

A bibliometric analysis of information technology and auditing publications

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Abstract: The recent demands of society as a result of modernisation have increased the need for information technology in auditing. This study seeks to evaluate the relationship between information technology and auditing while assessing the degree of information available for practitioners, students and researchers. Bibliometric and content analysis was used to review the auditing profession with regard to information technology. The study utilised data from the Scopus database for the period 1990 to 2023. A total of 637 documents were analysed. Citation analysis of documents and authors was applied in determining the impactful journals and influential authors in information technology within the auditing profession. The spontaneous increase in the number of publications over the years is evidence of the degree of research done on the subject. The analysis revealed that there is a positive relationship between auditing and information technology. The audit practice is seen to have involved meeting the demands of modern business by diversifying to cover different aspects of technological advancements being used in business. This resulted in the discovery of different audit and information technology forms that are linked to enable the achievement of objectives. The audit function has become a critical role required by stakeholders to ensure accountability for resources. Information technology has become an integral part of business processes aimed at ensuring efficient and effective operations. Consequently, I.T. is applied by auditors to evaluate technologically inclined businesses or enhance their operations.

Keywords: Information Technology, Auditing, Block chain, Bibliometric review

Introduction

The evolution of information technology coupled with the demands of modern society has increased the use of computers in the auditing profession. Computerisation plays a critical role in auditing by ensuring

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the integrity of information and reporting while safeguarding organisations against financial crises in the future (Senft and Gallegos 2014). According to the Indian Institute of Chartered accountants (2010), auditing under a Computerised Information System (CIS) environment requires auditors to be knowledgeable about the computer environment and abreast with current technology, even in the use of complex audit software. An efficient audit process requires practitioners to be knowledgeable in diverse fields (Daneci-Patrau and Spineanu-Georgescu, 2014; Ngungat and Lyimo, 2019). In the past, auditors used computers for making basic entries and calculations.

Incorporating technology in business has resulted in the development and adoption of several systems for the practice of auditing. Computer programs have been introduced to provide practitioners with varying packages that allow for completing tasks. Auditors use cloud computing for virtual information processing and analysis. Artificial intelligence is used to improve decision-making techniques (Sutton, Holt and Arnold, 2016) while blockchain technology is useful in analysing transactions (Dai & Vasarhelyi, 2017; O'Leary, 2017; Yermack, 2017). The Indian Institute of Chartered Accountants (2010) opines that, auditing under a computerised environment is characterised by speed, minimum clerical error, logical information processing platform, technological systems of internal controls and interacting computing systems for human use. Computers have become an integral aspect of organisational processes (Héroux & Fortin, 2013). Modern businesses rely on I.T. for their operations, this has increased the need for internal auditors with requisite expertise in information systems to be able to adequately evaluate risks that arise in business processes (Chen, Smit, Cao and Xia, 2014). Internal audit quality is thus, enhanced when information technology is incorporated into audit processes.

Organisational objectives are achieved when there are effective systems of internal controls in place. Internal auditing is designed to give management assurance on the efficacy of organisational governance processes. Auditors use information technology to retrieve online data, record manual data, analyse information, prepare working papers, evaluate audit criteria and report on findings. Accordingly, this research aims to analyse the Relationship between Information Technology and Auditing Publications about how information technology enhances auditing and whether audit publications are sufficient in Information Technology.

Technology has become an important tool in organisational processes by providing an avenue for effective operations. In this digital age, organisations require technology for smooth operations to ensure the effective and efficient use of resources (Mustapha and Lai, 2017). The integration of technology in business operations increases transaction processing and results in competitive advantage through the reduction of costs, human errors and inefficient processes (Abu-Musa, 2008). The auditor is challenged by increased calls for the incorporation of varying fields of expertise to achieve stakeholders' desired results (Ebimobowei, Kereotu and Brass Island, 2011). Stakeholders are of the view that confidence in the relevance of audits will be enhanced when there is a radical change in the practice of I.T. audits to reflect the demands of modern society (Appiah, Ametepe and Dapaah, 2014).

