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Big Data Analytics in Auditing: A Review of Current Applications and Future Directions

Salsabeel Hani Almarafi*, Noor Afza Amran, Mohd Hadzrami Harun Rasit

Department of Accountancy, Universiti Utara Malaysia, 06010 Sintok Kedah, Malaysia

* Correspondence: Salsabeel Hani Almarafi (almarafisalsabeel95@gmail.com)

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Abstract: A bibliometric analysis was conducted in this study covering the period between 2015 and 2024 to establish a roadmap for big data analytics in auditing. Excel, RStudio, and R software were employed to analyse the performance, co-occurrences, citations, and authorship of 91 articles selected from the Scopus database. According to the acquired results and pertinent observations, 2022 was the most productive year with 21 publications. The *Journal of Emerging Technologies in Accounting* was the most prolific journal, with ten publications. Besides, a total of 40 articles originated from the United States, significantly surpassing the number of publications issued by other countries. These findings indicated a growing attention on research related to audit quality and big data analytics in auditing. This thorough review provided insights into the historical background and current status of data analytics and auditing, while identifying gaps that necessitated further academic inquiry. The study provided a performance analysis and described the evolution of a profession, functioning as a vital resource for researchers and professionals who aim to understand emerging research trends in the pursuit of future studies.

Keywords: Big data analytics; Auditing; Accounting; Bibliometric analysis; Auditors

JEL Classification: M42; C55; O33

1. Introduction

Big Data Analytics (BDA) has garnered significant interest worldwide, with numerous studies highlighting its impact (George et al., 2016; Sivarajah et al., 2017; Vassakis et al., 2017). The term "big data" (BD) has led to a profound transformation in corporate management, compelling businesses to reassess their strategies (Yoon et al., 2015). It presents opportunities to enhance various business processes (Tang & Karim, 2018). BDA has gained immense popularity across various industries, including business, government, science, and research (Ajana, 2015), as well as extending to auditing and accounting practices (Liu & Vasarhelyi, 2014; Moffitt & Vasarhelyi, 2013). BD refers to datasets that exceed the capabilities of most modern information systems and processing techniques (Fisher et al., 2012). Zhu et al. (2021) defined BDA as the methods, technologies, and application software utilised to evaluate massive and complex datasets to enhance organisational performance. Regulatory bodies are also keen to understand the role and potential impact of BDA on financial statement audits. The Association of International Certified Public Accountants (AICPA) released its guide on "Audit Data Analytics" (ADAs), which was defined as "the science and art of discovering and analysing patterns, identifying anomalies, and extracting other useful information in data underlying or related to the subject matter of an audit through analysis, modelling, and visualization for planning or performing the audit" (AICPA, 2017).

In this regard, BDA in auditing is driven by the potential to enhance audit quality and the practical need to handle vast amounts of accessible data (Wang & Cuthbertson, 2015). This paradigm shift emphasises the importance of External Audit Effectiveness (EAQ) and its impact on financial statement accuracy and fraud detection (Cao et al., 2015). In this context, integrating BDA throughout the audit process offers auditors numerous benefits, such as improved accuracy, efficiency, and scope (Álvarez-Foronda et al., 2023; Shabani et al., 2021).

By replacing traditional sampling methods with testing all transactions, auditors can achieve greater accuracy, thereby bridging the gap between their expectations and those of the public (Shabani et al., 2021). Moreover, using BDA streamlines audit processes, thus reducing work hours and enhancing efficiency and effectiveness (Álvarez-Foronda et al., 2023). Automation in audit procedures becomes more feasible, with "data analytics" as a precursor to full audit automation (Chan et al., 2018).

Despite the advantages of BDA, its integration poses several challenges for external auditors. Companies face significant costs due to the increasing complexity of BD, necessitating the hiring of data scientists and investments in new technologies (Brown-Liburd et al., 2015). The lack of audit standards and scepticism from audit authorities hinders the full legitimisation of BDA in auditing (De Santis & D'Onza, 2021). Additionally, addressing privacy and security threats in the digital ecosystem remains a pressing concern (La Torre et al., 2018). Given the rising complexity of data, academic institutions must equip students with the skills and abilities to effectively utilise analytics in auditing (Brink & Stoel, 2018). However, non-Big Four auditors may face limitations in adopting data analytics tools due to high costs and a lack of training (Sanoran & Ruangprapun, 2023).

BDA has garnered significant scholarly interest in the auditing field owing to its transformational effects on audit methodologies and decision-making processes (Sanoran & Ruangprapun, 2023; Wang & Cuthbertson, 2015). Nonetheless, despite the increasing interest, a thorough comprehension of the conceptual framework, research trends, and thematic development in this domain remains insufficient. Consequently, there is a scarcity of research that combines systematic literature reviews with bibliometric analysis to examine the scope and rigour of BDA and audits on a global basis, identify the most significant publications and authors, and reveal emerging themes that will inform future research directions.

Bibliometrics is the quantitative study of the creation, evolution, maturity, and consumption of scientific publications using statistical and mathematical methods. Accordingly, it has emerged as a crucial tool for evaluating and studying the state of growth of the research area in terms of the researcher's output (Ellegaard & Wallin, 2015). Recently, evaluating the state-of-the-art technology in a scientific field has gained considerable popularity, primarily due to advancements in computing and the Internet. Bibliometric analysis is a topic of much debate in the literature (Merigó & Yang, 2017). It is possible to obtain insights into the structure of the scientific field, social networks, and thematic interests by combining and analysing these data. Bibliometric analysis is growing in popularity (Zupic & Čater, 2014). Performance analysis and scientific mapping are two types of bibliometric analysis methodologies. While performance analysis considers the contributions of research parts, science mapping concentrates on their connections (Donthu et al., 2021).

This study aims to analyse the development and current state of research in the audit field and, more importantly, identify key areas that warrant further investigation to build a robust research foundation. The bibliometric analysis of BDA-related studies provides valuable insights into the scholarly landscape, enabling the identification of significant contributions and emerging themes that address the four research questions guiding this study:

RQ1. "What are the current trends in research publications on BDA and auditing?"

RQ2. "Who are the primary contributors (authors, publication venues, and nations) in BDA and auditing?"

RQ3. "What are the main aspects and principal topics examined in BDA and auditing research by different scholars?"

RQ4. "What are the study gaps and potential directions for future investigation in the field of BDA and auditing?"

