Technology Integration in Internal Auditing: Insight, Current Trends and Future Directions

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Abstract

Research aim: The integration of technology in internal auditing is reshaping how audits are conducted, enabling greater efficiency, transparency and decision-making. This study aims to provide comprehensive insights into the intellectual structure, key contributors, thematic developments and theoretical foundations of technology integration in internal auditing. It also identifies critical gaps in the current literature for future research.

Design/ Methodology/ Approach: This research employed bibliometric techniques using VOSviewer and RStudio software. A total of 1037 articles published between 1993 and 2025 were retrieved from the Web of Science database and analysed to map the evolution, impact and direction of scholarly work on technology integration in internal auditing.

Research finding: This bibliometric study uncovers publication trends, core journals, influential institutions and authors, key countries and most cited articles. It also identifies thematic clusters, trending topics, conceptual structures, theoretical lenses and emerging keywords. The results offer a structured overview of how the field has evolved over the last three decades and highlight the intellectual foundations guiding the domain.

Theoretical contribution/Originality: This study is among the first to conduct a focused bibliometric analysis exclusively on internal auditing and technology integration. Unlike prior studies that reviewed either broad audit domains or single technologies like artificial intelligence (AI) or blockchain, this study provides a holistic and longitudinal view across multiple technologies.

Practitioner/Policy implication: It contributes by mapping thematic developments, theoretical integration and future research opportunities specific to internal auditing.

Research limitation: While this study provides a comprehensive mapping of technology integration in internal auditing, its reliance on Web of Science data may limit coverage, highlighting the need for future, theory-driven and interdisciplinary research that addresses underexplored themes such as ethical AI governance and explainability.

Keywords: Technology Integration, Internal Auditing, VOSviewer, R Studio, Web of Science

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1. Introduction

The rapid advancements in technology, particularly in information technology (IT) and artificial intelligence (AI), have fundamentally transformed how individuals and organisations operate on a global scale. According to the World Bank's Digital Progress and Trends Report, the IT services sector, including AI, has been growing at an annual rate of 8%, twice as fast as the global economy, underscoring the accelerating digital transformation across industries (World Bank, 2024). Notably, PwC forecasts that AI will contribute $15 trillion to the global economy by 2030, surpassing the current economic output of China and India combined (PWC, 2023). As part of this global momentum, substantial investments are being made to integrate AI and other digital technologies into internal auditing to enhance efficiency, accuracy, and risk management.

Reflecting this urgency, professional bodies such as the Institute of Internal Auditors (IIA) are urging the audit community to embrace technology or risk becoming obsolete. In a recent global study, one African internal audit leader warned: "*If we are not prepared for the AI revolution, then obviously we'll be walked over, and soon AI will cease to become the harnessed dog but rather become the wild lion in our communities*" (IIA, 2024a). This metaphor underscores the growing pressure on internal auditors to not only adopt emerging technologies but also to understand, govern, and strategically align them with audit objectives. As digital transformation accelerates, internal auditors are no longer just process evaluators but must evolve into forward-looking professionals equipped with digital skills, data literacy, and ethical oversight capabilities (IIA, 2024b).

Despite this growing momentum, academic research on technology integration in internal auditing remains fragmented. While studies have explored topics like AI, blockchain, data analytics, and IT governance, the research is dispersed across disciplines and lacks a consolidated synthesis of how this field has evolved (Agustí & Orta-Pérez, 2023; Pizzi, Venturelli, Variale & Macario, 2021; Rabbani, 2024; Wassie & Lakatos, 2024). There is currently no comprehensive bibliometric analysis that maps the intellectual structure, emerging themes, key contributors, and theoretical underpinnings of technology integration in internal auditing. This lack of structured knowledge limits our understanding of where the field stands and how future research can be meaningfully advanced. Therefore, to improve the adoption of technologies in internal audit, a better understanding of the field is essential.

Amid these reviews, only a few have directly explored the intersection of technology and internal auditing using bibliometric methods. For example,

while Pizzi et al. (2021) examined digital transformation, and Agustí & Orta-Pérez (2023) focused on AI and big data, both reviews treated auditing broadly and did not isolate internal auditing as a distinct function. Others, such as Huson, García & Benau (2024) and Hakami, Sabri, Al-Shargabi, Rahmat & Attia (2023), centred on information technology or blockchain but overlooked internal audit-specific developments. Furthermore, most prior studies lacked a longitudinal perspective and offered limited insights into publication trends, source outlets, or key contributors within this niche. Motivated by this gap, this study adopts a focused bibliometric approach to address the following questions: (RQ1) What are the key journals, influential institutions, countries, and impactful articles in the field of technology integration in internal auditing? and (RQ2) How has the integration of technology in internal auditing evolved over time?

In addition, the existing literature falls short in mapping conceptual structures and synthesising theoretical frameworks underpinning technology integration in internal auditing. While technological terms such as blockchain, data analytics, and AI appear frequently, few studies have classified the thematic evolution of these terms or integrated them into a cohesive intellectual landscape. Even fewer have applied theoretical lenses or proposed research agendas grounded in established models. To address these omissions, this study further investigates: (RQ3) What are the most impactful and trending topics in the field of technology integration in internal auditing? and (RQ4) What are the key themes, predominant theoretical frameworks, emerging concepts, and future research directions in the field of technology integration in internal auditing? In examining these research questions, the study relies solely on the Web of Science database instead of Scopus as the primary source due to its reliable search capabilities, high-quality indexing and strong academic credibility (Pranckutė, 2021).