The existence of controls in a computerised environment is evident in the practices, policies and processes designed to guarantee the achievement of organisational objectives. The incorporation of audits with information technology results in advanced methods of risk detection compared to the traditional methods which use manual methods for audit procedures (Higgins and Nandram, 2009).

Notwithstanding, there is limited literature on the relationship between information technology and auditing publications about how information technology enhances auditing and whether audit publications on Information Technology are sufficient. This study thus will seek to fill the research gap by making a Bibliometric Analysis of Information Technology and Auditing Publications.

Methodology

The study utilised publications from Scopus with the information technology auditing, computerised auditing, audit, information technology, auditor, audit practice and, audit evidence'. The use of eight

keywords is to ensure wide coverage of literature. This method was adopted in ensuring that the term ‘audit’ was sufficient in representing the profession with the keywords - “audit” or “auditor” “auditing” or “auditors” “auditing profession” or “audit profession” (Mumin et al., 2020)

The study used the Booleans search technique within Scopus database to acquire documents covering the topic ‘auditing AND information technology’. The population covered publications covering the period 1990 to date. This is a reliable scope in analysing the evolution of information technology and auditing and the impact of information technology on the auditing profession over the years. This is to ensure that all relevant data (publication) on the subject of study is included in the analysis. The period is considered suitable because it encompasses the period of globalisation of the World Wide Web which popularised the use of the internet in the early 1990s (Mugwira, 2022; Marson, 1997). The population considered generated 1,341 documents on the Scopus database.

To arrive at an appropriate sample for the study. The sampling criteria targeted the subject area, type of document, stage of publication, keywords and language. The sample used for the analysis was from 15 journal sources, written by 12 authors with at least 2 publications and linked to 83 institutions. This resulted in a sample size of 637 documents for the analysis. The sampled documents comprised 309 articles, 274 conference papers, 32 conference reviews and 22 reviews. According to Mumin et al (2020), including conference proceedings in the study will give the research a wide coverage of relevant studies on internet-related technologies in the audit profession.

Strategy

The findings will be analysed using bibliometrics. Bibliometric techniques are quantitative tools used to analyse literature reliably (Meditati et al., 2018). The study will use citation analysis, network analysis, bibliographical coupling and content analysis. Citation analysis will be used to show the performance of journals, articles, institutions and authors (Zupic & Ater, 2015). The study will review global and national publications every year. Bibliometric coupling is preferred because of its applicability in mapping current research fronts (Aria & Cuccurullo, 2017). The analysis will be carried out using VOSviewer and Excel.

Bibliometric Analysis

Annual publications

Table 1 below shows the yearly publication of documents on information technology and auditing on an annual basis. This is interpreted in the graph. The y-axis (horizontal side) is the number documents published per year. Series 1 represents the yearly publications and Series 2 is the cumulative number of publications available on the subject matter. The results show that studies on auditing and information technology began to rise steadily in 1998. It can be observed that the years 2020 and 2021 recorded the highest number of documents published on the subject matter. The year 2022 is the second highest (having 53 publications) even though the chart shows a decline in publications that year.

Table 1: Yearly research publications

Year	Publication	Cumulative Publications	Year	Publication	Cumulative Publications
1990	1	1	2003	7	42
1991	0	1	2004	19	61
1992	1	2	2005	22	83
1993	0	2	2006	12	95
1994	1	3	2007	18	113
1995	1	4	2008	30	143
1996	7	11	2009	25	168
1997	2	13	2010	31	199
1998	8	21	2011	33	232
1999	3	24	2012	22	254
2000	3	27	2013	31	285
2001	8	35	2014	18	303
2002	0	35	2015	26	329

Year	Publication	Cumulative Publications
2016	24	353
2017	30	383
2018	41	424
2019	35	459

Year	Publication	Cumulative Publications
2020	61	520
2021	61	581
2022	53	634
2023	3	637