The paper was organised into five principal sections. Section 2 delineated the methodologies for data gathering and bibliometric analysis. Section 3 delineated and examined the principal conclusions derived from diverse analytical parameters. Section 4 subsequently consolidated the findings by discussing the study's shortcomings and delineating prospective directions for further research. Ultimately, Section 5 discussed the practical implications obtained from the findings.

2. Research Methodology

2.1 Search Strategy

The first phase of the current research involves identifying relevant articles that discuss the relationship between BDA and auditing. This process required multiple steps, including defining databases, identifying keywords, eliminating duplicate articles, and aligning titles, abstracts, and key findings. According to Carvalho et al. (2019), the phases were prevalent in various frameworks that served as guidelines for systematic literature reviews. The significant journal database, Scopus, was utilised in this study, as it contains the most pertinent scientific publications. The search strategy approach is the primary determinant of the efficacy of the current analysis. Thus, when the database to be utilised was chosen, a successful search technique was developed based on the features of the database (Mishra et al., 2023).

2.2 Search Delimiting Criteria

The search terms employed were "audit* and BDA", "audit analytics*", and "data analytics". The search

encompassed articles, abstracts, and keywords on the Scopus platform. "In the Scopus database, on 7 January 2025, a total of 320 documents were found, which were limited to subject areas of 'Business, Management, and Accounting', 'Economics and Finance'; by 'conference paper' and 'articles'; (TITLE-ABS-KEY (audit*) AND ('data analytics' OR 'bigdata' OR 'BD' OR 'audit BDA') AND (LIMIT-TO (SUBJAREA, 'BUSI') OR LIMIT-TO (SUBJAREA, 'ECON')) AND (LIMIT-TO (DOCTYPE, 'ar') OR LIMIT-TO (DOCTYPE, 'cp')) AND (LIMIT-TO (LANGUAGE, 'English'))), resulting in 83 documents. However, after manual filtration, 91 documents were found as shown in Table 1".

Table 1. Main information on the data

Description	Results
Timespan	2015–2024
Papers	91
Citations	3,535
Years	10
Cites_Year	353.5
Cites_Paper	38.85
Cites_Author	1,520.25
Papers_Author	39.03
Authors_Paper	2.87
*h*_index	26
*g*_index	59
Sources (Journals, Books, etc.)	55
Documents	91
Annual Growth Rate (%)	5.15
Document Average Age	4.24
Average Citations Per Doc.	38.85
References	4,647
Keywords Plus (ID)	124
Author's Keywords (DE)	272
Authors	225
Authors of Single-Authored Docs	9
Single-Authored Docs	9
Co-Authors Per Doc	2.87
International Co-Authorships (%)	17.58
Articles	83
Conference Papers	5
Reviews	3

2.3 Paper Selection with Inclusion/Exclusion Criteria

Figure 1 provides a detailed summary of the inclusion and exclusion criteria applied in the bibliometric analysis focusing on auditing and BDA. An initial search in the Scopus database using the predefined keywords identified 1,013 records. During the screening phase, 457 records were excluded as they were unrelated to auditing or BDA. The dataset was then limited to studies within the subject areas of business, management, accounting and economics, econometrics, and finance.

Following this refinement, 167 records were removed based on document type, leaving only journal articles, review papers, and conference papers. The search was further restricted to publications written in English and published between 2015 and 2025, leading to the exclusion of an additional 306 papers. After a manual relevance screening, 83 papers remained. An additional eight (8) papers were identified through reference searches, resulting in a final dataset of 91 relevant publications.

Figure 1 summarises the entire workflow from the initial search to the final inclusion stage. These 91 academic papers on BDA and auditing (2015–2024) were subsequently analysed using RStudio, R software, VOSviewer and Microsoft Excel. The following section shows the findings using graphs, tables, and network visualisation derived from the investigated parameters.

Table 1 summarises the leading bibliometric indicators extracted from the dataset. The review spanned a decade from 2015 to 2024 and incorporated 91 papers from 55 different sources, reflecting an expanding and varied interest in BDA and auditing. These papers garnered a total of 3,535 citations, yielding an average of 38.85 citations per paper, indicative of a moderate-to-high impact level of research activity in this field. The annual growth rate of 5.15% indicated a consistent rise in publication patterns, along with the increasing academic focus on digital auditing technology. The *h*-index of 26 and *g*-index of 59 indicated a considerable number of works that have garnered significant recognition, thus underscoring the academic maturity in the area.

The dataset comprised 225 contributing authors, averaging 2.87 co-authors per document, and an international

co-authorship rate of 17.58%, thus indicating the collaborative and transnational character of this study domain. The prevalence of multi-authored articles (91%) relative to single-authored works (9%) signified that research in BDA and auditing frequently necessitated interdisciplinary collaboration. In terms of document types, 83 journal articles constituted the predominant category of contributions, followed by five (5) conference papers and three (3) review articles, indicating that the subject has been predominantly examined through empirical and applied research rather than conceptual analyses. The dataset included 272 author keywords and 124 Keywords Plus, offering substantial input for tracing topic progression in future investigations.