The current study makes several important contributions. The findings of RQ1 will assist researchers in identifying the most active journals, institutions, countries, and impactful articles, thus guiding publication strategies and collaborative opportunities. Insights from RQ2 and RQ3 will deepen understanding of how the field has evolved over time and what trending topics are gaining traction, enabling future scholars to position their research in high-impact areas. Finally, RQ4 offers theoretical and conceptual contributions by identifying dominant frameworks, thematic clusters, and emerging concepts by paving the way for future research to develop integrated models and testable hypotheses that advance the scholarly discourse on technology integration in internal auditing. To guide readers through this research, the structure of this paper is outlined as follows: the methodology is described in Section 2, followed by the presentation of key bibliometric findings in Section 3. Section 4 discusses the insights derived from the thematic clusters and theoretical lenses, while Section 5 concludes the paper by highlighting practical implications, study limitations, and future
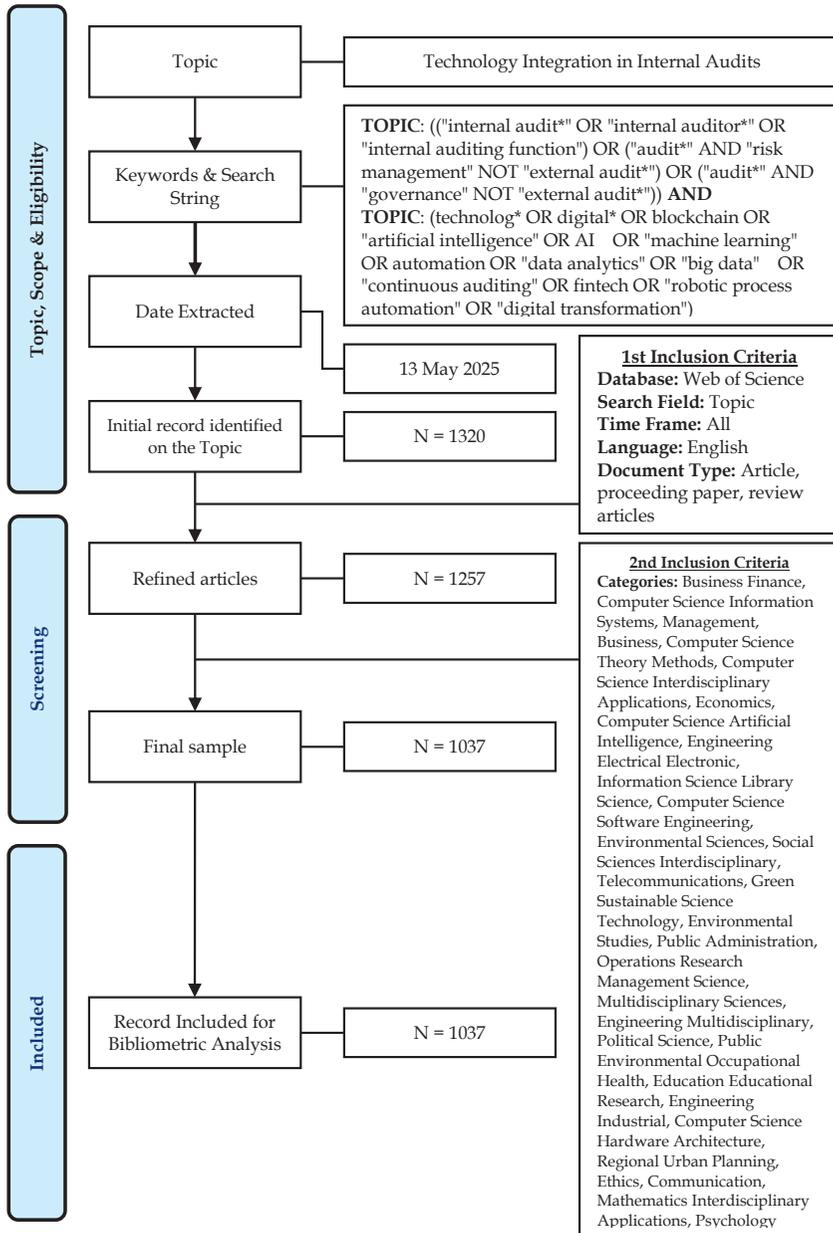
research directions.

2. Methodology

This study employs a bibliometric analysis to explore and map the intellectual landscape of technology integration within internal audits. Bibliometric analysis is a quantitative method for examining publication patterns, keyword trends, co-authorship structures, and thematic networks across academic literature. It allows researchers to visualise scientific progress, identify core research streams, and detect emerging themes (Aria & Cuccurullo, 2017).

There are two principal outputs of bibliometric analysis: bibliometric maps and bibliometric graphs. While maps are widely used, graphs offer clearer interpretability and stronger conceptual clustering (Van Raan, 2014). Therefore, this study focuses on bibliometric graphs to portray thematic structures and research linkages. The Web of Science (WOS) database was selected instead of Scopus as the primary source due to its high-quality indexing, refined search capabilities, and strong academic credibility (Pranckutė, 2021). Its advanced filtering and export options allow for rigorous and replicable bibliometric analyses.

2.1 Study Design

The methodological process was guided by a structured flow of three stage, as shown in Figure 1. The first stage involved defining the research scope and search strategy. The topic of interest was "Technology Integration in Internal Audits." Before conducting the bibliometric analysis, a targeted screening of prior review papers on technology integration in auditing was performed. Table 1 was established from this preliminary screening and includes only review articles with methodological, thematic, or conceptual relevance to internal audit technology, ensuring comparability across studies. Following best practices for keyword selection (Chen & Xiao, 2016), two search strings were created. The first string captured the internal audit domain using terms such as "internal audit*", "audit*", and "governance," while excluding "external audit." This exclusion is essential because internal and external auditing differ fundamentally in purpose, mandate, and organisational context; internal audit focuses on governance, risk, and organisational processes, whereas external audit centres on independent financial statement assurance, making the latter outside the scope of this study (Pramukti, 2024). The second search string identified emerging technologies relevant to the internal audit context, using keywords such as "AI," "blockchain," "big data," "continuous auditing," and "digital transformation."

Figure 1: Flow Diagram of the Search Strategy

Topic, Scope & Eligibility

| Topic | → | Technology Integration in Internal Audits |

Keywords & Search String → **TOPIC**: (("internal audit*" OR "internal auditor*" OR "internal auditing function") OR ("audit*" AND "risk management" NOT "external audit*") OR ("audit*" AND "governance" NOT "external audit*")) **AND** **TOPIC**: (technolog* OR digital* OR blockchain OR "artificial intelligence" OR AI OR "machine learning" OR automation OR "data analytics" OR "big data" OR "continuous auditing" OR fintech OR "robotic process automation" OR "digital transformation")

Date Extracted → 13 May 2025

Initial record identified on the Topic → N = 1320

1st Inclusion Criteria
Database: Web of Science
Search Field: Topic
Time Frame: All
Language: English
Document Type: Article, proceeding paper, review articles

Screening

Refined articles → N = 1257

2nd Inclusion Criteria
Categories: Business Finance, Computer Science Information Systems, Management, Business, Computer Science Theory Methods, Computer Science Interdisciplinary Applications, Economics, Computer Science Artificial Intelligence, Engineering Electrical Electronic, Information Science Library Science, Computer Science Software Engineering, Environmental Sciences, Social Sciences Interdisciplinary, Telecommunications, Green Sustainable Science Technology, Environmental Studies, Public Administration, Operations Research Management Science, Multidisciplinary Sciences, Engineering Multidisciplinary, Political Science, Public Environmental Occupational Health, Education Educational Research, Engineering Industrial, Computer Science Hardware Architecture, Regional Urban Planning, Ethics, Communication, Mathematics Interdisciplinary Applications, Psychology

Final sample → N = 1037

Included

Record Included for Bibliometric Analysis → N = 1037

The search was performed on 13 May 2025, retrieving an initial pool of 1,320 articles from the WOS database. Publications were filtered based on language (English), document type (articles, conference papers, reviews), and subject areas related to business, information systems, engineering, and related interdisciplinary domains. After applying the inclusion criteria, the refined dataset comprised 1,037 relevant publications used for bibliometric analysis.

2.2 Data Extraction and Selection

At the data selection stage, bibliographic data were exported from Web of Science in plaintext format. This included metadata such as titles, abstracts, author information, keywords, source journals, and citations. These data were compiled and converted into bibliographic format compatible with VOSviewer and R-based tools. At the data selection stage, we created a ".bib" file containing the bibliographic information of the selected publications.

