under Review]. Heliyon. For thesis citation: Leocádio, D. (2025). *Artificial Intelligence in Auditing Practices: A Conceptual Framework for the National Republican Guard* [Master's Dissertation]. Portuguese Military Academy.

1.1. Introduction

Amidst the continual evolution of technology within diverse knowledge domains, emerging trends and challenges come to the front, particularly within the fields of auditing and internal control. Technological advancements, regulatory shifts, and alterations in business landscapes significantly mold the dynamics of these domains (Fotoh & Lorentzon, 2023). Consequently, it becomes crucial to understand the state of the art in auditing and internal control to anticipate their future development.

In a context marked by technological revolutions, especially stemming from the Fourth Industrial Revolution, we are witnessing a widespread reconfiguration of conventional practices in auditing and internal control across various institutions. The integration of more advanced technologies, such as Artificial Intelligence (AI), Blockchain, and Big Data, has profoundly influenced financial management and organizational control processes. Far from being merely revolutionary, these transformations ascend as a focal point where innovative opportunities converge with complex challenges (Al-Khasawneh & Al-Khasawneh, 2023). As professionals strive to align their strategies with the demands of an increasingly digitized business landscape, a dynamic interaction between progress and complexity becomes clear.

As regulatory entities respond to the complexities inherent in digital transformation, legislative adaptations play a crucial role in this scenario (Reis & Melão, 2023). The constant evolution of regulatory requirements shapes auditing and internal control practices, demanding ongoing adjustments to ensure effectiveness in compliance (Vasarhelyi et al., 2012). Consequently, grasping these normative mutations becomes an essential aspect for professionals seeking to align their strategies with regulatory expectations.

Transformations in the business landscape, often pushed by global crises, pandemics, and shifts in consumer habits, introduce an additional layer of complexity to auditing and internal control practices. The ability to respond promptly to unexpected changes and adapt wisely to new business realities manifests as critical and differentiating factors for organizational success. Therefore, facing this dynamic and volatile scenario, professionals are compelled to work in their respective domains with expertise to thrive (Eulerich & Kalinichenko, 2018).

Taking all of this into consideration, this study sets the stage for an investigation into the latest developments that are shaping the areas of auditing and internal control. By employing a Systematic Literature Review (SLR), this research seeks to identify key trends

that are transforming traditional practices and organizational challenges. In examining both emerging trends and challenges, the main goal of this study is to analyze the current trends and challenges in the fields of auditing and internal control. Therefore, the research question defined for this SLR is as follows: "What trends and challenges are expected in the domains of auditing and internal control?". To achieve this objective, the manuscript is structured into six sections. Firstly, we present a conceptual background, elucidating the fundamental concepts inherent to the topic. Subsequently, we meticulously detail the adopted methodology, outlining the criteria employed. Then, we conduct a bibliometric analysis and a content analysis based on the data from the included studies. Following this, we proceed to the analysis of a business case and, finally, we explore the theoretical, practical, and academic implications of the study, describing its limitations and proposing suggestions for future research.

1.2. Conceptual Background

1.2.1. Transformation of Auditing and Internal Control

Significant transformations have become discernible within the domains of auditing and internal control, driven by the digital revolution, governmental initiatives, and a reconfiguration of auditors' competencies. Auditing, characterized by a set of systematic processes, involves the analysis and evaluation of financial and administrative operations within a specific entity. The primary objective is to provide assurances regarding the accuracy and compliance of records through an external assessment, often conducted independently, to ensure transparency and the integrity of financial records (Penini & Carmeli, 2010).

In contrast, internal control constitutes an internal system of procedures and policies implemented by an organization to safeguard its assets, ensure the accuracy of accounting records, promote operational efficiency, and ensure compliance with legislation (Turgaeva et al., 2020). Unlike auditing, which is an external assessment, internal control is a crucial internal function for the ongoing management of the institution's operations.

In this dynamic context we live in, the evolution of auditing and internal control transcends conventional approaches, adopting a more flexible and future-oriented stance. The digital revolution has triggered a redefinition of these disciplines' practices as professionals adapt to the demands of a constantly changing environment (Reis et al., 2020). Real-time analysis becomes an essential premise for identifying potential risks and irregularities (Chiu & Jans, 2019). Thus, governmental initiatives play a fundamental role in

investing in redefining these processes to ensure effective integration of auditing and internal control practices.

The skill set of professionals in these domains transforms, expanding beyond mere financial acumen to encompass a profound grasp of cybersecurity, data analytics, and emerging technologies. In both auditing and internal control domains, the proactive perspective of these professionals particularly contributes to the operational and strategic effectiveness of organizations (Kurniawan & Mulyawan, 2023).

Thus, this disruptive change in auditing and internal control underscores the continuous pursuit of transparency and integrity in various organizational processes, extending to include the ability to anticipate and mitigate emerging risks. Therefore, collaboration between auditing and internal control is of paramount importance, fostering a synergy that ensures effectiveness, thereby reinforcing the adaptability and success of organizations amidst the intricate challenges of the contemporary diverse organizational landscape.

1.2.2. AI-Enhanced Trends in Auditing

In recent times, AI has permeated various domains of knowledge, and the field of auditing is no exception. In this circumstance, current trends shaping the practice of activities related to auditing emerge as crucial elements in preserving the integrity and reliability of financial records. The digital transformation and technological revolution take on specific contours with the integration of AI into auditing (Agustí & Orta-Pérez, 2023). The automation of processes, thorough analysis of Big Data, and information systems auditing stand out as essential components driven by this integration. Beyond optimizing operational efficiency, the presence of AI empowers auditors for a deep and detailed analysis, unveiling patterns and irregularities that might go unnoticed by more conventional methods (Han et al., 2023).

In the evolution of auditing, the risk-based approach plays a predominant role, currently integrating advanced analyses and AI technologies. Auditors concentrate their efforts on areas of higher exposure, enhancing efficiency and reinforcing their competence in detecting frauds and irregularities. In the public sector, auditing continues to be a subject of significant debate, primarily motivated by the imperative for transparency and accountability across diverse public entities. The integration of data analysis tools, with a focus on AI, represents a bold advancement. Technologies like Machine Learning (ML) and Deep Learning (DL) are incorporated to refine pattern detection and risk identification,

enabling auditors to analyze large volumes of data more effectively and provide innovative perceptions (Amarnadh & Moparthi, 2023). The practice of continuous auditing, especially when applied to the public sector, emerges as a dynamic and adaptive response to the inherent complexities of an ever-evolving environment. With a spotlight on the integration of advanced technologies like artificial intelligence, this approach goes beyond offering a continuously updated view of diverse government operations. By incorporating AI, public sector auditing takes on a new dimension, allowing for an even deeper and more predictive real-time analysis. This technology empowers auditors to strengthen their responsiveness to emerging challenges (Dwivedi et al., 2021). In a scenario where transparency and accountability are imperative, the synergy between continuous auditing (in real-time) and artificial intelligence not only enhances the effectiveness of oversight but also drives proactive prevention of irregularities. This approach substantially contributes to more responsible governance, solidifying citizens' trust in ethical and efficient government practices (Manita et al., 2020).

Hence, AI plays a crucial role as a strategic ally in promoting integrity and compliance in public finances. This advancement indicates a significant milestone in the evolution of auditing, particularly in the public sector, standing out as an essential tool to strengthen new practices and ensure transparency, efficiency, and effectiveness in the management of resources.

1.3. Methodology

The Preferred Reporting Items for Systematic Reviews and Meta–Analysis (PRISMA) protocol stands as a widely recognized and indispensable checklist for conducting SLRs across various research domains. Its acclaim stems from its provision of a clear and structured approach to reporting the outcomes of such reviews (Tranfield et al., 2003). In this regard, the SLR establishes itself as a pivotal means of synthesizing information with precision, reliability, and transparency, employing predefined eligibility criteria to select empirical evidence and address specific research questions (Page et al., 2021). Within this framework, the development of this SLR adheres to a clear and structured sequence (Moher et al., 2009): firstly, articulating the objectives with clarity; then, devising a systematic search to identify all studies meeting the subsequently elucidated eligibility criteria; next, assessing the validity of articles included in this study; and finally, presenting a synthesis of the characteristics, peculiarities, and findings about the included studies.

The research was conducted within the Elsevier Scopus database, providing a

comprehensive array of publications pertinent to the studied theme. The PRISMA statement guided the selection process through four key phases (Moher et al., 2009): 1) Identification of relevant research: this entails conducting a thorough exploration, primarily within databases or academic journals, to assemble a comprehensive roster of potential studies. The intention is to cast a broad net, encompassing a diverse range of literature that holds the potential to contribute to the research question; 2) Screening process: The titles and abstracts of the collected studies undergo a systematic examination to assess their pertinence to the research topic. This process functions as a filter, eliminating studies that do not align with the research focus and resulting in a more precise and targeted compilation of literature for subsequent evaluation; 3) Eligibility: Encompassing a more comprehensive assessment of chosen studies, this phase relies on predetermined criteria. Researchers may scrutinize the complete texts of the studies to verify their alignment with specific inclusion criteria, which may incorporate aspects such as study design, publication date, or other pertinent parameters; 4) Selection of studies for inclusion: In this critical step, researchers make conclusive decisions on which studies will be included in the SLR. Studies that align with the research question, meet predefined criteria, and provide valuable insights are selected for inclusion. This meticulous selection process ensures that the final compilation of literature is pertinent and characterized by methodological rigor.

Thus, the advanced search was conducted on December 6, 2023, using the following formula: TITLE-ABS-KEY (Auditing) AND TITLE-ABS-KEY (Artificial AND Intelligence) AND PUBYEAR > 2020 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "BUSI")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j")) AND (LIMIT-TO (PUBSTAGE, "final")).

The table below summarizes the four phases of PRISMA by the employed criteria for this study.

Table 2 - Four phases of the PRISMA protocol

Scopus	Number of documents
Identification	
"Auditing" AND "Artificial Intelligence" (All)	20.494
Screening	
Title, abstract, and keywords (Title-Abs-Key)	555
Language (English)	543
Period (2021 to 2023)	272
Source type (Journal)	135
Document type (Article)	117
Publication stage (Final)	104
Subject area (*Business, Management and Accounting* and *Economics, Econometrics and Finance*)	33
Eligibility	
Full-text documents	33
Included	
Included studies	25

The advanced search started with the inclusion of the keywords "Auditing" and "Artificial Intelligence" across all fields, yielding the identification of 20.494 documents. To refine the analysis and ensure greater precision, specific criteria were applied in filtering the documents based on "title, abstract, and keywords" for each concept. Furthermore, only manuscripts in the English language, between 2021 and 2023, from journal articles, in the final publication stage, in the scope of "Business, Management and Accounting", and "Economics, Econometrics and Finance" were selected. After the screening phase, only articles from Q1 and Q2 journals were included in this study, resulting in a total of 25 final documents for analysis.

The findings from these 25 included studies are presented in a dual approach, through bibliometric analysis and content analysis. The bibliometric analysis was conducted by customizing various characteristics and data of the articles, organizing a series of easily understandable graphics, and providing insights into the characterization of the included studies (Ellegaard & Wallin, 2015). In a subsequent phase, a content analysis was undertaken to identify, assess, and synthesize the pre-existing knowledge corpus (Krippendorff, 2018). Next, a detailed reading of each of the 25 articles was carried out to immerse in the most prevalent concepts. Subsequently, the categorization of analogous terms was conducted, grouping them cohesively for refined analysis. Finally, these categories underwent meticulous scrutiny to discern intrinsic patterns, distill pertinent data, and confer significance

to the information. In this initiative, we used the advanced qualitative data analysis tool, NVivo 12 (Bazeley & Jackson, 2019).

1.4. Results of the Systematic Literature Review

1.4.1. Bibliometric Analysis

This section provides a bibliometric analysis of the 25 articles included in this SLR. Figure 1 shows the number of articles by year and the respective classification of the Journals (Quartile 1 or Quartile 2). Thus, 11 articles are from 2021 (where 7 are from Q1 journals and 4 are from Q2 journals); 6 articles are from 2022 (where 4 are from Q1 journals and 2 are from Q2 journals); finally, 8 out of the 25 articles included in this study are from 2023 and all belong to journals classified as Q1.

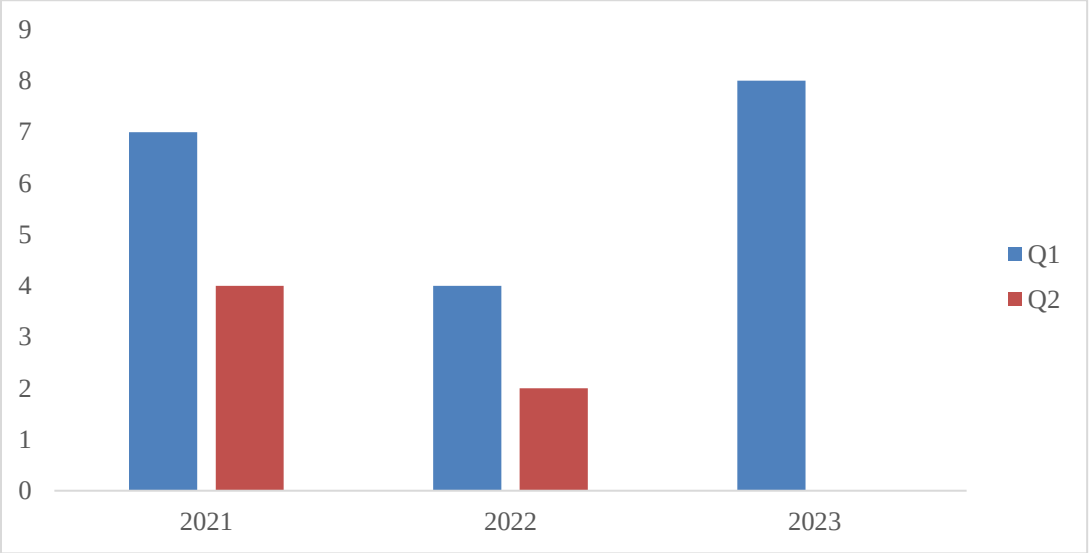

Figure 1 - Number of articles by year and the respective classification of the journals

Figure 2 illustrates the Journals with the most published articles in these areas of study, highlighting “Computer Law and Security Review” with 3 articles (in 2021, 2022 and 2023), “Accounting” with 2 hits (in 2021), and “International Journal of Accounting Information Systems” with 2 documents (in 2022 and 2023).

Figure 2 - Number of journals per year

Lastly, Figure 3 displays the Keywords used in each article, highlighting the following: Artificial Intelligence, Auditing, Technology, Innovation and Accounting. The introduction of these key concepts ensures a meticulous analysis, seamlessly aligning with the study's objectives. They afford a refined and pertinent approach, promoting an inclusive comprehension of the subject.

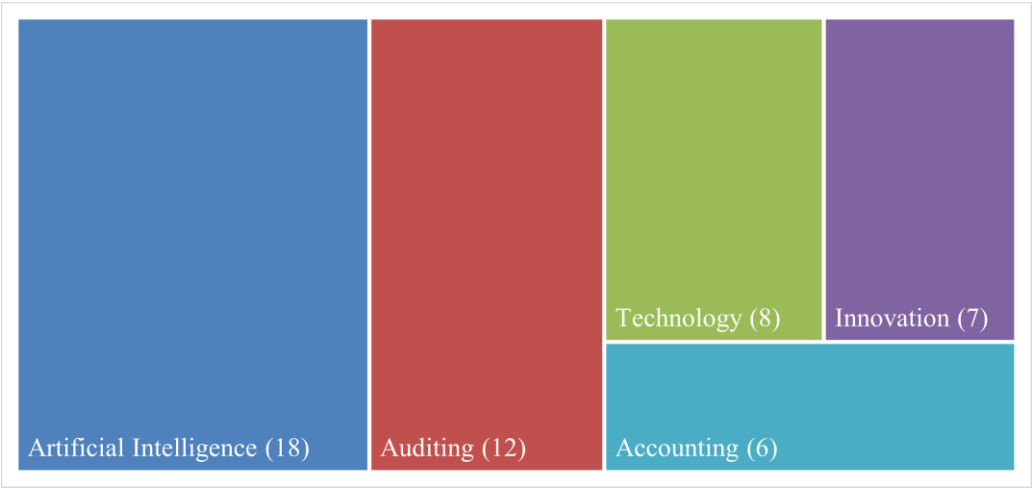

Figure 3 - Most used keywords per article

1.4.2. Content Analysis

In this phase encompassing content analysis, the NVivo software was employed to deepen the understanding and extract meaning from the previously collected data. NVivo 12, a computer-based qualitative data analysis tool, proved indispensable in managing the substantial volume of information, reducing the time required for manual tasks, and enhancing flexibility and depth in the analysis (Woolf & Silver, 2017). Hence, the use of NVivo 12 simplified a more systematic and efficient approach to categorizing and organizing the obtained information, enabling the identification of patterns, recurring themes, and relationships within the data, thereby contributing to a more profound analysis (John & Johnson, 2000).

To lend greater credibility and precision to the primary contributions of this investigation, a summary was formulated detailing the relevant content relationships among the different articles included in the study. This synthesis aimed to succinctly and objectively highlight the most significant findings and substantial contributions offered by the research. Consequently, we strive to present a clear and well-founded perspective on the achieved results, reinforcing the validity and importance of the principal discoveries in this current work.

1.4.2.1. AI Integration in Auditing Practices

As illustrated throughout this study, AI having crossed various stages of development, manifests tangible advancements, solidifying its presence and conferring diverse benefits to the broadening spectrum of human cognitive and functional outcomes.

Although the use of AI in auditing is not a new concept, we are presently experiencing a real revolution. There are promising indications of substantial growth in the upcoming years, driven by ongoing advancements in information technology. The ability of AI to process and analyze data is bringing about significant changes in traditional audit and internal control procedures (Pemer, 2020). The vast quantity of structured, semi-structured, and unstructured data is adding complexity to the evaluation of corporate performance, be it financial or non-financial. Therefore, in this challenging scenario, auditing stands out as a particularly conducive domain for the application of AI technologies, especially within accounting firms, where auditors incorporating AI can acquire, process data, and conduct analyses for the entire population of audited entities. This advancement significantly enhances the efficiency, effectiveness, and economy of auditing (Seethamraju & Hecimovic,

2022).

The nature of audit work has undergone a radical transformation with the evolution of computerization, automation, and new auditing technologies, ushering in a new era of performance benchmarks in the audit process. In contrast to traditional auditing approaches, AI-enabled methods demonstrate heightened efficiency and comprehensiveness, especially in automating repetitive and easily executable tasks. Automation arises as the ideal tool for structural tasks, such as substantive tests (verification, summation, and vouching), performing automated tasks to process data and provide instantaneous verification, ensuring that actual values correspond to the advanced analysis results (Al-Sayyed et al., 2021). Furthermore, AI technologies can be applied to analyze extensive datasets, collecting and summarizing information from various sources, providing auditors with sufficient evidence and information that can be included in process reviews (Goto, 2023). In this context, the ability to enhance decision-making capabilities and offer products or services with higher quality and elevated levels of assurance becomes feasible.

AI-enabled auditing techniques, particularly in data analysis, cover extraction, comparison, and validation of data. AI-based technology can extract textual information from complex electronic documents, allowing auditors to dedicate more time to areas that entail higher risk levels and provide more meaningful contributions to businesses. Recognizing the potential of AI and its advantages, the four major accounting/audit corporations (Deloitte, E&Y, KPMG and PwC) are continually developing AI techniques and heavily investing in technological innovation (Hu et al., 2021). The implementation of cognitive computing during audits provides profound cognitive capabilities and advanced analytical solutions, assisting clients in making prudent decisions and generating and capturing critical information.

Thus, the integration of AI into auditing practices represents a disruptive shift from the traditional approach, heralding the emergence of a new era that will shape the future of the auditing field innovatively and progressively.

1.4.2.2. Control Risk Assessment

In the domain of auditing, control risk assessment stands as a pivotal topic, materializing through the meticulous analysis of financial statements. This discipline aims to deepen the understanding of organizational processes designed to mitigate identified risks during auditing.

Initially, this approach demands a detailed identification of relevant internal controls,

followed by meticulous documentation of their interrelations with specific risks associated with audited processes (Mökander et al., 2021). The evaluation of the effectiveness of these controls transcends superficial analysis, encompassing both theoretical design and practical application. Operational tests are then conducted to validate the operational consistency of these mechanisms, generating detailed documentation of the results obtained and identifying areas susceptible to improvement (Damerji & Salimi, 2021). From this perspective, this assessment directly influences the overall audit strategy, adapting it to the confidence placed in various control mechanisms, playing a crucial role in reducing the need for extensive substantive procedures. The outcomes of this phase are communicated transparently to the management of the audited entity and regulatory bodies, promoting transparency, and providing concrete opportunities for continuous improvement (Han et al., 2023).

In the conclusive audit report, conclusions derived from the control risk assessment are integrated, emphasizing significant issues identified and providing specialized guidance for the continuous improvement of the organizational control environment. This approach, far from being static, dynamically adjusts to changes in organizational conditions and risks over time (Albawwat & Frijat, 2021).

The interconnection between this assessment and strategic management proves substantial, providing valuable insights for more informed and strategic decision-making. Effective collaboration between auditors and management fosters an organizational culture grounded in transparency and accountability, stimulating the proactive implementation of corrective measures (Faccia et al., 2022). In the regulatory context, the transparency stemming from control risk assessment supports ongoing compliance with standards and regulations, anticipating and preparing the entity for potential future changes in the regulatory landscape.

Thus, control risk assessment, far from being a formality in the audit process, emerges as a strategic tool, adding considerable value to corporate governance. By providing an in-depth understanding of internal controls and associated risks, this methodology becomes a powerful instrument to enhance operational efficiency, promote stakeholder confidence, and drive sustainable organizational success.

1.4.2.3. Performance in Audit Reports

The relentless pursuit of optimization in audit reports constitutes a complex journey, grounded in meticulous practices and the assimilation of innovative technologies, notably AI. This strategic process commences with a thorough analysis of audit and internal control

practices and procedures, emphasizing the imperative to identify and meticulously document relevant information and data, along with their interconnections with specific risks (Lehner et al., 2022).

The assessment of the effectiveness of these practices plays a central role, demanding a comprehensive analysis that encompasses not only theoretical design but also practical application. This analysis contributes to a deeper understanding of the procedures implemented by the organization, crucial for mitigating risks identified during the audit. Transparent communication of results and improvement opportunities proves essential. By disseminating findings to regulatory bodies, a culture of transparency is fostered, highlighting crucial issues identified and providing fertile ground for continuous improvements (Taherizadeh & Beaudry, 2023). This open and constructive dialogue between auditors and stakeholders becomes crucial to ensure that audit reports meet regulatory requirements and, to some extent, drive operational excellence. The adopted approach is dynamic, adapting to changes in conditions and risks over time, illustrating the importance of continuous adaptation. In this regard, the strategic balance between technological opportunities and internal processes is of utmost importance. The balanced strategy incorporates both human dexterity in formulating algorithms and the innovation provided by AI, maximizing the potential for successful initiatives (Zhang et al., 2022). The introduction of intelligent systems in evidence collection for audits provides operational advantages, enhancing effectiveness and enabling efficient analysis of data.

In this dynamic world, it becomes evident that understanding the intersection between AI and auditing is an area to explore, and it is crucial to comprehend the impacts of AI on auditing and identify best practices. Therefore, optimizing performance in audit reports is not merely a matter of operational efficiency but a strategic integration that combines human skills with technological advancements. Balance is the key, to shaping an audit narrative that is robust, transparent, and aligned with the fundamental principles of auditing practice.

1.4.3. Key Aspects in Auditing Trends and Challenges

This section highlights the crucial points in auditing, summarizing the most significant trends and challenges. Throughout this study, we observe a comprehensive and continuous integration of AI in auditing practices, emphasizing the growing role of AI in providing more advanced data analysis solutions, assisting in risk assessment, and strategically optimizing audit reports. Aspects such as promoting transparent communication of results and adopting dynamic approaches that balance human skills with innovation in AI

are also emphasized. However, challenges persist. Auditing professionals face the need to adapt to constantly evolving AI technologies, ensuring compliance with dynamic regulatory frameworks. Dealing with numerous ethical considerations in decision making processes influenced by AI is also a complex challenge, as is ensuring the integrity and security of data manipulated by AI systems.

Table 3 reflects a summary of the key aspects covered in this work, aiming to facilitate the understanding of concepts and what can be expected soon in this area:

Table 3 - Summary of the key aspects in auditing trends and challenges

Key Aspects	Summary	Authors Contributions
AI Integration in Auditing Practices	- Integration of AI in auditing is a revolutionary shift in the field. - AI enhances efficiency, effectiveness, and economy in traditional audit methods. - Major accounting firms heavily invest in AI for data analysis, decision support, and process reviews. - Cognitive computing in audits provides advanced analytical solutions, shaping the future of the auditing field.	(Pemer, 2020); (Seethamraju & Hecimovic, 2022); (Hu et al., 2021).
Control Risk Assessment	- Control risk assessment is a pivotal aspect of auditing, analyzing internal controls to mitigate identified risks. - Involves identification, documentation, and operational testing of controls, influencing overall audit strategy. - Results are communicated transparently, fostering a culture of transparency, accountability, and continuous improvement. - Strategic connection between control risk assessment and management provides valuable insights for informed decision-making and regulatory compliance.	(Han et al., 2023); (Albawwat & Frijat, 2021); (Faccia et al., 2022).
Performance in Audit Reports	- Performance of audit reports involve a strategic process incorporating AI technologies. - Comprehensive analysis of audit and internal control practices, emphasizing communication of results to regulatory bodies. - Dynamic approach adapts to changing conditions, balancing human skills with AI innovation. - Integration of intelligent systems in evidence collection enhances operational advantages, contributing to a robust, transparent audit narrative aligned with auditing principles.	(Lehner et al., 2022); (Taherizadeh & Beaudry, 2023); (Zhang et al., 2022).
Trends	- Increasing AI Integration: Involves a continuous and pervasive integration of AI in various facets of auditing practices. - Enhanced Analytical Capabilities: AI's role in providing advanced analytical solutions is shaping the evolution of auditing. - Strategic Reporting Optimization and Transparent Communication: Strategically optimizing audit reports through the incorporation of AI technologies, emphasizing transparent communication of audit results. - Dynamic Adaptive Approaches: Adapt to changing conditions through a balance of human skills and AI innovation.	(Damerji & Salimi, 2021); (Al-Sayyed et al., 2021); (Tsakalakis et al., 2021); (Goto, 2023).

Challenges	- Technological Adaptation: Adapting to rapidly growing AI technologies for auditing professionals. - Regulatory Compliance and Ethical Implications: Ensuring compliance with dynamic regulatory frameworks amid technological advancements and addressing ethical considerations in decision-making processes influenced by AI. - Data Security: Safeguarding the integrity and security of data manipulated by AI systems is critical for audit firms. - Human-AI Collaboration: Effectively integrating AI into audit practices while maintaining a balance with human skills.	(Taherizadeh & Beaudry, 2023); (Mökander et al., 2021); (van Bekkum & Borgesius, 2023); (Lehner et al., 2022).