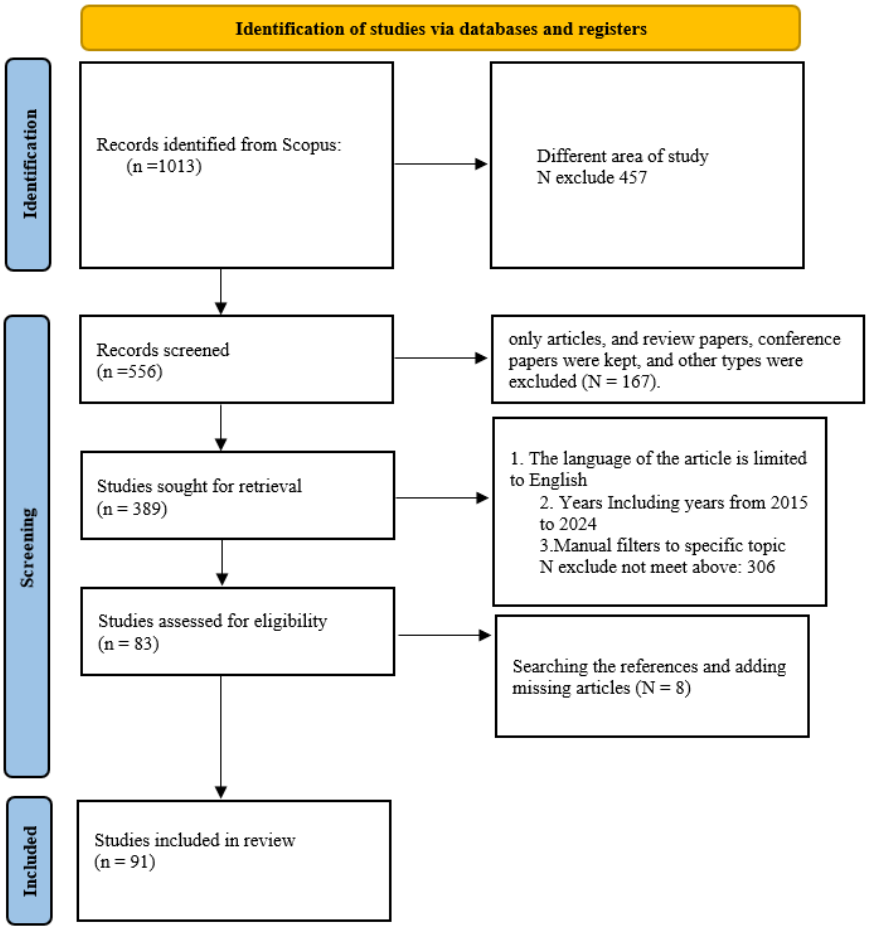


Figure 1. PRISMA structure
Source: Adopted from PRISMA 2020

3. Results and Discussion

3.1 Results of Performance Analysis

According to Figure 2, seven articles exploring the relationship between "audit and BDA" first surfaced in the academic literature in 2015, when researchers in the United States released the first paper titled "BDA in financial statement audits".

In 2016 and 2017, three papers were published yearly, and this trend appeared to be unexpected. The publishing trend continued to rise until 2018 and 2019, during which there was a notable surge in the number of publications (six and eight, respectively). After this era, the publishing pattern exhibited irregularity, with five publications recorded in 2020. There were 11 papers published in 2021, whereas the most productive year was 2022, with 21 publications. In 2024, the number of publications was 11, with expectations for further growth.

As illustrated in Figure 2, there was a noticeable increase in publications between 2021 and 2024, thus reflecting a surge in scholarly interest in BDA and auditing. The highest number of publications, 21 papers, was recorded in 2022, marking the peak of research activity during the study period. This upward trend indicates growing academic recognition of the importance of BDA in transforming audit practices, suggesting that new research streams and collaborations are emerging in this field. Given the increasing relevance of BDA to the auditing profession and its pivotal role in advancing the digital auditing era, continued research engagement in this area remains essential.

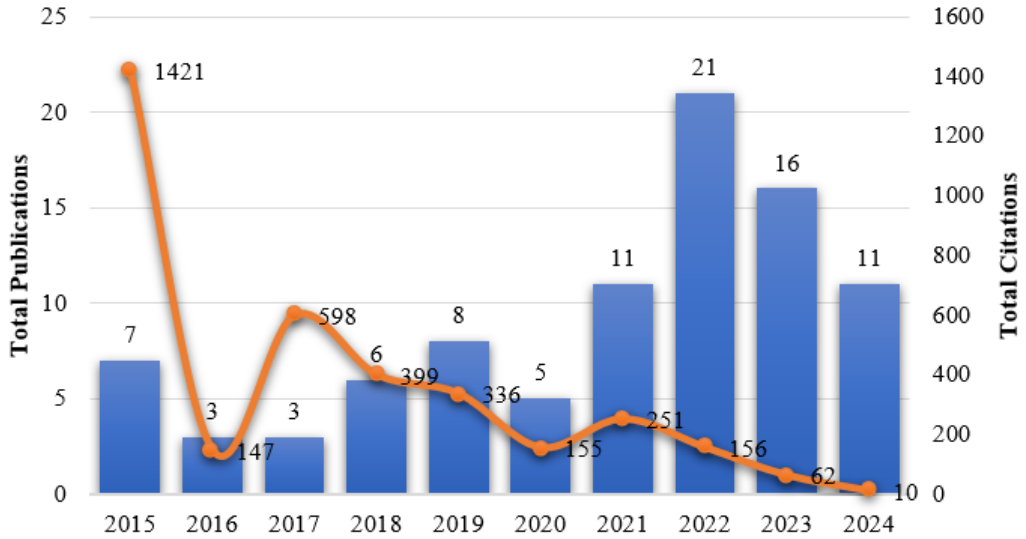


Figure 2. Growth trend of BDA and auditing research (2015–2024) (*n* = 91)

3.2 Prominent Citations by Author, Organisation, and Country of BDA and Auditing

3.2.1 The most publications by resources

Figure 3 illustrates the types of journals based on their volume of publications. The most prolific journal with ten publications is the *Journal of Emerging Technologies in Accounting*, followed by the *International Journal of Accounting*, which has eight publications. Seven articles were published in *Accounting Horizons* and four in the *Managerial Auditing Journal*. This distribution revealed that interest in BDA and auditing was primarily focused on journals that highlighted innovation and developing technologies in accounting. The significant volume of publications on these specialised channels indicated that the subject was in transition within conventional accounting journals, hence suggesting an emerging yet progressively expanding study domain.