2.3 Data Analysis and Visualisation

Data analysis was conducted using R Studio and the Bibliometrix R-package, complemented by VOSviewer for advanced network visualisations. Bibliometric indicators such as publication growth, source impact, author productivity, and institutional collaboration were calculated. Thematic analysis included keyword co-occurrence networks, cluster mapping, and conceptual structure identification using multidimensional scaling. VOSviewer was used to produce network graphs of author collaboration, keyword linkages, thematic evolution, and theoretical clustering. These visualisations provided insights into dominant research fronts, emerging trends, and intellectual structure.

2.4 Interpretation

The final step involved interpreting bibliometric results to derive meaningful insights into the knowledge structure, influential authors, institutions, journals, and recurring theoretical frameworks in the field. Trends were examined across three decades, revealing shifts in technology adoption, governance models, and audit innovations. The findings were organised into descriptive statistics, co-authorship networks, co-word analysis, conceptual clusters, and theoretical lenses. These outputs offer a comprehensive

Table 1: Summary of Prior Review Works

Title	Author	Research question	Gap	Methodology	Articles reviewed	Time frame	Databases	Theoretical integration
Artificial intelligence (AI) and the future of the internal audit function	(Wassie & Lakatos, 2024b)	RQ1. What is the current state of research on the use of AI in IAF? RQ2. What are the future avenues of research on the use of AI in IAF?	• focus on AI only	SLR	15	2019-2023	WoS	Yes (only 1)
Assessing the impacts of digital transformation on internal auditing: A bibliometric analysis	(Pizzi et al., 2021)	RQ1. What are the main research clusters about digital transformation in internal auditing? RQ2. What are future research topics about digital transformation in internal auditing?	• focus on digitalisation only	bibliometric & review	105	1985-2020	Scopus & Google Scholar	No
A bibliometric review of information technology, artificial intelligence, and blockchain on auditing	(Huson et al., 2024)	To depict publishing activity, research trends, and popular topics.	• focus on audit, not internal audit • focus on IT, AI and blockchain only	bibliometric	328	2017-2022	WoS	No
Big data and artificial intelligence in the fields of accounting and auditing a bibliometric analysis	(Agustí & Orta-Pérez, 2023)	RQ1. What is the current state of research on AI and BD in the domain of the auditing and accounting fields? RQ2. What research contexts and topics have been explored in the literature to date? RQ3. What research lines or themes can future research address?	• focus on audit, not internal audit • focus on big data and AI only	bibliometric	247	1986-2020	WoS	No

Title	Author	Research question	Gap	Methodology	Articles reviewed	Time frame	Databases	Theoretical integration
This Study	NA	RQ1. What are the key journals, influential institutions, countries, authors and impactful articles in the field of technology integration in internal auditing? RQ2. How has the integration of technology in internal auditing evolved over time? RQ3. What are the most impactful and trending topics in the field of technology integration in internal auditing? RQ4. What are the key themes, predominant theoretical frameworks, emerging concepts, and future research directions in the field of technology integration in internal auditing?	• A comprehensive review of the literature by quantifying (bibliometric) the study of technology integration in internal auditing by providing current in-depth insight, trend, predominant theoretical frameworks and key themes, while proposing emerging concepts and future research directions to fill future research gaps.	bibliometric	713	1993 - 2025	WoS	Yes

overview of how technology is shaping the future of internal auditing, guiding both academic inquiry and practical application.

3. Results

3.1 Preliminary Data Statistics

The preliminary data statistics for technology integration in internal auditing research reveal a significant evolving and growing trend with extensive collaboration over the past three decades in this field. A total of 1037 documents from 640 sources were collected for this study from 1993 to 2025. The research productivity shows a rapid increment with a 15.18% annual growth rate, supported by an average citations per document of 7.157, stating this topic is not only impactful but also frequently referenced by other scholars. Additionally, each document includes 2.99 authors, 2761 total number of authors, and 150 single-authored documents, with 12.83% of international co-authors marking this topic as a globally relevant issue.

At the same time, the annual scientific production, as illustrated in Figure 2, reveals a significant gradual growth, revealing rising research activity over the years. The growth curve remained steady from 1993 to 2007, the highest number of yearly publications was deficient (less than ten articles), and by this time (over 15 years), only 45 studies were published. However, from 2008 to 2020, it gradually rose to a total of 435 publications, representing 41.95% of the total sample. This gradual growth can be supported by the rapid adoption of technologies like Artificial Intelligence and Machine Learning (Cioffi, Travaglioni, Piscitelli, Petrillo & Felice, 2020).

The most dramatic spike occurred after 2020, indicating the highest publication period, probably due to the massive lockdown for the COVID-19 pandemic. During this period, the integration of technologies in all sectors was intensifying, including internal audits (Al-Okaily, Alqudah, Al-Qudah & Alkhwaldi, 2022; Eulerich, Wagener & Wood, 2022; Mujalli & Almgrashi, 2020). The slight deep of 2025 indicates that the year is ongoing, as the data is being collected until 13 May 2025. Therefore, this increasing trend marks the interest and vibrant future of technology integration in internal auditing research, indicating continued research opportunities in the future.

3.2 Most Relevant Journals, Articles, Institutions, and Authors

This section presents citation analysis highlighting the most impactful and relevant journals, articles, institutions, and authors. Table 2 below summarises the ten leading journals that published technology integration in internal auditing studies. As this is a multidisciplinary topic, the journals also represent diverse academic areas such as auditing, accounting, business and management, information systems, sustainability, reflecting

the interdisciplinary nature of the topic. Among 640 journals reviewed, the International Journal of Accounting Information Systems emerged as the most productive and consistently impactful journal, publishing 24 articles and accumulating 113 citations, with an h-index of 70. Other journals demonstrating substantial productivity include the Managerial Auditing Journal (22 articles, h-index: 76) and the Journal of Information Systems (21 articles, h-index: 48). Notably, Sustainability and IEEE Access, though broader in scope, also contributed significantly to the field with high h-indices of 207 and 290, respectively.
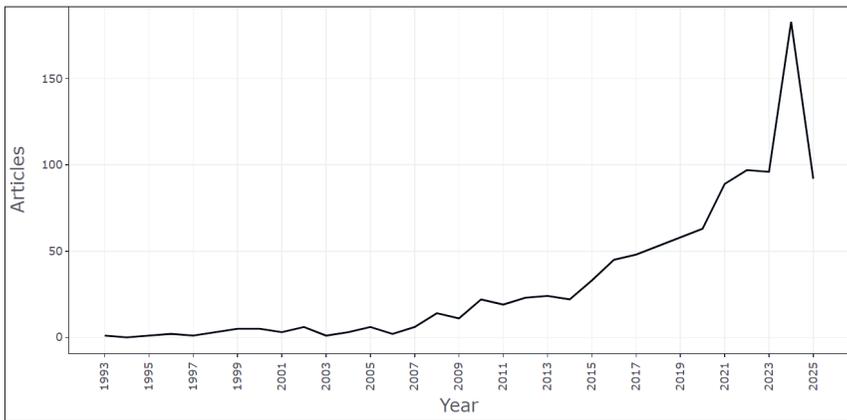
Figure 2: Annual Scientific Production