In a deeper analysis of the current scenario in the domain of auditing, the ongoing integration of AI arises as a disruptive transformation, reshaping traditional foundations and introducing complex challenges and trends for professionals in this domain. Primarily, it is crucial to understand which AI not only streamlines data management but also revolutionizes the analytical process itself, surpassing conventional methodologies. The prowess of AI technologies in processing extensive datasets enhances the efficiency and effectiveness of auditing procedures, fostering decision-making. This trend is underscored by the substantial investments made by accounting/ audit firms in AI technologies for data processing and analysis, decision support, and process monitoring (Hu et al., 2021). Secondly, control risk assessment is seen as a key aspect, enabling the analysis of various internal control reports to mitigate identified risks. The process involves defining risk indicators to identify, document, and test specific documents, influencing the overall audit strategy (Faccia et al., 2022). In turn, these results are communicated transparently, promoting a more accountable organizational culture. Hence, the strategic connection between control risk assessment and management provides numerous advantages, once again aiding in informed decision-making and legal compliance (Albawwat & Frijat, 2021). Finally, high performance in audit reports involves a strategic process of incorporating AI technologies. The continuous analysis of auditing and internal controls practices emphasizes the importance of communicating the results to regulatory entities (Lehner et al., 2022). In this regard, it is necessary to prepare a dynamic approach that adapts to constantly changing conditions, balancing human expertise with technological innovation. Thus, the integration of intelligent systems in data collection enhances operational advantages, contributing to a robust and transparent audit process (Taherizadeh & Beaudry, 2023).

Regarding the emerging trends, we have observed that the evolution of auditing is shaped by the increasing trend of more advanced analytical capabilities offered by AI technologies. Therefore, the strategic optimization of audit reports through the integration

of these technologies appears as a practice of growing relevance, particularly in enhancing transparent communication of audit results to regulatory bodies (Tsakalakis et al., 2021). Another trend to closely follow is the balance between the theoretical knowledge of the audit professional and their ability to apply it in practice with the assistance of AI. This crucial step must be taken to achieve economy, efficiency, and effectiveness in the field of auditing (Damerji & Salimi, 2021).

Concerning the challenges, auditors continuously face the difficulty of adapting to evolving AI technologies. Ensuring compliance with dynamic regulatory frameworks amid technological advancements is also a persistent challenge. Addressing ethical considerations in decision-making processes influenced by AI adds an additional layer of complexity, demanding a reflective and responsible approach (van Bekkum & Borgesius, 2023). Lastly, data security is considered as another critical challenge, requiring robust measures to safeguard the integrity and security of data manipulated by AI systems (Mökander et al., 2021).

Thus, it is evident that the effective integration of AI into auditing practices, balanced with human skills, stands as the greatest challenge. As a result, continuous adaptation by professionals working in these areas is necessary, opening the way for a promising future in auditing practices.

1.5. The Future of Auditing: The Business Case of Deloitte

Deloitte stands out globally for its comprehensive range of services, including auditing, consulting, financial advisory, and risk management. Renowned for aiding diverse organizations in overcoming complex challenges and thriving in dynamic environments, Deloitte plays a crucial role, especially in the area of auditing. Auditing practices are essential in analyzing organizations' financial reports, requiring sophisticated models to address the growing complexity of financial records and mitigate risks of omissions, errors, and fraud (Nguyen & Nguyen, 2020). Deloitte's audit practice acknowledges advances in statistical science and Big Data, showcasing its commitment to innovation and efficiency in this domain (Štager, 2018). As a major pioneer in a transformative era guided by the integration of AI technologies, Deloitte strategically realigned its approach. This strategic leap facilitated a profound realignment of the company's strategies, demonstrated by substantial investments in AI that reflect processes executed with economy, efficiency, effectiveness, and a new economic approach to auditing practices (Perdana et al., 2023).

When examining this specific case, it is relevant to explore certain aspects for a

complete understanding of the tools the company employs. In this regard, cognitive computing, a powerful subset of AI, takes a prominent role in Deloitte's auditing practices, offering advanced analytical solutions. By simulating human thought processes, cognitive computing enhances auditing practices, expediting processes, detecting irregularities, and providing several advantages in financial data analysis. Another crucial aspect to address is the control risk assessment which, grounded in risk indicators, radically transforms audit strategy, promoting a culture of openness in the firm. Transparency in control risk assessments provides valuable contributions to informed decision-making in compliance with legislation. As observed throughout this study, the incorporation of AI significantly redefines the effectiveness of audit reports. Deloitte's dynamic approach, seeking to balance human skills and knowledge with AI innovation, stands out in achieving concrete results through robust and transparent reports aligned with the fundamental principles of auditing (Bhaskar et al., 2019). Although the integration of AI technologies into Deloitte's processes offers numerous advantages and is considered an innovative strategy, it is not without complex challenges. Audit professionals need to adapt and learn specific training in these technologies, ensuring they stay constantly updated to handle compliance challenges. It is also necessary to have a complete understanding of ethical considerations in decision making driven by AI technologies and the assurance of data security, as these are the most complex challenges currently faced.

The influence of Big Data on Deloitte's success is evident from the inception of financial management planning to fraud prevention. The observed transition from the conventional approach of accounting audits to a continuous process, automating repetitive tasks, means a complete paradigm shift (Lugli & Bertacchini, 2023). Consequently, this new configuration contributes to promoting transparency and continuous internal information sharing.

Table 4 reflects the transformation of the audit process, highlighting the contrast between traditional and future audits:

Table 4 - Contrasting parameters in traditional and future audits

Parameters	Traditional Audits	Future Audits
Approach	Reactive	Proactive
Data Type	Quantitative and Structured	Unstructured and Semi-structured
External	Independent Role	Certifier of the Auditing System
Frequency	Periodic	Continuous
Internal	Independent Role	Collaborative
Nature	Time Intensive Labor	Handling Exceptions
Procedure	Manual and Analytical Review	Automatic and Continuous Controls
Reporting	Periodic	Continuous
Testing	Humans Perform Sample Testing	Models Monitors Entire Population

In the current scenario, there are two distinct approaches: traditional audit practices and the expected future consolidated practices. In the traditional approach, audits are reactive, dealing with quantitative and structured data periodically, applying an independent external function. These audits are characterized by manual reviews, periodic reports, and human-conducted sample tests. On the other hand, the future approach represents a significant transformation. Audits become proactive, anticipating, and preventing issues, handling unstructured and semi-structured data continuously. The external role advances into a certifier of the audit system, while internally there is a shift towards a more collaborative role. The nature of work shifts from being intensive to focusing on exception/irregularity management. Manual procedures and analytical analyses give way to automated and continuous controls, and reports shift from periodic to continuous. Additionally, audit tests are no longer conducted by human samples, but by models that monitor the entire population. This transition aims to enhance the efficiency and effectiveness of audits, providing real-time perceptions and identifying potential issues quickly and accurately (Alles, 2015).

Keeping all this in mind, Deloitte arises as a clear example pointing towards a more integrated and transparent landscape, shaping a resilient and adaptive future for audit practices. Human skills aligned with technological precision become a crucial aspect, consolidating AI not only as a useful tool, but also as a strategic partner in the pursuit of excellence in auditing. This continuous dialogue among professionals, regulatory entities,

and technological innovators charts a promising path where bridging the gap between AI, Big Data, and the emergence of new models drives the evolution of auditing as a field of knowledge.

By incorporating AI into audit practices, Deloitte fosters a cultural shift within the company. The ability to integrate these technologies influences how its professionals comprehend and handle the auditing practices. Thus, this firm stands out as a market leader, incorporating ethical values, transparency, and a culture of continuous learning. This commitment is increasingly viewed as a growing trend for addressing the most complex challenges in such a dynamic environment, further solidifying its position at the forefront of excellence in providing audit services.

1.6. Conclusions

From a comprehensive standpoint, the increasing integration of AI in auditing indicates a paradigmatic shift that redefines efficiency and effectiveness in traditional methods. Renowned audit and accounting firms invest significantly in AI technologies, propelling advancements that shape the future not only of this discipline but across various knowledge domains.

Control risk assessment is a crucial aspect within the scope of auditing, necessitating a meticulous analysis of internal procedures to mitigate identified risks. This process encompasses identification, documentation, and operational tests, exerting a marked influence on global audit strategies. The pressing need for risk indicators in institutions becomes evident, serving as pivotal elements for informed and grounded decision-making in full compliance with diverse prevailing laws. The promotion of a culture of accountability and continuous improvement materializes a transparent communication of results, establishing a strategic connection between control risk assessment and administrative bodies.

The preparation of audit reports is viewed as a strategic approach that is increasingly inclined to incorporate AI technologies. The comprehensive analysis of auditing and internal control practices, with a pronounced emphasis on transparent communication of results to regulatory entities, underscores a dynamic approach that adapts to ever-changing conditions, harmonizing human skills and knowledge with innovation in AI. Consequently, the integration of intelligent systems in evidence collection provides operational advantages, contributing to a robust, transparent audit narrative aligned with the fundamental principles of auditing.

The key aspects identified in this SLR, which encompass the integration of AI in auditing practices, control risk assessment, and performance in audit reports, corroborate the disruptive change brought about by AI technologies in the audit and internal control landscape. These aspects highlight a dynamic evolution towards a proactive and continuously adaptive auditing environment, where AI and human expertise collaborate to achieve optimal results. Additionally, the business case of Deloitte exemplifies an innovative and future-oriented approach to the integration of advanced technologies in auditing practices. Deloitte adopts some relevant strategies, like cognitive computing, to refine its analyses, expedite processes, and ensure the production of robust and transparent audit reports. This firm seeks to balance human skills and knowledge with innovation to maximize the effectiveness of this collaboration and, therefore, set a precedent for excellence in addressing the most complex challenges presented by technological evolution.

In responding to the research question, revolutionary trends in the application of AI in auditing come to the forefront, outlining potential challenges in adapting to technological changes and ensuring regulatory compliance. Nevertheless, the opportunities for enhancement in transparency, efficiency, and the quality of audit reports indicate a promising direction for the future of auditing and internal control. Despite the contributions of this study, it is imperative to acknowledge inherent limitations, such as the rapid technological evolution that may impact these findings over time. Generalizing results to different contexts and company sizes proves challenging, given the diversity of auditing practices. Regarding suggestions for future research, there is a need to explore the acceptance of AI among stakeholders, including managers, auditors, and regulators. Ethical investigations into decision-making in auditing under the influence of AI are crucial for the development of specific guidelines ensuring the ethical and responsible use of technology in this area. Longitudinal studies tracking the implementation of AI over time could provide a deeper understanding of the changes and challenges faced by organizations.

Thus, this study also highlights the opportunities and benefits of AI in auditing and underscores the necessity for continuous adaptation to theoretical, practical, and ethical challenges. In this transformative period in the field of auditing, exploring these implications and limitations provides a solid foundation for future research and the refinement of professional practices.

CHAPTER 2 – AUDITORS IN THE DIGITAL AGE: A SYSTEMATIC LITERATURE REVIEW

Executive Summary[2]

This second paper examines the dynamics of auditing practices in the digital age, with a specific focus on auditor competencies.

The adoption of innovative approaches in auditing compels auditors to improve their technical capabilities and face the ethical dilemmas. Within this scope, the necessity of redefining traditional methodologies and the essential adaptation required of auditors is evident. The main goal of this research is to understand how auditor competencies can be strengthened to confront the challenges posed by the digital age. To this end, a Systematic Literature Review (SLR) was carried out to ensure the transparency and credibility of the results. The main findings emphasize the importance of auditors enhancing their professional competencies to foster technological agility. This process encompasses the effective integration of advanced technologies, such as Artificial Intelligence (AI), Machine Learning (ML), and Blockchain, which have emerged as indispensable tools in the development of innovative auditing practices.

The foundation of this study lies in a triadic framework that elucidates the relation between auditors, auditing practices, and digital audits. This threefold structure establishes a new framework for promoting innovation and ensuring ethical responsibility within the area. With the growing importance of AI technologies in the audit process, ethical considerations concerning transparency, accountability, and maintaining professional standards emerge as key aspects. As a result, this research underscores the importance of a balanced approach that harmonizes technological efficiency with the permanent ethical implications of auditors.

The originality of this investigation is found in its exploration of the intersection between digital transformation and the evolving competencies of auditors. Practical

[2] This executive summary serves as an expanded version of the initially published abstract, providing a comprehensive understanding and ensuring alignment among the thesis articles. For citation guidance, please refer to the APA standards. For chapter citation: Leocádio, D., Malheiro, L., Reis, J. C. G. (2025). Auditors in the digital age: a systematic literature review. *Digital Transformation and Society*, *4*(1), 5-20. https://doi.org/10.1108/DTS-02-2024-0014. For thesis citation: Leocádio, D. (2025). *Artificial Intelligence in Auditing Practices: A Conceptual Framework for the National Republican Guard* [Master's Dissertation]. Portuguese Military Academy.

implications highlight the enhancement of auditor roles in digital transformation, covering ethics, technological adaptation, and continuous development to uphold the profession's integrity. Further research should prioritize the ethical dimensions of automation in auditing and develop innovative frameworks to address the pressing demands of organizations.

Keywords: Auditor; Auditing practices; Digital; Innovative practices; Professional capabilities

2.1. Introduction

The digital revolution has transformed professional domains, with auditing emerging as a fast-changing field (Alkabbji et al., 2023). Leading firms like Ernst & Young, Deloitte, PwC and KPMG have adopted data analytics, automation, and AI to enhance efficiency and effectiveness (Sierra-García et al., 2019). Hence, these advancements emphasize auditors' need to develop technical proficiency and social skills to meet current challenges (Seethamraju & Hecimovic, 2023).

Auditors now face opportunities and challenges with AI integration, requiring advanced technical skills, adaptability, and a commitment to continuous learning (Ramesh, 2019). Staying informed about the latest tools, methods, and industry best practices is essential. Thus, addressing these challenges and opportunities with a comprehensive framework for enhancing auditor competencies is paramount.

Our research employs a Systematic Literature Review (SLR) following PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) to understand how auditors' competencies evolve in the digital era. To do so, we designed a Research Question (RQ) – "How do auditor competencies evolve in response to innovative challenges within the digital age?".

This article is organized into seven sections. The first defines auditing within digital transformation and outlines auditor responsibilities. The research design section details the workflow and methodology of this SLR. We then provide an overview of the PRISMA statement. The results section highlights leading countries in this research field and identified categories. The discussion section analyzes these categories based on key determinants. Finally, the conclusion addresses the RQ, discusses limitations, contributions to theory and practice, and suggests future research directions.

2.2. Innovative Audit Conception

In the digital transformation era, auditing must adapt to integrating digital technologies that enhance efficiency, flexibility, and innovation within organizations (Liew et al., 2022). Consequently, converging traditional audit methods with emerging technologies drives significant changes in auditing practices, improving economy, efficiency, and efficacy (Goto, 2023). When successful, this integration enables auditors to analyze data more effectively, identifying complex patterns that conventional methods might miss.

The innovative adoption of AI technologies allows real-time data processing and pattern learning, adding a predictive dimension to auditing. This raises important considerations around data integrity, privacy, and algorithmic fairness, prompting auditors to address the ethical implications and ensure transparency in these practices.

Regarding innovation audits, the primary aim is to identify strengths and weaknesses, enabling companies to develop and sustain competitive advantages. This future-oriented approach uses both quantitative and qualitative data to highlight performance gaps and inform strategic action plans (Frishammar et al., 2019). Figure 4 illustrates the key dimensions of innovation audits:

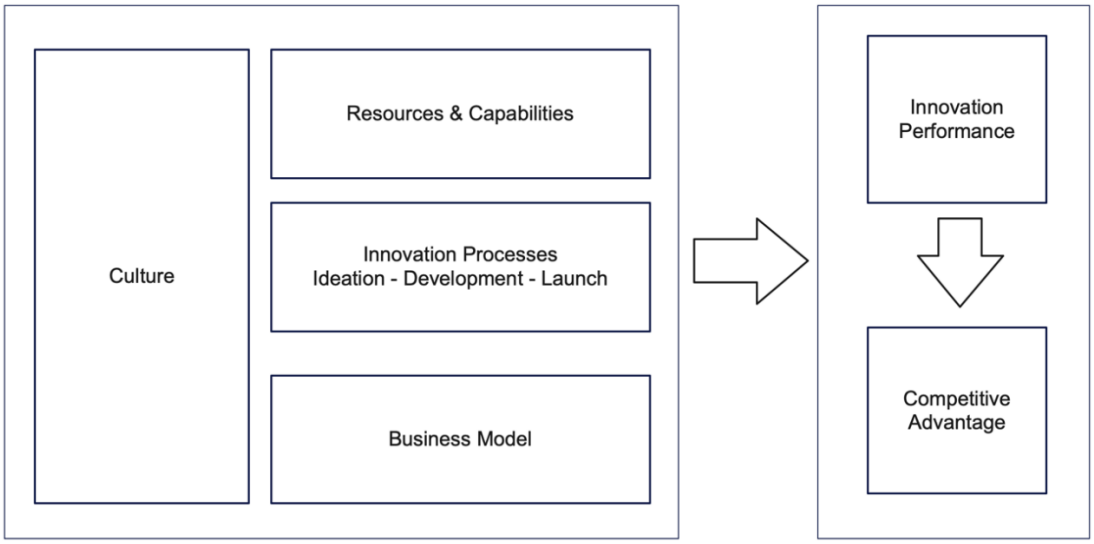

Figure 4 - Key dimensions of innovation audits

The essential dimensions of innovation audits are crucial for guiding professional approaches, drawing from past experiences, current observations, and future goals. Focused

on ideation, development, and launch phases, these audits pinpoint organizational strengths and weaknesses, offering a strategic framework. They dig into idea generation, development efficiency, and alignment with strategic objectives. By providing practical and strategic guidance, innovation audits serve as dynamic tools for ongoing improvement, guaranteeing that organizations proficiently cross the perpetually changing setting.

Acknowledging the paramount importance of human and financial resources, as well as capabilities in value generation and technology integration, these audits highlight the need for assets to implement innovative strategies effectively (Al-ahdal & Hashim, 2022). The ethos of an innovation culture, emphasizing values like proactivity, risk-taking, dedication, and adaptability, is integral to this process. Additionally, the business model assumes fundamental importance, conceptualized as a cognitive schema explaining how a company creates, delivers, and captures value through exploring business opportunities (Frishammar et al., 2019). However, despite notable progress in this domain, there are still many challenges and obstacles in current approaches. Such as the lack of emphasis on the openness and distributed innovation approach, and the absence of consideration for the significant influence of digital technologies, especially regarding the necessary competencies and skills to deal with them. Hence, updating existing frameworks is imperative, given the substantial influence of openness, servitization, and digitalization on innovation management (Frishammar et al., 2019).

2.2.1. AI Technologies in Auditing

In an era defined by the digital and technological revolution, rapid advancements across all domains demand continuous adaptation, with the integration of AI technologies bringing about disruptive change (Gooneratne et al., 2020). This transition marks a significant milestone in auditing practices, with advanced tools emerging to perform activities efficiently and with reduced risk.

AI, in the domain of auditing, is a hybrid set of technologies that complements and transforms traditional practices (Lois et al., 2020). It revolutionizes auditing by blending technologies, overcoming challenges of the digital age to enhance efficiency and adaptability (Shaikh et al., 2018). Beyond automating simple tasks, AI has been serving as a strategic partner enabling high-quality processes (Damerji & Salimi, 2021). This redefinition of the concept extends beyond the incorporation of technology into processes, showing its transformative potential. In this regard, we would like to highlight some technologies. Machine Learning (ML) has been introducing new dimensions to the analysis of audit reports

by leveraging its capacity to learn patterns from data (Ashtiani & Raahemi, 2022). Similarly, Deep Learning (DL) has improved the handling of complex data by simulating the performance of the human brain in deep layers of neural processing (Bakumenko & Elragal, 2022). The Natural Language Processing (NLP) is another commonly used technology, which interprets vast volumes of text, facilitating proficient comprehension and the identification of irregular financial operations (Rudžionis et al., 2022). Finally, Computer Vision provides contextualized visual analysis (Zaniolo et al., 2023).

AI technologies fundamentally reconfigure the auditing profession, challenging tradition and emphasizing the need to adapt existing standards and AI technologies (Fotoh & Lorentzon, 2021). Therefore, integrating AI in various stages of the auditing process optimizes each step, from data collection and risk mitigation to issuing real-time analyzed results. However, it is crucial to emphasize that the auditing profession must confront the challenges addressed thus far by adapting standards and trends and overcoming resistance (Frey & Osborne, 2017). Overall, AI and automation offer opportunities to focus on higher value tasks, but the role of the auditor must be rethought in this evolutionary process. The advent of AI-powered auditing signifies a complete revolution, relying on human expertise combined with emerging AI technologies in auditing practices.

2.3. Research Design

We identified the SLR as an essential tool for consolidating available information reliably and accurately, selectively identifying empirical evidence that meets predetermined eligibility criteria and addressing specific research questions. Unlike other methods, the SLR employs explicit and systematic techniques to enhance result reliability and minimize bias (Page et al., 2021). It involves establishing clear research objectives, systematically searching for all eligible studies, assessing the validity of included results, and methodically presenting and synthesizing study characteristics and findings.

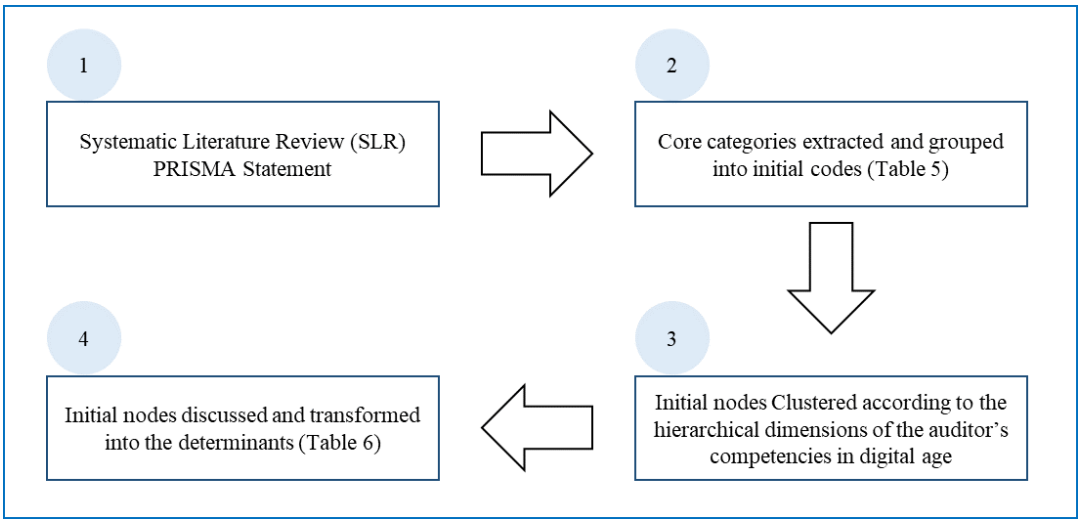

Figure 5 - Research design and development of work process

The research design, as shown in Figure 5, comprised two principal phases: initially, we conducted the SLR using the PRISMA statement, extracting main categories of auditor competencies and grouping them into nodes (step 1 and step 2); subsequently, we analyzed and discussed the initial nodes and defined the determinants related to the main research concepts (step 3 and step 4).

2.4. Systematic Literature Review – PRISMA Statement

As stated, this investigation adhered to the PRISMA guidelines introduced by Moher et al. (2009). PRISMA provides a structured framework for reporting review findings via a four-phase flowchart. Integrating PRISMA into our methodology ensured a consistent, transparent approach, enhancing the study's robustness and credibility.

2.4.1. Search Terms and Applied Criteria

We utilized the Elsevier Scopus database to access a vast repository of peer-reviewed manuscripts, aiming for a comprehensive understanding of the multidisciplinary scope of AI and related fields.

Our selection process followed four distinct phases (Page et al., 2021). First, we identified relevant research in the database. Next, abstracts were analyzed for relevance. This was followed by a full-text assessment, culminating in decisions about eligibility. Aligned with PRISMA's four-phase flowchart, our methodology began with identifying pertinent keywords to define the theoretical knowledge corpus (identification phase). Documents were

then screened using predetermined filters to select the most suitable ones (screening phase). The subsequent phases involved adherence to eligibility criteria (eligibility phase) and inclusion criteria for newly pertinent articles (inclusion phase). Figure 6 shows the PRISMA flowchart based on our database results and applied criteria.

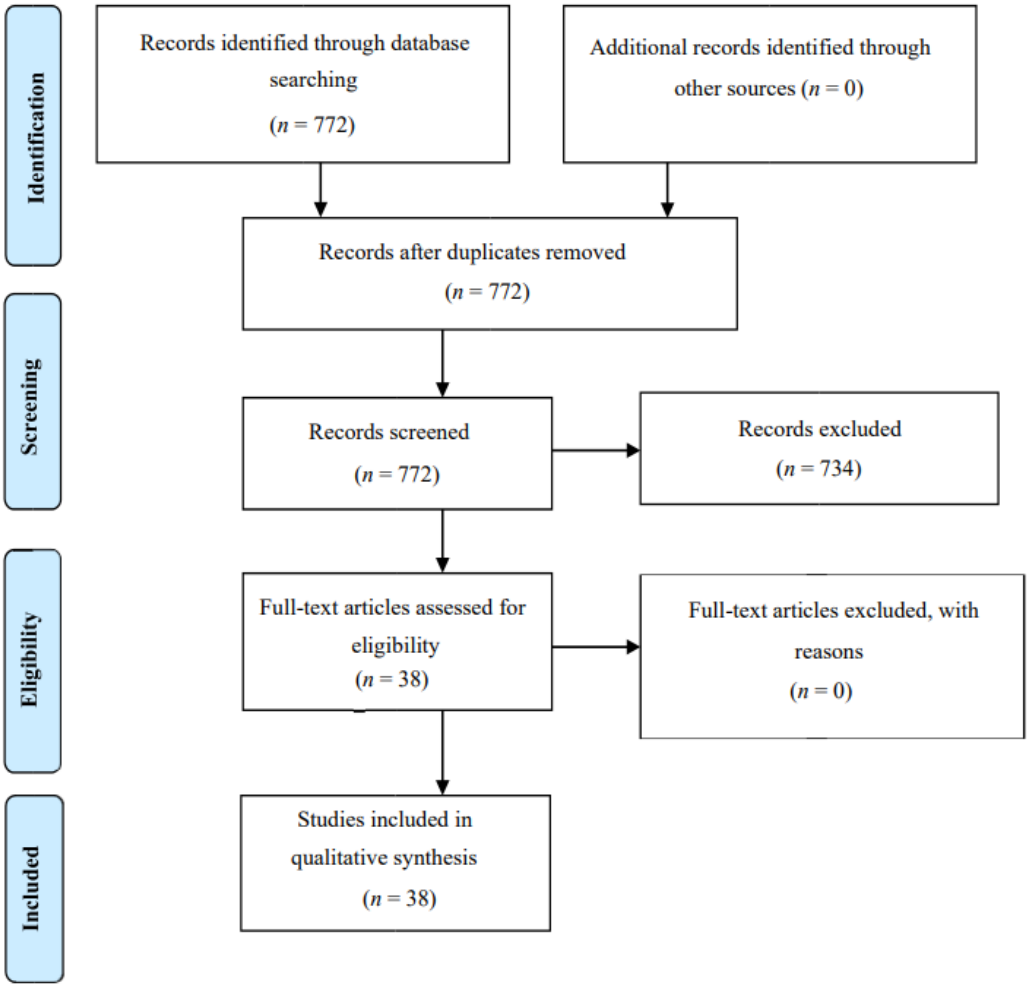

Figure 6 - PRISMA statement

The search was conducted on January 6, 2024, using the terms “Auditor” in the title and “Digital” in the title, abstract, and keywords. This initially yielded 772 documents. During the screening phase, we focused on publications from 2021 to 2023, reducing the sample to 257 records. We then applied filters to include articles in Business, Management and Accounting, as well as Economics, Econometrics and Finance, resulting in 65 articles. Further refinement by selecting only journal articles ensured higher quality standards, yielding 42 hits. Finally, we included only English-language studies that had reached the final publication stage, resulting in 38 studies.