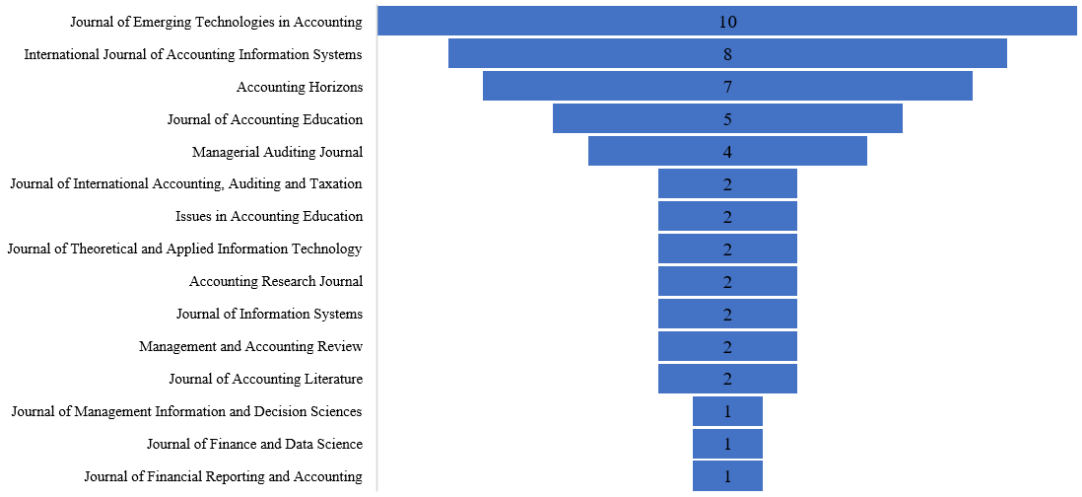


Figure 3. Most relevant resources

3.2.2 The most publications by author

Figure 4 illustrates the production of the 225 authors in the dataset over time through the circular chart. Each colour represents a specific author: Vasarhelyi (blue), Kogan (red), Appelbaum (green), Alles (purple), and D'Onza (light blue). The inner segments correspond to the years of publication, showing the temporal distribution of each author's research activity. The figure indicates that Vasarhelyi and Kogan are the most prolific contributors, with a continuous publication record spanning from 2015 to 2023. Appelbaum and Alles also show consistent research output, while D'Onza appears as a more recent contributor, with publications concentrated between 2021 and 2023. Overall, the figure highlights the leading authors and their evolution in scholarly productivity over time within the research domain.

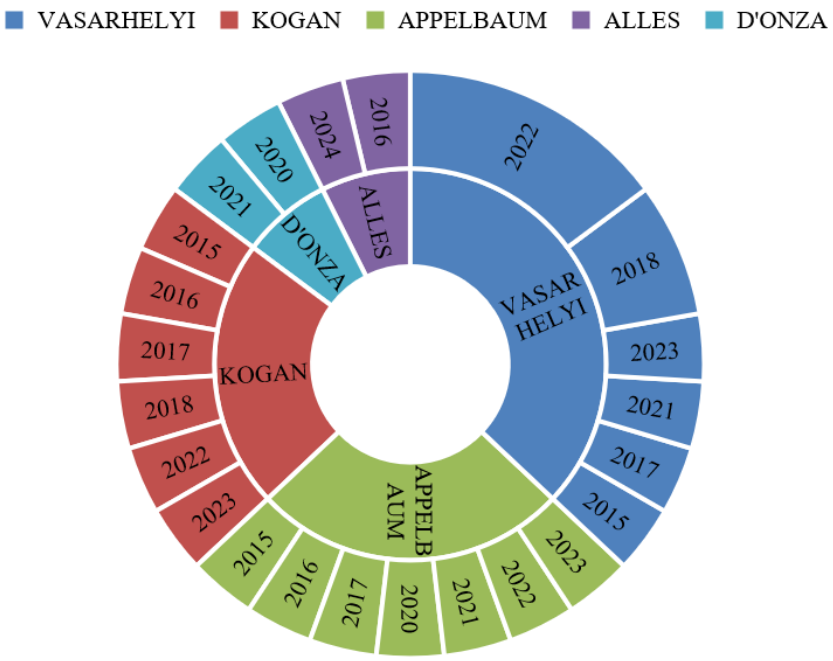


Figure 4. Most productive authors

According to the available information, Vasarhelyi has been actively publishing articles on BD in accounting and audit analytics. In 2015, Vasarhelyi collaborated with Kogan, A., and Tuttle, B. M. to publish an article entitled "BD in accounting: An overview". This article highlighted how the Big 4 accounting firms viewed BDA as essential in their assurance businesses, and it has received 324 citations, making it the top-ranked document in the data.

Then, in 2017, Vasarhelyi collaborated with Appelbaum and Kogan to publish another article titled "BD and analytics in the modern audit engagement: Research needs". This paper emphasises the importance of incorporating BDA into auditing and discusses the challenges posed by the evolving environment of BD and advanced analytics. Having received 232 citations, this article ranked fourth among the most cited documents (see Table 2).

Moving forward to 2018, Vasarhelyi published two articles. The first one, titled "Embracing textual data analytics in auditing with deep learning", is in collaboration with T. Sun. This study examined the value of textual data analytics as a technique for auditors and introduced deep learning as an AI tool for auditing purposes. In 2018, the second article, "Analytical procedures in external auditing: A comprehensive literature survey and framework for external audit analytics", was co-authored with Appelbaum and Kogan.

The activities of researchers resumed in 2021, with one article published. In 2022, the researchers remained active, and more publications were expected. Interestingly, the authors with the highest impact on the literature are Vasarhelyi, Appelbaum and Kogan, who have published a significant number of articles and received many citations in total. These authors have consistently produced papers that garnered high citations, indicating the importance and relevance of their research. Appelbaum published seven articles between 2015 and 2017; he continued to publish articles actively, with at least one article per year starting from 2020 till 2023.

3.2.3 The most publications by country

The global discourse surrounding the correlation between BDA and auditing was evident in the 30-country list, highlighting the affiliations of the 225 authors included in the dataset. The dataset shows output originating from various countries. The analysis in Table 3 considered the country with the highest productivity in terms of volume and the average citation rate per country.

Based on Table 3, it is evident that most publications on audit and BDA originated from the United States, with 40 articles significantly surpassing the number of publications from other countries. Malaysia (nine articles) and the United Kingdom (eight articles) are followed by China (seven articles) and Australia (five articles), which can be considered to have a lower number of publications. China (seven articles), Australia (five articles), Indonesia (five articles), Italy (five articles), Egypt (four articles), and Germany (four articles), respectively.

The United States of America has the highest number of 2,204 citations, followed by Australia with 484 citations, the United Kingdom with 392 citations, Italy with 276 citations, and China with 165 citations. The data presented here indicate that developed countries generally exhibit higher productivity levels.

