

A Systematic Literature Review of the Role of Big Data Analysis in Financial Auditing

Iyad Hosni Mohammed Ismail^{1*} and Fathilatul Zakimi bin Abdul Hamid²

¹ *PhD Accounting, University Utara Malaysia, Kedah, Malaysia*

² *Senior Accounting Lecturer, University Utara Malaysia, Kedah, Malaysia*

ABSTRACT

Big data analysis is increasingly important in financial auditing, yet its application in audit engagements lags behind. Despite the belief that data analysis will shape auditing in the future, limited publications have explored this transformative potential. This study investigated the role of big data analysis in auditing, and the opportunity to depict the development of this study trend and predict its future growth prospects in future audit assignments. Opportunities for and challenges of future auditing research have also been covered. The use of data analytics in auditing has a great deal of promise to improve audit quality, reduce errors, increase process transparency, and boost stakeholders' credibility. Researchers grounded upon the systematic literature review (SLR) using the PRISMA approach of 97 scientific articles extracted from Scopus and other scientific databases between the years 1990 and 2023. Analysis outcomes revealed the importance of IT knowledge, data categorization, and diverse skills for effective utilization. Challenges include data volume, lack of standards, and negative perceptions. Integration of advanced technologies like robots, AI, and blockchain showed promise for revolutionizing auditing and enhancing cybersecurity. Data specialists and digital tools improve efficiency and decision-making. Factors influencing the adoption and implementation of big data analysis in audits were identified. Implications, limitations, and future research directions are discussed for further investigation into enhancing audit processes and decision-making in the digital age.

Keywords: Audit Efficiency, Audit Quality, Big Data Analysis, Financial Auditing, Systematic Literature Review

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*Corresponding Author: Iyad Ismail; University Utara Malaysia, Sintok 06010, Kedah, Malaysia; Email: iismail.jsckrm@gmail.com; Tel: 00970599196276

INTRODUCTION

Big data refers to large, diverse data that require new technologies for collection, storage, and analysis. Miller et al. (2012) and Sicular (2013) referred that it aims to enhance decision-making, gain insights, facilitate discoveries, and optimize processes. Analytical capabilities help businesses understand customers and operations (Russom, 2013). Big data enhances a relatively new and significant concept that enhances decision-making but poses storage, transmission, and analysis challenges. Cloud computing improves shared computer resources (Yang et al., 2017). Furthermore, big data includes diverse information from various sources like machine-generated and sociological data. It encompasses abundant qualitative, quantitative, financial, and non-financial data (Basukie et al., 2020; Ghani et al., 2019).

Big data is characterized by key aspects referred to as "Vs." Saggi and Jain (2018) proposed seven Vs: velocity, variety, volume, valence, variability, veracity and value. These dimensions highlight the characteristics of large datasets, including size, diversity, speed of generation, and reliability and validity (Vasarhelyi et al., 2015; Yoon et al., 2015; Zhang et al., 2015). Audit firms leverage big data analysis, combining art and science to identify trends, anomalies, and extract valuable information. It enhances the auditing process through analytical tools, modeling, and visualization techniques (AICPA, 2014; Salijeni et al., 2019; Iqbal et al., 2020). Big data enhances accountants' value, aiding decision-making, improving standards, and auditing. It provides a competitive advantage but poses data management challenges (John et al., 2015).

Firms use information technology, requiring auditors to align with financial statement users' expectations (Knechel et al., 2019). Technology adoption is vital for effective audits (Castka et al., 2020). Accounting professionals exchange knowledge, emphasizing efficiency. Financial services firms manage information for internal knowledge control (Curtis and Taylor, 2018; Poole, 2019). Auditing and accounting involve big data analysis (Liu and Vasarhelyi, 2014). Financial professionals adapt to changes in social platforms, cloud computing, big data, the Internet, cybercrime, digital service delivery, and AI (IMA, 2013a). Big data raises questions about finance's future role, as auditors embrace it for decision-making and reshaping practices (CGMA Institute, 2013).

Big data enhances auditing with advanced analysis for control and risk management (ICAEW, 2014). Multimedia information benefits accounting and auditing (Crawley and Wahlen, 2014; Warren et al., 2015). Auditors utilize unconventional evidence alongside traditional methods (Moffitt and Vasarhelyi, 2013). Big data empowers accountants as valuable partners through enhanced analysis (Hagel, 2013; Smith, 2015). External IT audits are conducted by auditors outside the organization (Gantz, 2014). The study investigated the role of big data analysis in financial audits and suggests areas for further investigation (Aboud and Robinson, 2022; Hu et al., 2021; Jacky and Sulaiman, 2022; Zhang, 2021) through a systematic literature review (SLR) using the PRISMA approach. The findings indicated that big data analysis can enhance auditing tasks and improve information reliability by handling large volumes of data accurately. However, it is important to

consider qualifications and adhere to international auditing standards when using big data analysis in audits. It highlights enhanced auditing tasks, and improved information reliability. A comprehensive literature review examined reputable journal publications from 1990 to 2023, covering various categories and themes. Limited empirical studies on big data's significance in financial auditing exist due to incomplete disclosure by auditing companies. This article promotes research in multiple domains of big data analysis for auditing organizations.

This remainder of this paper is organized as follows: Section 2 describes our SLR approach for the 97 research outcomes. Section 3 discusses the significant achievements regarding the role of big data analysis and financial audits was covered through big data analysis (Section 3.1), and the financial audit data analytics (Section 3.2). After that section 4 represents summary of findings. Finally, the conclusion summarizes our main accomplishments, limitations, implications and suggests future research directions for big data analysis in financial audits.