Using these 38 documents, we conducted a thematic analysis following five steps outlined by Braun and Clarke (2021). First, we comprehensively read and re-read the documents to understand their content. Following, we extracted data into a spreadsheet, noting the title, author, publication year, country, and findings. We then coded the data to identify recurring patterns and connections, forming an initial set of emergent themes. These themes were iteratively refined and aligned with the research objectives. Finally, we synthesized and integrated the findings related to each theme, addressing the study's research question. This systematic approach provided a comprehensive exploration of the dataset, yielding relevant insights.

2.5. Results

2.5.1. General Overview – Leading Countries

The analysis encompassed 38 articles, highlighting their key attributes. Eleven manuscripts have ten or more citations, with the most cited article by Albitar et al. (2021) having 87 citations. Of the 38 articles, nine are from 2021, sixteen from 2022, and thirteen from 2023. Figure 7 shows the countries with the most publications on this topic: the United Kingdom (6), the United States (4), Jordan, Malaysia, and Romania (3 each), and Brazil, Egypt, Germany, Indonesia, South Africa, and Sweden (2 each).

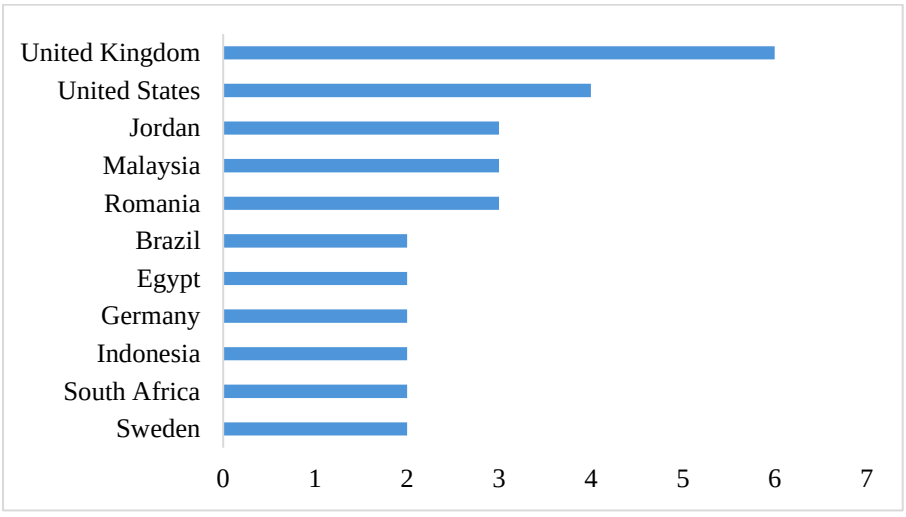

Figure 7 - Documents by country

The United Kingdom is a key contributor to the discourse on digital transformation in auditing, focusing on digital tools, innovative practices, and institutional structures (Aquino et al., 2022). The studies address regulatory proposals for the digital economy and

their implications on audit quality, stressing the need for investments in digital technologies (Albitar et al., 2021). The United States also makes significant contributions, examining remote work's impact, challenges in adopting blockchain, digital transformation in auditing, and automated processes in audits (Eulerich et al., 2022). In Jordan, studies explore the impacts of emerging technologies related to the Fourth Industrial Revolution (Allbabidi, 2021).

2.5.2. Overview of the Selected Categories

To address the research question – "How do auditor competencies evolve in response to innovative challenges within the digital age?" – the next phase involves identifying the most frequently referenced categories related to innovative audit practices and auditor competencies. Using NVivo for quality and reliability, we conducted a manual coding of the manuscripts (Woolf & Silver, 2017). NVivo efficiently managed the large dataset, supporting the analysis of initial nodes and cross-referencing key ideas (Bazeley & Jackson, 2019).

The initial nodes – Auditors, Audit, and Digital Audits – were identified using a word cloud, as shown in Figure 8. While these categories are expected due to the applied database filters, the critical aspect lies in the codes that introduce innovative and original insights. The development of constructs through these initial nodes significantly enriches the research outcomes discussed in section 2.6.

Figure 8 - Word cloud with the main concepts for initial nodes (NVivo software)

Following the design of the word cloud, we conducted a deeper investigation of the initial nodes to differentiate various contexts. These nodes were divided into three dimensions. The first dimension is the concept of the "Auditor", referring to professionals who assess and ensure financial and operational compliance (Jeacle & Carter, 2022). The second dimension involves "Auditing Practices", which are systematic examinations that ensure financial accuracy, operational efficiency, and compliance (Fotoh & Lorentzon, 2023). The third dimension, "Digital Audits", encompasses the integration of advanced technologies in auditing, transforming traditional practices for enhanced efficiency and adaptability (Betti & Sarens, 2021). After the review process, we identified three main focuses: Auditor, Auditing Practices, and Digital Audits. Table 5 presents the results of the SLR.

Table 5 - Results of the SLR

Initial nodes	Categories mentioned	Author(s) contribution
I. Auditor Competency Development Personal Identity Job Satisfaction	Readiness, Continuous Learning, Skill Enhancement, Professional Standards, Skepticism, Role Perception, Work Environment, Self-Awareness, Relationship Management	(Saengsith & Suntraruk, 2022), (Goto, 2023), (Al-Khasawneh & Al-Khasawneh, 2023), (Li et al., 2023), (Handoko et al., 2023)
II. Auditing Practices Triple-Entry Accounting (TEA) Robotic Process Automation (RPA) Remote Audit	Accounting; Blockchain, Smart Contracts, Transparency, Automation, Economy, Efficiency, Effectiveness, Ethical Standards, Technology Integration, Remote Communication, Feedback	(Sgantzos et al., 2023), (Al Shanti & Elessa, 2023), (Matskiv et al., 2023), (Eulerich et al., 2022), (Rahman & Ziru, 2023), (Albitar et al., 2021), (Farcane et al., 2023), (Aquino et al., 2022)
III. Digital Audits Quality Reports Performance Optimization Human-AI Interaction	Big 4, Reporting Standards, Internal Control, Cloud security, Indicators; Fraud Detection, Competency Framework, Machine Learning, Collaboration, Ethical AI Use; Human Expertise, Consistence	(Köktener & Tunçalp, 2021), (Al-Khasawneh & Al-Khasawneh, 2023), (Kartikasary et al., 2021), (Badewi, 2022), (Tiron-Tudor & Deliu, 2022), (Jeacle & Carter, 2022), (Moura de Carvalho et al., 2022)

Through a more detailed analysis of these initial nodes identified during the review

process, we discerned their significance across various scopes within specific dimensions of innovation auditing practices. These initial nodes were subsequently classified and grouped into three dimensions: the first dimension focuses on the auditor as a professional, addressing factors essential for competency development, professional identity, and job satisfaction; the second dimension discusses topics related to Auditing Practices, including the integration of Triple-Entry Accounting (TEA) system, Robotic Process Automation (RPA), and Remote Audit activities; lastly, the third dimension explores the impact of Digital Audits, encompassing aspects related to Quality Reports, Performance Optimization, and Human-AI Interactions.

2.6. Discussion

2.6.1. Auditor

A thorough examination of the initial nodes facilitated the delineation of the Auditor dimension (see Table 5), revealing its association with competency development, professional identity, and job satisfaction. Within the contemporary milieu, auditors' competencies are essential prerequisites for preserving the veracity and efficacy of financial information (Cassia & Magno, 2021). As evaluators of auditing practices, auditors possessing readiness attributes and seeking continuous learning, through the enhancement of their skills, are more likely to succeed in the digital age (Saengsith & Suntraruk, 2022). The proficient identity crafted by auditors relies on fundamental ideas such as professional standards, skepticism, and role perception, guided by principles that promote a critical attitude in evidence evaluation and a deep understanding of their responsibilities.

Auditors are being directly influenced by advanced technologies, particularly in terms of technological agility and professional growth. These skills encompass expanding their expertise, staying updated with technological advancements, and cultivating qualities such as leadership, communication, and problem-solving (Rydzak et al., 2023). There is a strong emphasis on continuous investment in professional skills to remain competitive in the market and be prepared for industry changes (Ab Wahid & Tan, 2023). Another essential determinant relates to competency advancement outcomes, acting as catalysts for successfully conducting auditing activities, driven by auditors' readiness and proficiency in ethical decision-making (Damerji & Salimi, 2021). Through the analysis of personal outcomes, perceptions about social status and the exploration of innovative possibilities frequently emerge in this field. Table 6 illustrates the determinants of Auditor, emphasizing critical concepts that focus on new trajectories in auditor competencies.

Table 6 - Determinants of Auditor

Dimension	Determinants
Auditor	Determinant 1: Enhanced Professional Capabilities Professional Growth Technological Agility Determinant 2: Competency Advancement Outcomes State of Readiness Ethical Decision Proficiency Determinant 3: Personal Outcomes Social Status Exploration of innovative possibilities

The analysis of the initial nodes revealed essential dimensions characterizing the scope of the Auditor: 1. Enhanced Professional Capabilities: This includes aspects such as professional growth through continuous learning and skill enhancement, as well as technological agility achieved through the expansion of knowledge and competencies and a refined role perception. 2. Competency Advancement Outcomes: This dimension focuses on the state of readiness, reflecting auditors' intentions to improve competencies and adapt to the work environment, as well as their proficiency in ethical decision-making, guided by professional standards, skepticism, and critical thinking. 3. Personal Outcomes: This encompasses factors like social status, including self-awareness and relationship management, and the exploration of innovative possibilities, encouraging auditors to embrace innovative opportunities in their professional journey.

Hence, auditors' elevated competencies strengthen their role in audit quality levels, contributing to integrity, ethics, and efficiency in the developed auditing practices. Continuous development, susceptibility to improvement, competency development outcomes, and personal outcomes are indispensable pillars, sculpting auditors poised for the most complex challenges of the modern auditing scenario.

2.6.2. Auditing Practices

In our discussion, we recognize a transformative shift in auditing practices, driven by the integration of advanced technologies to enhance human expertise. However, it is important to understand the most relevant aspects of the auditor's role and the competencies needed to apply these practices (refer to Table 5).

Within this dimension, the significant emphasis lies on concepts like the Triple-Entry Accounting (TEA) system, a groundbreaking innovation merging traditional accounting

principles with blockchain and smart contracts (Sgantzos et al., 2023). This approach aims to enhance the precision and reliability of financial transactions. Through blockchain integration, TEA introduces an added layer of security and transparency to accounting records. The decentralized and immutable nature of blockchain ensures transactions are recorded in an unalterable manner, accessible to all authorized parties, thus fortifying the integrity of financial data (Al Shanti & Elessa, 2023). Moreover, the incorporation of smart contracts in TEA allows perpetual automation in financial agreement execution, streamlining processes, reducing manual errors and performing an enabling audit based on principles of economy, efficiency, and efficacy. Consequently, the integration of these technologies promotes transparency and traceability, maximizing the ability to verify and audit transactions in a secure and automated environment (Matskiv et al., 2023).

Robotic Process Automation (RPA) arose in the literature as a fundamental part in innovative practices, aimed at revolutionizing and refining accounting processes (Eulerich & Kalinichenko, 2018). Aligned with the principles of optimizing efficiency, RPA involves deploying robots to automate routine tasks (Perdana et al., 2023). In the scope of auditing, the application of RPA signifies a revolution, through the incorporation of predictive analysis and visualization tools. Moreover, the incorporation of ML and DL empower auditors with comprehensive analytical perceptions, which provides a robust and adaptive framework (Zhang et al., 2022). That is, robots can process vast amounts of information swiftly and consistently, enabling a detailed analysis, saving time, and significantly reducing the risk of human errors associated with manual data manipulation (Rahman & Ziru, 2023). Beyond operational efficiency, the introduction of RPA in auditing enables the anticipation of patterns and trends. By freeing auditors from routine tasks, RPA allows them to concentrate on analytical activities, thereby adding greater value to innovative auditing practices. Thus, RPA raises the standard of data analysis, contributing to a more precise, critical, and proactive approach to ensuring the integrity of financial information.

Remote Audit also appeared in the literature as an important advancement in auditing practices, distinguished by the synergy between technology and remote communication (Farcane et al., 2023). This approach became particularly relevant during the COVID-19 pandemic, where technological resources such as video conferences, online collaboration tools, and specialized software were employed to conduct audits remotely, providing a flexible and efficient approach aligned with the needs of the digital era (Albitar et al., 2021). The implementation of Remote Audit enables auditors to conduct detailed procedures without the need for physical travel, reducing associated travel costs, providing flexibility in

schedules, and simplifying the response to client needs. Additionally, Remote Audit is especially relevant in global contexts where audit teams may be geographically dispersed (Aquino et al., 2022). By combining technology with remote auditing, organizations can readily adapt to changing work conditions, such as those prompted by unforeseen events or global crises (Barrett, 2022). In this regard, organizations must prioritize investing in infrastructure to establish a robust foundation for efficient resource allocation and to utilize communication platforms efficiently. Table 7 outlines the determinants impacting the dimension of Auditing Practices.

Table 7 - Determinants of Auditing Practices

Dimension	Determinants
Auditing Practices	Determinant 4: Continuous Improvement Training Programs Quality Control Mechanisms Determinant 5: Data Analytics Capabilities Predictive Analytics Visualization Tools Determinant 6: Technological Infrastructure Resource Allocation Communication Platforms

The analysis of initial nodes within the Auditing Practices domain revealed three additional determinants: 4. Continuous Improvement: This includes robust training programs integrating traditional accounting principles with advanced technologies and fostering proficiency in new communication platforms. Quality control mechanisms, such as adherence to ethical standards and feedback systems, ensure ongoing refinement. 5. Data Analytics Capabilities: Advanced analytics techniques like predictive analysis, powered by ML for optimized detection, and DL for recognizing intricate patterns, enhance efficiency and accuracy in auditing practices. Technological integration further bolsters these capabilities. 6. Technological Infrastructure: Strategic resource allocation optimizes collaboration within audit teams, while the integration of platforms facilitates seamless remote communication, showing the importance of a well-established technological framework.

2.6.3. Digital Audits

The mentioned categories in Digital Audits dimension can be consolidated into three

initial nodes (Table 5): quality reports, performance optimization, and human-AI interaction.

In the current context of innovative audit practices, the concept of digital audits arose in the literature as a key aspect to ensure the efficiency and operational reliability of organizations (Allbabidi, 2021). The nexus between quality reports, performance optimization, and human-AI interaction stood out as a crucial approach to address the challenges and trends of the digital era. Moreover, the integration of ML and DL further enriched this transformative process, taking audits to a new era of more substantiated and informed analyses (Tiron-Tudor & Deliu, 2022). Exploring all these elements, it is evident how they contribute to informed and strategic management. Quality reports are the foundation for assessment and accountability in digital audits. Emphasizing transparency became crucial to explain organizational practices, providing a clear view of operations (Rudžionis et al., 2022). In the context of the Big 4, particularly highlighted by Ernst & Young, it can be argued that these renowned firms are leveraging advanced data analysis technologies, reshaping the way audits are conducted. This redefinition allows companies to focus on high-risk areas and facilitate a smooth transition to increasingly automated and digitized processes (Köktener & Tunçalp, 2021). Through these premises, we frequently see high-quality services, bringing uniformity to the developed processes and enhancing efficiency at all levels.

In the pursuit of operational excellence, performance optimization unfolds across various essential dimensions. Thus, Key Performance Indicators (KPIs) also play a prominent role in innovative audit practices, by providing a continuous assessment of organizational performance. Simultaneously, fraud detection techniques are integrated to reinforce financial and operational security (Kartikasary et al., 2021). The introduction of a competency framework also highlights the significance of collaboration between human expertise and AI technologies, highlighting an ongoing commitment to ethical AI use within the organizational structure (Badewi, 2022). Furthermore, the introduction of cloud security assesses compliance, access management, encryption, monitoring, and incident response to protect data and systems. Considering the aforementioned factors, our attention also goes to the strategic frameworks, which are aimed at enhancing performance in the domain of digital audits. Hence, it is quite evident that the relationship between humans and AI is pivotal in the digital era. The continuous evolution and real-time adaptability inherent in ML and DL contribute to the agility of digital audits. These technologies can learn and evolve, ensuring that audit processes stay up-to-date with dynamic changes in organizations and emerging risks. Beyond pushing algorithmic efficiency, effective collaboration underlines the

importance of human expertise and continuous learning (Tiron-Tudor & Deliu, 2022). Accentuating this, ethics in AI usage ensures that decisions remain firmly anchored in ethical principles, fostering a harmonious environment where AI not only complements but also amplifies human competence, catalyzing sustained innovation (Moura de Carvalho et al., 2022). In this context, the continuous integration of human and AI resources is not just a strategic advantage but an imperative necessity to consistently conduct digital audits at the forefront of the digital revolution. Table 8 shows the determinants of Digital Audits.

Table 8 - Determinants of Digital Audits

Dimension	Determinants
Digital Audits	Determinant 7: Performance Measurement Key Performance Indicators (KPIs) Fraud Detection Techniques Determinant 8: Continuous Monitoring Frameworks Anomaly Detection Alerts Risk Indicators Determinant 9: Models for Performance Enhancement Customized Algorithms Real-time Monitoring

Examining the initial nodes and understanding how key categories interact, we identified the last three determinants within the Digital Audits: 7. Performance Measurement: Utilization of KPIs to foster collaboration and efficiency in specific areas; Integration of fraud detection techniques such as ML and DL for real-time transaction monitoring. 8. Continuous Monitoring Frameworks: Implementation of anomaly detection alerts powered by ML and cloud security measures; Establishment of risk indicators through monitoring systems to identify potentially risky transactions. 9. Models for Performance Enhancement: Development of customized algorithms focusing on ethical AI usage and competency frameworks; Implementation of real-time monitoring mechanisms combining human expertise with consistency. These determinants form a structured framework to effectively tackle emerging challenges and leverage opportunities in evolving business landscapes.

2.7. Conclusion

This SLR was conducted with the aim of uncovering strategies for auditors to enhance their competencies in response to emerging trends and challenges, revealing innovative

perceptions of the complexities of the modern auditing. The exploration of the three essential dimensions – Auditor, Auditing Practices, and Digital Audits – allowed to convert them into determinants that pave the way for excellence and effectiveness in innovative audit practices. Therefore, these three dimensions are crucial to understanding the required transformations and within the field of Auditing. In the first dimension, the highlighted determinants encompass the reinforcement of professional capabilities, the advancement of competencies, and the attainment of personal outcomes. This nexus implies continuous development, both in professional growth and technological agility, alongside with the incorporation of a state of readiness, exploring innovative possibilities. Regarding the second dimension, the determinants emphasize the importance of continuous improvement, data analytics capabilities, and technological infrastructure. These aspects can be achieved through continuous training programs, the implementation of quality control mechanisms, the use of data analysis with predictive and visualization tools, the integration of ML and DL, and the optimization of resources and communication platforms in auditing practices. In the last dimension, which relates to Digital Audits, the focus is on performance measurement, continuous monitoring frameworks, and models for performance enhancement. Consequently, a redefinition of KPIs, fraud detection techniques, and the establishment of structures for anomaly detection alerts and risk indicators take center stage. Moreover, the implementation of customized algorithms and real-time monitoring is emphasized. In general, it can be stated that these determinants provide a comprehensive overview of the crucial areas that require improvement to ensure excellence in modern auditing practices.

It can be asserted that auditors find themselves at a crucial crossroads, where the continuous evolution of competencies is inevitably interconnected with the technological revolution. The answer to the RQ lies in the upgrade related to technical skills, critical thinking, human-AI interaction, and ethical decision-making. Auditors prepared to control emerging technologies and cultivate a mindset of continuous learning, are well-prepared to face the innovative challenges of auditing in the digital age. However, it is crucial to acknowledge the limitations of this research. The dynamic nature of the digital environment means that some emerging trends or technologies have not been fully addressed, and we are aware that certain generalizations need to be made cautiously, as auditing practices diverge in other contexts and regions.

Regarding contributions to theory and practice, this study covers the way for further exploration of key competencies of auditors, highlighting the codes that introduce innovative and original information to understand how these competencies intertwine with audit

practices. Practical contributions are evident in the clarity provided to enhance the role of auditors in digital transformation. Emphasizing ethical integration, technological adaptation, and continuous development proved the need to elevate the quality of audits and fortify the integrity and effectiveness of the auditing profession. From this perspective, it is suggested that future research deeply explores the ethical impacts of automation in auditing, considering issues of privacy, data integrity, and algorithmic biases. Additionally, exploring innovative audit models aligned with the specific needs of an organization can provide added contributions to increase knowledge in the field.

Hence, this investigation not only addresses the question of how auditors can adapt but also lays the groundwork for innovative, ethical, and effective auditing practices in this digital era. By incorporating these findings into practice, the auditing profession can prosper, remaining relevant and valuable in an increasingly digitalized world.

CHAPTER 3 – ARTIFICIAL INTELLIGENCE IN AUDITING: A CONCEPTUAL FRAMEWORK FOR AUDITING PRACTICES

Executive Summary[3]

Based on the contributions presented in the preceding chapters, Artificial Intelligence (AI) is redefining the way in which organizational activities are conducted across various sectors, including finance, healthcare, manufacturing, and many others. In this regard, multiple corporations are shifting from traditional auditing methodologies to AI-powered solutions that progressively enhance operational effectiveness, and accuracy.

This research explores the impact of AI on auditing through a Systematic Literature Review (SLR) to develop a conceptual framework for auditing practices. The results show that the use of AI technologies in auditing is profoundly redefining how activities are conducted and transforming auditors' roles, shifting from retrospective examination to proactive real-time monitoring. Consequently, there is a need for auditors to develop new competencies, mainly in the management of advanced tools.

Traditionally, auditors have focused on reviews of financial records, often evaluating compliance after the fact. However, AI has emerged to completely shift the way auditing practices are conducted, enabling continuous oversight. This evolution enhances the accuracy of audits and allows auditors to identify potential risks, increasing the overall value of the audit process. Moreover, managerial contributions highlight the advantages of AI in auditing, particularly its role in improving decision-making, optimizing resource management, and ensuring compliance.

Future research should investigate critical areas, including the assessment of AI's impact on audit efficiency and performance through case studies, the regulatory issues related to AI-driven audits, and the formulation of effective adaptation strategies for auditors in response to these technological advancements. Considering these aspects is crucial to embrace AI integration in auditing practices, fostering innovation, competitiveness, and

[3] This executive summary serves as an expanded version of the initially published abstract, providing a comprehensive understanding and ensuring alignment among the thesis articles. For citation guidance, please refer to the APA standards. For chapter citation: Leocádio, D., Malheiro, L., Reis, J. (2024). Artificial Intelligence in Auditing: A Conceptual Framework for Auditing Practices. *Administrative Sciences, 14*(10), 1-16. https://doi.org/10.3390/admsci14100238. For thesis citation: Leocádio, D. (2025). *Artificial Intelligence in Auditing Practices: A Conceptual Framework for the National Republican Guard* [Master's Dissertation]. Portuguese Military Academy.

resilience.

Keywords: Artificial Intelligence; Auditing; Conceptual framework; Real-time monitoring

3.1. Introduction

The transition of business systems to digital formats has integrated advanced technological tools, pushing innovations in diverse operations conducted by organizations (Afsay et al., 2023). This process, driven by the increasing access to large databases and the ease of direct communication among them, reflects the current digital revolution. The integration of Artificial Intelligence (AI), big data, and cloud computing is consolidating a paradigm shift in organizational processes and how current professionals conduct their activities (Shapovalova et al., 2023).

AI encompasses various capabilities, including real-time information processing, trend identification, and task automation (Jagatheesaperumal et al., 2022). It is defined as "a system's ability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation" (Kaplan & Haenlein, 2019). Therefore, integrating data-driven insights and automated processes enhances productivity and efficiency, complementing human decision-making (Seethamraju & Hecimovic, 2023). AI is being used by accounting firms to enhance audit processes, risk assessments, transaction tests, analytics, and audit work-paper preparation for improved accuracy and compliance (Munoko et al., 2020). Big data introduces a revolutionary approach to handling large amounts of information, materialized by the ability to collect, store, and process data on a large scale and allowing organizations to anticipate trends, identify patterns, and make reasoned decisions (Agustí & Orta-Pérez, 2023). In turn, cloud computing establishes an important element amid innovative technologies, reconfiguring the technological infrastructure of organizations (Alotaibi, 2023). This transformation significantly reduces dependence on physical infrastructures and offers scalable and flexible computing resources over the internet, enabling swift adaptation to the market. Hence, the combined implementation of these advanced technologies redesigns professionals' approach to task execution. The agility, predictive capability, and automation introduced by these innovations present a transformative landscape, fostering efficiency, adaptability, and innovation across all levels of the organization (Rahman & Ziru, 2023).

The evolution of advanced technologies has changed the way business systems are structured, with the integration of AI standing out as a transformative strength, particularly

in the field of auditing (Goto, 2023). Currently, AI in auditing plays a crucial role in redefining traditional practices and enhancing efficiency in financial reports (Rodrigues et al., 2023). The impact of AI on auditing is still a path to explore and is growing to encompass other aspects related to advanced data analytics, automation, and decision support. The Big-4 corporations – Ernst and Young (EY), Deloitte, PwC and KPMG – are at the forefront of adopting AI technologies to ensure greater efficiency and effectiveness in their activities, leading in the auditing sector (Adeoye et al., 2023). The incorporation of AI in auditing indicates that auditors in the digital era gain specific skills and obey the fundamental ethical considerations of the profession. Consequently, while there are numerous advantages to the integration of advanced technologies in auditing, it is crucial to adopt a more critical perspective, particularly in evaluating the strengths and limitations of existing studies. Many publications tend to emphasize positive outcomes, often overlooking significant challenges, such as data privacy issues, the complexities involved in technology integration, and the potential displacement of human auditors (Cornacchia et al., 2023). This tendency towards an overly optimistic narrative does not fully reflect the practical realities and ethical considerations these innovations may introduce. A more balanced evaluation is essential to reveal both the transformative potential and the inherent limitations of these technologies, ensuring that their implications for the auditing profession are examined rigorously.

As organizations increasingly embrace the integration of more advanced technologies into their processes, it becomes crucial to address the best practices to adopt to meet the challenges and opportunities of daily operations. Faced with a dynamic technological landscape and the integration of AI in auditing, auditors face the challenge of working with greater creativity and being attuned to the creation of innovative frameworks that simplify the execution of their tasks. By conducting a systematic literature review (SLR), this study aims to explore the development of a conceptual framework for performing audit procedures. Hence, the research question for this research is: “What is the impact of AI on auditing practices?”.

The remainder of the study is structured as follows: section 3.2 presents the results. Section 3.3 contains the data analysis and discussion of the conceptual framework. Section 3.4 provides the materials and methods used. Lastly, section 3.5 summarizes the results, highlighting both the theoretical implications and managerial contributions, addressing the study’s limitations, and outlining topics for future research.

3.2. Results

Of the twenty-one included manuscripts, fifteen are from 2023, and six are from 2024. Additionally, 67% of the published studies were Scopus Q1, 9% were Scopus Q2, and 24% were Scopus Q3. The average CASP score is 17 pts (Appendix A) on a four-level scale (poor, moderate, good, and excellent), which indicates the overall quality is good. The CASP evaluation shows that 38% of the articles scored excellent, 48% good, and 14% moderate quality.