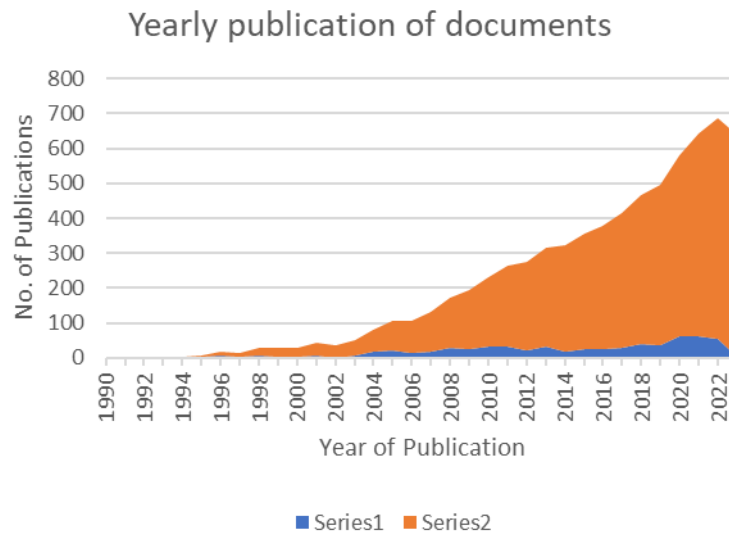


Figure 1: Annual publications

Country-specific production

Data was analysed to determine extent of research studies on the subject presented in Figure 2 and Table 2. The results were generated on a country basis. 83 countries were identified to have contributed a minimum of one (1) document on the subject. The total strength of co-authorship link with other countries was calculated and the country with the greatest link selected.

The pictorial visualisation shows that the United States dominated the research stream on the subject with increased studies spanning from 2012. The second dominant country shown is India with publications spanning from 2018 with a decline in 2018. Despite research on the subject in Africa dates back to 2012, the overall production is documents is low with no relationship with publications of other countries.

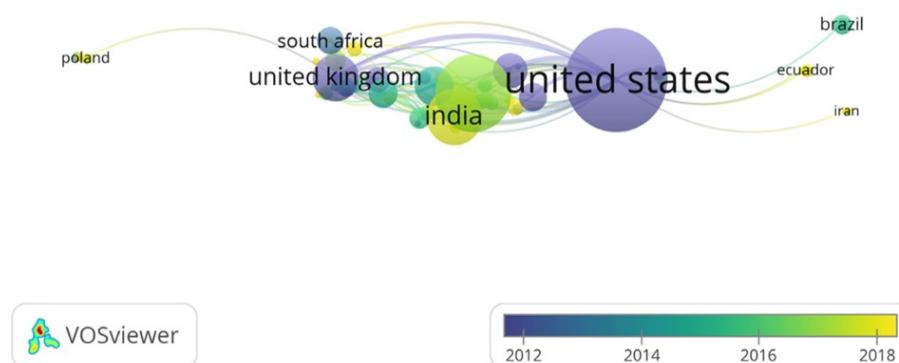


Figure 2: Country-specific production

Table 2: Countries with the largest set of items

Country	Publications	Citations	Percentage
United States	174	4054	27.230047
India	62	556	9.7026604
United Kingdom	46	1257	7.198748
Ecuador	5	6	0.7824726
Brazil	10	29	1.5649452
Iran	2	16	0.312989

Country	Publications	Citations	Percentage
South Africa	18	465	2.8169014
Poland	4	21	0.6259781

Citation analysis

Zuptc and Ater (2015) opined that citation analysis is used to deduce the performance of publications in relation to journals, articles, institutions and authors. This study used the analysis to determine the connection among documents, authors and sources. This is relevant in answering the first research question. Documents (279) with a minimum of 5 citations were considered for the analysis. 14 documents had the highest connection. This result is displayed in Figure 3. As could be seen in Figure 3, the citation connections between them are shown as arrows. The size of each node reflects the number of citations that the publication has received from other publications within the dataset. The green cluster consisting of Bierstaker et al. (2001), Du and Cong (2010), Eulerich and Kalinichenko (2018), Alles et al. (2006), Groomer and Murthy (2004). These references primarily revolve around impact of information technology on accounting and auditing process. Furthermore, a significant portion of the literature delves into the functionality of information technology reducing manually of accounting and auditing and revolving challenges accompany this revolution, exploring the different dimensions and indicators that contribute to the overall effectiveness and reliability of audit processes.