METHODOLOGY

This study embraced a systematic strategy to carry out a literature review to reduce prejudice and provide its findings with scientific validity. To reduce bias and ensure scientific validity, this study used a methodological strategy to conduct a literature review. We drew from previous literature on auditing (Bellucci et al., 2022; Massaro et al., 2016; Denyer and Tranfield, 2009) obvious, comprehensive, informative, and intuitive essentials to maintain the integrity of our approach. In order to help authors in improving the systematic reviews documentation, we disclosed our analytic processes using Ms. Office package in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). PRISMA is a reporting process for systematic reviews that was created through the life sciences sector to improve the translucence and precision of the literature reviews. It consists of a checklist and a flow chart (Page et al., 2021). PRISMA was chosen over the other current protocols because of its generalizability, widespread usage across many fields (e.g., medicine and health), and capability to boost the uniformity of reviews (Pahlevan-Sharif et al., 2019).

Planning Design

Throughout the study, we adhered to the guidelines set forth by Jesson et al. (2011), which included the following steps:

- Defining the research question
- Designing a plan;
- Conducting a Literature Search
- Using exclusion and inclusion criteria
- Undertaking the quality estimation; and
- Discussion of the Findings.

Accordingly, to gather pertinent literature from multiple sources, a thorough study was conducted with the following aims and objectives.

1. Gain an overview of big data analysis in the context of financial auditing.
2. Outline the role of big data analysis in financial auditing as well as future research objectives.

Defining The Research Questions

Research questions that specify the topic, goal, and context of a study guide the systematic review process (Booth et al., 2012). Consequently, the researchers determined the subsequent study inquiries:

- Q1.** What are the latest studies on big data analysis in financial auditing?
- Q2.** What is the role of Big Data analysis in financial auditing? Does big data analysis affect audit supply? How? Does it affect audit quality? What about audit fee? Recognize whether clients respond to big data analysis and what was the nature of their responses?
- Q3.** What are the future research directions regarding big data analysis for financial auditing?

While Q2 clarifies our extra aim to examine practical and academic aspects, Q1 and Q3 state the primary objectives of the systematic review procedures connected to the study.

Doing A Literature Search

After defining the research questions, the systematic literature review went through sequential procedures used to guide the conduct of research, as shown in Table 1.

Table 1: SLR Procedures Using PRISMA Schedule

No.	Procedure	Papers regarding “Big Data Analysis and Financial Auditing” published among 1990 and 2023
1.	Searching criteria with “keywords”	Big Data Analysis, Audit Data Analytics, Financial Auditing, Audit Supply, Audit Quality, Audit Fees.
2.	Choose databases and conduct searches	Google Scholar, Scopus, and Web of Science.
3.	Selected documents	English-language publications, in trustworthy sources, and included big data analysis and financial auditing.
4.	Combine resources	Evaluation of the listed publications thoughtfully.
5.	Advertise review outcomes	Results are based on the compilation of information or the most recent evidence from the results of multiple independent studies, which can help with practices based on proof.

Using The Criteria of Exclusion and Inclusion

The three components of the search approach are keyword identification, screening, and eligibility. The research topic served as the foundation for the selection of keywords: Big Data Analysis, Audit Data Analytics, Financial Auditing, Audit Supply, Audit Quality, and Audit Fees were the keywords chosen for this review. This study searched Google Scholar, Scopus, and Web of Science for studies on the role of big data analysis in financial auditing. The databases were chosen based on access rights, availability, and references listed in papers published during the specified interval that dealt with big data analysis and financial auditing. Additionally, the chosen databases made a significant number of peer-reviewed articles available in the research field. The search criteria are listed in Table 1. The inclusion criteria were as follows:

1. Research on Big Data Analysis in the Reality of Financial Auditing
2. Research released in 1990 and 2023.
3. Research released in English.
4. This research has been reported in one of the most reputable and referenced publications.

Further documents that did not fulfill these requirements were disqualified. Table 1 and Figure 1 provide an overview of the systematic literature review method utilizing PRISMA.

Undertaking The Quality Estimation

In a systematic literature review, the initial abstract of each study was investigated, and the details of each study were analyzed to acquire a greater understanding of the review's goal. The major findings from each research were then documented and utilized in the creation of a systematic literature review (Page et al., 2021). Since big data analysis is a relatively new research area, we decided to include conference proceedings and book chapters in addition to the publications. The exploration and mining of the study data were performed in one of the four stages:

1. Publications can be found by researching online databases for the terms "big data analysis," "audit data analytics," "financial auditing," "audit supply," "audit quality," or "audit fees." Additionally, duplicate entries were deleted.
2. We carefully examined the headlines, abstracts, keywords, and, if needed, the content of the publications to identify those that should be deleted due to irrelevance (Booth et al., 2012).
3. Exclusions were made with good justification after eligibility was determined by a full-text evaluation of the papers.
4. For a thorough analysis, publications with cross-references were screened, and the ultimate choice of publications to be considered for the systematic review was determined.

The redundant publications were excluded from the analysis. The abstracts and titles of the study papers were carefully examined for their appropriateness. Additionally, the reference lists of publications that had already been chosen were

searched for additional pertinent research. The selected publications were investigated. According to the justifications and conclusions employed in each study, the selected publications were categorized into two groups: the first was divided into two parts and the second into three parts.

The Diagram Of PRISMA

The significance of big data analysis in audits was highlighted by a systematic review. Figure 1 illustrates the procedures used when utilizing a PRISMA diagram that we modified to better match a qualitative systematic review (Page et al., 2021). Information flow across the various stages of a systematic review was depicted in the PRISMA flowchart. It depicted the number of documents that were found, included, excluded, and explanations for exclusions.