The dominant subjects in the reviews center on digital transformation (Taherizadeh & Beaudry, 2023), technological advancements (Hu et al., 2023), innovative developments (Goto, 2023), and ethical considerations (Estep et al., 2023). The authors explored technologies like AI, Machine Learning (ML), Blockchain, and the Internet of Things (IoT), assessing their applications in accounting and auditing, while also highlighting the ethical issues for their reliable use. Moreover, these studies provided valuable contributions to better understanding the paradigm shift in the field of accounting, addressing associated challenges, and identifying key dimensions of AI-driven digital transformation. Ethical considerations were also consistently emphasized, highlighting the crucial need for the mindful and clear adoption of these technologies in the auditing profession.

Thus, based on the aforementioned information, we present a conceptual framework for auditing practices (Figure 9). The development of this conceptual framework essentially relied on data extracted from articles with high CASP scores.

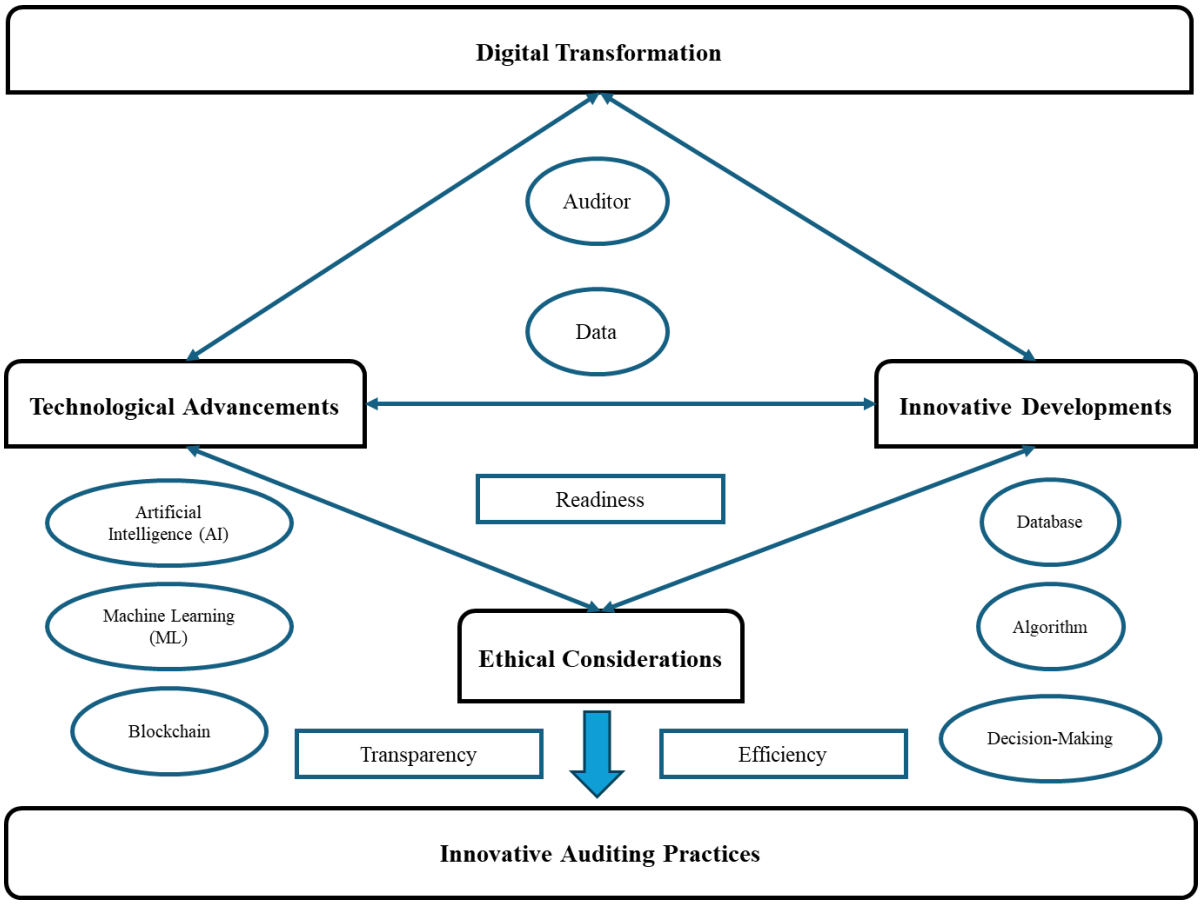

Figure 9 - Conceptual framework for auditing practices

The concept of digital transformation is progressively redefining auditing practices through the integration of emerging technologies. This shift relies heavily on technological advancements, including AI, ML, and Blockchain. AI and ML significantly enhance data analysis and automation, while Blockchain provides a secure and transparent mechanism for recording transactions. These advancements foster innovative developments, resulting in clean databases, more refined algorithms, and enhanced decision-making processes. However, these emerging technologies introduce critical ethical considerations. As technology evolves, auditors must be prepared to evaluate issues related to data privacy, algorithmic bias, transparency, and more. The following subsections offer detailed explanations of each topic, designed to help readers gain a deeper understanding of the concepts and their importance within the field of auditing.

3.2.1. Digital Transformation

The digital transformation in the field of auditing is tied to changes in the global economy and professional practices (Rodgers et al., 2023). The shift from traditional

auditing practices to technology-driven digital audits is propelled by factors such as more centralized accounting systems and the growth of e-commerce (Semenikhin et al., 2023).

The global perspective on digital transformation is substantiated by evidence found in Saudi Arabia's Vision 2030, where digital transformation strategies are proliferating (Abdullah & Almaqtari, 2024). The focal point lies in the auditors' readiness to embrace this change, highlighting the need to explore organizational factors for this transformation. The increasing importance of integrating emerging technologies into auditing practices is also emphasized as a crucial approach to addressing the complex demands of the digital economy (Adeoye et al., 2023). Reluctance to embrace these advancements poses a substantial challenge for auditing firms, threatening their ability to adapt to the contemporary business landscape (Shapovalova et al., 2023). The perspective explored on the grounded theory of AI-driven digital transformation in Canadian SMEs highlights five essential dimensions of the digital transformation in the field of auditing: assessing the transformation context, auditing organizational readiness, piloting AI integration, expanding implementation, and leading the transformation (Taherizadeh & Beaudry, 2023). Within this context, this topic not only provides benefits but also accentuates the challenges associated with data analysis, including the need for trust in emerging technologies, the establishment of ethical conduct, and shifts in business models. Emphasis is also placed on the profound cultural, professional, and strategic changes that auditors must experience to remain relevant in the digital era (Estep et al., 2023).

Global trends combined with practical dimensions redefine the foundations of auditing practices. The convergence of different perspectives illustrates how this revolution is influenced by various factors, encompassing economic contexts to the organizational spectrum. Hence, a necessity arises for a proactive adaptation to ensure continuous efficiency and transparency within the dynamic landscape.

3.2.2. Technological Advancements

Technological advancements have played a transformative role in the field of auditing, enhancing not only efficiency and precision but also providing a comprehensive understanding of the involved procedures (Huson et al., 2024). The integration of AI and ML technologies into auditing processes revolutionizes the way auditors operate. By harnessing the power of AI, auditors can analyze vast datasets in record time, identifying complex patterns and anomalies that may elude human detection (Taherizadeh & Beaudry, 2023). ML models continuously learn from data, improving their accuracy and efficiency

over time. Therefore, AI-driven tools can prioritize areas of concern, allowing auditors to allocate their time and resources more efficiently. This innovative approach enhances the quality of audits, ensuring that critical issues are addressed swiftly (Adeoye et al., 2023). Consequently, the development of new competencies for auditors requires a redefinition of the inherent responsibilities in such activities (Samiolo et al., 2023).

AI technologies arise as a clear example capable of transforming the effectiveness and transparency of auditing practices (Goto, 2023). ML empowers auditors to process extensive real-time data, discerning patterns, and trends with heightened precision (Blösser & Weihrauch, 2024). Blockchain in auditing stands out as an essential topic, promoting safer, automated, and transparent processes due to its immutable and decentralized nature (Han et al., 2023). In this context, there are increasingly more resources and means to achieve an optimized solution for conducting auditing activities.

The transition to advanced technology-driven auditing practices requires careful analysis, considering both cultural and operational transformations (Agustí & Orta-Pérez, 2023). Cloud computing serves as an essential example, allowing remote access to data and fostering more efficient collaboration. Auditors in the digital era need a more flexible and agile mindset. Technological competencies become crucial, going beyond mere tool usage and demanding a critical understanding of data and the ethical implications of AI (Seethamraju & Hecimovic, 2023). Therefore, the importance of specialized knowledge in data analysis is highlighted, emphasizing the need for accurate interpretation of results.

In the Industry 4.0 context, the ability to incorporate disruptive technologies brings about a profound transformation in procedures related to various activities, resulting in the creation of an interconnected network of real-time information and redefining the role of auditors (Abdullah & Almaqtari, 2024). In the current digital era, instead of being confined to the traditional review of historical records, auditors take on a proactive role, monitoring and evaluating various events in real-time. The adoption of these technologies is seen as a strategic requirement for the evolution and relevance of auditing. In a global scenario, as witnessed during the COVID-19 pandemic, these tools provide the flexibility to face significant challenges. This pandemic example highlights the urgency of implementing advanced technologies in this field, making it more efficient and resilient in the face of unexpected crises (Castka & Searcy, 2023).

Thus, technological advances in auditing extend beyond the simple update of tools for innovative practices. They represent a radical transformation in the auditor's approach to the collection, analysis, and processing of significant volumes of data. Therefore, the

effective implementation of these technologies optimizes operational efficiency, endowing auditors with a fundamental strategic role.

3.2.3. Innovative Developments

The pursuit of innovative developments has been significant in all spheres of knowledge, particularly gaining prominence in the field of auditing. This phenomenon signals the need for adaptation and redefinition of traditional practices in response to rapid advancements in the digital era (Seethamraju & Hecimovic, 2023). In this context, it becomes fundamental to effectively integrate different technological capacities, gain greater familiarity with emerging technologies, and foster an innovative organizational culture (Taherizadeh & Beaudry, 2023).

Innovation in the field of auditing involves a profound shift in the professional mindset joined with a reevaluation of traditional practices. Strategies like digital auditing, the exploration of ethical concerns linked to AI, and remote collaboration via cloud computing emerge as key elements in this new paradigm (Shapovalova et al., 2023). Specialization in AI is essential for addressing current challenges, enhancing efficiency and precision across all processes, and easing decision-making. Auditor competencies encompass the ability to manage emerging technologies, enabling the analysis of large volumes of real-time data, identification of complex patterns, and detection of anomalies. Therefore, specialization in databases also becomes crucial, aiming to create customized algorithms to achieve efficiency and effectiveness in auditing practices (Rodgers et al., 2023). Hence, real-time monitoring capability, along with the auditor's competence in handling vast amounts of available data, provides a solid foundation for decision-making.

The implications of innovations in auditing practices redefine the role of auditors in the digital era. In a profession where knowledge and practice are directly interrelated, innovation developments require the adoption of a transformative mindset that shapes the future of this profession (Goto, 2023). Beyond technical competence, a deeper understanding of ethical issues in using these advanced technologies is mandatory (Samiolo et al., 2023). Moreover, the ability to adapt and readiness to embrace technological innovations become crucial as auditing advances toward an era of convergence between human expertise and digital potential (Anh et al., 2024). Thus, the current challenge lies in ensuring the broader adoption of emerging technologies and a profound understanding of their interactions, ensuring sustainable change in auditing practices.

3.2.4. Ethical Considerations

As advanced technologies become prevalent in the field of auditing, reflection on ethical considerations may be indispensable. Addressing more specific aspects such as data analysis, cybersecurity, continuous learning, and global standardization is crucial for providing a comprehensive overview of the ethical complexities associated with emerging technologies in auditing practices (Abdullah & Almaqtari, 2024).

From a broader perspective, the scrutiny of ethical considerations is undertaken in the context of four fundamental pillars – equity, responsibility, transparency, and explainability (Blösser & Weihrauch, 2024). These principles, given the growing impact of AI across various domains, offer a guiding framework for organizations to implement more rigorous ethical standards. In the context of AI, ethics becomes critical, with issues related to accuracy, data security, and regulatory compliance arising as key elements to ensure auditors perform their duties efficiently and transparently (Han et al., 2023).

Examining the review of specific parameters and the use of AI-based monitoring systems associated with the automation of critical tasks, it becomes essential to establish ethical conduct standards. Therefore, the complexity of the ethical landscape in modern auditing is emphasized, requiring a careful approach and a constant commitment to fundamental ethical values (Adeoye et al., 2023). Beyond these considerations regarding the auditor's role, there is a need to establish clear guidelines for the adoption of innovative technologies in auditing, ensuring integrity, transparency, and accountability at all stages of the audit procedures. This aspect proves essential for constructing more efficient and innovative auditing practices in line with ethical conduct standards, enabling auditors to confront current dynamic challenges and technological transformations (Seethamraju & Hecimovic, 2023).

It can be asserted that the establishment of regulatory standards by influential organizations, including the OECD (Organisation for Economic Co-operation and Development) and the European Commission, reinforces a collective commitment to uphold these pillars, not only to protect consumer rights but also to promote ethical AI use (Blösser & Weihrauch, 2024). In parallel, the European Union (EU) is leading the way in AI regulation, aiming to set global standards for the responsible development and use of AI through initiatives such as the AI Act. Although this act addresses critical issues in the field, significant gaps remain, particularly in ensuring that AI systems are both transparent and accountable when failures arise. This is in line with the criticisms highlighted by Laux et al.

(2024), who argue that the Commission's approach of equating "trustworthiness" with acceptable risk levels is overly simplistic. The authors point out that the theoretical and empirical foundations of the AI Act are insufficient, and that additional sector-specific regulation may be necessary to fully address these issues. It is also emphasized that building trust in AI cannot rely solely on expert judgments about risk, as this overlooks the knowledge gaps between AI developers and the general public. Instead, public participation and the presence of impartial intermediaries, such as "notified bodies", are crucial for fostering genuine trust. While the EU's leadership in AI regulation is essential for setting a global standard, there is a clear need for more comprehensive measures to align regulatory policies with real-world understanding and public perceptions of AI (Laux et al., 2024).

Hence, the integration of advanced technologies assumes a strong commitment to the principles of ethical AI, crucial for strengthening ethical considerations in the development and implementation of AI systems. It is a commitment that contributes to the broader effort of achieving a harmonious balance between technological innovation and ethical responsibility in auditing.

3.3. Discussion: The Case of MindBridge

As observed earlier, digital transformation is reshaping the core competencies of the auditing profession. This change involves an integration of emerging technologies, designing a new approach to how auditors perform their tasks (Saengsith & Suntraruk, 2022).

Auditing plays a critical function in guaranteeing the reliability of an organization's financial information. Currently, this scenario faces complex challenges, highlighting the importance of safeguarding transparency and integrity in business operations (Wassie & Lakatos, 2024). In this regard, AI stands out as a potent ally, providing innovative approaches and solutions to auditors (Samiolo et al., 2023). Traditionally, auditors have scrutinized accounting records to uphold adherence to standards and regulations, while also identifying irregularities and potential instances of fraud (Peng & Tian, 2023). However, technological advancements, particularly in AI, open up new possibilities for financial auditing, providing innovative solutions to improve performance in audit procedures (Fedyk et al., 2022).

Headquartered in Ottawa, Canada, and founded in 2015, MindBridge stands out as a pioneer in adopting advanced technologies in the context of auditing, providing support to organizations worldwide in dealing with the growing challenges of the contemporary

business environment (MindBridge, 2024). This company has developed a revolutionary solution to enhance auditing by creating an advanced data analysis platform – MindBridge AI. This platform empowers auditors to identify unusual patterns, potential frauds, and errors swiftly and efficiently in financial information (Prokofieva, 2023). It has the capacity to automate manual tasks and perform real-time data analysis, allowing organizations to conduct more effective audits, mitigate risks, ensure legal compliance, and make informed decisions based on accurate information (Bento & White, 2023). The MindBridge AI platform significantly reduces the time needed to conduct audits, boosting auditors' productivity and enabling them to concentrate on more strategic matters (MindBridge, 2024). The platform uses complex data analysis algorithms to identify irregularities and unusual trends that may indicate fraud, mistakes, or financial risks. This improves audit accuracy and gives companies a deeper understanding of their financial position.

With the increasing public scrutiny of companies' financial practices, this platform plays a vital role in ensuring regulatory compliance and transparency in financial operations, helping to identify and mitigate non-compliance risks and protecting the reputation and integrity of organizations (Prokofieva, 2023). MindBridge employs an integrated approach, employing AI, ML, and advanced data analysis to enhance efficiency, accuracy, and relevance in auditing. Consequently, this AI-based platform effectively detects irregularities and uncommon patterns in financial data, such as suspicious transactions and discrepancies in accounting records. This ongoing assistance aids auditors in identifying potential frauds, errors, and financial risks, providing pertinent insights into areas of concern. Furthermore, the MindBridge AI enables a comprehensive analysis of all available data, eliminating the need for sampling result reliability.

The platform has the capacity to analyze historical trends and relationships between different sets of financial data, helping auditors better understand the context and interconnection of information (Prokofieva, 2023). MindBridge AI provides reporting and data visualization features, making it easier for auditors to communicate the results of their analyses clearly and comprehensibly to stakeholders (KPMG, 2024). These are just some of the ways in which MindBridge employs advanced technologies to enhance innovative auditing practices, providing efficiency, accuracy, and relevance in an increasingly complex and data-driven environment. This innovative technology is redefining auditing practices and assisting companies in maintaining market confidence and driving sustainable growth (Bento & White, 2023). Moreover, MindBridge has also formed strategic collaborations with renowned audit and consulting organizations, broadening the platform's reach and effect.

MindBridge's collaboration with KPMG emphasizes the success and relevance of its platform in auditing processes, highlighting firms' commitment to embracing innovative and advanced technologies to ensure transparency and integrity in their financial operations (KPMG, 2024).

The integration of real-time auditing with AI and advanced data visualization techniques has highlighted several innovative research avenues in the field of financial oversight and compliance. The shift from traditional audits to continuous, AI-driven monitoring represents a substantial evolution in auditing practices, allowing organizations to identify and address financial issues with unprecedented immediacy and precision. This transformation underscores the need for further exploration into how real-time data processing and visualization can enhance auditing accuracy and effectiveness. Therefore, MindBridge serves as a compelling example of how innovative developments can profoundly transform the field of auditing. Its platform empowers auditors with powerful tools to identify risks and anomalies, enhancing efficiency, accuracy, and reliability in the processes developed.

Thus, in a context where the use of advanced technologies plays a crucial role, the AI-based platform stands out as a leader at the forefront of auditing, reflecting the commitment to provide innovative solutions that propel the profession to new levels of excellence.

3.4. Materials and Methods

3.4.1. Search Process

In the current scenario of auditing, marked by increasing interest, regulatory intervention, interdisciplinary research, and information volume, there is a need to attain a clear understanding of how these technological advancements are reshaping traditional audit practices and creating new opportunities for innovation and efficiency in the auditing industry. Therefore, an advanced search was conducted on Elsevier Scopus using article titles, abstracts, and keywords to identify manuscripts in English. The search terms employed were "Artificial Intelligence" AND "Auditing". On 18 February 2024, Scopus yielded 598 documents, showing a consistent growth trend since 2016 (representing 78% of total hits). The identified documents were mostly conference proceedings (45%) and articles (40%) from the USA, China, India, and the United Kingdom, with a focus on computer science (65%), and engineering (23%).

3.4.2. PRISMA Protocol

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) protocol is widely acknowledged and essential in various research domains, serving as a checklist for the systematic literature review process. This checklist provides a transparent and well-organized method for presenting the outcomes of such reviews (Tranfield et al., 2003). Therefore, a Systematic Literature Review (SLR) is a fundamental method for accurately, dependably, and transparently synthesizing information. It employs predefined eligibility criteria to select empirical evidence and address precise research questions (Moher et al., 2009). We used a single database to offer a pragmatic overview of the characteristics, through a systematic review, aiming to be transparent, replicable, and easily accessible in all steps (Page et al., 2021). Selected for its reputation, Scopus stands as the largest international and multidisciplinary database of peer-reviewed manuscripts and, therefore, a fundamental tool to simplify the investigation process (Guz & Rushchitsky, 2009).

The PRISMA statement oriented the selection process into four phases (Page et al., 2021): initially, we identify relevant research by thoroughly exploring databases and academic journals, aiming to compile a comprehensive list of potential studies. This broad net is cast to encompass the diverse literature contributing to the research question. Next, a screening process is employed, systematically examining titles and abstracts to assess their relevance to the research topic. This serves as a filter, excluding studies not aligned with the research focus, resulting in a more precise compilation of literature for subsequent evaluation. Moving to the eligibility phase, we conduct a comprehensive assessment of chosen studies based on predetermined criteria. This involves scrutinizing complete texts to verify alignment with specific inclusion criteria, such as study design, publication date, main findings, or other pertinent parameters. The final and critical step encompasses the selection of studies for inclusion in the SLR. Conclusive decisions are made based on alignment with the research question, adherence to predefined criteria, and the provision of valuable insights. Hence, this selection process ensures that the final compilation of literature may be pertinent and characterized by methodological rigor (Krippendorff, 2019). Figure 10 shows the PRISMA flowchart for this SLR:

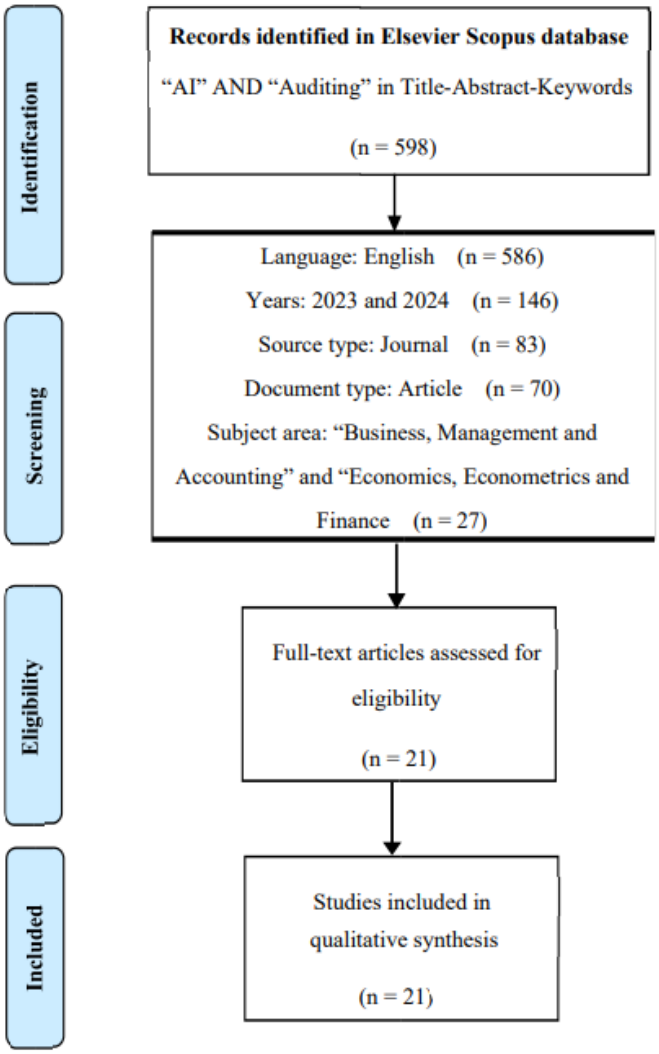

Figure 10 - PRISMA flowchart

In the screening phase, we only selected studies in the English language, obtaining 586 manuscripts. Then, we restricted the sample between 2023 and 2024, concentrating on recent investigations (146 records). Additionally, we also applied filters to select journal articles, in the areas of "Business, Management and Accounting" and "Economics, Econometrics and Finance" (27 hits).

All documents were carefully read to exclude any articles lacking full-text access. We prioritized methodological rigor by evaluating the strength of the research design and the overall contribution to the field. Articles that did not provide sufficient detail in these areas or failed to meet established academic standards were excluded from our analysis (n = 6). Therefore, the process was completed with 21 manuscripts included in qualitative synthesis, considering that no additional articles were included beyond those obtained in the

Scopus database. Moreover, this study serves as a comprehensive summary of the literature from the preceding year. It is crucial to recognize that studies from different types of literature have not been incorporated, thereby characterizing this study as a snapshot of a period.

3.4.3. Data Extraction and Synthesis

Data extraction from Scopus, refined by the PRISMA protocol, culminated in the creation of a comprehensive report. This report included pertinent information about the author(s), year, purpose, methodology, and main findings, providing the synthesis of current knowledge over the past year (Appendix B). Therefore, a content analysis was developed to further enhance the depth of understanding.

We conducted the analysis with the aid of computer-assisted data analysis software (CAQDAS) called NVivo (Bazeley & Jackson, 2019). NVivo is a powerful tool that enhances the efficiency and precision of content analysis, particularly when managing large datasets. In this study, NVivo (Version 12) streamlined the analysis of the 21 included documents by facilitating the systematic classification, coding, and interpretation of key concepts and relevant ideas. Therefore, this software enables researchers to identify patterns and organize data effectively, making it invaluable for rigorous qualitative research.

The synthesis process was developed following five essential steps (Braun & Clarke, 2021): firstly, the manuscripts underwent thorough reading and re-reading to acquire a more profound understanding of the content. Then, the information about the title, author, publication year, country, and main findings was extracted and recorded in a spreadsheet. The data were coded to identify patterns and connections, resulting in the establishment of an initial set of themes. Following, themes were refined, ensuring alignment with the research objectives. Lastly, the outcomes under each theme were integrated, considering the research question delineated for this investigation.

3.4.4. Quality Assessment

The assessment of methodological quality involved the use of the Critical Appraisal Skills Program (CASP), which is a qualitative scoring checklist applied to the included reviews. We adhere to the procedural guidelines outlined on the CASP website (https:// casp-uk.net, accessed on 22 February 2024), which comprehensively delineates information affecting systematic reviews (Singh, 2013). This checklist evaluates the included reviews

using 10 possible items. The use of CASP played a fundamental role in the identification of high-scoring reviews and the delineation of relevant themes for subsequent analysis. The necessity of critical evaluation in qualitative studies, crucial for ensuring validity, further underscores our deliberate decision to employ CASP in this context (Miller et al., 2009).

3.5. Conclusions

3.5.1. Theoretical Implications

The integration of AI into auditing practices represents a significant and paradigmatic shift in the fields of accounting and financial management. This study enriches existing theory by examining and emphasizing the theoretical implications of this transition through the construction of a conceptual framework.

Firstly, our research addresses a critical need to comprehend the effects of digital transformation on auditing. We examined a wide array of studies, providing a comprehensive understanding of emerging trends and areas of interest for future investigation. As the analysis progressed, it became evident that the shift towards technology-driven auditing practices implies a fundamental change in the core of the auditing context. Historically, auditing has been interpreted as a retrospective examination of records, with auditors examining documents to uncover errors and irregularities. However, our research reveals that AI is redefining this scope, transforming auditors into proactive agents of real-time monitoring and assessment. This paradigm shift is indispensable for advancing the theoretical conception of auditing as an ever-evolving discipline. It entails a fundamental reimagining of auditors' roles and responsibilities in the digital age, surpassing the mere adoption of innovative technologies to augment current practices. The integration of AI into auditing practices demands an innovative adaptation in auditors' competencies, requiring them to understand and analyze real-time data, apply advanced pattern analysis techniques, and proactively detect anomalies.

Hence, this study contributes to a holistic understanding of the ongoing transformation in the field of auditing. By situating AI integration as part of a broader shift towards a more dynamic and future-oriented profession, we explored a new track for auditing practices. This theoretical perspective is essential not only for informing academic research but also for guiding professional practices and policy development in auditing.