Table 2: Top 10 Most Impactful and Productive Journals

Source	Publications	TC	Avg. Citations	h_index
International Journal of Accounting Information Systems	24	113	4.7083	70
Managerial Auditing Journal	22	107	4.8636	76
Journal of Information Systems	21	50	2.381	48
Sustainability	16	86	5.375	207
IEEE Access	14	52	3.7143	290
Journal of Emerging Technologies in Accounting	13	0	0	31
Journal of Financial Reporting and Accounting	11	35	3.1818	33
Accounting Auditing & Accountability Journal	10	509	50.9	129
Accounting Horizons	7	65	9.2857	94

Information & Management	7	64	9.1429	204

From an impact standpoint, Accounting, Auditing & Accountability Journal stood out with the highest average citations per article (50.9), followed by Information & Management (9.14) and Accounting Horizons (9.29), despite having comparatively fewer publications. These findings suggest that while the field is still emerging, a core set of journals is driving both academic productivity and scholarly impact in the area of technology adoption in internal auditing.

Table 3 presents the top 15 most relevant articles in the domain of technology integration within internal auditing and related fields. The articles are evaluated using three bibliometric indicators: Total Global Citations (TGC), TGC per year, and Normalised TC. TGC reflects the total number of citations an article has received since its publication, indicating its accumulated scholarly influence. TGC per year accounts for the average annual citation rate, offering insight into the article's sustained impact. Normalised TC further adjusts for field and time bias, allowing a fair comparison across publication years.

Table 3: Top 15 Most Relevant Articles

Author-year	TGC	TGC per Year	Normalised TC
Yermack, 2017	455	50.56	21.25
Spears & Barki, 2010	225	14.06	4.56
Arena et al., 2010	218	13.63	4.42
Nolan & McFarlan, 2005	187	8.90	5.97
Loconto & Busch, 2010	140	8.75	2.84
Masli et al., 2010	137	8.56	2.78
Arnaboldi et al., 2017	136	15.11	6.35
Duffield, 2001	128	5.12	2.78
Grote & Künzler, 2000	128	4.92	2.52
MacKinnon, 2000	126	4.85	2.48
Rejeb, 2021	122	24.40	25.31
Chi et al., 2015	122	11.09	11.18
Sinkovics et al., 2016	121	12.10	12.78
Ho et al., 2011	117	7.80	12.92
Pina et al., 2010	111	6.94	2.25

Among the articles, Yermack (2017) stands out with the highest overall citation count (TGC = 455) and the highest yearly citation rate (TGC/year = 50.56), indicating enduring and increasing relevance in recent years. Spears & Barki (2010) and Arena et al. (2010) also appear as highly cited foundational works in information systems and risk management, with TGC values

of 225 and 218, respectively. In terms of normalised impact, Rejeb (2021) exhibits the highest Normalised TC of 25.31, suggesting exceptional scholarly influence in a short time frame. Other notable works with strong normalised citation performance include Sinkovics et al. (2016) and Chi et al. (2015), both exceeding a Normalised TC of 10. These findings highlight a combination of foundational and emerging studies shaping the research landscape in internal auditing and technology adoption, offering future scholars a solid base for theoretical and empirical advancement.

Table 4 highlights the top 15 organisations contributing to research on technology integration in internal auditing. The University of London leads with 12 publications, followed closely by the Royal Melbourne Institute of Technology (RMIT) with 11 publications. Other institutions with notable contributions include the Egyptian Knowledge Bank (EKB), University of Cambridge, and University of Manchester, each with 7 to 8 publications. In terms of geographical distribution, these institutions span a diverse range of regions including the UK, Australia, USA, Egypt, Romania, Spain, Brazil, China, Croatia, and Italy. Although the contributing institutions are diverse, a noticeable concentration emerges, with several top-performing institutions originating from the UK and the USA. This pattern reflects the strong research capacity and established expertise in audit and governance within these countries. However, developed economies continue to dominate scholarly output in this domain. Although institutions from emerging markets, such as Egypt, Brazil, China, and Romania are represented, the majority of contributions still originate from traditionally research-intensive countries in Europe, North America, and Oceania. This pattern suggests that while interest in technology integration within internal auditing is becoming global, the academic leadership remains concentrated in well-established research ecosystems, highlighting a potential gap for broader engagement from developing regions.

Table 4: Top 15 Organisations or Institutes

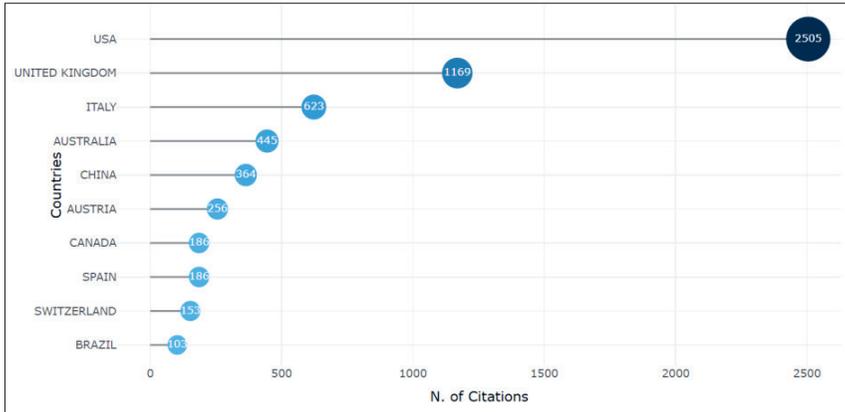| Organisations/Institutions	Publications	Country
University of London	12	UK
Royal Melbourne Institute of Technology (RMIT)	11	Australia
Egyptian Knowledge Bank (EKB)	8	Egypt
Bucharest University of Economic Studies	7	Romania
Universidad De Castilla-La Mancha	7	Spain
University of Cambridge	7	UK
University of Manchester	7	UK
University of Washington	7	USA
University of Zagreb	7	Croatia
Universidade De Brasilia	6	Brazil
University of California System	6	USA
University of North Carolina	6	USA
University System of Ohio	6	USA

| Chongqing Technology and Business University | 5 | China |
| Polytechnic University of Milan | 5 | Italy |

As illustrated in Figure 3, the United States leads scientific production in this field with 203 publications, followed by China (147), the United Kingdom (120), Australia (65), Italy (39), Spain (38), India (35), Indonesia (34), Brazil (32), and Canada (31). These ten countries collectively represent the most active contributors to research on technology integration in internal auditing. Research activity is heavily concentrated in North America, Western Europe, and East Asia, whereas most regions in Africa and parts of South America show minimal or no scientific output. In terms of scholarly influence, measured by total citations, the United States again ranks first with 2,505 citations, followed by the United Kingdom (1,169), Italy (623), Australia (445), China (364), Austria (256), Canada and Spain (186 each), Switzerland (153) and Brazil (103) (see Figure 4). While China demonstrates strong productivity, its relatively lower citation count suggests its research is still building international influence. Overall, the findings highlight the USA and UK as leading countries in terms of both research output and scholarly impact, while China's high publication volume signals growing momentum in the field.