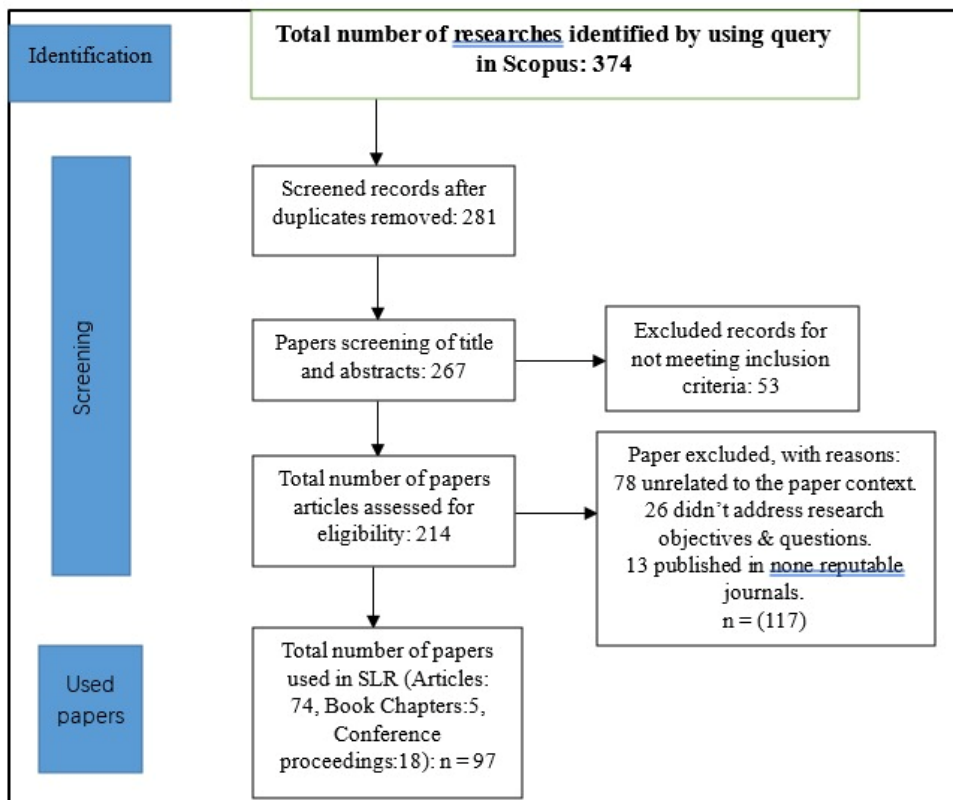


Figure 1: PRISMA chart of the systematic review procedure

Details of the Presented Publications

Finally, the selected publications were evaluated in light of the aims of the systematic review. A total of 97 papers from reputable databases that had undergone a peer review met these requirements. The overall number of pertinent articles is presented according to the sources in Table 2.

Table 2: Articles illustrated in the systematic review

Source	Number of concerning studies
Scopus and Web of Science	47
Google Scholar	50
Total publications	97

The search resulted in a total of 374 publications (from 1990 to 2023) from March 2022 to July 2023 as a work period. Scopus and Web of Science findings included forty-seven articles, and the remaining fifty articles were from Google Scholar. There were seventy-four publication research reports, eighteen papers of conference articles, and five book series chapters.

ANALYSIS OF LITERATURE REVIEW

This study focused on the role of big data analysis in financial auditing. Furthermore, two main big data analysis issues, were appropriate according to the prior related literature, which is represented in Figure 2 The given framework consisted of two levels: big data analysis and financial audit data analysis. The objective of this framework was to explore how big data analysis influences the components of financial audits. Therefore, the current study was an endeavor to accomplish this gap.

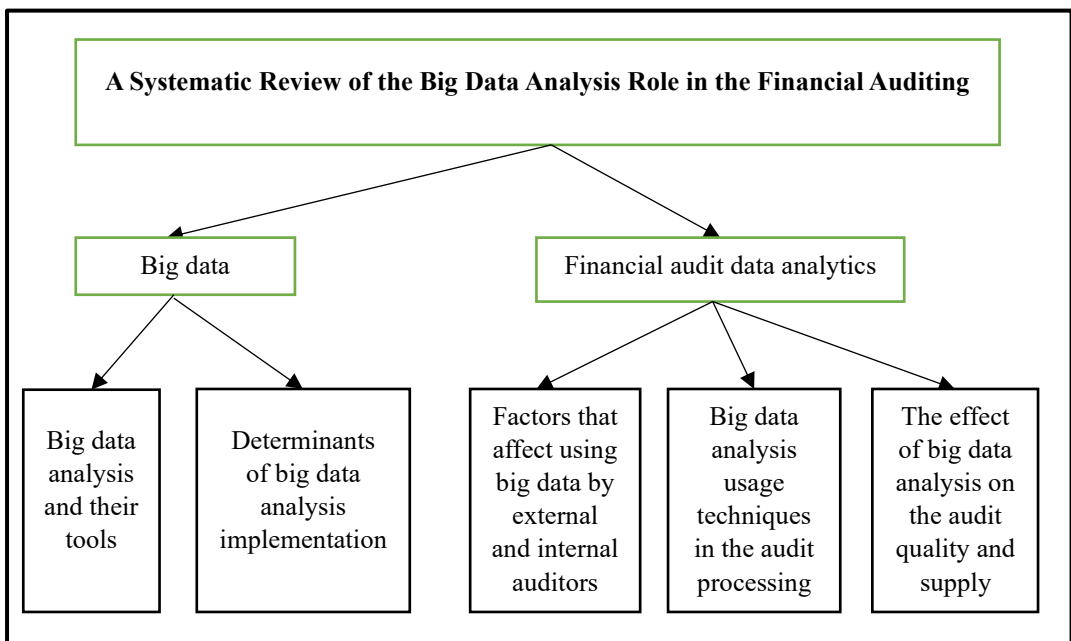


Figure 2: Conceptual framework

Big Data Analysis

Big data analysis and their tools

Big data analysis transforms raw data into valuable insights for decision-making (Cao et al., 2015). It encompasses the data's potential, values, and goals (Markus and Topi, 2015). Researchers explore its application in audits, considering advantages, challenges, and the need for adapting professional standards (Tang and Karim, 2017). Big data is prevalent in society, seen in IoT products, smart cars, social networking, and enterprise apps. Key industries like finance, banking, insurance, telecom, and healthcare heavily invest in big data tech for tasks like fraud detection, risk assessment, and customer support (Arena and Pau, 2020). Big data analysis acquires and analyzes large volumes of data for actionable insights. It drives changes in data processing and utilization, while "massive data" refers to substantial amounts of structured or unstructured data that can be mined (Sharma, 2018).