3.5.2. Managerial Contributions

This study highlights several contributions to management that can revolutionize how organizations approach auditing and decision-making strategies. The integration of innovative developments into auditing practices not only redefines organizational processes but also offers a range of managerial benefits crucial for professionals in the field. Recognizing the transformative role of AI in reshaping organizational processes is crucial. These technologies constitute a profound transformation in organizational operations and data engagement. Managers, equipped with a deep comprehension of their impact on auditing practices, can make informed decisions about their integration within their respective organizations, extending their influence to encompass risk analysis, financial decision-making, and regulatory compliance strategies.

Furthermore, by examining the business case of MindBridge, this study provides valuable practical contributions for managers in selecting and integrating AI solutions into their auditing strategies. By demonstrating how leading companies are employing AI to enhance efficiency, accuracy, and transparency in their auditing operations, this investigation offers an innovative framework for other organizations to follow. Managers can learn from these success stories and adapt these practices to their own organizational realities, promoting innovation and competitiveness in the sector. Understanding the implications of emerging technologies and their integration into auditing practices not only enhances operational efficiency but also fortifies organizations' capacity to respond to market dynamics and evolving regulatory requirements. Managers who adopt these innovative solutions are strategically positioning their organizations at the vanguard of digital transformation, thereby equipping them to confront future challenges with confidence and resilience.

3.5.3. Limitations and Future Research

While we acknowledge the significant contributions of this study, it is essential to address the inherent limitations that may influence the interpretation of the results. One potential limitation lies in the possibility that some relevant contributions may have been inadvertently omitted during the search and selection of articles. Despite diligent efforts to cover a wide range of sources, time constraints, access to certain databases, and the selection of keywords may have limited the inclusion of certain pertinent studies. Moreover, as systematic reviews depend on the quality and timeliness of available materials, our analysis

is subject to the quality of the included studies as well as the risk of publication bias, where studies with negative or neutral results may not be as readily available or published. This may impact the generalizability of the results and the comprehensive understanding of the field of study.

Another limitation to consider is the constant evolution of the field of study. AI-driven auditing technologies are in a state of rapid change and development. As a result, our analysis may reflect a snapshot limited in time, not fully capturing the most recent or emerging trends. Additionally, the final remarks of this research may be influenced by the quality of the included studies. Variations in the quality of the studies may affect the reliability and validity of the results, as well as the facility to generalize the conclusions. Consequently, it is fundamental to consider these constraints and acknowledge that our overview of the subject matter may be influenced by methodological and contextual variables.

Based on our analysis, we have identified promising areas for future research. These suggestions represent only some of the many potentially fruitful research areas that have arisen from our literature review. We expect that these directions will encourage future investigations and contribute to a more comprehensive understanding of the impact of AI on auditing practices. Therefore, to further enrich the presented analysis, it would be beneficial to include a broader range of industry case studies beyond MindBridge, showcasing its impact on performance and audit outcomes. There is also a need to explore the regulatory challenges related to using AI in auditing and create guidelines to ensure responsible and transparent AI usage. The EU is at the forefront of AI regulation, establishing global standards for responsible AI development and use. While the AI Act addresses key issues like transparency and accountability, there are still gaps, particularly in ensuring systems are understandable and accountable when failures occur. Moreover, it is essential to assess how auditors adapt to emerging technologies and their role in organizational change, including perspectives on AI adoption and the development of training programs, to ensure a seamless transition and enhance their competencies in dealing with innovative developments.

These new research frontiers are indispensable for enhancing our comprehension of the connection between technology, auditing, and management, thereby empowering organizations to confront the challenges and seize the opportunities presented by the digital age.

CHAPTER 4 – EXPLORATION OF AUDIT TECHNOLOGIES IN PUBLIC SECURITY AGENCIES: EMPIRICAL RESEARCH FROM PORTUGAL

Executive Summary[4]

This final chapter explores the integration of Artificial Intelligence (AI) into auditing practices within a Portuguese public security agency, providing a comprehensive analysis of its potential to enhance efficiency, accuracy, and accountability. The study illustrates how key auditing tasks, such as data extraction, analysis, and verification can be streamlined, creating opportunities for more effective and agile financial oversight.

The research employs a qualitative methodology, reinforced by custom-developed Python algorithms designed to integrate key indicators into the audit process. Particular attention is given to analyzing economic classification and ensuring adherence to expenditure limits, which are essential components of public sector financial management. The main findings reveal that the use of personalized algorithms significantly reduces manual workloads, improves precision, and ensures stronger compliance with regulatory standards. These innovative developments not only enhance the reliability of audits but also empower decision-makers with accurate data-driven insights.

Although the study explores AI's potential, it equally recognizes the inherent challenges. The most pressing obstacles include concerns about safeguarding data privacy and the weighty investments required to build and maintain the necessary technological infrastructure. Addressing these issues will require careful planning and a commitment to innovation, as well as the development of frameworks that prioritize ethical considerations and organizational readiness.

Ultimately, this study makes a valuable contribution to the current literature of public sector governance. By highlighting the practical applications and benefits of AI in auditing, it provides a foundation for future research aimed at adapting AI-based models to diverse

[4] This executive summary serves as an expanded version of the initially published abstract, providing a comprehensive understanding and ensuring alignment among the thesis articles. For citation guidance, please refer to the APA standards. For chapter citation: Leocádio, D., Malheiro, L., & Reis, J. (2025). Exploration of Audit Technologies in Public Security Agencies: Empirical Research from Portugal. *Journal of Risk and Financial Management, 18*(2), 1-18. https://doi.org/10.3390/jrfm18020051. For thesis citation: Leocádio, D. (2025). *Artificial Intelligence in Auditing Practices: A Conceptual Framework for the National Republican Guard* [Master's Dissertation]. Portuguese Military Academy.

public administration contexts.

Keywords: Artificial Intelligence; Auditing; Portugal; Public sector; Python

4.1. Introduction

Artificial intelligence (AI) in the public sector has been driving significant changes, reshaping governance methods, and management processes (Jarrahi et al., 2023). In the current context, in which technology plays an increasingly crucial role in all levels of society, AI has redefined auditing practices and internal control mechanisms.

Advanced technologies and tools including AI, Blockchain, and Big Data analytics are revolutionizing organizational management, optimizing processes and introducing innovative methodologies (Cammarano et al., 2024). These technological advancements are crucial in addressing the complex challenges faced by public administration. Incorporating AI technologies into auditing practices enables organizations to enhance efficiency in detecting financial irregularities, minimize human errors, improve the accuracy of data analysis, and offer strategic insights for informed decision-making (Goto, 2023). Leading corporations in the area, such as Ernst & Young (EY), Deloitte, PwC and KPMG, are at the forefront of this transformation by implementing AI in their processes. This implementation not only highlights the growing importance of AI in the public sector but also underlines the need for professionals in the field to acquire new competencies and quickly adapt to an innovative environment (Zamzam et al., 2024). It is also relevant to note that the integration of AI technologies into the public sector raises ethical considerations and creates new challenges for professionals as well as the need to reinforce professional skepticism when dealing with automated systems and data analysis (Aquino et al., 2022).

Understanding the potential of AI in the public sector, government organizations can promote more efficient, transparent, and accountable governance, bringing concrete benefits to citizens (Nzobonimpa, 2023). Therefore, the integration of innovative technologies is not just a temporary trend but rather a radical shift in how activities are conducted. AI enables us to focus on activities that add greater value and also assist in identifying trends and predicting issues, improving decision-making. It is also relevant to emphasize there are still several challenges to its successful integration into the public sector, such as data privacy, investment in infrastructure, and specialized training (Kamila & Jasrotia, 2023). This represents a continuous transformation seeking to redefine the future of management, and the incorporation of AI, particularly through algorithm-based applications, offers a

significant opportunity to improve auditing practices, enhance efficiency, and optimize decision-making.

Regarding the integration of AI in the public sector, it is closely linked to the International Public Sector Accounting Standards (IPSAS), which focus on transparency and accountability. In the context of auditing, standards like IPSAS 1 (Presentation of Financial Statements), IPSAS 24 (Presentation of Budget Information), and IPSAS 3 (Accounting Policies) require clear and accurate financial reporting, which AI can support by automating the verification of transactions and ensuring compliance with accounting norms. Innovative developments can quickly analyze large datasets, identifying discrepancies that might be missed by auditors. It also helps with IPSAS 3, ensuring that accounting estimates and errors are corrected, improving the accuracy and reliability of financial reports (IPSAS, 2021).

The remainder of this paper is structured as follows: sections 4.1.1 and 4.1.2 describe the overview of the institution and the audit process; section 4.2 details the methodology; section 4.3 presents the results and discussion; and lastly, in the section 4.4, we focus on theoretical and managerial contributions, research limitations and suggestions for future research.

4.1.1. Overview of the Institution and Research Question

In the context of security institutions in Portugal, there are forces tasked with upholding democratic legality, internal security, and the rights of citizens, while also contributing to the implementation of national defense policy. This research aims to strengthen transparency, efficiency, and modernization within the public sector in Portugal, ensuring effective risk management and compliance with democratic and national standards. Therefore, it focuses on a relevant security agency distinguished by a highly hierarchical organizational structure, employing over 20.000 individuals and managing a budget approaching one billion EUR. The complexity and scale of this institution require the implementation of advanced auditing methodologies and internal control mechanisms to enhance decision-making processes. Auditing practices within this organization entail an assessment by auditors to provide recommendations for improvement, ascertaining that internal control is established through measures designed to mitigate risks. Consequently, it is essential to study and implement both activities to ensure the effective management of risks and operational processes. Innovative auditing practices have been integrating advanced technologies, as a consequence of their labor-intensive nature, regulatory load, and competitive pressures, making them a prominent area for process automation. Although AI

tools integrating technologies such as Robotic Process Automation (RPA) and Machine Learning (ML) are seen as potentially transformative in current auditing practices, there is still a scarcity of empirical studies exploring their effective incorporation into this domain.

The Research Question (RQ) defined for this study is as follows: "How can AI improve auditing practices in a public security agency?". This manuscript employs a qualitative research strategy, justified by the need to better understand the relationship between AI technologies and auditing practices in the public sector (Yin, 2018). In this regard, the unit of analysis is a public security agency, integrating a case study that describes the key aspects of a created scenario for an innovative implementation with focus on auditing practices. The unit of analysis was selected by convenience, which is a type of non-probabilistic sampling that involves selecting the sample from a conveniently available group of respondents (Etikan et al., 2015). In this case, obtaining relevant data can be challenging given their closed nature, sometimes requiring security clearance under specific circumstances.

4.1.2. Audit Process

An audit within a public institution is a crucial process to ensure transparency and efficiency in the management of financial resources (Kateb & Belgacem, 2024). The agency under review has a Financial Resources Department, which includes the Internal Control Division that primarily focuses on financial auditing, divided into two main offices: the monitoring, control, and risk management office and the internal audit office. The monitoring, control, and risk management office is responsible for financial reporting, scrutinizing the expenditure processes of financial centers at the end of each month. This report encompasses four essential points – compliance, accountability, revenue, and expenditure (GNR, 2021). Although the entire process is already digitalized, it is not feasible to individually analyze all processes. Consequently, an annual risk matrix is established which identifies areas of greater vulnerability. In turn, internal auditing is a more complex approach, conducted in a planned mode, following an audit program structured into ten stages (GNR, 2021): audit subject, audit objectives, scope delimitation, evidence collection, audit risk, materiality, methods, scheduling and necessary resources, and communication with the audited center. The audit subject refers to information about the activity or theme to be audited. The audit objectives describe the specific goals of the audit. The scope delimitation addresses the questions "What?", "Who?", "Where?", and "When?", and identifies the audit criteria based on regulations. In evidence collection, the techniques to be

used are defined, such as surveys, interviews, physical observations, sampling, document examination, and information systems analysis. The audit risk establishes the acceptable audit risk, and materiality identifies the threshold for significance and its connection to risk. The methods define the audit approaches after understanding the center's environment and internal control. Scheduling and necessary resources plan the phases of the audit process, including the preparation of the report, identification of necessary resources, and assignment of responsibilities to the audit team. Communication with the audited center establishes continuous interaction between the audit team and the representatives of the financial center.

After the audit program is defined, the audit team is appointed. The selection of auditors is critical, based on their experience, knowledge, technical capability, training, and ethics. The primary objective is to gather relevant, sufficient, and appropriate evidence to address audit questions and support observations, conclusions, and recommendations. The audit process encompasses several critical phases (GNR, 2021): strategic planning, assessing internal control mechanisms, testing control procedures, scheduling audit activities, applying audit methods, and gathering evidence from the examinations conducted. Each stage is documented through Working Papers (WPs), which serve as proof of the auditor's work and form the basis for issuing opinions in accordance with auditing standards. The execution phase includes an analytical phase, involving data collection and examination, and a communication phase, in which observations, arguments, and perspectives are assessed. The collection of audit evidence is vital, as it underpins the content of the reports. The quality and quantity of the evidence are analyzed simultaneously, applying the auditor's professional judgment to ensure the evidence reflects reality. As the audit progresses, preliminary conclusions and potential recommendations are recorded in the WP. The preliminary audit report presents the results obtained, informing the audited center of the findings in advance and enabling timely decision-making. This report aims to communicate the methods and procedures used, identify non-compliances, and propose corrective measures to improve control performance and mitigate risks. Recommendations should be constructive, clear, and feasible, specifying the areas requiring action. This process ensures that financial management within the organization is conducted transparently and in compliance with established standards, promoting more responsible and effective public administration.

The current state of the organization reflects an auditing process that is time consuming and primarily managed manually, although it has already transitioned to a digital format. While advanced data analysis tools have not yet been implemented, the digitalization

of the process has established a solid foundation for the integration of algorithmic solutions. Once implemented, these algorithms could substantially improve the efficiency and accuracy of the process by automating data analysis, optimizing workflows, and equipping auditors with powerful tools to manage large volumes of data.

4.2. Methodology

Regarding the methodology, a structured approach was adopted, organized into three distinct phases: exploratory, analytical, and conclusive (Kalu, 2017). The exploratory phase included the planning and preparation for data collection from various sources, such as semi-structured interviews, direct observations, and analysis of official documentation. The preparation involved creating an interview protocol, based on information obtained from existing literature and organizational reports (see Appendix C). In this phase, the contact was established with the intermediate level of the organization, which included specialists in the area under study. Interviewees were selected from various categories, capable of providing different perspectives on the phenomenon under analysis. Semi-structured interviews were conducted with thirteen military personnel using Google Forms. The research followed the principles of the Declaration of Helsinki, with informed consent obtained from the participants prior to its execution. According to Guest et al. (2006), twelve interviews are often sufficient for studies based on emergent themes. In this study, the patterns identified in the responses demonstrate that the information collected was consistent, reaching the point of theoretical saturation. This concept refers to the moment when additional interviews no longer contribute relevant or new themes (Faulkner & Trotter, 2017). Hence, the recurrence of ideas in the responses suggests that the main issues were adequately explored, reinforcing the depth and reliability of the data obtained.

In the analytical phase, we processed a significant amount of data using content analysis techniques. Initially, we conducted a thorough review of all available materials, including interview transcripts, and official documents. We coded the phrases into categories and subcategories to identify relevant patterns and ideas, enabling us to create a comprehensive data map. To optimize the manipulation of qualitative data, we utilized NVivo 12 software, which not only reduced the time spent on manual tasks but also enhanced the depth of our analysis (Bazeley & Jackson, 2019). This approach enabled us to identify significant relationships among the emerging themes, providing a comprehensive view of the auditing practices within the organization. This strategy ensured not only the validity of the results but also facilitated the formulation of well-founded recommendations aimed at

continuous improvement.

The conclusive phase focused on interpreting, evaluating, and discussing the evidence gathered from the data analysis, with the intent of identifying opportunities and contributions concerning the integration of AI within auditing practices. In this context, we outlined the limitations of the research and presented recommendations for future investigations. This process not only enhanced our understanding of contemporary auditing practices but also illuminated areas that present significant opportunities for improvement and innovation. Our objective transcended the mere description of data, as we aimed to provide a critical analysis that could serve as a foundation for continuous advancements within the area. Our methodology was firmly anchored in the aim of delivering a refined perspective on auditing practices within a renowned security agency in Portugal. By integrating interviews, document analysis, and direct observations, we aimed to ensure the validity and reliability of our conclusions and recommendations, improving the overall rigor of our research.

4.3. Results and Discussion

In the thirteen interviews conducted, nine of the participants were male and four were female. In terms of experience, two military individuals had more than seven years, five had between four and seven years, three had between one and less than four years, and the remaining three had less than one year. Additionally, nine of the participants belonged to the sergeant category, and four were officers. This distribution provides a balanced view, with perspectives from participants with different levels of experience and different places within the military hierarchy.

The results show relevant categories related to the integration of AI in the auditing practices of the institution under analysis. The analysis of the conducted interviews allowed for the identification of three main categories: key indicators for the application of AI in the auditing process, phases to which the integration of AI is considered essential, and challenges in AI implementation. The participants emphasized that AI has the potential to significantly improve the efficiency and accuracy of audits in the more time-consuming phases, including document analysis and record confirmation. However, considerable challenges were also highlighted, such as the obsolescence of information systems and the need for adequate training for auditors. By identifying these categories, it is possible to understand how auditors can operate with AI technologies, as well as to indicate areas that require attention to ensure a successful integration into the audit process. The subsequent

sections provide a description of the results obtained in the investigation.

4.3.1. Key Indicators

The interviewees highlighted a variety of essential factors for integrating AI into the audit process. The main idea focused on improving the efficiency and accuracy of audits, ensuring they are conducted more swiftly and with a reduced margin of error. The capacity of AI tools to simultaneously audit a greater number of financial centers through the automation of certain processes and the expanded scope of the audit was also emphasized as a crucial point. The interviewees underlined that AI should focus on identifying data samples with a higher risk potential, allowing the audits to concentrate on the most critical and vulnerable areas. Other key indicators mentioned include the correct economic classification of expenses and the control of expenditure limits by suppliers. In this case, it is possible to automate these assessments, ensuring a greater control and standardization of processes.

4.3.2. Essential Phases for AI Integration

Considering the phases of the audit process that are the most relevant in the use of AI, the interviewees identified document analysis and record confirmation as the most significant stages. These are time-consuming phases that can be automated, resulting in a substantial reduction in execution time. The preparatory phase and the preparation of reports were also mentioned as crucial for the integration of AI technologies, as they enable data analysis and the generation of detailed reports. Moreover, the verification of deadlines stands out as an aspect on which AI can have a significant impact. A more comprehensive analysis of the specific tools for AI implementation will be presented in subsequent sections (sections 4.3.4 and 4.3.5), in which the key indicators and practical applications are explored.

Through advanced data analysis and the automation of routine processes, AI tools are essential in evaluating internal controls, enabling the prevention of errors, and the reinforcement of risk management by delivering real-time insights and predictive capabilities. In phases involving the verification of large volumes of data or the collection of information and evidence, it can significantly accelerate the process and enhance the accuracy of detecting irregular patterns. Considering the substantial workforce reduction of over 50% within the Internal Control Division over the past decade, the interviewees believe that AI tools can play a fundamental role in various phases of the audit process. This reduction is primarily due to the lack of human resources allocated to this area, which has

limited the division's ability to fulfill its responsibilities effectively. As a result, the integration of advanced technologies has become essential to successfully complement the current team by automating repetitive tasks, enhancing data analysis capabilities, and ensuring a more efficient allocation of the limited workforce. However, it is important to note that one of the respondents, a member of the sergeant category with less than one year of experience in auditing, demonstrated unfamiliarity with the concept of AI and did not provide any insights regarding its potential impact on auditing practices.

4.3.3. Challenges in AI Implementation

Regarding the challenges that may compromise the execution of audits, both in the present and in the future, the interviewees emphasized key aspects to consider. The obsolescence of information systems emerged as one of the main obstacles, as many of these systems are outdated, making data processing difficult, especially in the initial phases of expenditure. This was particularly evident in cases in which the auditors had to manually reconcile data due to system limitations. The migration of data between different systems increases the margin for human error, further aggravating the situation. Another identified challenge is the outdated nature of current financial regulations, highlighting the need for reforms to better align them with today's reality. Direct observations indicated delays in audits caused by the complexity of interpreting older regulations in a modern context. The interviewees also emphasized the urgent need for organizational innovation and appropriate training for professionals. The lack of practical training for auditors was generally cited as a significant barrier, as many professionals do not possess the necessary skills to use more advanced technologies, limiting the potential of AI in the process.

Hence, developing qualified human resources, both theoretically and practically, is considered crucial to overcoming these limitations.

4.3.4. The Audit Process with Python

Python stands out for its versatility and simplicity, providing a wide range of possibilities for the development of algorithms in various fields (Oliphant, 2007). The integration of personalized algorithms in the audit process represents an innovative development, with the potential to radically transform traditional auditing practices (Wood, 2024). In the public sector, its implementation enables the development of automated systems that achieve high levels of efficiency in operations. These innovative solutions

incorporate dynamic and adaptable procedures, precisely adjusting to the needs of and ensuring responsiveness to the demands of each organization (Hooda et al., 2020).

The ease provided by Python in constructing algorithms, due to its capacity for data manipulation and organization, makes it an invaluable tool for developing robust and flexible systems at all stages of the audit process. Through the implementation of different criteria, it becomes feasible to configure systems that collect, structure, and analyze data with rigor and precision, enabling the control and scrupulous supervision of audit activities. The flexibility afforded by this framework allows the systems to be adjusted to the specificities of each activity, establishing a solid structure that promotes the detection of nonconformities, the optimization of information flow, and enhanced transparency in procedures (Koshiyama et al., 2024). This approach minimizes human errors and liberates auditors to focus on more complex and strategic issues. However, there are still many critical aspects to consider, including the obsolescence of existing systems and the urgent need for specialized training for auditors.

To ensure the effective integration of customized algorithms, the definition of key indicators proves to be essential. These indicators structure the algorithm in a way that optimizes the audit process, allowing focus to be directed toward the most critical aspects with the highest rigor (Özbaltan, 2024). In the context under analysis, which centers on a public security agency in Portugal, it becomes crucial for the audit process to achieve high levels of economy, efficiency, and effectiveness. Currently, this process is still performed manually, especially during the document analysis phase, resulting in a lengthy execution that is often ineffective. In this regard, it is fundamental to find solutions that accelerate this phase and provide precision in record verification. Efficiency in the process not only reduces the time required for analysis but also ensures a more comprehensive audit focused on areas of greater risk. In addition, precision minimizes the incidence of errors, enabling the programming of algorithms that adhere to rigorous criteria, ensuring continuous monitoring, as well as quality and reliability.

Among the most relevant indicators for the context under analysis are Economic Classification and Expenditure Limits, both essential for ensuring legal compliance and financial accountability. Economic Classification allows for the detailed organization of expenses, being fundamental for effective internal control and alignment with established economic parameters. In turn, Expenditure Limits ensure that financial resources are allocated within pre-defined thresholds, avoiding overspending and guaranteeing compliance with regulatory frameworks.

Based on the results, Figure 11 was created with the aim of enhancing the understanding of the key indicators for the application of AI in the audit process:

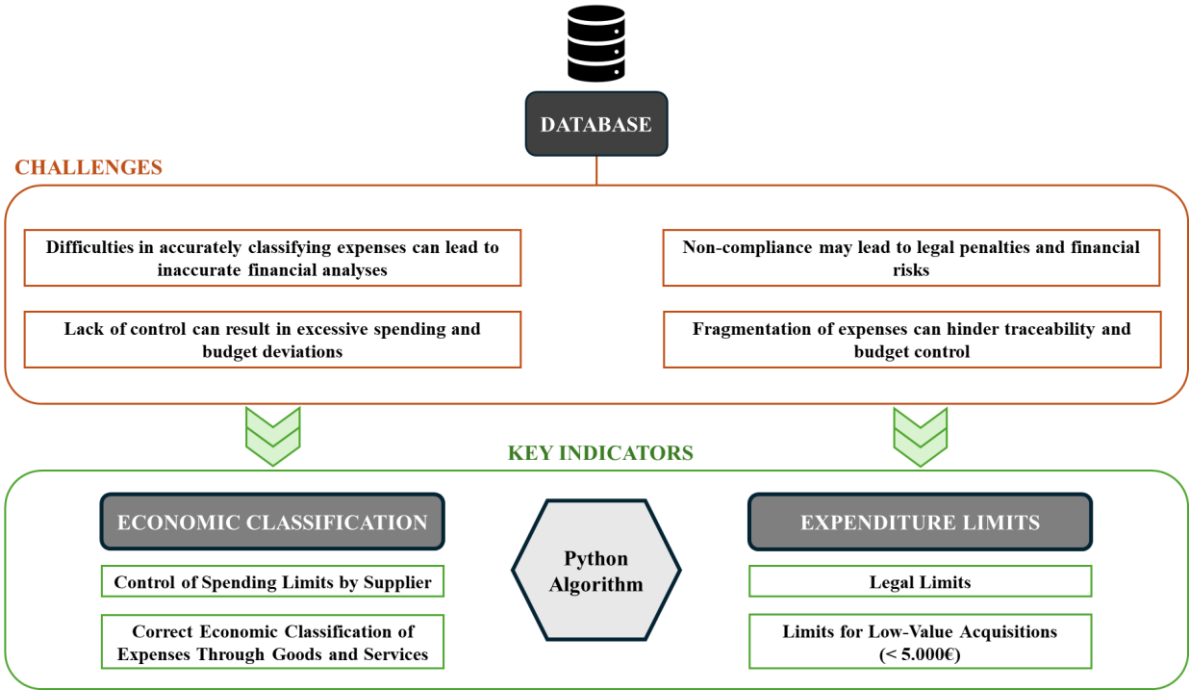

Figure 11 - Key indicators for implementing AI in the audit process

The integration of customized algorithms facilitates the automation of transaction validation, ensuring accuracy in document analysis and optimizing time by reducing the need for manual reviews. The automation of economic classification ensures that all goods and services are properly categorized, making the process more rigorous and compliant with the high standards required. In a public management context, in which accountability in resource administration is crucial, this categorization provides a clearer view of financial operations, preventing unwanted deviations. The indicator related to Expenditure Limits is important for ensuring that transactions fall within established legal limits, preventing irregular practices such as the fragmentation of expenses, especially in low-value acquisitions (below 5000 EUR). The use of Python allows for the continuous monitoring of these transactions, providing a more detailed view of operations, and ensuring compliance with current financial regulations. The ability to closely supervise and analyze financial operations enables the identification and correction of any irregularities, promoting a culture of responsible governance and accountability.

The integration of a Python code into the document analysis phase proves to be

extremely valuable, as it enables the automatic extraction of relevant data from extensive financial documents or datasets (Anand et al., 2020). By doing so, auditors can significantly reduce the time and effort spent on manual data collection tasks, allowing them to focus their attention on more critical aspects of the audit process. This innovative solution improves operational efficiency and enhances the quality of analyses, empowering auditors to identify nonconformities and make informed decisions more swiftly. However, the implementation of algorithms still faces challenges, particularly the obsolescence of the current information systems, which can obstruct the implementation of innovative developments. Many of these systems are based on outdated technologies, requiring a prior technical assessment to prevent potential problems related to data integrity. This assessment is crucial to ensuring that the solutions are compatible and can operate seamlessly with existing infrastructures. Another challenge lies in the training of auditors, who must possess the necessary technical skills to operate and interpret distinct codes. The resistance to change observed in public organizations emphasizes the need for a gradual and carefully planned implementation, ensuring a smooth transition between traditional practices and technological innovations. Lastly, another aspect to consider relates to ethical issues, as the use of algorithms raises concerns about data privacy and security. In public institutions, for which trust from both citizens and stakeholders is paramount, it becomes necessary to develop policies that ensure the protection of sensitive information in strict compliance with current legislation.