Figure 3: Country's Acientific Production

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Figure 4: Most Cited Countries

3.3 Temporal Evolution of Research Themes

The temporal evolution of research themes offers crucial insights into how scholarly attention has shifted over time in the domain of technology integration within internal auditing. Thus, this study examines the temporal evolution of research themes across four distinct periods: 1986-2004, 2005-2013, 2014-2022, and 2023-2025 (Figure 5). This segmentation captures the emergence, continuity, and transformation of dominant scholarly themes, offering insights into both historical underpinnings and future research directions (Newaz & Appolloni, 2024).

In the foundational period (1986-2004), the thematic landscape was relatively narrow, with research primarily focused on audit and risk management. These themes reflect early conceptualisations of internal auditing, particularly its role in financial accountability and risk control. The appearance of IT governance also marks the beginning of scholarly engagement with technology-related audit structures.

The subsequent phase (2005-2013) witnessed a significant thematic broadening. New and emerging themes such as corporate governance, information security, information technology, and internal control began to surface, indicating a shift in focus toward integrating audit functions with enterprise-level control systems and cybersecurity. Notably, governance and IT governance continued to evolve, highlighting the growing role of internal auditing in managing both operational and technological risks.

During the 2014-2022 period, the field matured further with a

proliferation of themes that reflect a deeper engagement with digital transformation and ethical considerations in auditing. Core themes such as blockchain, audit quality, case study, and certification emerged alongside the continued presence of corporate governance and risk management. This period also saw the rise of governmentality as a critical lens through which audit practices and technological oversight were examined. The sustained momentum of IT governance underscores its centrality in navigating audit complexities in an increasingly digital environment.

Figure 5: Temporal Evolution of Keywords
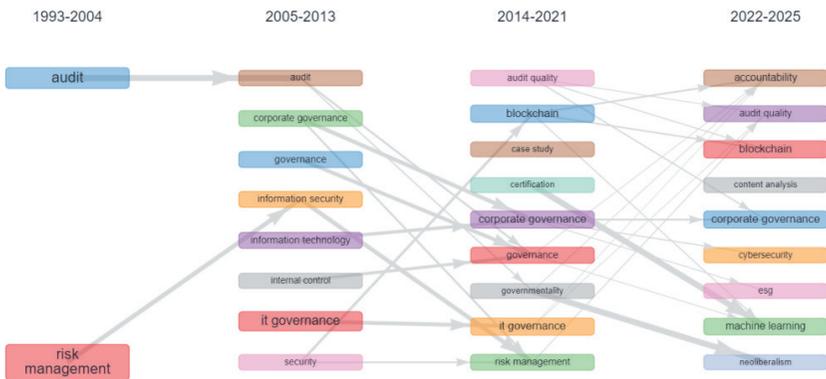
Finally, the most recent period (2023-2025) demonstrates a strategic shift toward automation, sustainability, and digital ethics. Themes such as machine learning, cybersecurity, ESG, and neoliberalism reflect a broadened research agenda that incorporates both advanced analytics and socio-political dimensions of audit practice. The continued strength of corporate governance, audit quality, and blockchain reinforces their enduring relevance as the field moves into an era marked by heightened expectations for accountability, transparency, and digital assurance. The thematic continuity of corporate governance, risk management, and IT governance, alongside the recent surge in machine learning and ESG, suggests that future research must balance technological advancement with ethical and institutional accountability.

3.4   Most Trending Topics

Despite growing scholarly attention in recent years, technology integration in internal auditing remains an emerging research domain. However, the topic has accelerated in momentum, particularly in the post-pandemic period, as evidenced by the clustering and expansion of keywords across time. Figure

6 illustrates the trending topics over the last two decades, highlighting not only the frequency of certain themes (represented by bubble size) but also their temporal relevance (denoted by the length of the horizontal bar).

Earlier research (2002-2014) emphasised foundational constructs such as services, business, model, agency costs, and frameworks, reflecting a conceptual phase where internal audit was linked to governance structures and cost-performance models. These themes served as entry points into more technology-oriented discourses. From 2015 onward, the field witnessed a thematic shift. Keywords such as governance, corporate governance, adoption, framework, information technology, and impact gained significant traction. Their prolonged presence and increasing frequency indicate their centrality to discussions around digital transformation in audit contexts.

Figure 6: Trending Topics in Technology Integration Within Internal Auditing
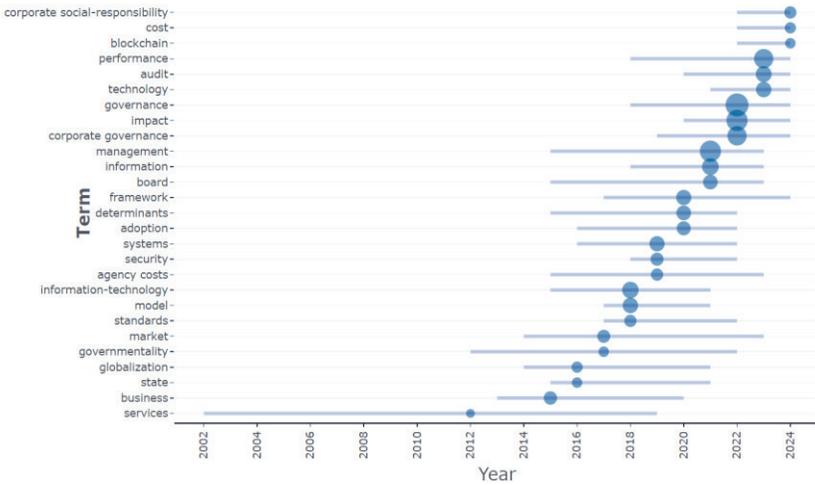
In recent years, a new wave of technology-driven terms has emerged. Notably, blockchain, cost, and corporate social responsibility have become more prominent in the 2020-2024 window. These keywords are not only frequent but also temporally concentrated, suggesting that they represent frontier themes driving the research discourse in internal auditing and technology. Their appearance marks a shift from general integration frameworks toward specific applications, ethical concerns, and economic implications of digital tools in audit processes.

These insights offer important implications for future research. For instance, the adoption and audit implications of blockchain technology, the cost-performance trade-offs of digital systems, and the intersection

between sustainability reporting (CSR) and internal audit oversight remain underexplored yet highly relevant. Additionally, emerging areas such as AI, machine learning, and data-driven audit assurance, while not dominant in this bubble chart are expected to define the next wave of research. Scholars are encouraged to explore these fast-evolving intersections to contribute to theory-building and practical frameworks that address audit quality, risk management, and accountability in a rapidly digitising audit environment.