Big data and IoT revolutionize learning for personalized education (Hassaneen, 2020). Analyzing big data benefits large companies with a comprehensive view, improved understanding of actions, and enhanced performance (Amerhom, 2020). Shortage of skilled experts hampered big data adoption in Qatar. Collaboration between institutions and stakeholders is crucial to identify skills and provide training resources (ICT, 2014). Tech advancement and data growth presented challenges in managing and applying data. Robust systems are needed for national goals (24th SLA/AGC). Big data enhanced services, but shortages in resources and training persist (Al Muzain, 2019). Sultan Qaboos University libraries faced fulfillment and constraint issues. Employees, including managers, require skills in tools, privacy, access, distinction, and analysis. Training is crucial (Abdullah and Al Hinai, 2018). Big data is crucial for efficiency and quality in all industries. Arab nations should adhere to information assurance policies for innovation and development. It enables informed decision-making, adds value, and aids progress monitoring and equitable development (Meguenani and Mokadem, 2019). Companies face data storage and utilization challenges, requiring solutions for maximum benefits (Fatiha and Rashid, 2019).

The growing data volume in the big data era poses audit challenges (Tian, 2020). Big data was applied to various disciplines, including risk-based auditing (Qiuju, 2020). Big data analysis enhanced auditors' capabilities by analyzing structured and unstructured data (Richins et al., 2017). Audit technology was average, but expectations included improved prediction and analysis. The auditing profession was evolving with new technologies, maintaining quality standards while adapting to the market (Cristea, 2021). The audit industry faced complex legitimization for big data analysis, led by Big Four firms. Lack of standards and negative perceptions hindered acceptance (De Santis and D'Onza, 2021). Key themes in audit evolution included digital inclusion, showcasing processes, online reports, and ongoing audits (Ageeva et al., 2021). Rapid big data growth requires national plans, highlighting untapped opportunities. Shortages in expert systems emphasized the need for data specialists. The study showed significant commercial value, varying with analysis methods (Alaklabi, 2017).

Ongoing auditing used digital tools for efficient analysis. Auditors utilized specialized software for large dataset reviews (Hazar, 2021). Generalized auditing software served multiple purposes, including population evaluation, transaction identification, fraud risk assessment, control evidence gathering, and group selection (Smidt et al., 2019). Big data analysis, robots, and AI enhanced audits by freeing auditors for critical decision-making (Kend and Nguyen, 2020). Blockchain has implications for audits, cybersecurity, and accounting (Demirkan et al., 2020). Visual dashboards aided communication and justification. Also, big data transforms worked in audit companies (Salijeni et al., 2021). Auditors prioritized post-COVID tech adoption for transparency (Sharma et al., 2022).

The systematic literature review, demonstrated the transformative potential of big data analysis in auditing, enabling informed decision-making through valuable insights from raw data. Despite challenges, such as the growing data volume and acceptance hurdles, the auditing profession must adapt to new technologies while upholding quality standards. Big data analysis enhances auditors' capabilities and utilizes specialized software and digital tools for efficient analysis. The integration of robots, AI, and blockchain technology in audits presented implications for cybersecurity and accounting. The review emphasized the importance of data specialists, ongoing audits, and technology adoption for transparency. Overall, this research contributes to understanding the role of big data analysis in enhancing audit processes, decision-making, and the effectiveness of the auditing profession.

- Supposition 1: Big data analysis has the potential to significantly enhance audit quality and effectiveness.
- Supposition 2: The adoption of big data analysis in the audit industry is hindered by challenges such as data volume, lack of standards, and negative perceptions.
- Supposition 3: The integration of advanced technologies, such as robots, AI, and blockchain, can revolutionize the auditing profession and improve cybersecurity and accounting practices.
- Supposition 4: The role of data specialists is critical in effectively implementing big data analysis in auditing.
- Supposition 5: Ongoing auditing, supported by digital tools and specialized software, can enhance efficiency and decision-making in audits.

Determinants of big data analysis implementation

Big data analysis drove new audit technologies, ensuring comprehensive coverage (Xu et al., 2020). Its extensive use impacted national operations and the development of the audit sector (Jiang, 2020). It enhanced accounting abilities and required adaptation from standard setters, teachers, and professional organizations (Richins et al., 2017). Auditors faced information overload, but big data analysis

reduced cognitive errors and aids data interpretation (Ahmad, 2019). Auditors need big data analysis and technology for efficient performance. Stakeholders emphasized using audit data analysis to address the expectation gap in risk disclosure (Michael and Dixon, 2019). However, Portuguese auditors showed reluctance toward adopting big data (Maldonado et al., 2020).

Auditing focused on data analysis and explored advanced methodologies for big data audits (Zhang, 2021). The audit profession was gradually adapting to big data analysis (Joshi and Marthandan, 2020). Accounting expertise has transitioned to electronic systems, moving toward smart accounting (Wang, 2020). Auditors should embrace AI to enhance business effectiveness. However, the use of big data in auditing is still in its early stages, requiring further exploration and adaptation. Advancements in network computing systems will impact auditing informationization, prompting auditors to adopt new mindsets and procedures (Qiu and Xu, 2020).

The TOE framework analyzed program and system implementation in various industries (Ramdani et al., 2009). It considered environmental, organizational, and technological factors in technology adoption (Thong, 1999). Factors like auditing procedures, internal control systems, working style, and audit committees influenced external audit reliance on big data analysis (Zhu and Kraemer, 2005). Figure 3 clarify the TOE guidelines assist auditing companies in assessing acceptance of big data analysis, considering organizational, environmental, and technological contexts (De Pietro et al., 1990).