Table 2. Citations by year and the 15 most cited articles

No.	Author(s)	Title	Source	Total Citations	Citations by Year
1	Vasarhelyi et al. (2015)	"Big data in accounting: An overview"	*Accounting Horizons*	324	29.45
2	Brown-Liburd et al. (2015)	"Behavioural implications of big data's impact on audit judgment and decision making and future research directions"	*Accounting Horizons*	247	22.45
3	Cao et al. (2015)	"Big data analytics in financial statement audits"	*Accounting Horizons*	244	22.18
4	Appelbaum et al. (2017)	"Big data and analytics in the modern audit engagement: Research needs"	*Auditing*	232	25.78
5	Gepp et al. (2018)	"Big data techniques in auditing research and practice: Current trends and future opportunities"	*Journal of Accounting Literature*	202	25.25
6	Richins et al. (2017)	"Big data analytics: Opportunity or threat for the accounting profession?"	*Journal of Information Systems*	189	21.00
7	Arnaboldi et al. (2017)	"Accounting, accountability, social media and big data: Revolution or hype?"	*Accounting, Auditing, and Accountability Journal*	177	19.67
8	Alles (2015)	"Drivers of the use and facilitators and obstacles of the evolution of big data by the audit profession"	*Accounting Horizons*	170	15.45
9	Earley (2015)	"Data analytics in auditing: Opportunities and challenges"	*Business Horizons*	164	14.91
10	Krahel & Titera (2015)	"Consequences of big data and formalization on accounting and auditing standards"	*Accounting Horizons*	139	12.64
11	Zhang et al. (2015)	"Toward effective big data analysis in continuous auditing"	*Accounting Horizons*	133	12.09
12	Salijeni et al. (2018)	"Big Data and changes in audit technology: Contemplating a research agenda"	*Accounting and Business Research*	127	18.14
13	Kend & Nguyen (2020)	"Big data analytics and other emerging technologies: The impact on the Australian audit and assurance profession"	*Australian Accounting Review*	82	13.67
14	Alles & Gray (2016)	"Incorporating big data in audits: Identifying inhibitors and a research agenda to address those inhibitors"	*International Journal of Accounting Information Systems*	76	7.60
15	Appelbaum et al. (2018)	"Analytical procedures in external auditing: A comprehensive literature survey and framework for external audit analytics"	*Journal of Accounting Literature*	73	9.13

Table 3. Publications by country

Country	Continent	Total Publications	Percentage of publications	Total Citations
United States	"North America"	40	45.05%	2,204
Malaysia	"Asia"	9	9.89%	6
United Kingdom	"Europe"	8	8.79%	392
China	"Asia"	7	7.69%	165
Australia	"Oceania"	5	5.49%	484
Indonesia	"Asia"	5	5.49%	8
Italy	"Europe"	5	5.49%	276
Egypt	"Africa"	4	4.40%	63
Germany	"Europe"	4	4.40%	121
Saudi Arabia	"Asia"	4	4.40%	60
Jordan	"Asia"	2	2.20%	26
New Zealand	"Oceania"	2	2.20%	24
South Africa	"Africa"	2	2.20%	23
Thailand	"Asia"	2	2.20%	8

3.3 Most Influential Articles and Citations of BDA and Auditing

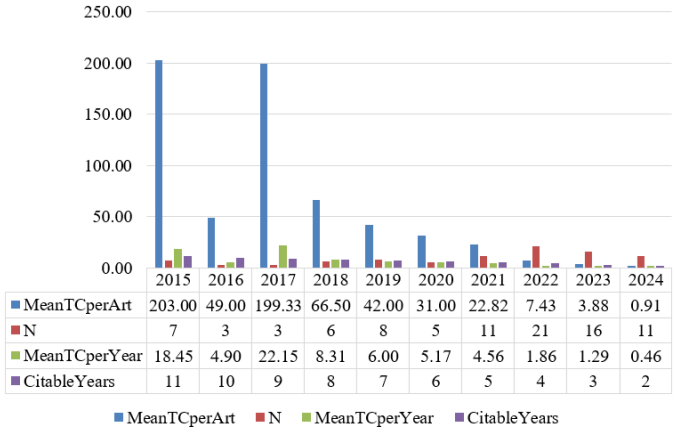
Citation counts were enticing raw data for the evaluation of scientific performance because they were "unobtrusive measures that do not require the cooperation of a respondent and do not contaminate the response" (Bornmann & Daniel, 2008). By analysing the number of citations, one can accurately depict the documents published in a particular field, which, to comprehend the structure of science, has a lengthy history (Klavans & Boyack, 2015). Table 2 displays the 15 most-cited articles from the sample, each receiving at least 73 citations. The number of citations indicates the paper's prominence and influence within the scientific community. The paper quoted the most was "Vasarhelyi et al. (2015)", with 324 citations, followed by "Brown-Liburd et al. (2015)", with 247 citations.

Analysing the most frequently referred publications in the dataset could discern distinct clusters of papers that have initiated investigations into the connections between audit practices and the use of BD, approached from various perspectives. Notably, many of these publications feature conceptual papers. Several authors have investigated the impact of BD on auditing. Vasarhelyi et al. (2015) examined the significance of BD within the accounting field, specifically highlighting its relevance in auditing. The study conducted by Brown-Liburd et al. (2015) explored the behavioural consequences of audit judgment and decision-making influenced by BD. It identified potential avenues for further research in this area. Alles (2015) examined the use of BD in the context of external auditing, to offer an extensive examination of the factors that drive its adoption, usage, factors that enable its implementation, and challenges that hinder its progress in the audit profession.

The influence and capabilities of BDA on financial statement audits were emphasised by Cao et al. (2015) and Tang & Karim (2018). Gepp et al. (2018) highlighted the analysis of contemporary trends and future possibilities of BD methodologies in auditing research and practice. There is a separate group of publications, mainly focused on large-scale data analysis in continuous auditing. For instance, Zhang et al. (2015) elucidated how BDA methodology fostered innovation in practice and improved the efficiency and efficacy of continuous auditing. Moreover, Joshi & Marthandan (2020) demonstrated the use of BDA and presented a method of establishing continuous internal audits. Feung & Thiruchelvam (2020) examined the framework model for ongoing financial statement audits utilising BDA. Additional studies concentrated on the impetus for employing BD and data analytics in external auditing (Al-Ateeq et al., 2022; Dagilienė & Klovienė, 2019). Several studies have examined audit evidence and BDA, as noted by Krahel & Titera (2015). A limited number of documents examined the audit classes and education within the framework of BDA (Blix et al., 2021; Weirich et al., 2018).

Figure 5 elucidates the average number of cumulative citations each year. This analysis discerned the years in which the average accurately represents the impact of papers published in those respective years and the years where it might be skewed by a few articles with a significant number of citations alongside others with only a few citations. Notably, 2015 is the year with the highest average contribution. During this year, they published the most highly cited papers in the collection, such as Vasarhelyi et al. (2015) and Brown-Liburd et al. (2015), as well as contributions with a few citations, resulting in a low average.