3.5   Conceptual Thematic Map

Conceptual thematic mapping refers to determining and analysing continuing patterns or themes in a pool of research. The conceptual thematic mapping presented in Figure 7, within the technology integration research in internal auditing, identifies and categorises themes into four categories: niche themes (type 1), motor themes (type 2), emerging themes (type 3), and basic themes (type 4). These four quartiles help present and organise key patterns, concepts, and research areas, allowing researchers to understand the field better (Ahmad, Najam & Mustamil, 2024).

Figure 7: Thematic mapping
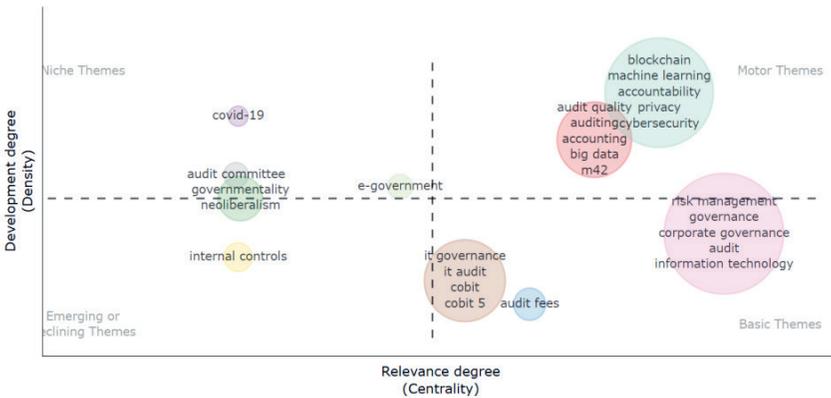
The topics in the type 2 quadrant have high density and high centrality connections and, thus, are regarded as mainstream or motor themes. Motor themes are usually incorporated with influential and well-developed themes in this research. This quadrant includes topics related to blockchain, machine learning, accountability, cybersecurity, and privacy, which are the themes that are currently driving the research momentum and shaping the strategic direction of internal audit transformation. However, the topics in quadrant type 3, with low density and centrality, are emerging or declining themes

with the potential to expand or decline further. Here, "internal controls" is the main keyword in this quadrant, suggesting a decline in isolated focus or a shift toward more integrated digital control systems.

The topics in quadrant type 4, with low density and high centrality, are fundamental and basic. This quadrant includes broad, well-established themes such as risk management, governance, corporate governance, audit, and information technology. These topics form the intellectual backbone of research on technology integration in internal auditing and remain central to theoretical and practical frameworks. The last quadrant (type 1) is the niche themes quadrant (top-left), keywords like COVID-19, audit committee, neoliberalism, and governmentality appear. These topics exhibit high density but low centrality, indicating tightly focused research clusters that may not yet be broadly integrated into mainstream discourse. While niche, they often represent critical contextual or sociopolitical explorations, and their position suggests potential for interdisciplinary expansion.

This mapping reveals that internal audit research is anchored by traditional governance and risk frameworks but is rapidly evolving toward advanced technology-driven themes. The strong positioning of machine learning, blockchain, and accountability as motor themes highlights the future trajectory of the field, while themes such as data ethics, governance, and internal control signal foundational debates that remain essential.

3.6   Co-word Analysis and Thematic Cluster

Using the co-occurrence feature in VOSviewer, this study performed a co-word analysis to uncover the underlying intellectual structure of research on technology integration in internal auditing. The resulting network, visualised in Figure 8 and detailed in Table 5, revealed five prominent thematic clusters. Each cluster represents a unique area of focus where keywords frequently co-occur, signifying distinct yet interrelated streams of inquiry in this evolving field.

The first cluster, Technological Integration in Risk Assurance, highlights the growing emphasis on using advanced technologies to enhance audit reliability and risk mitigation. Keywords such as risk management, blockchain, machine learning, cybersecurity, and data governance indicate a shift toward integrating intelligent systems within assurance functions. This theme reflects how technological tools are increasingly employed to strengthen transparency, privacy, and compliance in high-risk audit environments, particularly amid rising digital complexity.

The second cluster, Corporate Governance and Audit Performance, centres on the role of governance mechanisms in shaping audit outcomes. High-frequency terms like corporate governance, audit quality, impact, earnings management, and audit committee point to a growing body of research concerned with performance oversight, board accountability, and

Table 5: Thematic Clusters

Theme 1 (Technological Integration in Risk Assurance)	Theme 2 (Corporate Governance and Audit Performance)	Theme 3 (Policy and Institutional Governance)	Theme 4 (IT Governance Frameworks)	Theme 5 (Internal Control Systems and Analytics)
risk management (35)	corporate governance (66)	governance (98)	management (62)	internal control (17)
blockchain (30)	impact (54)	sustainability (18)	audit (47)	firms (11)
accountability (28)	performance (41)	policy (12)	IT governance (28)	big data (10)
technology (22)	risk (30)	globalisation (11)	information-technology (24)	CSR (7)
security (20)	quality (26)	governmentality (11)	framework (23)	internal control weaknesses (7)
privacy (15)	information (25)	market (11)	model (19)	internal controls (7)
transparency (15)	audit quality (16)	neoliberalism (10)	systems (19)	social media (7)
machine learning (14)	board (16)	corporate social-responsibility (9)	information technology (15)	ESG (6)
standards (13)	determinants (16)	efficiency (8)	adoption (14)	
compliance (12)	audit committee (14)	power (8)	business (14)	
auditing (11)	disclosure (13)	technologies (8)	IT audit (11)	
cybersecurity (11)	earnings management (13)	cost (7)		
challenges (10)	firm (13)	audit culture (6)		
cloud computing (10)	firm performance (12)	industry (6)		
accounting (8)	innovation (12)	state (6)		
corruption (8)	audit fees (10)	system (6)		
data governance (8)	agency costs (9)			
design (8)	ownership (9)			
implementation (8)				
information security (8)				
supply chain (8)				

the influence of audit structures on firm behaviour. This cluster underscores the managerial and strategic importance of auditing as part of broader corporate governance frameworks.

Figure 8: Network Diagram

In contrast, the third cluster, Policy and Institutional Governance, captures a more macro-level, policy-driven perspective on auditing. Dominated by keywords such as governance, sustainability, policy, globalisation, and corporate social-responsibility, this theme reflects the institutional, regulatory, and ideological contexts in which internal auditing operates. It indicates that researchers are increasingly examining how socio-political systems and public accountability shape the adoption and legitimacy of audit technologies, particularly in public and hybrid sector settings.

The fourth cluster, IT Governance Frameworks, turns attention to the technical and structural enablers of audit transformation. Keywords like IT governance, information-technology, framework, COBIT, and adoption reflect a focus on systems and models that align IT infrastructure with audit strategy. This cluster captures the methodological dimension of how internal audits are operationalised through formal frameworks and structured

governance tools, supporting the integration of digital capabilities within the audit function.