Thus, the integration of algorithms in Python into the audit process represents a paradigm shift and should be viewed as a complement to the work of auditors. This innovative solution can add value to any public institution by increasing the accuracy and efficiency of processes, without ever replacing the analytical skills and human expertise of auditors, who remain primarily responsible for interpreting the data. The harmonious integration of advanced tools into audit practices not only enriches the work of auditors but can also lead to a more efficient, credible, and responsible public management system.

4.3.5. The Case of Economic Classification and Expenditure Limits

Considering the previously developed sections, the goal is to outline a scenario to which it is possible to apply an algorithm structured around the identified key indicators, with the aim of building a solid theoretical framework for financial auditing in the public security agency under study. This framework focuses on the rigorous monitoring of the organization’s expenditure, ensuring the correct economic classification of each expense and promoting proactive control of the limits applicable to low-value acquisitions (below 5000

EUR). This process aims to enable compliance with the current legislation, enhancing transparency, agility, and efficiency in the management of financial resources.

The outlined scenario is based on real descriptions of goods and services, enabling the application of a Python code that integrates the previously identified key indicators. The Economic Classification ensures that each expense is properly allocated to the corresponding category, guiding the management of each classification according to the type of permissible expenditure. Simultaneously, the Expenditure Limits, set in this context for amounts up to 5000 EUR, establish the maximum threshold for each category, allowing the algorithm to verify whether each expense complies with the stipulated limit. When the limit is exceeded, the system automatically issues an alert, signaling a breach of the predefined budgetary parameters.

For a solid and systematic data analysis, it is crucial to implement a structured method combining the use of Excel and Python. The data to be analyzed are exported from a central platform and stored in an Excel file. From this database, the auditor can visualize information about the incurred expenses, including the supplier, type of expense, code, category, and associated amount (in EUR).

Regarding the development of the algorithm, it is essential to establish the analysis criteria, which define the parameters for categorizing and evaluating expenses. This phase involves creating an Economic Classification system that maps each expense to its specific category, using a dictionary or a table to facilitate the association. The categories include specific codes for various items, such as clothing, technical assistance, or administrative equipment, enabling a precise division of expenditures. The algorithm performs a verification of the Economic Classification, determining whether each expense is correctly categorized according to legislation. If the category is incorrect, the classification is deemed invalid, with this validation being a crucial step to ensure expenses comply with established parameters. In parallel, Expenditure Limits are defined for each category based on pre-established thresholds. In the scenario under analysis, low-value acquisitions were considered. The algorithm is programmed to verify compliance with expenditure limits in each category by comparing the expense against the established threshold. If the amount exceeds the limit, an alert is automatically generated, signaling the irregularity and enabling a proactive response to the violation of regulations. As an additional control measure, the model introduces a column that monitors the frequency of use for each supplier, providing a tool to enhance oversight in acquisitions. This measure highlights the reliance on frequent suppliers, enabling the identification of spending patterns or potential issues in repetitive

contracts that may warrant closer scrutiny.

Table 9 presents a simulation of data extracted from the platform used by the agency:

Table 9 - Database simulation

Supplier	Type of Expense	Amount (EUR)
Supplier A	Kitchen aprons	1000
Supplier B	Advertising	9200
Supplier C	Oil Changes – Vehicle Lubrication	8500
Supplier D	Helmets	500
Supplier A	Coal	2000
Supplier E	Laptop	2000

This database includes information about suppliers, the type of expense, and the amount (in EUR). The first column, "Supplier", contains the names of the suppliers involved in the transactions. The "Type of Expense" column describes the type of goods or services acquired, and the "Amount (EUR)" column provides the cost of each item.

In this scenario, values were assigned to simulate a realistic situation. As an example, the institution incurred an expense of 1000 EUR with "Supplier A" for the purchase of kitchen aprons, as well as an additional acquisition of coal worth 2000 EUR. "Supplier B" is associated with an expense of 9200 EUR for the publication of advertising. Regarding "Supplier C" an expense of 8500 EUR was recorded for oil changes and vehicle lubrication. The "Supplier D" supplied helmets for 500 EUR, and "Supplier E" incurred a cost of 2000 EUR for the purchase of a laptop. This table presents the information in a simple and structured manner, allowing for an effective analysis of the amounts spent with each supplier, as well as the associated types of expenses. This information should be properly organized in rows and columns in the Excel file, facilitating the identification of expenses that may exceed the established limits and highlighting the relationships between the suppliers and the acquisitions made. Figure 12 shows the Python code developed for this scenario:

```python
import pandas as pd

# Example data: Supplier, Expense, Code, Category, Amount (€)
data = {
    'Supplier': ['Supplier A', 'Supplier B', 'Supplier C', 'Supplier D', 'Supplier A', 'Supplier E'],
    'Expense': ['Kitchen aprons', 'Advertising', 'Oil change - vehicle lubrication',
                'Helmets', 'Coal', 'Laptop'],
    'Code': ['02.01.07', '02.02.17', '02.02.03', '02.01.21.C0', '02.01.02', '07.01.07.A0.B0'],
    'Category': ['AB - Clothing and personal items', 'AS - Communication and advertising', 'AS - Conservation of goods',
                 'N/A', 'AB - Fuels and lubricants', 'ABC - IT Equipment - Others'],
    'Amount (€)': [1000, 9200, 8500, 500, 2000, 2000]
}

# Creating DataFrame from the provided data
df = pd.DataFrame(data)

# Defining the expense limit
expense_limit = 5000

# Function to check compliance with the expense limit
def check_limit(row):
    if row['Amount (€)'] > expense_limit:
        return '❌'
    else:
        return '✔'

# Function to check economic classification
def classify_expense(expense):
    classification = {
        'Kitchen aprons': '✔',
        'Advertising': '✔',
        'Oil change - vehicle lubrication': '✔',
        'Helmets': '❌',
        'Coal': '✔',
        'Laptop': '✔'
    }
    return classification.get(expense, '❌')

# Counting frequent suppliers
frequent_supplier = df['Supplier'].value_counts()

# Applying the expense limit check
df['Expense Limit Check'] = df.apply(check_limit, axis=1)

# Applying the economic classification check
df['Correct Economic Classification'] = df['Expense'].apply(classify_expense)

# Adding the Supplier Usage column
df['Supplier Usage'] = df['Supplier'].map(frequent_supplier)

# Organizing columns as requested
df_final = df[['Supplier', 'Expense', 'Code', 'Category', 'Correct Economic Classification', 'Amount (€)',
               'Expense Limit Check', 'Supplier Usage']]

# Displaying the results
print("Audit Analysis:")
print(df_final)

# Exporting the results to an Excel file
df_final.to_excel('audit_results_refined.xlsx', index=False)

print("\nThe audit results have been saved to the 'audit_results_refined.xlsx' file.")
```

Figure 12 - Python algorithm for economic classification and expenditure limits

The process begins with the definition of a data dictionary containing information about the supplier, the expense, the code, the category, and the expense amount. These data are then converted into a pandas Data Frame, a tabular data structure that facilitates the analysis and manipulation of this information. Next, the code sets the expenditure limit at

5000 EUR and creates two functions to verify compliance with this limit and classify each expense according to predefined criteria. The first function, `check_limit`, is applied to each row of the Data Frame to check whether the expense amount exceeds the 5000 EUR limit. If the limit is exceeded, the function returns a "non-compliance" icon (❌). Otherwise, a "compliance" icon (✓) is displayed. The second function, `classify_expense`, assigns a classification to the expense based on the type of expense mentioned. For expenses in this scenario, such as "Advertising" and "Coal", the function returns a compliance classification (✓), while the expense related to "Helmets" is marked as non-compliant (❌) due to the lack of a category description ("N/A"). Then, the code counts the suppliers to indicate how frequently each supplier has been used, allowing the auditor to determine whether there are any violations. This count is performed using the `value_counts()` method of pandas, which returns the number of occurrences of each supplier. As a result, the code is programmed to add a new column to the Data Frame called "Supplier Usage", which shows how many times each supplier was used. The code then applies the previously created functions to the Data Frame to add two new columns: "Expense Limit Check", which indicates whether each expense is within the 5000 EUR limit, and "Correct Economic Classification" which provides the classification of the expense based on the predefined rules.

Finally, the code organizes the Data Frame by selecting the columns of interest in the specified order and displaying an overview of the situation. The results are presented in a clear and organized way, including a column that indicates, using symbols like "✓" and "❌", whether the economic classification and expenditure limits are in compliance. This method of presentation allows for quick and effective interpretation, enabling the auditor to promptly identify any deviations from the established criteria. The results of the analysis can be exported to a new Excel file, named 'audit_results.xlsx,' using the `to_excel()` method from pandas, allowing the data to be stored in an accessible format for future reference.

This model ensures compliance with the current regulations, promoting greater transparency, accuracy, and efficiency in the auditing process. It is important to highlight the relevance of human expertise throughout the process, as the implementation of the algorithm aims to facilitate the auditor's work, making the process more efficient during the more time-consuming phases. After executing the code, the file "audit_results.xlsx" will contain a table with additional information on the classification and verification of expenses. Table 10 reflects the results for this scenario:

Table 10 - Simulation of the results after running the code

Supplier	Type of Expense	Code	Category	Correct Economic Classification	Amount (EUR)	Expense Limit Check	Supplier Usage
Supplier A	Kitchen aprons	02.01.07	AB - Clothing and personal items	✓	1000	✓	2
Supplier B	Advertising	02.02.17	AS - Communication and advertising	✓	9200	❌	1
Supplier C	Oil Change – Vehicle lubrification	02.02.03	AS - Conservation of goods	✓	8500	❌	1
Supplier D	Helmets	02.01.21	N/A	❌	500	✓	1
Supplier A	Coal	02.01.02	AB - Fuels and lubricants	✓	2000	✓	2
Supplier E	Laptop	07.01.07	ABC - IT equipment	✓	2000	✓	1

The results table generated by the code includes various columns providing a detailed overview of the audited expenses. The first column, "Supplier", indicates the name of the supplier associated with each expense. The "Type of Expense" column describes the type of expense incurred, while the "Code" column displays the specific code related to the expenditure. The "Category" column classifies the expense according to its nature, such as clothing, advertising, or Information Technology (IT) equipment.

The "Correct Economic Classification" column verifies whether the “Category” is correctly assigned, marked with a "✓" when the classification is correct and a "❌" when it is incorrectly attributed. The "Amount (EUR)" column shows the expense value, while the "Expense Limit Check" column indicates whether the expense exceeds the established limit for its “Category”. The icon "✓" signifies compliance with the limit, and a "❌" indicates that the limit was exceeded. Finally, the "Supplier Usage" column informs the auditor how many times each supplier was used for the agency's various acquisitions, providing an overview of the supplier usage frequency. This set of information enables a more precise analysis of expenses, facilitating compliance verification and the identification of potential irregularities.

Thus, the created scenario offers a solid foundation for applying personalized algorithms within the public security agency under study, emphasizing the importance of proper expense classification and adherence to expenditure limits. The presented code automates this process, enabling efficient, swift, and easy analyses, improving the overall auditing process and assisting auditors in conducting their reviews more effectively.

4.4. Conclusions

4.4.1. Theoretical and Managerial Contributions

The integration of AI tools in the audit process is an emerging trend and represents an innovative development in automating repetitive tasks, including data extraction and transaction verification. This approach reduces the manual workload, improving the accuracy and efficiency of auditing practices. Custom algorithms in Python, which includes a scenario created in this research, enabled precision and delivered comprehensive assessments for data analysis, facilitating the proactive identification of risks and the mitigation of irregularities. This approach is crucial in the context of the public sector, as it promotes transparency and strengthens regulatory compliance in audits across various institutions. Moreover, it allows auditors to redirect their focus from repetitive and time-consuming tasks to core responsibilities, such as conducting in-depth financial analyses and performing strategic evaluations. This reallocation of effort improves the overall efficiency of and elevates the quality of audits. By embedding these practices, institutions foster a culture of accountability and continuous improvement in resource management. The development of the algorithm, based on established key indicators – economic classification and expenditure limits – shows the effectiveness of this solution in enforcing financial standards. In this case, automated systems strengthen compliance controls by ensuring the categorization of expenses and verifying transactions below 5000 EUR, ensuring that all transactions are monitored, and any discrepancies are promptly identified and addressed. This is particularly relevant in public organizations, in which transparency and accountability depend on efficient resource management and the integrity of administrative processes.

From a theoretical perspective, this study highlights the potential of AI to change traditional auditing methods. It advances our understanding of how algorithms can empower human expertise to enhance decision-making, make predictive risk assessments, and detect anomalies. The integration of the presented scenario provides a framework for refining auditing practices by aligning innovative developments with established governance standards. Furthermore, this research shows the importance of balancing automation with ethical considerations, including data privacy and security, which are fundamental pillars for the responsible implementation of AI technologies in the public sector.

Regarding managerial contributions, the findings offer a perspective for public agencies looking to implement AI-driven auditing solutions. It highlights the importance of

a phased approach to AI incorporation, especially in the context of public organizations that may face challenges such as outdated systems, bureaucratic processes, resistance to change, and limited technological infrastructure. To ensure the success of these innovative developments, it is crucial to address these obstacles through tailored interventions. Specifically, a gradual integration of AI technologies into existing processes allows agencies to manage the transition more effectively, minimizing disruptions while progressively enhancing their operational capabilities. To this end, a fundamental aspect of this transition is the training of auditors, ensuring that they are not only proficient in the technical application of AI tools but also capable of interpreting and utilizing AI-driven insights within the wider framework of auditing standards. The culture should emphasize continuous learning and adaptation, enabling public agencies to ensure that AI tools are utilized to their full potential. This approach will facilitate enhanced decision-making, more precise risk assessments, and improved overall audit outcomes. Although this research was conducted within the context of a Portuguese security agency, its findings possess broader relevance across public administrations, particularly within the European Union (EU), where similar challenges persist. The proposed scenario is adaptable and can be changed to different administrative contexts, providing a scalable solution to improve auditing practices and public resource management across various countries.

Hence, this study emphasizes how integrating AI technologies into the audit process can improve public resource management. This research provides a comprehensive roadmap for modernizing auditing practices, focusing on both technological advancements and the readiness of organizations to adopt them. Ultimately, it underscores the importance of expanding knowledge of advanced technologies in the public sector for more efficient, transparent, and accountable practices in the future.

4.4.2. Limitations and Recommendations for Future Research

This article is limited by its research design. In our view, it provides contributions that deserve to be highlighted, but it is important to acknowledge issues that may affect its generalizability. Many challenges faced by public administrations in other countries are similar, and this research focuses on a single public security agency in Portugal. Considering this, it is worth noting that the central platform used by this agency is shared by most public administration organizations in Portugal, which facilitates the potential application of these findings to other institutions. Additionally, the analysis was confined to a select set of key indicators, such as Economic Classification and Expenditure Limits, excluding other

variables that could further enrich the analysis and offer a more comprehensive understanding of the impact of AI on public agencies audits.

The adoption of AI solutions in auditing practices remains a recent phenomenon, necessitating a gradual and carefully structured approach to fully assess the benefits and implications of this transformation. Consequently, an additional limiting factor arises from the early stage of the implementation of AI in auditing, which hinders a comprehensive and conclusive evaluation of its long-term effects. As the field continues to evolve, it is essential to further explore how AI can be integrated, to better understand the wider implications this transformation may have for the future.

Future research should aim to explore how AI-based auditing models can be successfully adapted and implemented in different public administration contexts, with the goal of improving public governance and fostering practices that are more transparent, efficient, and accountable. It is also important to expand the integration of AI tools in auditing, developing new systems and evaluating their feasibility across diverse public organizations, both within the EU and beyond. Moreover, the organizational changes required for the effective adoption of these technologies should be a key area of future investigation. Research into the application of AI in public auditing has the potential to provide valuable insights for both the EU and other contexts worldwide, where the digital transformation of public administration is becoming an increasingly significant priority.

CONCLUSION

This dissertation was conducted to obtain a Master's Degree in Military Administration. The main objective was to understand "how" the GNR can integrate AI into auditing practices. The integration of AI technologies in auditing represents a paradigmatic shift, redefining the role of auditors from retrospective examiners to proactive agents of real-time monitoring and evaluation.

From a theoretical standpoint, this research extends existing knowledge by demonstrating how AI disrupts conventional auditing paradigms. The findings reinforce the argument that AI-based solutions necessitate the evolution of auditors' competencies, integrating technological literacy with critical evaluative skills. In this regard, the study refines existing theoretical models on digital transformation in public sector, positioning AI-driven auditing as a pivotal element in the modernization of oversight mechanisms. From a managerial perspective, this study highlights the advantages of AI technologies in enhancing decision-making, risk assessment, and regulatory compliance. The MindBridge is one of the best examples that shows the efficiency, accuracy, and transparency that AI brings to the processes. The MindBridge AI platform eliminates manual efforts and instantly identifies financial discrepancies and risks. It also provides powerful data analysis and visualization capabilities to support auditors in making informed decisions and presenting findings to stakeholders. These findings introduce a realistic strategy for the GNR to implement AI-based solutions, emphasizing the importance of a gradual approach to overcome challenges related to outdated systems, bureaucratic resistance, and limited technological infrastructure. Furthermore, this research emphasizes the importance of continuous learning and adaptability, preparing auditors to interpret and use AI-generated insights in accordance with auditing standards.

Regarding milestones achieved, this thesis provides a comprehensive framework on modernizing auditing practices. It illustrates how AI integration enhances operational efficiency and reinforces accountability in public resource management. Aligning innovative developments with the established standards, this study paves the way for more transparent, and efficient auditing practices within the GNR. It enables the organization to advance at the forefront of digital transformation in the public sector, ensuring its ongoing adaptability and responsiveness to future challenges. Therefore, this research resulted in the description of a method for incorporating AI into the audit process. The method was designed with the

objective of identifying discrepancies based on key indicators, enabling auditors to monitor, in real time, the expenses incurred. The design of the method proves to be robust, even when applied in a created scenario, due to the consistency of the results obtained. These findings align with the vulnerability analyses identified throughout the investigation, both from the literature and the contributions of the organization's interviewees.

The results observed in the information gathering and exploration phases were noteworthy. The research began with an analysis of emerging trends and challenges in auditing through a systematic review, which proved essential for understanding the current state of the art. Then, an analysis of the competencies required for auditors in the digital age was conducted, providing a fundamental starting point for understanding the phenomenon under study. In the exploration phase, the entire audit process was described, reflecting the current reality and projecting how these procedures could be implemented in the near future. After identifying the main challenges and key indicators, an algorithm was developed to facilitate data analysis, enabling the auditor to visualize the current state of the database in the created scenario, after executing the code. This procedure ensures a more agile and accurate approach to monitoring the process, resulting in more efficient management of resources. Therefore, the framework proposed in this dissertation presents considerable potential to redefine the audit process.

This study has limitations that should be recognized, including the lack of real-world application of the method and the restricted scope of indicators used. These constraints may affect the generalizability of the results. To strengthen its effectiveness, it is essential that it be tested in the organizational context, allowing for a more accurate assessment of its practical applicability. This will offer an opportunity to refine the system based on observed outcomes, contributing to its continuous improvement. Moreover, this model must be consolidated by incorporating other key indicators, encompassing a wider range of criteria that can provide a more accurate analysis. The inclusion of new parameters will allow for more comprehensive oversight, enabling the framework to adapt to diverse contexts and institutional realities. Lastly, it is crucial that this framework be replicable by other organizations, especially those in which audit processes still rely predominantly on conventional methodologies. The shift to AI-based auditing techniques reflects a major change, and the capacity to replicate the model in other contexts will be key to its broader dissemination and impact. Further investigations should focus on adapting it to the specificities of other agencies, with an emphasis on continuous auditor training, ensuring they can fully harness the benefits of AI integration in auditing practices.

REFERENCES

Ab Wahid, R., & Tan, P.-L. (2023). QMS external quality auditors' competency requirements: perspectives from accredited certification bodies in Malaysia. *International Journal of Quality & Reliability Management*, *40*(7), 1621–1646. https://doi.org/10.1108/IJQRM-04-2021-0127.

Abdullah, A. A. H., & Almaqtari, F. A. (2024). The impact of artificial intelligence and Industry 4.0 on transforming accounting and auditing practices. *Journal of Open Innovation: Technology, Market, and Complexity*, *10*(1), 1–20. https://doi.org/10.1016/j.joitmc.2024.100218.

Adeoye, I. O., Akintoye, R. I., Theophilus, A. A., & Olagunju, O. A. (2023). Artificial intelligence and audit quality: Implications for practicing accountants. *Asian Economic and Financial Review*, *13*(11), 756–772. https://doi.org/10.55493/5002.v13i11.4861.

Afsay, A., Tahriri, A., & Rezaee, Z. (2023). A meta-analysis of factors affecting acceptance of information technology in auditing. *International Journal of Accounting Information Systems*, *49*, 1–27. https://doi.org/10.1016/j.accinf.2022.100608.

Agustí, M. A., & Orta-Pérez, M. (2023). Big data and artificial intelligence in the fields of accounting and auditing: a bibliometric analysis. *Revista Espanola de Financiacion y Contabilidad*, *52*(3), 412–438. https://doi.org/10.1080/02102412.2022.2099675.

Al-ahdal, W. M., & Hashim, H. A. (2022). Impact of audit committee characteristics and external audit quality on firm performance: evidence from India. *Corporate Governance: The International Journal of Business in Society*, *22*(2), 424–445. https://doi.org/10.1108/CG-09-2020-0420.

Albawwat, I., & Frijat, Y. (2021). An analysis of auditors' perceptions towards artificial intelligence and its contribution to audit quality. *Accounting*, *7*(4), 755–762. https://doi.org/10.5267/j.ac.2021.2.009.

Albitar, K., Gerged, A. M., Kikhia, H., & Hussainey, K. (2021). Auditing in times of social distancing: the effect of COVID-19 on auditing quality. *International Journal of Accounting and Information Management*, *29*(1), 169–178. https://doi.org/10.1108/IJAIM-08-2020-0128.

Alkabbji, R., Almubaydeen, T. H., Qushtom, T., & Hamza, M. (2023). The Impact of The Digital Revolution on The Efficiency of Auditors in Auditing Computerized Programs. *Information Sciences Letters*, *12*(8), 2559–2565. https://doi.org/10.18576/isl/120812.

Al-Khasawneh, R. O., & Al-Khasawneh, T. (2023). An Empirical Study on the Impacts of the Fourth Industrial Revolution Technologies on Internal Audit in Jordanian Banks. *Journal of System and Management Sciences*, *13*(6), 554–569. https://doi.org/10.33168/JSMS.2023.0632.

Allbabidi, M. H. A. (2021). Hype or hope: Digital technologies in auditing process. *Asian Journal of Business and Accounting*, *14*(1), 59–86. https://doi.org/10.22452/ajba.vol14no1.3.

Alles, M. G. (2015). Drivers of the Use and Facilitators and Obstacles of the Evolution of Big Data by the Audit Profession. *Accounting Horizons*, *29*(2), 439–449. https://doi.org/10.2308/acch-51067.

Alotaibi, E. M. (2023). Cloud computing to audit quality-evidence from the Kingdom of Saudi Arabia. *International Journal of Applied Economics, Finance and Accounting*, *17*(1), 18–29. https://doi.org/10.33094/ijaefa.v17i1.1004.

Al Shanti, A. M., & Elessa, M. S. (2023). The impact of digital transformation towards blockchain technology application in banks to improve accounting information quality and corporate governance effectiveness. *Cogent Economics and Finance*, *11*(1), 1-20. https://doi.org/10.1080/23322039.2022.2161773.

Al-Sayyed, S., Al-Aroud, S., & Zayed, L. (2021). The effect of artificial intelligence technologies on audit evidence. *Accounting*, *7*(2), 281–288. https://doi.org/10.5267/j.ac.2020.12.003.

Alsulami, F. H. A. (2025). Digital Innovation and Sustainable Accounting Practices: A Systematic Literature Review Through The Governance Context. *Journal of Governance and Regulation*, *14*(1), 38–48. https://doi.org/10.22495/jgrv14i1art4.

Amarnadh, V., & Moparthi, N. R. (2023). Comprehensive review of different artificial intelligence-based methods for credit risk assessment in data science. *Intelligent Decision Technologies*, *17*(4), 1265–1282. https://doi.org/10.3233/IDT-230190.

Anand, V., Bochkay, K., Chychyla, R., & Leone, A. (2020). Using python for text analysis in accounting research. *Foundations and Trends in Accounting*, *14*(3–4), 128–359. https://doi.org/10.1561/1400000062.

Anh, N. T., Hoa, L. T., Thao, L. P., Nhi, D. A., Long, N. T., Truc, N. T., & Ngoc Xuan, V. (2024). The Effect of Technology Readiness on Adopting Artificial Intelligence in Accounting and Auditing in Vietnam. *Journal of Risk and Financial Management*, *17*(1), 1–15. https://doi.org/10.3390/jrfm17010027.

Aquino, A. C. B. D., Lino, A. F., Azevedo, R. R. D., & Silva, P. B. D. (2022). Digital

affordances and remote public audit practice. *Financial Accountability and Management*, *38*(3), 447–467. https://doi.org/10.1111/faam.12337.

Ashtiani, M. N., & Raahemi, B. (2022). Intelligent Fraud Detection in Financial Statements Using Machine Learning and Data Mining: A Systematic Literature Review. *IEEE Access*, *10*, 72504–72525. https://doi.org/10.1109/ACCESS.2021.3096799.

Badewi, A. (2022). When frameworks empower their agents: The effect of organizational project management frameworks on the performance of project managers and benefits managers in delivering transformation projects successfully. *International Journal of Project Management*, *40*(2), 132–141. https://doi.org/10.1016/j.ijproman.2021.10.005.

Bakumenko, A., & Elragal, A. (2022). Detecting Anomalies in Financial Data Using Machine Learning Algorithms. *Systems*, *10*(5), 1–29. https://doi.org/10.3390/systems10050130.

Barrett, P. (2022). New development: Whither the strategic direction of public audit in an era of the 'new normal'? *Public Money and Management*, *42*(2), 124–128. https://doi.org/10.1080/09540962.2021.1965756.

Bazeley, P., & Jackson, K. (2019). *Qualitative data analysis with NVivo* (3rd ed.). SAGE Publications.

Bento, R. F., & White, L. F. (2023). Artificial Intelligence and Ethical Professional Judgments in a Small Audit Firm Context. *Business and Professional Ethics Journal*, *42*(3), 315–357. https://doi.org/10.5840/bpej20231018146.

Betti, N., & Sarens, G. (2021). Understanding the internal audit function in a digitalised business environment. *Journal of Accounting and Organizational Change*, *17*(2), 197–216. https://doi.org/10.1108/JAOC-11-2019-0114.

Bhaskar, K., Flower, J., & Sellers, R. (2019). *Disruption in the audit market: The future of the big four*. Routledge.

Blösser, M., & Weihrauch, A. (2024). A consumer perspective of AI certification – the current certification landscape, consumer approval and directions for future research. *European Journal of Marketing*, *58*(2), 441–470. https://doi.org/10.1108/EJM-01-2023-0009.

Braun, V., & Clarke, V. (2021). *Thematic Analysis: A Practical Guide*. SAGE Publications.

Cammarano, A., Varriale, V., Michelino, F., & Caputo, M. (2024). A Framework for investigating the adoption of key technologies: Presentation of the methodology and explorative analysis of emerging practices. *IEEE Transactions on Engineering Management*, *71*, 3843–3866. https://doi.org/10.1109/TEM.2023.3240213.

Cassia, F., & Magno, F. (2021). Antecedents of professionals' self-efficacy in professional service firms: effects of external source credibility and content quality. *Journal of Business and Industrial Marketing*, *36*(13), 187–198. https://doi.org/10.1108/JBIM-11-2019-0485.