On the other hand, in 2022, they published a substantial number of articles, totalling 21 pieces. However, the average citation count for these papers was relatively low, indicating that the impact of the publications that year was not as prominent as in 2015. In summary, Figure 5 illustrates the varying average citation impacts across different years, emphasising the significance of identifying when a few highly cited papers might drive the impact or when it can more accurately reflect the overall effect of the publications.



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
MeanTCperArt	203.00	49.00	199.33	66.50	42.00	31.00	22.82	7.43	3.88	0.91
N	7	3	3	6	8	5	11	21	16	11
MeanTCperYear	18.45	4.90	22.15	8.31	6.00	5.17	4.56	1.86	1.29	0.46
CitableYears	11	10	9	8	7	6	5	4	3	2

Figure 5. Average citations per year

Note: The x-axis represents the publication years (2015–2024), while the y-axis shows the average citation metrics, including MeanTCperArt (mean total citations per article), N (number of articles), MeanTCperYear (mean total citations per year), and CitableYears (number of years considered citable).

The data in Table 4 revealed that 2015 was the most influential year in terms of citation impact, as it had the highest number of citations, totalling 1,421, for the seven publications. This impressive number of citations could be attributed to the fact that auditing and accounting research acquired significant momentum in 2015, resulting in extensive referencing and recognition of seminal works published during that year. Three articles and 598 citations followed in 2017. There are a total of 3,535 citations and 91 articles for the ten years spanning from 2015 to 2024.

Table 4. Total citations per year

Year	Total Number of Publications	Total Number of Citations
2015	7	1,421
2016	3	147
2017	3	598
2018	6	399
2019	8	336
2020	5	155
2021	11	251
2022	21	156
2023	16	62
2024	11	10
Total	91	3,535

3.4 Keyword Analysis

The frequently repeated keywords employed by the writers were evaluated to ascertain the most relevant topic addressed in the data collection. The investigation began by examining the distribution of the ten most commonly used keywords identified by the writers over the years (see Figure 6). The phrase "BD" has been mentioned in 43 instances, followed by "data analytics," which occurred 30 times, and "audit," which occurred 19 times.

To identify the most relevant issue addressed in the dataset, the frequently occurring keywords used by the writers were subsequently examined. The keywords, examined in the 91 publications in the collection, provide significant insights into the content and fundamental themes about the interaction between auditing and BDA.

The relationship between the frequency of words and the growth of data analytics was investigated in the context of the BD and auditing revolution from 2015 to 2024. A significant increase in the use of BDA in auditing has been observed over the years, thereby underscoring the importance of data analytics in auditing for an ever-evolving world. With so much data at stake, the need for accurate and trustworthy auditing procedures has become even more intensified. Both auditing and BDA have experienced significant growth in recent years, indicating an increasing emphasis on data-driven decision-making and risk management. It is anticipated that auditing and data analytics will continue to rise in prominence in the future. As technology advances and data-driven approaches demonstrate their value, these topics will play a more important role in shaping various industries.

According to Figure 7, the frequency of all the terms appeared relatively low from 2015 to 2018, indicating that these topics were less explored or simply emerging fields during this period. From 2019 to 2022, there was a noticeable increase in frequency, particularly in terms like "BD" and "data analytics", implying a growing interest and adoption of these concepts in auditing research. The result showed a large frequency of all terms from 2023 to 2024, suggesting sustained or growing interest. The chart illustrates a clear upward trend in research related to these terms, particularly from 2019 onwards. The rise aligned with the increasing importance of technology and analytics in auditing and fraud detection processes.

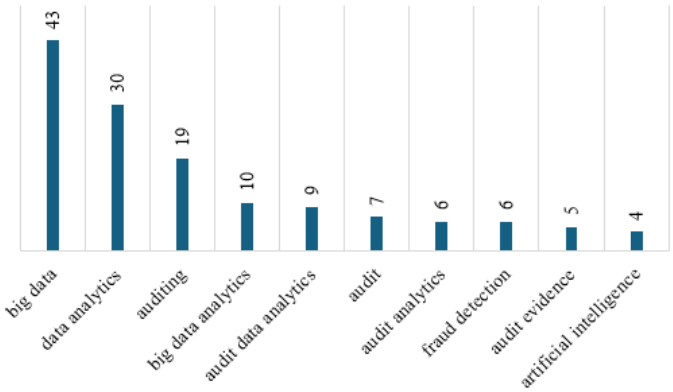


Figure 6. Top 10 mostly used keywords

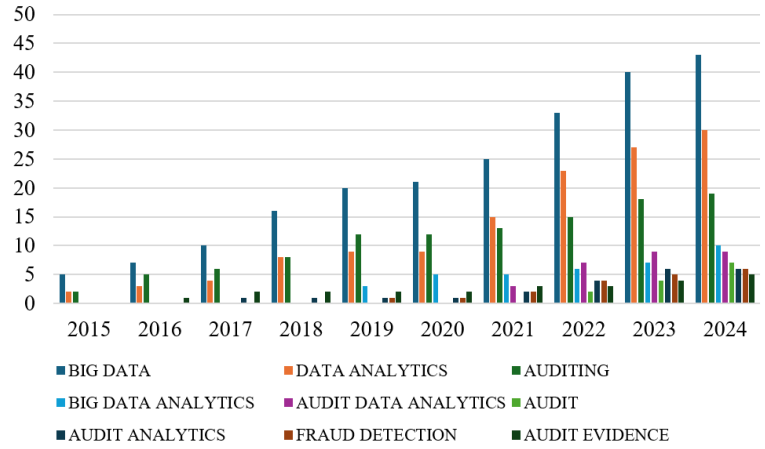


Figure 7. Word frequency over the time

Figure 8 illustrates the evolving research trends in BDA from 2015 to 2024, presenting the frequency of significant phrases in abstracts. A notable rise in the keywords "data" and "analytics" from 2015 to 2016 indicates a substantial escalation in discourse and investigation. From 2017 to 2020, the consistent increase in most keywords implies an expanding study area. From 2021 to 2024, words like "Audit", "Analysis", and "Financial" demonstrated significant growth and maturation of the discipline and its increased incorporation into auditing and financial research. Emerging focal points, such as "research", "external", "accounting", and "auditors", albeit initially at lower frequencies, have demonstrated a steady rise in recent years, signifying the evolution of specialised research domains.