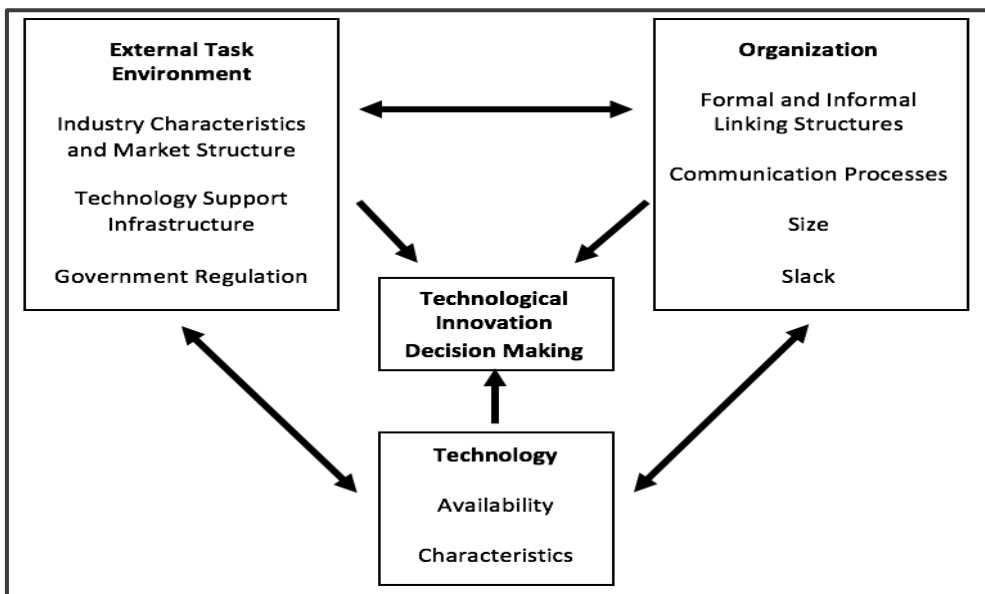


Figure 3: TOE framework Source: De Pietro et al. (1990, P. 153)

Big data audits advanced informationization and ensured comprehensive coverage. They relied on significant technologies for data analysis across multiple entities, integrating fieldwork with operational platforms and utilizing auditing management portals (Zhang et al., 2020). IT usage varied between Big Four and non-Big Four firms, based on the customer's technological level (Tarek et al., 2017). Difficulties in adopting to big data hindered its widespread use (Patel and Shah, 2023). Factors influencing the adoption of data analytics in audit practice included reliance on IT specialists, auditor skills and knowledge, data storage for audit trails, and quality controls (Jacky and Sulaiman, 2022).

The systematic literature review yielded valuable insights for the field. Big data analysis drove the development of new audit technologies, enhancing accounting abilities and improved performance by reducing cognitive errors. Stakeholders emphasized the importance of audit data analysis in addressing the expectation gap in risk disclosure. However, there are challenges in adopting big data, as exhibited by Portuguese auditors. The audit profession is gradually adapting to big data analysis and exploring advanced methodologies. The TOE framework provides a valuable framework for understanding the adoption of big data analysis in audits. Big data audits contribute to informationization and rely on significant technologies for data analysis. IT usage varies between firms, and challenges in adopting big data hinder its widespread use. Factors influencing data analytics adoption in audits include IT reliance, auditor skills, data storage, and quality controls. The review contributes to the field by highlighting challenges, adaptations, and the importance of considering various factors in the implementation of big data analysis in audits.

- Supposition 1: Big data analysis has the potential to significantly transform the audit profession by driving the development of new audit technologies and enhancing accounting abilities.
- Supposition 2: Auditors who embrace big data analysis and technology are likely to achieve more efficient performance and reduce cognitive errors associated with information overload.
- Supposition 3: Stakeholders emphasize the importance of using audit data analysis to bridge the expectation gap in risk disclosure, highlighting the value of incorporating big data analysis into audit processes.
- Supposition 4: The adoption of big data analysis in auditing is still in its early stages, indicating the need for further exploration and adaptation to fully realize its potential.
- Supposition 5: The transition toward electronic systems and smart accounting suggests that auditors should embrace artificial intelligence to enhance business effectiveness and keep up with technological advancements.

- Supposition 6: Factors such as auditing procedures, internal control systems, working style, and audit committees play a significant role in influencing the extent to which auditors rely on big data analysis in external audits.
- Supposition 7: Difficulties in adopting big data hinder its widespread use in the audit profession, highlighting the challenges that auditors and organizations face in implementing and accepting big data analysis.
- Supposition 8: Factors influencing the adoption of data analytics in audit practice include the reliance on IT specialists, auditor skills and knowledge, data storage capabilities for audit trails, and the implementation of quality controls.

Financial Audit Data Analytics

Factors that affect using big data by external and internal auditors

The integration of auditing with information characteristics in the Internet era emphasized the importance of information auditing. Advanced auditing technologies played a crucial role in this transformation, requiring auditors to possess strong IT knowledge (Lin, 2021). Categorizing big data enhances audit efficiency and effectiveness (Krieger and Drews, 2018). Krieger et al. (2021) stressed the significance of audit firms' technical capacity for data analysis. Efficient utilization of big data requires skills in questioning, critical thinking, comprehension, analysis, and communication. These skills were emphasized in accounting education programs, with more focus on questioning, comprehension, and analysis rather than communication and critical thinking (McBride and Philippou, 2021).