Castka, P., & Searcy, C. (2023). Audits and COVID-19: A paradigm shift in the making. *Business Horizons*, *66*(1), 5–11. https://doi.org/10.1016/j.bushor.2021.11.003.

Chiu, T., & Jans, M. (2019). Process mining of event logs: A case study evaluating internal control effectiveness. *Accounting Horizons*, *33*(3), 141–156. https://doi.org/10.2308/acch-52458.

Cornacchia, G., Anelli, V. W., Biancofiore, G. M., Narducci, F., Pomo, C., Ragone, A., & Di Sciascio, E. (2023). Auditing fairness under unawareness through counterfactual reasoning. *Information Processing and Management*, *60*(2), 1–27. https://doi.org/10.1016/j.ipm.2022.103224.

Damerji, H., & Salimi, A. (2021). Mediating effect of use perceptions on technology readiness and adoption of artificial intelligence in accounting. *Accounting Education*, *30*(2), 107–130. https://doi.org/10.1080/09639284.2021.1872035.

Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., Duan, Y., Dwivedi, R., Edwards, J., Eirug, A., Galanos, V., Ilavarasan, P. V, Janssen, M., Jones, P., Kar, A. K., Kizgin, H., Kronemann, B., Lal, B., Lucini, B., … Williams, M. D. (2021). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, *57*, 1–47. https://doi.org/10.1016/j.ijinfomgt.2019.08.002.

Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics*, *105*(3), 1809–1831. https://doi.org/10.1007/s11192-015-1645-z.

Estep, C., Griffith, E. E., & MacKenzie, N. L. (2023). How do financial executives respond to the use of artificial intelligence in financial reporting and auditing? *Review of Accounting Studies*, *29*, 2798–2831. https://doi.org/10.1007/s11142-023-09771-y.

Etikan, I., Musa, S. A., & Alkassim, R. S. (2015). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1-4. https://doi.org/10.11648/j.ajtas.20160501.11.

Eulerich, M., & Kalinichenko, A. (2018). The current state and future directions of continuous auditing research: An analysis of the existing literature. *Journal of*

Information Systems, *32*(3), 31–51. https://doi.org/10.2308/ISYS-51813.

Eulerich, M., Pawlowski, J., Waddoups, N. J., & Wood, D. A. (2022). A Framework for Using Robotic Process Automation for Audit Tasks. *Contemporary Accounting Research*, *39*(1), 691–720. https://doi.org/10.1111/1911-3846.12723.

Faccia, A., Pandey, V., & Banga, C. (2022). Is Permissioned Blockchain the Key to Support the External Audit Shift to Entirely Open Innovation Paradigm? *Journal of Open Innovation: Technology, Market, and Complexity, 8*(2), 1-22. https://doi.org/10.3390/joitmc8020085.

Farcane, N., Bunget, O. C., Blidisel, R., Dumitrescu, A. C., Deliu, D., Bogdan, O., & Burca, V. (2023). Auditors' perceptions on work adaptability in remote audit: a COVID-19 perspective. *Economic Research-Ekonomska Istrazivanja*, *36*(1), 422–459. https://doi.org/10.1080/1331677X.2022.2077789.

Faulkner, S. L., & Trotter, S. P. (2017). Data saturation. In J. Matthes, C.S. Davis & R.F. Potter (Eds.), *The International Encyclopedia of Communication Research Methods*. Wiley. https://onlinelibrary.wiley.com/doi/abs/10.1002/9781118901731.iecrm0060.

Fedyk, A., Hodson, J., Khimich, N., & Fedyk, T. (2022). Is artificial intelligence improving the audit process? *Review of Accounting Studies*, *27*, 938–985. https://doi.org/10.1007/s11142-022-09697-x.

Fotoh, L. E., & Lorentzon, J. I. (2021). The Impact of Digitalization on Future Audits. *Journal of Emerging Technologies in Accounting*, *18*(2), 77–97. https://doi.org/10.2308/JETA-2020-063.

Fotoh, L. E., & Lorentzon, J. I. (2023). Audit Digitalization and Its Consequences on the Audit Expectation Gap: A Critical Perspective. *Accounting Horizons*, *37*(1), 43–69. https://doi.org/10.2308/HORIZONS-2021-027.

Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? *Technological Forecasting and Social Change*, *114*, 254–280. https://doi.org/10.1016/j.techfore.2016.08.019.

Frishammar, J., Richtnér, A., Brattström, A., Magnusson, M., & Björk, J. (2019). Opportunities and challenges in the new innovation landscape: Implications for innovation auditing and innovation management. *European Management Journal*, *37*(2), 151–164. https://doi.org/10.1016/j.emj.2018.05.002.

Gooneratne, C. P., Magana-Mora, A., Contreras Otalvora, W., Affleck, M., Singh, P., Zhan, G. D., & Moellendick, T. E. (2020). Drilling in the Fourth Industrial Revolution-Vision and Challenges. *IEEE Engineering Management Review*, *48*(4), 144–159.

https://doi.org/10.1109/EMR.2020.2999420.

Goto, M. (2023). Anticipatory innovation of professional services: The case of auditing and artificial intelligence. *Research Policy*, *52*(8), 1-10. https://doi.org/10.1016/j.respol.2023.104828.

Guarda Nacional Republicana [GNR]. (2021). *PDGNR M 2-07-02 Manual de Auditoria Financeira da GNR*. GNR.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough?: An experiment with data saturation and variability. *Field Methods*, *18*(1), 59–82. https://doi.org/10.1177/1525822x05279903.

Guz, A. N., & Rushchitsky, J. J. (2009). Scopus: A system for the evaluation of scientific journals. *International Applied Mechanics*, *45*(4), 351–362. https://doi.org/10.1007/s10778-009-0189-4.

Han, H., Shiwakoti, R. K., Jarvis, R., Mordi, C., & Botchie, D. (2023). Accounting and auditing with blockchain technology and artificial Intelligence: A literature review. *International Journal of Accounting Information Systems*, *48*, 1-16. https://doi.org/10.1016/j.accinf.2022.100598.

Hilario, M., Paredes, P., Mayhuasca, J., Liendo, M., & Martínez, S. (2024). Evaluation of the Impact of Artificial Intelligence on the Systems Audit Process. *Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications*, *15*(3), 184–202. https://doi.org/10.58346/JOWUA.2024.I3.013.

Hooda, N., Bawa, S., & Rana, P. S. (2020). Optimizing fraudulent firm prediction using ensemble machine learning: A case study of an external audit. *Applied Artificial Intelligence*, *34*(1), 20–30. https://doi.org/10.1080/08839514.2019.1680182.

Hu, K.-H., Chen, F.-H., Hsu, M.-F., & Tzeng, G.-H. (2023). Governance of artificial intelligence applications in a business audit via a fusion fuzzy multiple rule-based decision-making model. *Financial Innovation*, *9*(1), 1-31. https://doi.org/10.1186/s40854-022-00436-4.

Huson, Y., Sierra-García, L., & Garcia-Benau, M. A. (2024). A bibliometric review of information technology, artificial intelligence, and blockchain on auditing. *Total Quality Management & Business Excellence*, *35*(1–2), 91–113. https://doi.org/10.1080/14783363.2023.2256260.

International Public Sector Accounting Standards Board. (2021). *International public sector accounting standards (IPSAS)*. International Federation of Accountants. Available online: https://www.ifac.org (Accessed on 14 November 2024).

Jagatheesaperumal, S. K., Rahouti, M., Ahmad, K., Al-Fuqaha, A., & Guizani, M. (2022). The Duo of Artificial Intelligence and Big Data for Industry 4.0: Applications, Techniques, Challenges, and Future Research Directions. *IEEE Internet of Things Journal*, *9*(15), 12861–12885. https://doi.org/10.1109/JIOT.2021.3139827.

Jarrahi, M. H., Askay, D., Eshraghi, A., & Smith, P. (2023). Artificial intelligence and knowledge management: A partnership between human and AI. *Business Horizons, 66*(1), 87–99. https://doi.org/10.1016/j.bushor.2022.03.002.

Jeacle, I., & Carter, C. (2022). Audit society goes viral: the rise of the online auditor. *Qualitative Research in Accounting and Management*, *19*(2), 231–240. https://doi.org/10.1108/QRAM-10-2021-0185.

John, W. S., & Johnson, P. (2000). The Pros and Cons of Data Analysis Software for Qualitative Research. *Journal of Nursing Scholarship, 32*(4), 393–397. https://doi.org/10.1111/j.1547-5069.2000.00393.x.

Kalu, F. (2017). What makes qualitative research good research? An exploratory analysis of critical elements. *International Journal of Social Science Research, 5*(2), 43–56. https://doi.org/10.5296/ijssr.v5i2.10711.

Kamila, M. K., & Jasrotia, S. S. (2023). Ethical issues in the development of artificial intelligence: Recognizing the risks. *International Journal of Ethics and Systems, 41*(1), 45-63. https://doi.org/10.1108/IJOES-05-2023-0107.

Kaplan, A., & Haenlein, M. (2019). Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. *Business Horizons, 62*(1), 15–25. https://doi.org/10.1016/j.bushor.2018.08.004.

Kartikasary, M., Laurens, S., & Sitinjak, M. (2021). Factors affecting the use of generalized audit software in audit process in Indonesia. *Accounting*, *7*(4), 819–824. https://doi.org/10.5267/j.ac.2021.2.002.

Kateb, I., & Belgacem, I. (2024). Navigating governance and accounting reforms in Saudi Arabia's emerging market: Impact of audit quality, board characteristics, and IFRS adoption on financial performance. *International Journal of Disclosure and Governance, 21*(2), 290–312. https://doi.org/10.1057/s41310-023-00193-5.

Khuong, N. V, Anh, L. H. T., Ha, L. T. N., Cuong, L. V, Ngan, N. P. T., Thu, H. T. M., & Minh, L. K. (2023). Factors Affecting Decision to Adopt Artificial Intelligence During COVID-19 Pandemic Period: Evidence from PLS-SEM and fsQCA. *Vision*, 1–15. https://doi.org/10.1177/09722629221149847.

Kokina, J., Blanchette, S., Davenport, T. H., & Pachamanova, D. (2025). Challenges and

opportunities for artificial intelligence in auditing: Evidence from the field. *International Journal of Accounting Information Systems*, *56*, 1–22. https://doi.org/10.1016/j.accinf.2025.100734.

Köktener, B., & Tunçalp, D. (2021). Old game, new rules and "odd friends": Digitalization, jurisdictional conflicts, and boundary work of auditors in a "big four" professional service firm. *Journal of Professions and Organization*, *8*(3), 349–373. https://doi.org/10.1093/jpo/joab016.

Koshiyama, A., Kazim, E., Treleaven, P., Rai, P., Szpruch, L., Pavey, G., Ahamat, G., Leutner, F., Goebel, R., Knight, A., Adams, J., Hitrova, C., Barnett, J., Nachev, P., Barber, D., Chamorro-Premuzic, T., Klemmer, K., Gregorovic, M., Khan, S., … Chatterjee, S. (2024). Towards algorithm auditing: Managing legal, ethical and technological risks of AI, ML and associated algorithms. *Royal Society Open Science*, *11*(5), 1–34. https://doi.org/10.1098/rsos.230859.

KPMG. (2024). KPMG and MindBridge Announce Alliance to Power KPMG Audits with AI Technology. Available online: https://kpmg.com/xx/en/home/media/press-releases/2023/04/kpmg-and-mindbridge-announce-alliance-to-powerkpmg-audits-with-ai-technology.html (Accessed on 25 March 2024).

Krippendorff, K. (2019). *Content analysis. An introduction to its methodology* (4th ed.). SAGE Publications.

Kurniawan, Y., & Mulyawan, A. N. (2023). The Role of External Auditors in Improving Cybersecurity of the Companies through Internal Control in Financial Reporting. *Journal of System and Management Sciences*, *13*(1), 485–510. https://doi.org/10.33168/JSMS.2023.0126.

Laux, J., Wachter, S., & Mittelstadt, B. (2024). Trustworthy artificial intelligence and the European Union AI act: On the conflation of trustworthiness and acceptability of risk. *Regulation & Governance*, *18*(1), 3–32. https://doi.org/10.1111/rego.12512.

Lehner, O. M., Ittonen, K., Silvola, H., Ström, E., & Wührleitner, A. (2022). Artificial intelligence based decision-making in accounting and auditing: ethical challenges and normative thinking. *Accounting, Auditing & Accountability Journal*, *35*(9), 109–135. https://doi.org/10.1108/AAAJ-09-2020-4934.

Liew, A., O'Leary, D. E., Perdana, A., & Wang, T. (2022). Digital Transformation in Accounting and Auditing: 2021 International Conference of the Journal of Information Systems Panel Discussion. *Journal of Information Systems*, *36*(3), 177–190. https://doi.org/10.2308/ISYS-2022-008.

Lois, P., Drogalas, G., Karagiorgos, A., & Tsikalakis, K. (2020). Internal audits in the digital era: opportunities risks and challenges. *EuroMed Journal of Business*, *15*(2), 205–217. https://doi.org/10.1108/EMJB-07-2019-0097.

Lookadoo, K., & Moore, S. (2024). Is Your Résumé/Textbook Up-To-Date? An Audit of AI ATS Résumé Instruction. *Business and Professional Communication Quarterly*, 1–24. https://doi.org/10.1177/23294906231223101.

Lugli, E., & Bertacchini, F. (2023). Audit quality and digitalization: some insights from the Italian context. *Meditari Accountancy Research*, *31*(4), 841–860. https://doi.org/10.1108/MEDAR-08-2021-1399.

Manita, R., Elommal, N., Baudier, P., & Hikkerova, L. (2020). The digital transformation of external audit and its impact on corporate governance. *Technological Forecasting and Social Change*, *150*, 1–10. https://doi.org/10.1016/j.techfore.2019.119751.

Matskiv, H., Smirnova, I., Malikova, A., Puhachenko, O., & Dubinina, M. (2023). The application of blockchain technology in accounting and auditing: experience of Ukraine and Kazakhstan. *Financial and Credit Activity: Problems of Theory and Practice*, *1*(48), 180–192. https://doi.org/10.55643/fcaptp.1.48.2023.3955.

Miller, B., Haber, J., Yost, J., & Jacobs, S. . (2009). Evidence-Based Practice Challenge: Teaching Critical Appraisal of Systematic Reviews and Clinical Practice Guidelines to Graduate Students. *Journal of Nursing Education*, *48*(4), 186–195. https://doi.org/10.3928/01484834-20090401-07.

MindBridge. (2024). The MindBridge AI Platform General Ledger. Available online: https://www.mindbridge.ai/ (Accessed on 22 March 2024).

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Group, and the P. (2009). Reprint—Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *Physical Therapy*, *89*(9), 873–880. https://doi.org/10.1093/ptj/89.9.873.

Mökander, J., Morley, J., Taddeo, M., & Floridi, L. (2021). Ethics-Based Auditing of Automated Decision-Making Systems: Nature, Scope, and Limitations. *Science and Engineering Ethics*, *27*(4), 44. https://doi.org/10.1007/s11948-021-00319-4.

Moura de Carvalho, R., Inácio, H. C., & Marques, R. P. F. (2022). Ledger to ledger: off-and on-chain auditing of stablecoin. *International Journal of Digital Accounting Research*, *22*, 129–161. https://doi.org/10.4192/1577-8517-v22_5.

Munoko, I., Brown-Liburd, H. L., & Vasarhelyi, M. (2020). The Ethical Implications of Using Artificial Intelligence in Auditing. *Journal of Business Ethics*, *167*(2), 209–234. https://doi.org/10.1007/s10551-019-04407-1.

Nguyen, H. T., & Nguyen, A. H. (2020). Audit expectation gap: Empirical evidence from Vietnam. *Journal of Asian Finance, Economics and Business, 7*(5), 51–60. https://doi.org/10.13106/JAFEB.2020.VOL7.NO5.051.

Nzobonimpa, S. (2023). Artificial intelligence, task complexity and uncertainty: Analyzing the advantages and disadvantages of using algorithms in public service delivery under public administration theories. *Digital Transformation and Society, 2*(3), 219–234. https://doi.org/10.1108/DTS-03-2023-0018.

Oliphant, T. E. (2007). Python for scientific computing. *Computing in Science and Engineering, 9*(3), 10–20. https://doi.org/10.1109/MCSE.2007.58.

Özbaltan, N. (2024). Applying machine learning to audit data: Enhancing fraud detection, risk assessment and audit efficiency. *EDPACS, 69*(9), 70–86. https://doi.org/10.1080/07366981.2024.2376793.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ, 372*, 1-9. https://doi.org/10.1136/bmj.n71.

Pemer, F. (2020). Enacting Professional Service Work in Times of Digitalization and Potential Disruption. *Journal of Service Research, 24*(2), 249–268. https://doi.org/10.1177/1094670520916801.

Peng, C., & Tian, G. (2023). Intelligent auditing techniques for enterprise finance. *Journal of Intelligent Systems, 32*(1), 1-11. https://doi.org/10.1515/jisys-2023-0011.

Penini, G., & Carmeli, A. (2010). Auditing in organizations: A theoretical concept and empirical evidence. *Systems Research and Behavioral Science, 27*(1), 37–59. https://doi.org/10.1002/sres.990.

Perdana, A., Lee, W. E., & Mui Kim, C. (2023). Prototyping and implementing Robotic Process Automation in accounting firms: Benefits, challenges and opportunities to audit automation. *International Journal of Accounting Information Systems, 51*, 1–23. https://doi.org/10.1016/j.accinf.2023.100641.

Prokofieva, M. (2023). Integrating data analytics in teaching audit with machine learning and artificial intelligence. *Education and Information Technologies, 28*(6), 7317–7353. https://doi.org/10.1007/s10639-022-11474-x.

Rahman, M. J., & Ziru, A. (2023). Clients' digitalization, audit firms' digital expertise, and

audit quality: evidence from China. *International Journal of Accounting and Information Management*, *31*(2), 221–246. https://doi.org/10.1108/IJAIM-08-2022-0170.

Ramesh, V. (2019). Digitization and audit profession. *International Journal of Innovative Technology and Exploring Engineering*, *8*(6), 33–39. https://doi.org/10.35940/ijitee.

Reis, J., & Melão, N. (2023). Digital transformation: A meta-review and guidelines for future research. *Heliyon*, *9*(1), 1-19. https://doi.org/10.1016/j.heliyon.2023.e12834.

Reis, J., Amorim, M., Melão, N., Cohen, Y., & Rodrigues, M. (2020). Digitalization: A literature review and research agenda. In Proceedings on 25th International Joint Conference on Industrial Engineering and Operations Management–IJCIEOM: *The Next Generation of Production and Service Systems, 25* (pp. 443-456). Springer International Publishing. https://doi.org/10.1007/978-3-030-43616-2_47.

Rodgers, W., Al-Shaikh, S., & Khalil, M. (2023). Protocol Analysis Data Collection Technique Implemented for Artificial Intelligence Design. *IEEE Transactions on Engineering Management*, 1–12. https://doi.org/10.1109/TEM.2023.3269291.

Rodrigues, L., Pereira, J., da Silva, A. F., & Ribeiro, H. (2023). The impact of artificial intelligence on audit profession. *Journal of Information Systems Engineering and Management*, *8*(1), 1–7. https://doi.org/10.55267/iadt.07.12743.

Rudžionis, V., Lopata, A., Gudas, S., Butleris, R., Veitaitė, I., Dilijonas, D., Grišius, E., Zwitserloot, M., & Rudzioniene, K. (2022). Identifying Irregular Financial Operations Using Accountant Comments and Natural Language Processing Techniques. *Applied Sciences*, *12*(17), 1–15. https://doi.org/10.3390/app12178558.

Rydzak, W., Przybylska, J., Trębecki, J., & Sellitto, M. A. (2023). The communication gap and the effect of self-perception on assessment of internal auditors' communication skills. *Economics and Sociology*, *16*(2), 148–166. https://doi.org/10.14254/2071-789X.2023/16-2/10.

Saengsith, N., & Suntraruk, P. (2022). Assessing the internal auditors' readiness for digital transformation. *Global Business and Economics Review*, *28*(1), 1–21. https://doi.org/10.1504/gber.2023.127552.

Samiolo, R., Spence, C., & Toh, D. (2023). Auditor judgment in the fourth industrial revolution. *Contemporary Accounting Research*, *41*(1), 498–528. https://doi.org/10.1111/1911-3846.12901.

Seethamraju, R., & Hecimovic, A. (2023). Adoption of artificial intelligence in auditing: An exploratory study. *Australian Journal of Management*, *48*(4), 780–800.

https://doi.org/10.1177/03128962221108440.

Semenikhin, M., Fomina, O., Aksyonova, O., & Khmeliuk, A. (2023). Management Accounting of Payment Risks of Online Trade during Military Operations. *Theoretical and Practical Research in the Economic Fields*, *14*(2), 473–483. https://doi.org/10.14505/tpref.v14.2(28).23.

Sgantzos, K., Hemairy, M. A., Tzavaras, P., & Stelios, S. (2023). Triple-Entry Accounting as a Means of Auditing Large Language Models. *Journal of Risk and Financial Management*, *16*(9), 1-12. https://doi.org/10.3390/jrfm16090383.

Shaikh, H., Jokhio, M. U., Maher, Z. A., Chandio, S., Bin Abdullah, M. M., Raza, A., Salam, S., & Shah, A. (2018). Beyond traditional audits: The implications of information technology on auditing. *International Journal of Engineering and Technology*, *7*(2), 5–11. https://doi.org/10.14419/ijet.v7i2.34.13897.

Shapovalova, A., Kuzmenko, O., Polishchuk, O., Larikova, T., & Myronchuk, Z. (2023). Modernization of the National Accounting and Auditing System Using Digital Transformation Tools. *Financial and Credit Activity: Problems of Theory and Practice*, *4*(51), 33–52. https://doi.org/10.55643/fcaptp.4.51.2023.4102.

Sierra-García, L., Gambetta, N., García-Benau, M. A., & Orta-Pérez, M. (2019). Understanding the determinants of the magnitude of entity-level risk and account-level risk key audit matters: The case of the United Kingdom. *The British Accounting Review*, *51*(3), 227–240. https://doi.org/10.1016/j.bar.2019.02.004.

Štager, V. (2018). Strong competition among audit companies and power to achieve higher audit fees: Who is at the forefront? *Scientific Annals of Economics and Business*, *65*(2), 119–138. https://doi.org/10.2478/saeb-2018-0012.

Suarez, S. R., Huamani, B. M., Meléndez, M. A., & Ovalle, C. (2024). Methodology applied to computer audit with artificial intelligence: a systematic review. *IAES International Journal of Artificial Intelligence*, *13*(4), 3727–3738. https://doi.org/10.11591/ijai.v13.i4.pp3727-3738.

Taherizadeh, A., & Beaudry, C. (2023). An emergent grounded theory of AI-driven digital transformation: Canadian SMEs' perspectives. *Industry and Innovation*, *30*(9), 1244–1273. https://doi.org/10.1080/13662716.2023.2242285.

Tiron-Tudor, A., & Deliu, D. (2022). Reflections on the human-algorithm complex duality perspectives in the auditing process. *Qualitative Research in Accounting and Management*, *19*(3), 255–285. https://doi.org/10.1108/QRAM-04-2021-0059.

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a Methodology for Developing

Evidence-Informed Management Knowledge by Means of Systematic Review. *British Journal of Management*, *14*(3), 207–222. https://doi.org/10.1111/1467-8551.00375.

Tsakalakis, N., Stalla-Bourdillon, S., Carmichael, L., Huynh, T. D., Moreau, L., & Helal, A. (2021). The dual function of explanations: Why it is useful to compute explanations. *Computer Law & Security Review*, *41*, 1-4. https://doi.org/10.1016/j.clsr.2020.105527.

Turgaeva, A. A., Kashirskaya, L. V, Zurnadzhyants, Y. A., Latysheva, O. A., Pustokhina, I. V, & Sevbitov, A. V. (2020). Assessment of the financial security of insurance companies in the organization of internal control. *Entrepreneurship and Sustainability Issues*, *7*(3), 2243–2254. https://doi.org/10.9770/jesi.2020.7.3(52).

Van Bekkum, M., & Borgesius, F. (2023). Using sensitive data to prevent discrimination by artificial intelligence: Does the GDPR need a new exception? *Computer Law & Security Review*, *48*, 1–12. https://doi.org/10.1016/j.clsr.2022.105770.

Van Hueveln, N. (2017). *Ventilator-Associated Pneumonia and the Effectiveness of Endotracheal Tubes Coated with Silver Sulfadiazine* [Master Thesis, The School of Nursing]. Rhode Island College. https://digitalcommons.ric.edu/etd/251.

Vasarhelyi, M. A., Alles, M., Kuenkaikaew, S., & Littley, J. (2012). The acceptance and adoption of continuous auditing by internal auditors: A micro analysis. *International Journal of Accounting Information Systems*, *13*(3), 267–281. https://doi.org/10.1016/j.accinf.2012.06.011.

Wassie, F. A., & Lakatos, L. P. (2024). Artificial intelligence and the future of the internal audit function. *Humanities and Social Sciences Communications*, *11*(1), 1-13. https://doi.org/10.1057/s41599-024-02905-w.

Wood, D. A. (2024). More transparent and explainable machine learning algorithms are required to provide enhanced and sustainable dataset understanding. *Ecological Modelling*, *498*, 1–7. https://doi.org/10.1016/j.ecolmodel.2024.110898.

Woolf, N., & Silver, C. (2017). *Qualitative Analysis Using NVivo*. Routledge.

Yin, R. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE Publications.

Zhang, C., Cho, S., & Vasarhelyi, M. (2022). Explainable Artificial Intelligence (XAI) in auditing. *International Journal of Accounting Information Systems*, *46*, 1–22. https://doi.org/10.1016/j.accinf.2022.100572.

Zamzam, I., Mahdi, S. A. R., & Sardju, F. (2024). The influence of competency and professional behavior on internal auditor performance in the digital era with time budget pressure as a moderator. *Australasian Accounting, Business and Finance Journal*,

18(2), 120–132. https://doi.org/10.14453/aabfj.v18i2.08.

Zaniolo, L., Garbin, C., & Marques, O. (2023). Deep learning for edge devices. *IEEE Potentials*, *42*(4), 39–45. https://doi.org/10.1109/MPOT.2022.3182519.

Zhang, C., Cho, S., & Vasarhelyi, M. (2022). Explainable Artificial Intelligence (XAI) in auditing. *International Journal of Accounting Information Systems*, *46*, 1–22. https://doi.org/10.1016/j.accinf.2022.100572.

Zhao, J., & Wang, X. (2024). Unleashing efficiency and insights: Exploring the potential applications and challenges of ChatGPT in accounting. *Journal of Corporate Accounting and Finance*, *35*(1), 269–276. https://doi.org/10.1002/jcaf.22663.