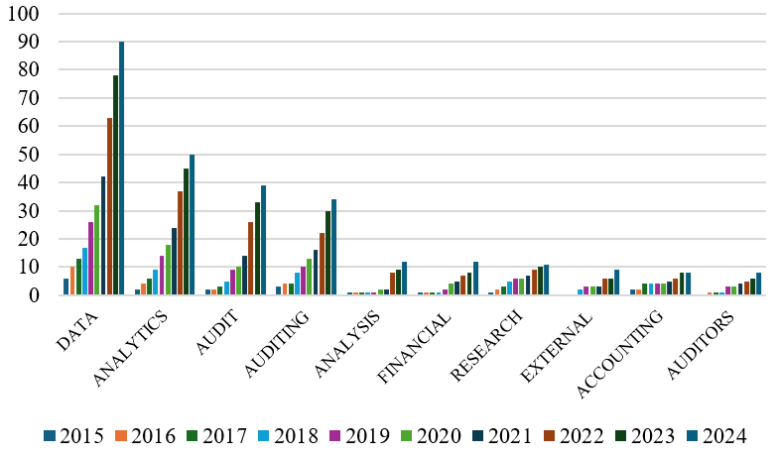


Figure 8. Word frequency in abstracts over time

The annual growth trend, depicted by colour-coded bars, illustrates the consistent rise of publications focusing on these terms. Figure 8 highlights the important roles of "Data" and "Analytics", while terms like "Audit", "Financial", and "Research" are becoming more critical. The persistent increase in terms such as "Accounting" and "Auditors" further highlights the escalating significance of BDA in professional auditing and financial analysis.

3.5 Findings of Science Mapping Analysis of BDA and Auditing

Science mapping is a technique for examining the relationships among many components of research, including the intellectual interactions and structural relationships of these elements (Donthu et al., 2021).

Bibliometric techniques determine how disciplines, fields, specialities, and individual publications are interconnected (Göksu, 2023). The methodologies used in scientific mapping included citation analysis, co-citation analysis, and co-word analysis (Donthu et al., 2021). VOSviewer can create networks of scientific publications, journals, researchers, research organisations, countries, keywords, and concepts. Items in these networks can be linked by co-authorship, co-occurrence, citation, bibliographic coupling, and co-citation connections.

Six out of 30 countries were identified, each with at least five documents and 30 citations. As shown in Figure 9, the United States as the central contributor that collaborated or was most frequently cited in connection with

Malaysia, the United Kingdom, China, Italy, and Australia. This indicates that research outputs from the United States have strong international linkages and influence within the global citation network.

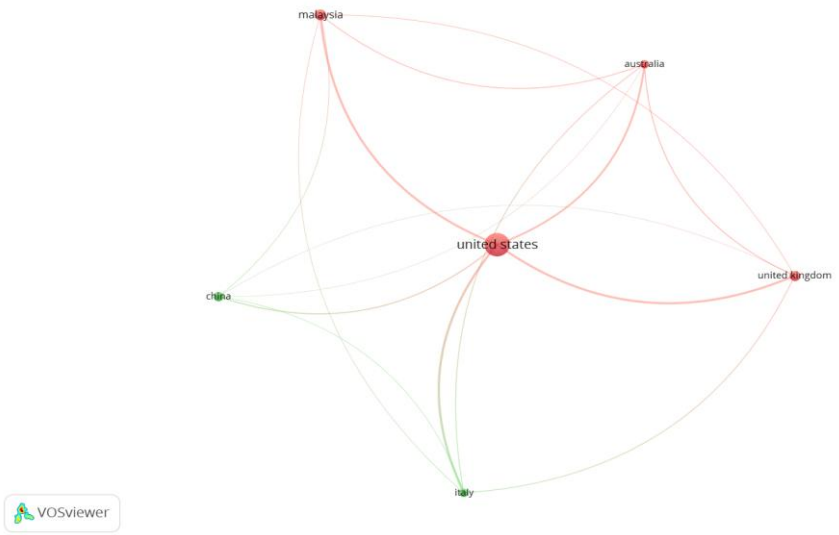


Figure 9. Country analysis

In addition, "Malaysia, Italy, Australia, and the United States" support the United Kingdom. China is distant from the previous clusters but has closer ties with the United Kingdom and Italy. The cooperation network reveals that nations with the highest publication output tend to operate in collaborative environments. It also illustrates the growth of transnational cooperation between researchers from developed and developing countries. Overall, this pattern signifies the accelerating globalisation of research on BDA in auditing, where cross-border collaborations enhance knowledge exchange, methodological diversity, and innovation in the field.

The co-citation of journals suggests semantic similarity between the publications. At a threshold of 20 citations, Figure 10 displays the results involving co-citations of the 20 most cited journals in "BDA and auditing". The breadth of the lines indicates the intensity of connections between any two journals and the distance between them. The *Journal of Accounting Horizons* emerges as the most frequently co-cited journal in the field, followed closely by the *International Journal of Accounting*. When examining spatial relationships between journals, *Accounting Horizontal* exhibits strong associations with the *International Journal of Accounting* and the *Journal of Accountancy*. Similarly, the *Journal of Information Systems* shares its primary intellectual affinities with *Accounting Horizons*, the *International Journal of Accounting*, and *Auditing: A Journal of Practice*. Furthermore, the *Journal of Emerging Technology* also demonstrates notable intellectual connections with *Accounting Horizons*. The interplay of co-citation and spatial affinity highlights the dynamic network of scholarly communication and knowledge dissemination within accounting and related fields.