External auditing's adoption of data analytics was influenced by multiple factors, including the audit profession, technology, organizational structure, and client considerations (Jacky and Sulaiman, 2022). However, firms may choose to reduce audit expenditures, potentially compromising overall audit quality (Eulerich et al., 2022). The accountancy profession faced challenges in hiring technology-proficient staff due to high demand and competition in other fields (Christ et al., 2021; Eulerich et al., 2022). External auditors prioritized value addition to organizations and regulatory compliance, with big data analysis being an option (Dagilienė and Klovienė, 2019). They also strove to improve audit quality, effectiveness, efficiency, and cost reduction through the integration of big data analysis methods (Serag and Aqiliy, 2020). Continuous internal audit and monitoring techniques need to demonstrate their benefits more fully. Big data possessed opportunities and challenges for auditors and accountants, necessitating the acquisition of new analytical skills (Joshi and Marthandan, 2020).

In the era of big data, internal auditing has become a crucial responsibility, requiring the development of robust systems to leverage big data for risk reduction and improved efficiency (Lin and Huang, 2020; Wang, 2020). The use of big data

analysis in internal audits enhanced efficiency and calls for advanced analytical technology (Sihem et al., 2023). Professional credentials and data analysis were valued in internal audit tasks, with a significant allocation of budget for data analysis (Tang et al., 2017). Data quality in internal audits relied on data size and auditors' qualifications (Popa and Păun Năstase, 2018). Despite the widespread use of information technology and big data, internal auditors had limited adoption of generalized auditing software, including in Australia (Smidt et al., 2019). Big data possessed significant organizational challenges, driving the need for improved data processing and decision-making. Internal auditors must stay updated with technology advancements and address data quality, security, and technical support issues (Vieira et al., 2017).

In summary, the review provided valuable insights into the integration of auditing with information characteristics in the Internet era. The findings underscore the importance of auditors possessing strong IT knowledge, categorizing big data, and acquiring a diverse skill set. They also revealed challenges and considerations in the adoption of data analytics in both external and internal auditing, and the need for improved data processing, decision-making, and skills acquisition. By addressing these findings, auditors and accountants can effectively leverage big data for enhanced audit quality, efficiency, and risk reduction in the rapidly evolving landscape of the digital age.

- Supposition 1: Categorizing big data in auditing processes will lead to improved audit efficiency and effectiveness.
- Supposition 2: Audit firms with strong technical capacity for data analysis will be more successful in leveraging big data for audit purposes.
- Supposition 3: Accounting education programs that emphasize a diverse skill set including questioning, critical thinking, comprehension, analysis, and communication will better prepare auditors for working with big data.
- Supposition 4: The adoption of data analytics in external auditing will be influenced by factors such as the audit profession, technology availability, organizational structure, and client considerations.
- Supposition 5: Firms that prioritize cost reduction in audits may compromise overall audit quality, potentially hindering the adoption of data analytics.
- Supposition 6: The demand for auditors with strong IT skills will create challenges in recruiting technology-proficient staff for the accountancy profession.
- Supposition 7: The integration of big data analysis methods in auditing practices will lead to improved audit quality, effectiveness, efficiency, and cost reduction.

Supposition 8: Internal auditors will need to acquire new analytical skills to effectively utilize big data for risk reduction and improved efficiency.

Big data analysis usage techniques in the audit processing

Implementing big data technologies in auditing faced challenges, but knowledge graphs offered viable solutions for data fusion and efficient retrieval in audits (Liu et al., 2020). Computerized audits effectively detected errors and enhanced outcomes, highlighting the need for monitoring analytics in the big data era (Jiang, 2021). Integrating data presentation and analysis improved auditors' decision-making, while insufficient integration remained an issue (Hamdam et al., 2021). Streamlining audits can be achieved through trusted custodians with verified data custody (Wang et al., 2016). Auditors' engagement with big data included identifying risks, understanding the organization to detect misrepresentations (ISA 315), assessing financial statement fraud risks and conducting fraud tests (ISA 240), performing analytical procedures based on risk assessment, and using big data for overall audit conclusions (ISA 520) (Cao et al., 2015).

Researchers identified driving factors (company-regarded and foundational) for using big data analysis in audits, emphasizing the interaction between audit firms, corporate clients, and regulators (Dagilienė and Klovienė, 2019). Big data technology improved audits by combining learning capabilities and automation, offering a comprehensive view of the situation and enhancing risk assessment. The study proposed a framework that integrated auditing processes with big data approaches, mapping data sources to the risk assessment stage (Yudowati and Alamsyah, 2018). For identifying risks, the big data framework method offered a thorough insight of the entity and its environment which can be illustrated as in Figure 4.

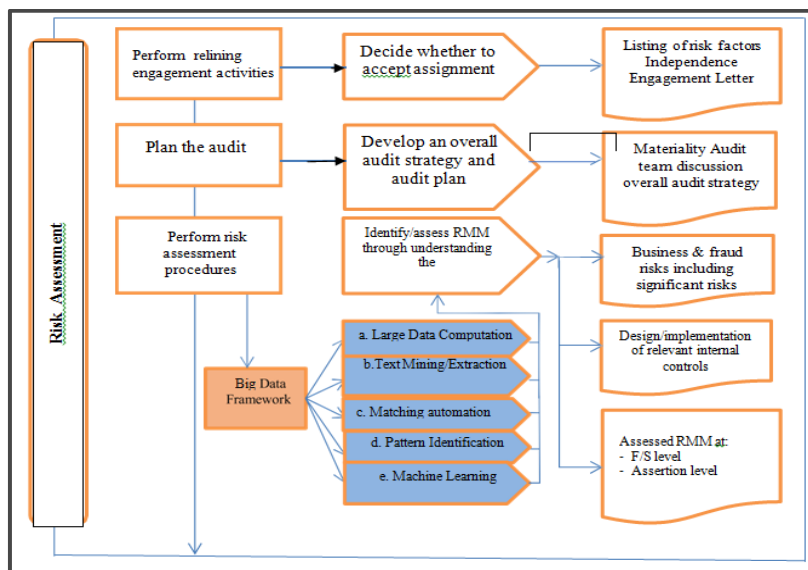


Figure 4: Diagram of the audit procedures following the implementation of big data (Yudowati & Alamsyah, 2018)

Figure 4 demonstrates how big data is applied in risk-based auditing, particularly during the risk evaluation phase. The auditor assessed and analyzed the organization being audited, investing additional time for better understanding. Subsequently, the organization is re-audited (Yudowati and Alamsyah, 2018). Big data analysis was employed for audit evidence and fraud detection. Audit data analytic tools were commonly used for anomaly identification and management assertion testing. Auditors perceived the integration of audit data analytics technologies as enhancing auditing effectiveness (Sanoran and Ruangrapun, 2023).