APPENDICES AND ANNEXES

APPENDIX A – METHODOLOGICAL QUALITY RATINGS BASED ON CASP (n = 21)

Author(s)	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Score	Classification Quality	Scimago
Lookadoo & Moore	Y	C	C	C	C	Y	Y	C	Y	Y	15	Good	Q2
Semenikhin et al.	Y	C	C	N	C	Y	Y	Y	Y	C	14	Moderate	Q3
Zhao & Wang	Y	C	C	C	C	Y	Y	C	Y	Y	15	Good	Q2
Shapovalova et al.	Y	C	C	C	C	Y	Y	C	Y	Y	15	Good	Q1
Adeoye et al.	Y	C	C	N	Y	Y	Y	C	Y	C	14	Moderate	Q3
Samiolo et al.	Y	Y	C	C	Y	Y	Y	Y	Y	Y	18	Excellent	Q1
Anh et al.	Y	Y	C	N	Y	Y	Y	Y	Y	C	16	Good	Q3
Khuong et al.	N	C	C	N	Y	Y	Y	Y	Y	Y	14	Moderate	Q3
Seethamraju & Hecimovic	Y	Y	Y	C	Y	Y	Y	Y	Y	Y	19	Excellent	Q1
Estep et al.	Y	Y	C	C	Y	Y	Y	Y	Y	Y	18	Excellent	Q1
Castka & Searcy	Y	N	C	C	Y	Y	Y	C	Y	Y	15	Good	Q1
Taherizadeh & Beaudry	Y	C	C	Y	Y	Y	Y	C	Y	Y	17	Good	Q1
Abdullah & Almaqtari	Y	Y	Y	Y	C	Y	Y	C	Y	Y	18	Excellent	Q1
Han et al.	Y	Y	Y	C	C	Y	Y	C	Y	Y	17	Good	Q1
Van Bekkum & Borgesius	Y	Y	Y	C	C	Y	Y	C	Y	Y	17	Good	Q1
Huson et al.	Y	Y	C	Y	Y	Y	Y	C	Y	Y	18	Excellent	Q1
Rodgers et al.	Y	Y	C	C	C	Y	Y	Y	Y	Y	17	Good	Q1
Hu et al.	Y	Y	C	C	Y	Y	Y	Y	Y	Y	18	Excellent	Q1
Blösser & Weihrauch	Y	Y	Y	C	Y	Y	Y	Y	Y	Y	19	Excellent	Q1
Agustí & Orta-Pérez	Y	Y	C	C	C	Y	Y	C	Y	Y	16	Good	Q3
Goto	Y	Y	Y	Y	C	Y	Y	C	Y	Y	18	Excellent	Q1

Abbreviations: Y = Yes; C = Can't tell; N = No. Classification: Yes = 2; C = 1 and N = 0. Overall classification: Excellent = 18/20; Good = 15/17; Moderate 10/14; Poor ≥ 10.

1 = Did the review address a clearly focused question?; 2 = Did the authors look for the right type of papers?; 3 = Do you think all the important, relevant studies were included?; 4 = Did the review's authors do enough to assess the quality of the included studies?; 5 = If the results of the review have been combined, was it reasonable to do so?; 6 = What are the overall results of the review?; 7 = How precise are the results?; 8 = Can the results be applied to the local population?; 9 = Were all important outcomes considered? 10 = Are the benefits worth the harms and costs? (Van Hueveln, 2017).

APPENDIX B – REPORT: CHARACTERISTICS OF REVIEW STUDIES (n = 21)

Author(s)	Year	Purpose	Methodology	Main Findings
Lookadoo & Moore	2024	Examine coverage of résumés and AI Applicant Tracking Systems (ATS) in textbooks	Literature Review	The findings indicate a lack of consensus in 18 textbooks, highlighting challenges in providing specific advice on emerging AI technology
Semenikhin et al.	2023	Explore the impact of management accounting on payment risks in online trade during military operations	Exploratory Study	The findings show that effective management accounting, including fast transaction identification and fraud loss estimation, significantly reduces payment risks in online trade during crises
Zhao & Wang	2024	Explore ChatGPT's applications in accounting	Literature Review	The findings indicate that ChatGPT can automate tasks, enhance reporting, improve auditing, but ethical considerations are crucial for reliable use
Shapovalova et al.	2023	Develop a modernization concept for national accounting policy within the Accounting 4.0 paradigm, integrating advanced technologies like AI, blockchain, and IoT	Literature Review	The findings indicate that adopting advanced technologies like AI, blockchain, and IoT enhances efficiency, accuracy, and transparency in national accounting policy, improving competitiveness
Adeoye et al.	2023	Explore the effect of AI on audit quality	Exploratory Study	The results showed that AI has a positive impact on audit quality
Samiolo et al.	2023	Examine the impact of technological advancements, particularly AI, on the auditing profession and challenge assumptions about automation's feasibility.	Literature Review	The results indicate that technology in auditing has risks: automating simple tasks may overlook judgment aspects, changing auditor habits and affecting practical knowledge acquisition.
Anh et al.	2024	Investigate the impact of technology readiness (TR) on artificial intelligence (AI) adoption by accountants and auditors in Vietnamese companies	Exploratory Study	The findings reveal positive relationship found between TR and AI adoption, with perceived usefulness and ease-of-use mediating this relationship
Khuong et al.	2023	Explore factors influencing AI demand in Vietnamese Accounting and Auditing	Experimental Research	The findings, validated by fsQCA, show that finance, tasks, technology, epidemics, readiness, and trust positively impact AI use
Seethamraju & Hecimovic	2023	Explore the impact of AI on audit, examining factors influencing AI adoption in audit practice	Exploratory Study	The findings display that several factors affect AI adoption in audit. While AI can enhance audit quality, concerns about control and transparency exist, necessitating a reevaluation of audit practices
Estep et al.	2023	Examine managers' perceptions of AI use in financial reporting and its impact on audit adjustments	Literature Review	The findings indicate that managers are uncertain about the benefits from auditors' AI use, but it influences larger audit adjustments for companies using AI in complex accounting estimates

Castka & Searcy	2023	Explore the adoption of new technologies in auditing	Literature Review	The study reveals an emerging TIC paradigm, shaped by innovative technology, urging an immediate transition
Taherizadeh & Beaudry	2023	Identify the key dimensions of AI-driven digital transformation (AIDT) and develop a grounded theory that provides an understanding of how the AIDT process unfolds within Canadian SMEs	Literature Review	The study reveals five core dimensions: evaluating transformation context, auditing organizational readiness, piloting the AI integration, scaling the implementation, and leading the transformation
Abdullah & Almaqtari	2024	Investigate the impact of AI, Industry 4.0 readiness, and Technology Acceptance Model (TAM) variables on various aspects of accounting and auditing operations	Experimental Research	The findings indicate that AI, big data analytics, cloud computing, and deep learning can improve accounting and auditing practices
Han et al.	2023	Explore the impact of blockchain on accounting, particularly AI-enabled auditing, focusing on transparency, trust, and decision-making improvement	Literature Review	The findings indicate that blockchain enhances transparency, trust, and efficiency in accounting, along with highlighting challenges and the need for cautious adoption
Van Bekkum & Borgesius	2023	Explore whether the GDPR's rules on special categories of personal data hinder preventing AI-driven discrimination, focusing on the European context	Literature Review	The findings display that the GDPR generally prohibits using special category data, posing challenges in preventing AI-driven discrimination. The paper explores arguments for and against exceptions to address this tension
Huson et al.	2024	Examine the literature about information technology, artificial intelligence, and blockchain in auditing	Literature Review	This study provides an overview of the profound impact of technology on the evolution of the auditing profession
Rodgers et al.	2023	Propose a framework to employ think-aloud protocols (TaP) and thematic analysis in qualitative accounting research	Exploratory Study	The results indicate that the lack of an AI framework, IFRS knowledge, and legislation conflict may adversely interact with standard implementation
Hu et al.	2023	Explore the incorporation of AI in internal audit practices, proposing strategies for effective implementation and decision-making within a comprehensive and interconnected framework	Experimental Research	The results indicate that the prioritized improvement order for implementing AI-driven internal audit involves strategies, governance, human factors, and data infrastructure, fostering efficient decision-making in a big data environment
Blösser & Weihrauch	2024	Reveal important insights into the consumer perspective of AI certifications	Literature Review	The findings show that trust in AI certification is complex, and consumers seem to approve more of non-profit entities than for-profit entities, with the government approving the most.
Agustí & Orta-Pérez	2023	Explore the influence of Big Data and AI in the fields of accounting and auditing	Literature Review	The main findings encompass mapping the evolution of publication activity, highlighting key contributors, and summarizing significant literature within this specific domain
Goto	2023	Explore how PSFs can establish and utilize service R&D to innovate services	Case study	The findings display the detailed process of how newly created service R&D organizations advanced AI adoption in the case of firms

APPENDIX C – INTERVIEW PROTOCOL

Having acknowledged that:

(a) I am free to withdraw my participation at any time, should I wish to do so.

(b) I understand that my participation is voluntary and has no associated economic cost.

(c) My responses are confidential and will be accessible only to the researcher.

(d) All data will be analyzed collectively and never on an individual basis.

(e) The data from this study will be used solely for scientific research purposes.

(_) I accept

_____

Respondent Profile

Age: ___ Gender: ___

Academic degree: ___ Category: ___

_____

Artificial Intelligence (AI) in the Evolution of Auditing Practices

1. Indicate the number of years of experience in auditing:

(_) Less than 1 year (_) Between 1 and less than 4 years

(_) Between 4 and less than 7 years (_) More than 7 years

2. How significant is the integration of AI technologies in the organization?

(_) Insignificant (_) Minimal Significance

(_) Significant (_) Critical Significance

3. How significant is the integration of AI technologies in the evolution of audit processes?

(_) Insignificant (_) Minimal Significance

(_) Significant (_) Critical Significance

4. The incorporation of AI technologies can enhance the effectiveness and efficiency of the audit process.

(_) Insignificant (_) Minimal Significance

(_) Significant (_) Critical Significance

5. How do you assess the potential impact of adopting AI technologies on the analysis and mitigation of risks identified during internal control?

(_) Insignificant (_) Minimal Significance

(_) Significant (_) Critical Significance

6. How important is risk management in auditing?

(_) Insignificant (_) Minimal Significance

(_) Significant (_) Critical Significance

7. The audit process in the organization is effective.

(_) Completely Disagree (_) Disagree

(_) Agree (_) Completely Agree

8. How important is the ability to perform continuous and real-time audits using AI?

(_) Insignificant (_) Minimal Significance

(_) Significant (_) Critical Significance

9. The organization has training and professional development initiatives for auditors.

(_) Completely Disagree (_) Disagree

(_) Agree (_) Completely Agree

10. The organization has access to advanced data analysis tools for conducting audits.

(_) Completely Disagree (_) Disagree

(_) Agree (_) Completely Agree

11. The organization's audit methods are regularly updated to incorporate best practices.

(_) Completely Disagree (_) Disagree

(_) Agree (_) Completely Agree

12. Communication between the audit team and representatives of the audited financial center is effective throughout the process.

(_) Completely Disagree (_) Disagree

(_) Agree (_) Completely Agree

13. Preliminary audit reports are useful for timely decision making by managers of the audited financial center.

(_) Completely Disagree (_) Disagree

(_) Agree (_) Completely Agree

14. Internal auditing contributes to the continuous improvement of internal control mechanisms.

(_) Completely Disagree (_) Disagree

(_) Agree (_) Completely Agree

15. Audit recommendations are generally implemented by the organization.

(_) Completely Disagree (_) Disagree

(_) Agree (_) Completely Agree

16. The annual risk matrix is effective in identifying critical areas.

(_) Completely Disagree (_) Disagree

(_) Agree (_) Completely Agree

17. The audit process in the organization is efficient.

(_) Completely Disagree (_) Disagree

(_) Agree (_) Completely Agree

18. The organization has a culture of innovation that supports the modernization of existing processes.

(_) Completely Disagree (_) Disagree

(_) Agree (_) Completely Agree

19. What indicators/ criteria do you consider essential for the application of AI in the audit process?

20. At which stages of the audit process do you consider AI application essential, and why?

If you find it relevant, please provide additional contributions regarding the audit process.

Examples: What can be improved and how? What are the main challenges in conducting audits today? What are the challenges for the future?

ANNEX A – PEER-REVIEW COMMENTS: DIGITAL TRANSFORMATION AND SOCIETY

General comments

Firstly, we extend our sincere gratitude for dedicating your time to offering valuable recommendations. To enable an understanding of the revisions incorporated into our manuscript, we have opted to denote them using blue color in Microsoft Word.

We always take the revision very seriously. Hence, if you find that our revisions are not satisfactory, we are entirely available to reformulate accordingly. The following paragraphs address your detailed recommendations.

Reviewer 1

Reviewer point #1: Does the abstract relate to the article? Does it provide an adequate summary of the content? Is the language easy to understand and clear for the reader? I suggest to modify. Please include the practical implications.

Author response #1: Thank you for your recommendation. We have integrated the practical implications into the abstract and further strengthened their presence throughout the article text.

Reviewer 2

Reviewer point #1: Recommendation: Accept.

Author response #1: Thank you very much.

The authors,

May, 2024

ANNEX B – PEER-REVIEW COMMENTS: ADMINISTRATIVE SCIENCES

General comments

Firstly, we would like to extend our gratitude for dedicating your time to offering valuable recommendations. We are confident that your review insights have enhanced the paper in many ways. Therefore, we hope that you will find the revised version of this article to be more robust. To enable understanding of the revisions incorporated into our manuscript, we have opted to denote them using the color blue in Microsoft Word.

We have taken the revision very seriously. If you find that our revisions short, we are entirely available to reformulate accordingly. The following paragraphs address your detailed recommendations.

Reviewer 1

Reviewer point #1: In the material and data section, a subsection should be devoted to what is meant by artificial intelligence and to explain, at least briefly, why Cloud Computing, Machine Learning, Blockchain, Internet of Things, etc. are also included.

Author response #1: Your recommendation is very pertinent. The (re)definition of AI is already outlined in the introduction. The concepts of machine learning and blockchain were addressed in the results section to demonstrate how these advanced technologies are currently being applied to facilitate the work of institutions. By doing so, we ensure that the focus remains on the core definition of AI while also highlighting specific applications of emerging technologies within the context of auditing.

Reviewer point #2: Likewise, the debugging process is explained until the relevant documents are found. I understand that this is the methodology and, therefore, the results are oriented to the major topics covered in Scopus impact journals. Well, this should be highlighted in the text, as well as the most “successful” topics in each category of Q1; Q2; Q3; Q4 journals.

Author response #2: Thank you for this observation. We appreciate the importance of highlighting the most "successful" topics across Q1, Q2, Q3, and Q4 journal categories. While we included a brief summary of the main findings in the annexes to maintain the flow of the main text, this approach allows for a more detailed exploration without interrupting the narrative.

The appendices provide a dedicated space to present these findings comprehensively, ensuring that readers can access this information easily while keeping the primary sections focused on the methodology and overarching themes. We have made sure to clearly reference these appendices in the relevant sections of the text, emphasizing the significance of the successful topics identified in each category. This structure aims to enhance clarity and ensure that critical insights are readily available for readers.

Reviewer point #3: It is worth explaining the NVivo tool, which is key to the work carried out.

Author response #3: We followed your suggestion, much appreciated.

Reviewer point #4: As I mentioned earlier, it is a literature review paper, so the discussion, I understand, should be about the relevance of the new topics addressed and their implications for the audit profession and/or lines of audit research. The authors include the MindBridge case, which, while laudable, is not apparent from the

review conducted. The discussion, I repeat, should be about the relevance of the findings, the timeliness, which is precisely what research seeks: to find cutting-edge and appropriate lines of research over time. This is precisely what the authors indicate when they note that auditing practice demands an innovative adaptation of auditors' skills. I believe that these conclusions are the ones that should be reinforced in the discussion and not the case they have included.

Author response #4: Thank you for this observation. We fully understand the importance of focusing the discussion on the relevance of the topics addressed and their implications for the audit profession and future research directions. The inclusion of the business case was intended to illustrate current practices, providing a real-world context that enhances the practical applicability of the theoretical findings. We believe this adds value by offering insights for readers who may be interested in identifying practical gaps and understanding the tangible benefits of innovations such as AI integration in auditing. Additionally, we would like to note that one of the reviewers found the case to be of particular interest. However, we acknowledge your point, and should you deem it essential, we are prepared to remove the case in the next revision. Our priority is to ensure that the article aligns with your expectations and contributes meaningfully to the field.

Reviewer 2

Reviewer point #1: The idea is a good one, but it would be appropriate to base it a little more on the theoretical level. I suggest this publication: Big Data and Artificial Intelligence in the Fields of Accounting and Auditing: A Bibliometric Analysis. REFC – Spanish Journal of Finance and Accounting. Forthcoming.

Author response #1: Thank you for this observation. We have used this article in our analysis of the results and focused on providing a clear understanding of all the concepts within the conceptual model. This approach ensures that the theoretical foundations are robust and that key ideas are well-supported, aligning with the relevant literature in the field.

Reviewer 3

Reviewer point #1: First, while the PRISMA protocol is mentioned and the search process is described, a little more detail about how you handled the inclusion/exclusion criteria during the screening phase could strengthen transparency. For example, providing a bit more explanation on how certain studies were excluded due to relevance or quality would help readers better understand the rigor behind the selection process.

Author response #1: We followed your suggestion, much appreciated.

Reviewer point #2: Second, in Section 5.3 (Limitations and Future Research), you briefly mention regulatory challenges related to AI in auditing. A more detailed exploration of these regulatory issues could further strengthen the discussion. What are the current regulatory frameworks, and where do they fall short when it comes to AI in auditing?

Author response #2: Thank you for this observation. We recognize the importance of a more detailed exploration of regulatory issues related to AI in auditing. To address this, we have integrated a discussion on the current regulatory frameworks and their shortcomings. Specifically, we have added a paragraph in Section 3.4 (Ethical Considerations) to further explore these regulatory issues. This addition aims to provide a comprehensive understanding of existing frameworks, highlight their gaps, and emphasize the need for guidelines to ensure responsible and transparent AI usage in auditing.

Reviewer point #3: Third, while you touch on auditor adaptation to AI, more could be said about the specific types of training or education that will be necessary for auditors to fully embrace these new technologies. How can auditing firms or professional organizations support this transition?
Author response #3: Thank you for this comment. We acknowledge the importance of addressing the specific training and educational requirements necessary for auditors to fully integrate and utilize AI technologies. While this is a crucial aspect of AI adoption, we have chosen to focus on developing a robust conceptual model in this paper. This model provides the theoretical foundation for understanding how AI can be integrated into auditing processes. The exploration of specific training programs, educational frameworks, and the role of professional organizations in facilitating this transition is a relevant topic. However, it extends beyond the scope of this current study, which aims to establish a broader understanding of AI's implications in the field. We propose that future research should explore practical training strategies and institutional support mechanisms in this area. This distinction enables us to maintain a clear focus on our theoretical contributions while acknowledging the critical importance of auditor education and training in AI adoption as a key avenue for future investigation.

Reviewer point #4: Fourth, the conceptual framework figure (Figure 2) could be slightly improved by adding more annotations or explanations for clarity. For instance, it may help readers if you provide more detailed descriptions of each component directly in the figure or in a figure caption.
Author response #4: Your recommendation is very pertinent. We agree that enhancing the clarity of Figure 2 with additional annotations or explanations would be beneficial. To address this, we have added a paragraph to improve the connection between the conceptual framework and the results obtained. This addition aims to provide a description of each component of the model, introducing the concepts that will be explained later, enhancing overall clarity and understanding for the readers.

Reviewer point #5: Fifth, throughout the paper, terms like “digital transformation,” “AI,” and “machine learning” are used. Ensure that these terms are consistently defined and applied throughout the document.
Author response #5: We followed your suggestion, much appreciated.

Reviewer point #6: Sixth, the MindBridge case study is a strong example. If space permits, you could expand on this by adding one or two more industry case studies to provide a broader context of how other firms are adopting AI in auditing.
Author response #6: Thank you for this observation. Expanding on the MindBridge case study by including one or two additional industry case studies would provide a broader context for how other firms are adopting AI in auditing. We have carefully chosen to limit our focus to this business case, as it effectively serves the purpose of illustrating the key theoretical insights essential to our conceptual framework. Therefore, we will include this suggestion in the conclusions as a valuable direction for future research.

Reviewer 4

Reviewer point #1: The paper's organization needs improvement. Sections should flow more logically, and transitions between ideas should be smoother. The framework introduced could benefit from a more structured breakdown with clearer connections to the existing literature. Adding subheadings within larger sections would also enhance readability.

Author response #1: Thank you for this observation. We appreciate your feedback regarding the organization of the paper. The sections are intentionally structured to first provide a solid foundation before moving on to more specific and complex discussions. This sequence follows a logical progression that allows readers to gradually build a comprehensive understanding of the topic. The transitions between ideas have been crafted to emphasize the interdependencies of the concepts discussed, reinforcing the integrated nature of the subject matter. Additionally, the use of subheadings has been kept strategic to avoid overwhelming the reader with unnecessary interruptions, ensuring that the flow of reading remains continuous and engaging.

Reviewer point #2: The proposed conceptual framework lacks innovation. It does not present anything significantly new. Strengthen this by integrating findings from cutting-edge research or proposing more actionable insights. The framework should more clearly reflect current challenges and opportunities.
Author response #2: Thank you for this comment. The proposed conceptual framework aims to provide a practical approach aligned with the current challenges in the field. It has been constructed based on a synthesis of existing literature and seeks to integrate concepts that, while previously discussed, still require more practical and systematic application. Instead of proposing entirely new concepts, the goal is to refine and adapt current theories to effectively address the real-world challenges faced by today's professionals. This focus on actionable insights ensures that the framework remains relevant and applicable in the current context. We have integrated findings from recent research to strengthen the framework's relevance and innovation, ensuring it provides practical solutions while addressing key opportunities in the current context. Should additional adjustments be required, we are open to further refining the framework to ensure it meets the necessary standards for clarity and innovation.

Reviewer point #3: Some references are outdated or not directly relevant to the claims being made. Reassess the reference list to ensure all citations are contemporary and relevant to the core arguments of the paper. The literature review also needs to be more critical, assessing the strengths and limitations of existing studies.
Author response #3: We followed your suggestion. We have strengthened our explanation regarding the integration of AI in auditing by emphasizing the importance of critically assessing existing studies. While numerous publications highlight the benefits of advanced technologies, they often overlook significant challenges, including data privacy concerns, the complexities of technology integration, and the potential displacement of human auditors. Therefore, a balanced evaluation is essential to understand both the transformative potential and the limitations of these technologies, ensuring their implications for the auditing profession are thoroughly examined.

Reviewer point #4: The methodology described seems sound, but the paper does not provide enough critical analysis of the results. Strengthen the discussion by acknowledging the limitations of the framework and how these could be addressed in future research. More emphasis should be placed on explaining how the systematic review informs the framework.
Author response #4: We followed your suggestion. We have strengthened the discussion by explicitly acknowledging the limitations of the framework and outlining how these could be addressed in future research. Additionally, we have placed greater emphasis on explaining how the systematic review informs the framework, highlighting the connections between the reviewed literature and the proposed model. We have also integrated a paragraph in the discussion to further align the literature with the model, enhancing the overall

coherence and depth of the analysis.

The authors,
September, 2024

ANNEX C – PEER-REVIEW COMMENTS: JOURNAL OF RISK AND FINANCIAL MANAGEMENT

General comments

Firstly, we extend our sincere gratitude for dedicating your time to offering valuable recommendations. We are confident that your revision has enhanced the paper on multiple ways. Therefore, we hope that you will find the revised version to represent a more robust contribution. To enable understanding of the revisions incorporated into our manuscript, we have opted to denote them using the color blue in the manuscript.

We have taken the revision very seriously. If you find that our revisions are not satisfactory, we are entirely available to reformulate accordingly. The following paragraphs address your detailed recommendations.

Reviewer 1

Reviewer point #1: According to whom is the audit process described on the second and third pages?
Author response #1: As part of the study, we created a scenario to simulate the audit process. The description on pages two and three was initially based on the institution's audit process but presented without direct reference to avoid explicitly identifying the institution. However, to enhance transparency and rigor, we have now included the proper reference to the institution's audit process while maintaining the integrity of the study.

Reviewer point #2: See Line 293. Where did this picture come from? Is it the result of the author's own elaboration or does it refer to a model created by a previous author? when the scheme was created?
Author response #2: Thank you for your comment. The figure was created by the authors during the course of the research. Moreover, the figure is grounded in the results, with the intention of improving the understanding of the key indicators. We have added this information in lines 313 and 314.

Reviewer point #3: How were the interviewees selected in this paper? can the script of the interview material sent by the researcher to the interviewees via Google Form be sent to this review section?
Author response #3: Thank you for your observation. The script of the interview, which was shared with participants via Google Forms, has been included as an appendix to provide full transparency. However, if the reviewer believes it would be more effective, we can incorporate selected questions and corresponding responses directly into the article to provide additional evidence.

Reviewer 2

Reviewer point #1: The article covers an aspect of improving auditing practices in public security agency so, the introduction should start talking about it instead of elaborating on AI. At the tail end mention the proposition of AI/Python to enhance auditing processes.
Author response #1: We followed your suggestion. In response, we have revised the introduction to incorporate the concept of "algorithm-based applications", with the explanation regarding Python placed in Section 3.4 of the article, which we believe to be the most appropriate section for this discussion.

Reviewer point #2: The literatures on Public Security Agencies should be further explored. What is the current status of auditing this agency and tools?

Author response #2: Thank you very much for your comment. We have added a paragraph explaining the current state of the auditing process within the agency, highlighting that while the process remains time-consuming and primarily manual, it has already transitioned to a digital format. Although advanced data analysis tools have not yet been implemented, the digitalization of the process has laid a solid foundation for the integration of algorithmic applications.

Reviewer point #3: International Public Sector Accounting Standards (IPSAS) ought to be cited.
Author response #3: We followed your suggestion, much appreciated.

Reviewer point #4: Line 67-68. Maybe the authors would like to say "……ascertaining that internal control is established through measures designed to mitigate risks".
Author response #4: We followed your suggestion, much appreciated.

Reviewer point #5: Line 69. Kindly verify if this is a direct citation from Yin (2018) or rewrite as an indirect citation.
Author response #5: Thank you for your observation. The sentence has been revised to reflect an indirect citation of Yin (2018).

Reviewer point #6: Line 90. Noteworthy that apart from enhancement of transparency and efficiency of systems the auditing of public agency could toe the concern of certifying Legality of transactions and compliance. Authors are advised to draw from the IPSAS.
Author response #6: We followed your advice, much appreciated.

Reviewer point #7: Maybe authors would consider changing the theme of the article to include "Technology"
Say: Improving auditing practices technologies in Public Security Agencies: Empirical research from Portugal.
Author response #7: We have adopted a new appropriate title: "Exploration of Audit Technologies in Public Security Agencies: Empirical Research from Portugal". However, we are open to making further changes if necessary.

Reviewer point #8: Line 230-232. One respondent was unfamiliar with the concepts of AI and did not provide input. Which category of respondents. Stipulate. Is it associated with the issue of lack of training?
Author response #8: Thank you for your comment. We have incorporated the requested clarification into the manuscript. The respondent in question belongs to the Sergeant category, with less than one year of experience in auditing, which may reflect the issue of limited training.

Reviewer point #9: Line 210-232. In analysis of AI Integration, it is not clear how AI document analysis and record confirmation were run. Kindly throw more light.
Author response #9: Thank you for your feedback. The primary objective of the section 3.2., particularly document analysis and record confirmation, is to emphasize the key indicators identified by the interviewees as being most relevant to the auditing process. The detailed exploration of these key indicators is further developed in sections 3.4. and 3.5., where the specific applications of AI are thoroughly examined. To address the point raised, we have enhanced section 3.2. to provide a clearer bridge to these subsections, ensuring that the progression from the identification of key indicators to their detailed exploration is more comprehensible.

Reviewer point #10: Overall, there are processes which are currently performed manually. What is your contribution (roadmaps) as to migrating to automated processing, particularly adopting AI in public sector agencies.

Author response #10: Thank you for your observation. We have enhanced section 4.1. to provide a clearer focus on the contributions towards the adoption of AI in public sector agencies. This revision emphasizes the importance of transitioning from manual processes to automated systems, outlining contributions for the effective implementation of AI in auditing.

The authors,

January, 2025