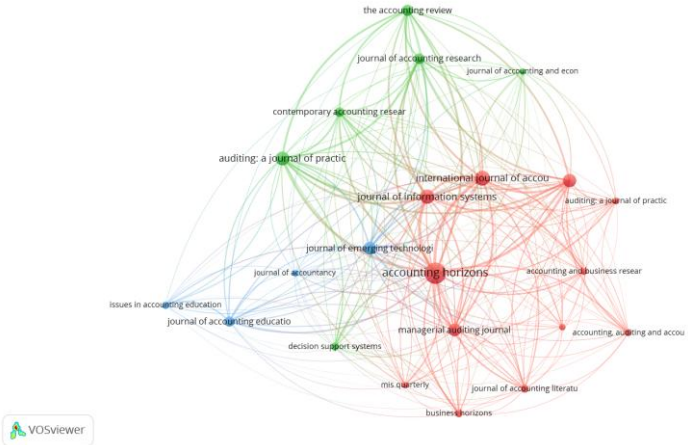


Figure 10. Co-citations of journals in BDA and auditing

The word cloud in Figure 11 visually represents the frequency and significance of essential terms associated with BDA and audits, highlighting the predominant themes in research and the principal subjects influencing these areas, along with their relative significance. The prominent words, including "BD", "data analytics", and "auditing", signify their pivotal role in academic discourse and publications, to underscore their importance in the domain. Less familiar yet significant terminology, such as "BDA", "audit analytics", "fraud detection", and "machine learning", indicates crucial usage and developing trends in the business. Terms like "artificial intelligence," "audit evidence," and "external auditors" are becoming increasingly critical in the expanding field of data-driven auditing practices.

Figure 11 presents the word cloud encompassing terminology related to various facets of auditing and data analytics, including "technologies", "machine learning", and "artificial intelligence". Applications include phrases like "fraud detection" and "audit evidence", whereas roles consist of "external auditors" and "internal audit". The word cloud for processes features "continuous auditing" and "data visualisation". Increased font sizes denote more frequent or significant terms, whereas smaller fonts indicate less frequent but pertinent terms.

The hue combination serves aesthetic purposes, although it does not signify any classification. The word cloud suggests the incorporation of sophisticated technology, such as data analytics, into conventional auditing methodologies. It underscores the increasing emphasis on analytics, fraud detection, and evidence-based audits, thus illustrating a trend towards data-driven decision-making.

Figure 11. Word cloud

4. Conclusions, Limitations, and Suggested Research Directions

4.1 Conclusions

This paper provided a comprehensive review of BDA and audits from 2015 to 2024. The research utilised the Scopus database to review 91 publications, employing both qualitative and quantitative evaluations, which relied on computational tools and software. The study facilitated engagement in the ongoing academic conversation related to BDA and auditing. During the designated timeframe, VOSviewer software, R, and Excel were utilised to facilitate knowledge generation.

The findings in this study indicate that the gradual increase in publications on BDA and auditing reached its culmination in 2022, making it the most productive year, with 21 articles released. With a total of six publications, Vasarhelyi has been one of the most active contributors in the field of BD in accounting and audit analytics. Moreover, the paper authored by Vasarhelyi emerged as one of the most influential documents in the domain of BDA and auditing, with 324 citations underscoring its significant impact on subsequent research.

In terms of publication outlets, the *Journal of Emerging Technologies in Accounting*, with 10 publications, stands out as the leading journal dedicated to disseminating research on BDA and auditing. Furthermore, the United States ranks as the most productive and influential country in this domain, having contributed 40 publications and accumulated a total of 2,204 citations.

The study also selected the most prominent themes, such as BDA and auditing, that have attracted considerable scholarly attention in this research area. Additionally, a diversification of topics in this field can be observed in emerging themes, including audit evidence, fraud detection, financial reporting, the digital economy, and audit data analytics, thus reflecting the evolving research directions.

4.2 Limitations of the Study and Directions for Future Research

The development and current state in the field have been elucidated through a bibliometric analysis of BDA and auditing. BDA fosters and improves the integrity of audits and the auditing procedure. This connection has been investigated in prior research; however, further research is necessary to understand the factors that influence its adoption by auditors fully. Identifying the limitations of existing research is crucial for outlining prospects for subsequent research. This section highlights the principal weaknesses that can be identified in the study, along with recommendations for further enhancement.

The bibliometric analysis was based solely on publications retrieved from the Scopus database. Significant databases, including Web of Science (WoS) and ProQuest, were excluded, despite potentially housing pertinent and high-impact research. Subsequent studies may thus integrate various databases to acquire a more comprehensive and diverse dataset, facilitating broader insights and improved trend identification. This analysis was restricted to English-language publications, thereby excluding significant studies authored in languages other than English. Integrating multilingual sources in future research would promote inclusivity and reduce any language bias, thereby enhancing global comprehension of the adoption of BDA in auditing.

Additionally, the data extraction conducted in December 2024 provided a snapshot of the literature at that time. Given the rapid evolution in the field, forthcoming bibliometric studies should conduct updated analyses at regular intervals to identify new developments and emerging research clusters. The parameters of this study were confined to publications categorised under “Social Sciences”, “Economics, Econometrics, and Finance”, and “Business, Management, and Accounting”. Incorporating related fields such as computer science, information systems, and data engineering into future assessments may yield a more interdisciplinary viewpoint and enhance understanding of how technological improvements transform audit processes.

Future studies should combine bibliometric analysis with qualitative methods, such as interviews or case studies, to better understand BDA and its adoption of contextual and behavioural dimensions in auditing practices. Researchers should investigate underexplored topics, including the ethical implications of BDA, its impact on auditor independence, and the challenges of integrating advanced technologies such as artificial intelligence and blockchain. Future work should also examine contributions from developing countries to provide a global perspective on BDA adoption and address unique regional challenges in implementing these technologies.

5. Practical Implications

This bibliometric review has significant practical implications for essential stakeholders, including auditors, academics, researchers, and policymakers. First, the findings provided valuable insights for auditors seeking to adapt to the digital changes in their profession. This study identified growing research issues, including audit data analytics, fraud detection, risk assessment, and digital audit evidence, thereby highlighting opportunities for auditors to improve their analytical competencies. The expanding literature emphasised the necessity for auditors to develop technical competencies in data analytics tools, programming, and data interpretation to enhance audit quality and efficiency. The mapping of worldwide research trends allows audit businesses to compare their methods of technological adoption with international practices. Consequently, the report advocated the application of continual learning and innovation for auditors to maintain competitiveness in a progressively data-driven audit landscape.

Second, for academics, the study uncovered underexamined research domains and prospective collaboration networks within the field of BDA in auditing. The identified study clusters and keyword co-occurrence patterns provide a basis for formulating new theoretical models that amalgamate auditing, data science, and technology acceptance frameworks. Third, regulators and professional groups might leverage the findings from this study to develop training programs and revise their professional standards to integrate BDA competencies. The findings also informed the development of regulations that foster technology-driven audit processes while ensuring the maintenance of ethical and quality standards in the digital auditing landscape.

Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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