Purple cluster consisting Bierstaker et al. (2001), Murthy and Groomer (2004), Janvrin (2001), Zhao et al. (2004) and Flowerday and von Solms (2005). These references concentrate on digitalisation impact on financial reporting and other key areas of financial accounting. The cluster represented by yellow nodes indicates the low number of references made to Eulerich (2014) in the area of continues auditing quality of information technology is key in achieving this objective.

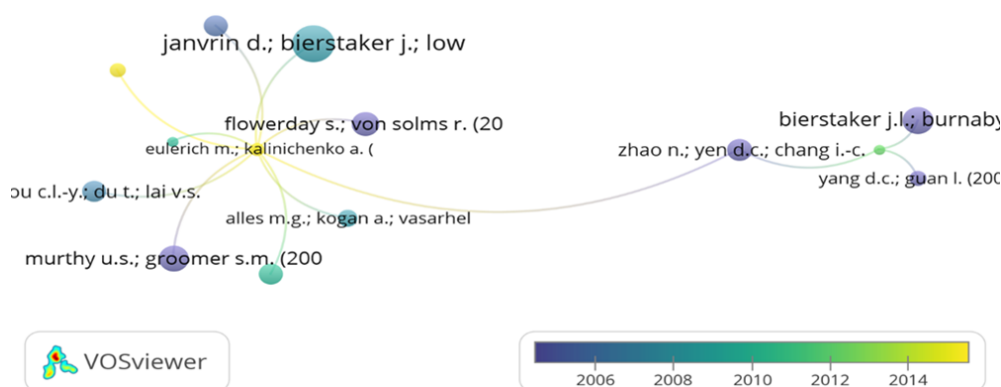


Figure 3: Citation analysis

Table 3: Citation analysis

Authors	Documents	Citations	Total Link Strength
Antipova T	3	20	0
Bukhsh F. A.; Weigand H	2	7	0
Elshiekh A. A.; Dominic P. D. D.	2	5	0
Flowerday S.; Von Solms R	2	63	0
Kotb A.; Roberts C.	2	28	0
Maciejewska I	2	1	0
Mkoba E.; Marnewick C	2	13	0
Pathak J.	2	35	0
Pedrosa I.; Costa C. J	2	15	0
Ren Y.; Shen J.; Wang J.; Fang I	2	6	0
Rosli K.; Yeow P.H.P.' Eu-gene S	2	20	0
Vroom C.; Von Solms R.	2	301	0

The citation analysis of authors with a minimum of two documents were analysed. Totally, 12 authors were identified to meet this threshold. The analysis revealed that there is no link among the authors. This result is displayed in Table 3 and Figure 4.