Auditing Standards Statement No. 80 emphasized the need for combining IT regulation examinations with thorough testing for auditing purposes when clients heavily rely on IT (ASB, 1996). Auditors faced challenges in identifying trends in big data representations compared to traditional audit evidence. They showed less interest in big data representations when examined before analyzing conventional audit evidence, and conflicting trends raised concerns about potential misleading statements (Rose et al., 2017).

Data analysis positively impacted audit evidence collection. KPMG was advised to embrace data analysis to address implementation challenges fully (Wadesango et al., 2021; Newman et al., 2021). It improved audit evidence collection and compliance with auditing standards. By replacing manual techniques with data mining, audit opinions became more reliable, and handling mining enabled auditors to keep up with technological advancements (Werner et al., 2021). Big data analysis automated auditing practices and expanded the evidentiary scope (Salijeni et al., 2021). However, it may not significantly increase confidence levels compared to traditional audit procedures (Barr-Pulliam et al., 2021).

The current audit methodology lacked efficient use of unstructured data, requiring improvement. Incorporating big data analysis enhanced findings and communication during brainstorming sessions. Auditors should employ big data techniques throughout the analysis phase (data gathering, aggregation, fraud detection, group sessions, findings, and reporting) (Tang and Karim, 2019). Skills in auditing, victimology, criminology, psychology, communication, and ICT aided in fraud detection, while investigatory, legal, and accounting skills were less crucial. Certain abilities proved more beneficial post-deception. Certain abilities gain value post-fraud discovery (Fadilah et al., 2019). Auditors' intentions to use computer-based audit technologies in Malaysia were influenced by performance, effort expectations, and enabling factors (Mohamed et al., 2019). These technologies enhanced fraud detection and improved audit operations (Widuri and Gautama, 2020).

The analysis of results revealed challenges in implementing big data technologies, such as data fusion and efficient retrieval, but suggested solutions like knowledge graphs. The importance of monitoring analytics for error detection and the need to streamline audits by improving data presentation and analysis integration were emphasized. Driving factors for using big data analysis in audits and a proposed framework for integrating auditing processes with big data approaches were identified. Application in risk-based auditing involved employing big data analysis during the risk evaluation phase for a comprehensive view and improved fraud

detection. Challenges in identifying trends in big data representations, the need for better utilization of unstructured data, and the significance of employing big data techniques throughout the analysis phase were recognized. Skills in various disciplines and factors influencing auditors' intentions to use computer-based audit technologies were highlighted. Overall, the findings contributed to enhancing audit quality, fraud detection, and auditing effectiveness through the effective utilization of big data.

- Supposition 1: The integration of knowledge graphs in auditing can address challenges related to data fusion and efficient retrieval, improving the effectiveness of big data technologies in audits.
- Supposition 2: Incorporating monitoring analytics in the big data era enhances error detection and audit outcomes, suggesting that auditors should prioritize the adoption of such technologies.
- Supposition 3: The insufficient integration of data presentation and analysis indicates a need for improved methodologies and tools to streamline audits and enhance decision-making.
- Supposition 4: The proposed framework that integrates auditing processes with big data approaches can improve risk assessment in audits, providing a more comprehensive understanding of the organizations being audited.
- Supposition 5: Auditors face challenges in identifying trends in big data representations compared to traditional audit evidence, suggesting the need for methodologies and techniques that facilitate the interpretation of big data trends.
- Supposition 6: Embracing data analysis and leveraging data mining techniques can improve audit evidence collection, making audit opinions more reliable and enabling auditors to keep up with technological advancements.
- Supposition 7: The efficient use of unstructured data and the incorporation of big data analysis throughout the audit analysis phase can enhance findings, communication, and the effectiveness of brainstorming sessions.
- Supposition 8: The development and utilization of a diverse skill set encompassing auditing, victimology, criminology, psychology, communication, and ICT can aid auditors in fraud detection and investigation.
- Supposition 9: Factors such as performance, effort expectations, and enabling factors influence auditors' intentions to adopt computer-based audit technologies, indicating the importance of addressing these factors to promote technology adoption in audits.

The effect of big data analysis on the audit quality and supply

The International Audit and Assurance Standards Board (IAASB) investigated auditors' use of data analysis to improve audit quality and distribute best practices. Growing client demand for data analysis in audits drove audit firms to promote big data analysis, enhancing trust and adding value to clients (IAASB, 2016). AI challenges and benefits accounting firms. To adapt, they must integrate AI and auditing theory, enhance big data utilization, and expand information system implementation. This improved audit effectiveness, quality, and firm growth (Zhou, 2021). Computer audit tech in big data environments enhanced efficiency and widened public procurement audits (Zhang et al., 2018). Embracing new tech reduced tax evasion risks and boosted auditors' productivity (Atayah and Alshater, 2021).

Legal auditors use computer-based audit technologies for improved performance, efficiency, quality, and risk reduction. These technologies were essential for documentation, collaboration, and monitoring (Pedrosa et al., 2015). Big data adoption resolved auditing issues, allowing direct data collection and evaluation, and enhancing flexibility and efficiency (Zhu and Huang, 2019). However, big data analysis did not directly impact assurance standards or users' judgments on audit quality (Barr-Pulliam et al., 2021). Proficiency in data analysis was crucial for improving efficiency (Bender, 2017). Jacky and Sulaiman (2022) identified factors influencing data analysis usage in external auditing: utility, alignment with audit standards, data quality, auditors' abilities, client considerations, and costs. Corporate digitalization widened the quality gap between large and small audit firms, favoring bigger firms (Lugli and Bertacchini, 2022).