The fifth cluster, Internal Control Systems and Analytics explores data-intensive approaches and internal control mechanisms that underpin audit execution. Terms such as internal control, big data, social media, ESG, and CSR suggest a shift toward analytics-driven auditing with heightened attention to data assurance, ESG compliance, and risk profiling. This theme blends technological sophistication with core audit functions to support real-time monitoring and accountability. Researchers can explore future research possibilities on integrating technology in internal auditing by conducting multilevel studies that include the five suggested clusters.

3.7   *Theoretical Lenses*

With the help of the VOS viewer's text mining function and using the title and abstract fields of the selected articles, we identified key theoretical frameworks applied to examine the integration of technologies in internal auditing. VOS text mining function uses a binary counting method and provides the terms with the number of occurrences and their relative score. The relatedness of terms is determined by co-occurrences of keywords in the selected documents (Hofmann & Chisholm, 2016). As shown in Figure 9, three major theoretical lenses emerged prominently: the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Technology-Organisation-Environment (TOE) Framework. These frameworks appear interconnected with several relevant constructs such as acceptance, intention, usefulness, internal auditors, public sector, effort expectancy, and organisational readiness.

Figure 9: Network Visualisation of Theories in Technology Integration in Internal Auditing

Figure 10: UTAUT network link visualisation

Figure 11: Technology Acceptance Model (TAM) Network Link Visualisation
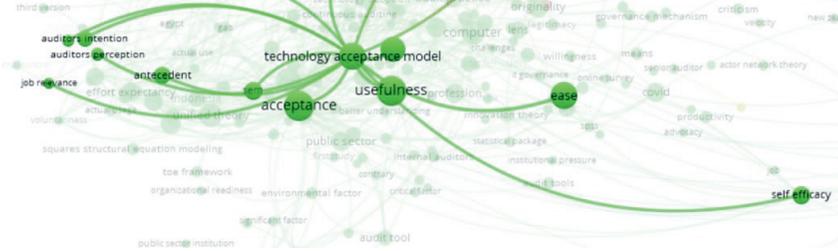
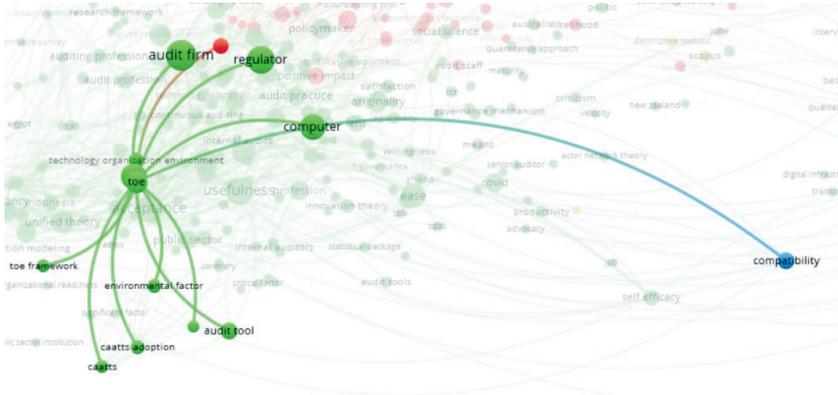Figure 12: TOE Framework Network Link Visualisation

Figure 10 visualises the UTAUT network, highlighting its association with terms such as acceptance, usefulness, auditing profession, audit firm, intention, performance expectancy, voluntariness, public sector, and blockchain technology. Developed by Venkatesh, Morris, Davis & Davis (2003), UTAUT integrates constructs from eight theoretical models (including TAM, TPB, and SCT) and has been widely adopted to examine user acceptance of new technology. In internal auditing, this theory helps explain how auditors' perceptions and external influences shape their willingness to adopt technologies such as blockchain and AI. The strong co-occurrence between UTAUT and blockchain underscores the rapid rise of blockchain-enabled assurance mechanisms and the importance of trust, integrity, and intention in technology uptake. In Figure 11, the Technology Acceptance Model (TAM) is mapped, showing its links to terms such as ease, usefulness, intention, technology acceptance, and computer. Originally proposed by Davis (1989), TAM has long served as a foundational model to assess perceived usefulness and perceived ease of use as drivers of technology adoption. In internal audit research, TAM is frequently used to explore how perceived benefits and simplicity of technology (e.g., audit tools, data analytics) influence internal auditors' behavioural intention and actual usage.

Figure 12 illustrates the TOE framework, which is prominently connected to terms like technology adoption, audit firm, environmental factor, public sector, organizational readiness, and audit tool. The TOE model, introduced by Tornatzky, Fleischer & Chakrabarti (1990), offers a comprehensive lens that considers how technological (e.g.,

perceived usefulness), organisational (e.g., top management support), and environmental (e.g., regulatory pressure) contexts collectively influence technology adoption. In internal auditing, TOE enables multi-level analysis, explaining how firm-level and ecosystem factors drive or hinder the integration of advanced technologies such as continuous auditing, CAATs, and cloud platforms. In conclusion, these three theories are central to understanding the behavioural and contextual drivers of technological change in internal auditing. Their application supports the development of robust models to assess auditor readiness, organisational capabilities, and broader institutional pressures influencing adoption decisions. As the field evolves, future studies may build on these theories or extend them to incorporate emerging constructs such as explainability, trust in AI, and risk perception.

4. Discussion

This bibliometric study explores the intellectual development and future trajectory of research on technology integration in internal auditing. The earliest article in this domain was published in 1993, marking the beginning of scholarly engagement with digital systems in internal audit. Using the Web of Science (WOS) database, a total of 1,037 articles published between 1993 and 2025 were retrieved and analysed. The annual scientific production shows a strong upward trend, particularly after 2015, reflecting the growing relevance of technologies such as AI, blockchain, and data analytics in audit functions. The field's average annual growth rate stands at 15.18%, supported by an average of 7.157 citations per document, confirming that technology integration in internal auditing is a high-impact and rapidly expanding area of research. Notably, the third decade (2014–2024) witnessed the most significant rise in publications, likely driven by increased regulatory pressure, digital transformation policies, and global investments in AI-led assurance systems by top firms and governments.

In response to the first research question (RQ1), this study identified the most influential sources, authors, institutions, and countries shaping the field. The analysis identified several core journals that consistently publish research in this domain, including the International Journal of Accounting Information Systems, Sustainability, Journal of Information Systems, and the Managerial Auditing Journal. These journals have consistently published high-quality work and attracted significant citations, making them essential outlets for researchers in this domain. On the institutional front, universities such as Rutgers University, the University of South Florida, and the University of New South Wales emerged as leaders, especially in North America and Australia. Country-wise, the United States dominated both in publication volume and citation impact, followed by the United

Kingdom, China, and Australia. Western countries also demonstrated stronger international collaboration networks, underscoring the need for broader engagement from emerging economies where technology adoption in auditing is growing but underrepresented in the literature.