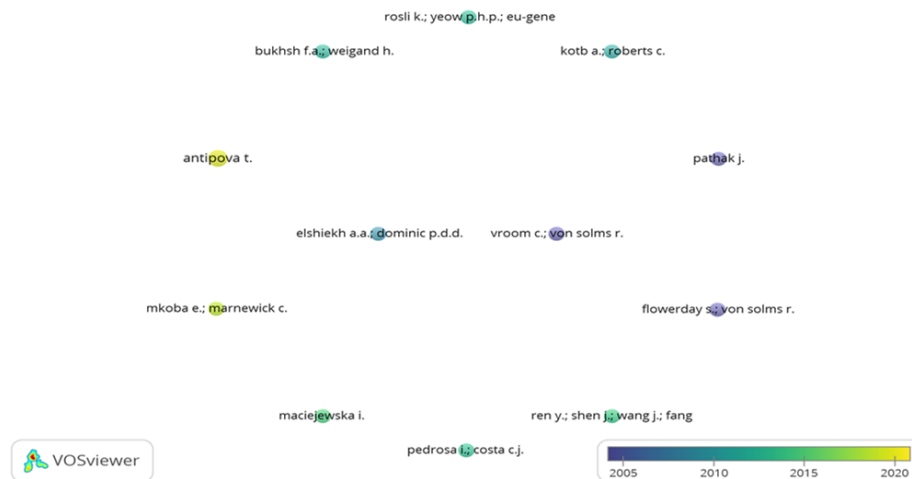


Figure 4: Author citation analysis zero (0) connection

The document and author citation analysis identified 12 influential authors in the subject matter. Citation analysis of document sources was conducted with keywords of five documents per journal or source. It was revealed that seven sources had the largest set of connected items. The sources identified to be the most influential per the subject matter are: Journal of Information Systems, International Journal of Accounting, ACM International Conference, Decision Support Systems and Computers and Security. The most influential publications in a research area is useful in identifying the most relevant articles with impactful ideologies as well as possibility of recommending future research areas (Alon et al., 2018). The most influential articles are assessed based on the article with the strongest link with other publications. The basis for determining the link is the total number of publications and citations. Therefore, the article with the strongest list has a high quantity of documents and a huge number of citations. In lieu of this, the journal of information systems is considered the most influential out of the five influential sources because it has a huge number of document citations and quantity of publications. This is shown pictorially in Figure 5 and in Table 4.

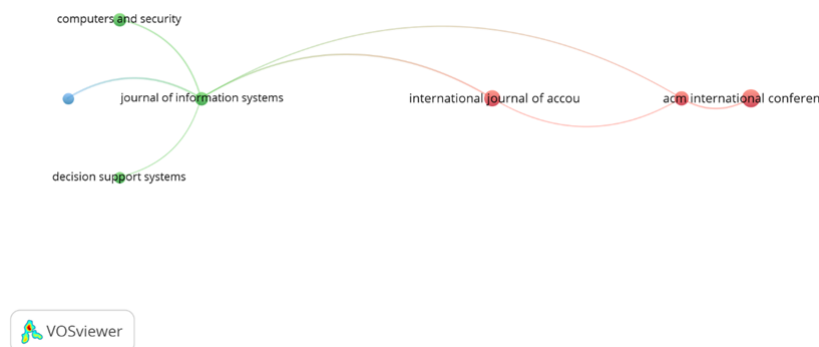


Figure 5: Source citation analysis

Table 4: Source citation analysis

Sources	Publications	Citations	Total link and strength
Journal of Information Systems	8	717	9
Computers and Security	8	439	2
Decision Support Systems	5	94	1
International Journal of Accounting	14	502	3
ACM International Conference	19	60	2

Bibliographic co-occurrence

Co-occurrence on words was used to determine evolution of keywords on auditing and information technology. This analysis is used to answer the second research question. The relationship between the

variables was analysed by running co-occurrence on author key words. The search method used is full counting. Documents with a minimum of 5 occurrence of the keywords was selected for the analysis. The bibliographic results as presented in Table 5 and Figure 6 show the association between auditing, information technology and other audit and IT related keywords such as big data, internal auditing, continuous auditing, accounting, block chain management, internal controls, data security, distributed ledger technology. The results show that studies on auditing, internal auditing, risk management and information technology were dominant in 2010. The periods 2012 to 2016 witnessed researches in auditing and cloud computing, continuous auditing and data securities. This result is similar to the results of Mugwira, (2022) which revealed that, the period 2010 to 2019 was characterised by astronomical rise in related key words on internet related technologies on auditing such as cloud computing, blockchain, big data, machine learning and data analytics.