Audit data analytics benefitted quality and review continuity, acting as a cybersecurity moderator (Ditkaew and Suttipun, 2023). Data analytics enhanced audit effectiveness, efficiency, and material misstatement identification (Jacky and Sulaiman, 2022). COVID-19 accelerated technology adoption in auditing, previously limited to the Big Four and large organizations (Sharma et al., 2022). Technology-enabled stock auditing improved quality, requiring implementation guidelines (Christ et al., 2021). Nonstandard auditing hours correlated positively with clients' stock performance and Tobin's Q in subsequent years. This held true for clients audited by reputable auditors or those valuing high-quality audits. Even after considering accounting quality measures, this correlation remained valid. Surprisingly, investors may not fully recognize the value of audit efforts based on investment return assessments (Lee et al., 2021).

Considering the effect of big data analysis on the audit quality and supply, findings include the importance of meeting client demand, leveraging technology, and enhancing efficiency. Factors influencing data analysis usage, benefits of audit data analytics, and the impact of technology adoption on stock auditing were also highlighted. The review emphasized the significance of audit quality, productivity, and decision-making in the context of big data and technology. These insights contributed to the field by informing auditors, accounting firms, and regulatory bodies on how to enhance audit practices in the rapidly evolving landscape of big data.

- Supposition 1: Client demand and integration of big data analysis in auditing can enhance trust, add value, and improve audit outcomes.
- Supposition 2: Integration of AI, enhanced utilization of big data, and expanded information system implementation can enhance audit effectiveness, quality, and firm growth.
- Supposition 3: Adoption of computer audit technologies in big data environments can increase audit efficiency and widen audit coverage.
- Supposition 4: Factors such as utility, alignment with audit standards, data quality, auditors' abilities, client considerations, and costs influence the usage of data analysis in external auditing.
- Supposition 5: Corporate digitalization widens the quality gap between large and small audit firms, favoring larger firms.
- Supposition 6: Audit data analytics act as a cybersecurity moderator, contributing to audit quality and review continuity.
- Supposition 7: Adoption of technology-enabled stock auditing improves audit quality, requiring implementation guidelines.
- Supposition 8: Nonstandard auditing hours correlate positively with clients' stock performance, indicating the impact of high-quality audits by reputable auditors or valued by clients.

SUMMARY OF FINDINGS

This study examined the role of big data analysis in financial auditing and contributes to the existing literature. It highlights the benefits and challenges of adopting data analytics in auditing and introduces a unique methodology using renowned databases. The study sample included research articles published from 1990 to 2023. Our SLR analysis provided valuable insights into the transformative potential of big data analysis in auditing. It highlights the importance of auditors possessing strong IT knowledge, categorizing big data, and acquiring a diverse skill set. The review emphasized challenges and considerations in the adoption of data analytics in auditing and the need for improved data processing and decision-making. It also recognized the benefits of audit data analytics, the impact of technology adoption on stock auditing, and factors influencing data analysis usage. Overall, the findings contribute to enhancing audit quality, efficiency, and risk reduction through the effective utilization of big data.

CONCLUSION

The primary purpose of the current research is to observe the existing literature about the role of big data analysis in the financial auditing and to identify prospective areas for additional study, along with the opportunities and challenges it presents throughout thirty-three years. This study provided valuable insights into the potential of big data analysis to enhance audit quality and effectiveness. The review highlighted the transformative impact of integrating big data analysis in the audit profession, driving the development of new audit technologies and improving accounting abilities. It also emphasized the importance of auditors embracing technology and data analysis to achieve more efficient performance and reduce cognitive errors associated with information overload. Stakeholders recognized the value of incorporating big data analysis into audit processes to bridge the expectation gap in risk disclosure. However, challenges such as data volume, lack of standards, and negative perceptions hindered the adoption of big data analysis in the audit industry. The integration of advanced technologies, including robots, AI, and blockchain, has the potential to revolutionize the auditing profession and improve cybersecurity and accounting practices. The role of data specialists is critical in effectively implementing big data analysis, and ongoing auditing supported by digital tools and specialized software enhances efficiency and decision-making in audits. The review also highlighted the influence of factors such as auditing procedures, internal control systems, and organizational structure on the extent to which auditors rely on big data analysis in external audits. Further research is needed to explore and adapt the adoption of big data analysis in auditing fully. The transition towards electronic systems and smart accounting suggests the need for auditors to embrace artificial intelligence and keep up with technological advancements. The adoption of data analytics in audit practice is influenced by various factors, including the reliance on IT specialists, auditor skills, and knowledge. The review emphasized the importance of addressing challenges, promoting technology adoption, and considering various factors in implementing big data analysis in audits. Future research should focus on exploring the implications of big data analysis on audit quality, further investigating the challenges and barriers to its adoption, and examining the role of technology and data specialists in enhancing audit effectiveness.

Additionally, it is essential to explore the limitations of current audit methodologies in effectively utilizing unstructured data and to develop methodologies and techniques for interpreting trends in big data representations. This systematic literature review implications suggests that integrating big data analysis can enhance audit quality and effectiveness by utilizing advanced technologies and data analytics. Overcoming challenges and promoting the acceptance of big data analysis can lead to improved audit outcomes and increased efficiency. Developing data analysis skills and expertise within auditing teams is crucial for effectively implementing big data analysis in auditing. The study has limitations, which include the reliance on existing literature and potential publication bias. Future research should consider new developments and strive for standardized methodologies and larger sample sizes. Ethical and privacy implications of big data analysis in auditing

should be further explored, and guidelines for responsible data usage should be developed.

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