To address RQ2, this study examined trending concepts and keyword frequency using word clouds, tree maps, and temporal keyword evolution. The analysis revealed a transition from early focus areas such as "information systems" and "internal control" to more recent terms like "artificial intelligence," "blockchain," "data analytics," "governance," and "risk management." This shift reflects how internal auditing has evolved from a procedural compliance function to a digitally driven, insight-oriented profession. Keywords such as "audit quality," "IT governance," and "fraud detection" have remained central across decades, indicating their persistent relevance. Moreover, newer themes such as "cloud computing," "continuous auditing," and "automation" suggest a broader convergence between IT innovation and audit methodologies. The results show that technology is not only transforming how audits are performed but also reshaping the conceptual vocabulary of internal auditing research.

In response to RQ3, the study used co-word analysis and cluster mapping to uncover the conceptual and thematic structure of the domain. Five distinct clusters were identified: (1) Technological Integration in Risk Assurance, (2) Corporate Governance and Audit Performance, (3) Policy and Institutional Governance, (4) IT Governance Frameworks, and (5) Internal Control Systems and Analytics. Each cluster reflects a unique but interconnected stream of research. For instance, Cluster 1 highlights risk-centric innovations like blockchain and cybersecurity, while Cluster 2 focuses on how technology influences audit performance and quality through governance mechanisms. Cluster 3 extends the discussion into policy, sustainability, and social responsibility contexts. Meanwhile, Cluster 4 provides insights into frameworks such as COBIT and IT audit standards, and Cluster 5 underscores analytics-driven auditing approaches. These clusters collectively map the intellectual terrain of the field and suggest a multidimensional approach to studying technology in internal auditing.

Lastly, RQ4 explored the theoretical foundations of the domain using text mining and network visualisations. The analysis revealed that only a limited number of studies are grounded in formal theoretical frameworks. Among those that did employ theory, the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Technology–Organisation–Environment (TOE) framework were the most prominent. TAM and UTAUT were typically used to study user acceptance of audit technologies, while TOE provided a broader context by integrating organizational and environmental factors. Despite their relevance, the application of these theories was inconsistent and often superficial.

Table 6: Future Research Agenda for Technology Integration in Internal Auditing

Emerging Theme	Research Gap	Suggested Future Direction	Supporting References
Transparency and explainability in internal audit	Limited research on how the explainability of audit technologies affects auditor's judgment confidence and risk assurance.	Investigate how transparent or interpretable audit tools (e.g., rule-based vs. black-box models) influence auditor's trust, perceived risk, and decision-making.	(Waltersdorfer & Sabou, 2025; Zhong & Goel, 2024)
Governance structures and internal audit effectiveness	Lack of studies linking governance structures (e.g., board independence, audit committees) to the performance impact of technology-integrated internal audits.	Empirically test how different governance structures affect internal audit effectiveness and decision-making in tech-enabled environments.	(Abdelrahim & Al-Malkawi, 2022; Popescu-Grădișteanu & Mocuța, 2023)
Human-AI collaboration in risk assessment	Lack of understanding of how auditors and AI systems interact in complex audit scenarios.	Explore models of shared decision-making between internal auditors and AI systems for tasks like risk prioritisation and fraud detection.	(Chassang, Thomsen, Rumeau, Sedes & Delfin, 2021; Iturbe, Rios & Toledo, 2023)
Real-Time Internal Control Systems	Limited research on continuous monitoring via real-time data and analytics.	Explore real-time, data-driven control environments enabled by automation and IoT.	(Leocádio, Malheiro & Reis, 2024; Wang & Vasarhelyi, 2024)
Ethical Governance of AI in Internal Auditing	Lack of comprehensive frameworks to guide the ethical use of AI in internal audit functions.	Develop ethical governance models and practical guidelines to ensure responsible AI deployment in audit activities such as risk assessment, compliance monitoring, and decision support.	(Laine, Minkkinen & Mantymaki, 2024; Murikah, Nthenge & Musyoka, 2024)

Many articles focused on descriptive analysis without embedding their work in theoretical models. This signals a critical gap in the literature and a need for more robust theory-driven research. Future studies could advance the field by integrating behavioural theories with audit-specific contexts, exploring cross-level interactions (e.g., between policy and individual auditor behaviour), and empirically testing conceptual models that capture the complexity of technology adoption in auditing.

Building on the insights gained from the bibliometric mapping, thematic clusters, and theoretical analysis, this study proposes a structured future research agenda to guide scholars in advancing the field of technology integration in internal auditing. Table 6 outlines five emerging themes, key research gaps, and actionable directions drawn from the intellectual landscape identified in this review. These recommendations aim to address conceptual fragmentation, encourage theory-driven exploration, and support practical advancements across governance, risk, transparency, analytics, and ethical AI implementation. By synthesising gaps across both established and emerging audit technologies, the table highlights opportunities for interdisciplinary research that aligns with the evolving demands of the internal audit profession. The next section concludes the study by summarising its key contributions, implications, and limitations.

5. Conclusion

This bibliometric study systematically examined the intellectual landscape, research trends, and thematic evolution of technology integration in internal auditing over the past three decades. Drawing from 1,037 publications indexed in the Web of Science database, this review mapped the growth trajectory of the field, identified key contributors and sources, and highlighted the most prominent topics and theoretical frameworks shaping the discourse.

The analysis revealed a significant rise in research activity after 2020, corresponding with the increasing adoption of artificial intelligence, blockchain, and data analytics in audit functions. Keyword and thematic analyses uncovered five major clusters ranging from technological risk assurance and corporate governance to internal control systems and IT governance frameworks. While the study found a growing interest in emerging technologies, it also noted the uneven application of theoretical frameworks such as TAM, TOE, and UTAUT, which indicates a need for stronger theory-driven investigations. Furthermore, influential journals, institutions, and countries were mapped to provide a clearer picture of knowledge dissemination and collaborative networks.

This study contributes to the internal audit literature by consolidating fragmented research, providing structured thematic clusters, and

synthesizing intellectual developments in technology integration within internal auditing. It highlights key themes shaping the field and identifies opportunities for advancing theory and practice. A comprehensive future research agenda has been outlined in the Discussion section, offering actionable directions for scholars and practitioners. These findings can help researchers, educators, and policymakers align academic inquiry with real-world technological advancements and auditing needs.

From a practical perspective, the results of this study can support audit firms, regulatory bodies, and professional associations in identifying strategic research priorities and developing training frameworks that prepare internal auditors for a technology-driven future. Moreover, the integration of ethical, transparent, and

context-specific technologies in audit environments remains an urgent area for investigation and policy support.

By aligning research efforts with the technological transformation of the audit profession, this study provides both a snapshot of scholarly progress and a forward-looking roadmap. It encourages future scholars to build on these foundations through interdisciplinary, theoretically grounded, and methodologically diverse investigations that can advance the role of internal auditing in the digital age.

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