Table 5: Co-occurrence of keywords

Keywords	Occur- rences	Link Strength	Keywords	Occur- rences	Link Strength
Auditing	105	101	Information systems	14	19
Block chain	63	78	Internal Auditing	16	18
Cloud computing	41	51	Internal Audit	16	17
Accounting	24	46	Integrity	8	16
Information Technology	40	37	Internal control	9	12
Continuous auditing	24	28	Auditors	9	13
Audit	28	22	Cloud storage	13	12
Public auditing	16	22	Risk management	8	12
Artificial intelligence	11	21	Block chain technology	8	3
Big data	20	21	I. T. Audit	8	9
Data security	10	20	Communication technologies	6	6
Information security	20	20			

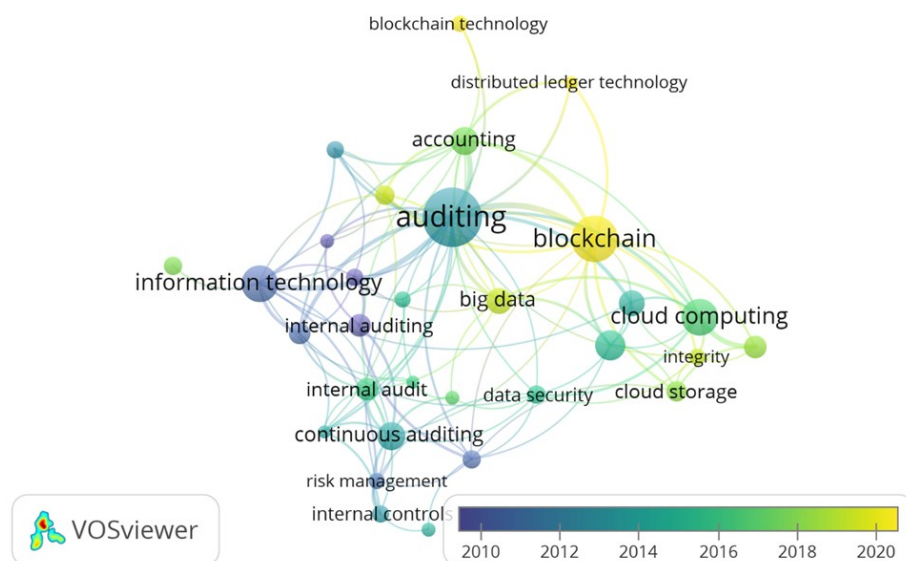


Figure 6: Co-occurrence of keywords

Bibliographical coupling

This approach was used to identify underlying research streams. This analysis is useful for forming a basis for answering the third research question. 639 documents were analysed with a minimum of 5 citations per document. 279 items met the search criteria, however, the analyses concluded that only 9 documents with a minimum of 3 clusters were linked seen in Figure 7. The research streams found in the literature include the effect of information technology on audits, the impact of big data on auditing, challenges associated with Cloud computing in the audit profession and factors that influence the use of artificial intelligence.



Figure 7: Document bibliographical coupling

Effect of Information Technology on auditing

In the past, auditors relied on financial statement information in assessing risk (Song et al, 2014). This caused standard setters to clearly define the responsibility of the auditor as evidence gathering aimed at providing reasonable assurance. The responsibility for the prevention of fraud is now charged to management. Information technology has helped auditors in making informed fraud evaluations on unorganised data (Dong et al., 2018). Client information technology resources are essential in bringing improvement to current and future audit efficiency (Pincus et al., 2017). According to Malaescu and Sutton 2015, external auditors' reliance on internal audits is increased when internal audit activities are I.T inclined.

Impact of big data on auditing

Big data is a series of interrelated data with a wide-reaching system characterised by storage difficulties, complicated analysis and interpretation. In the audit practice, big data can be used internally and externally. Practically, the degree of use of big data by clients determines the amount of big data to be used by auditors (Dagilien & Klovien, 2019; Lombardi et al., 2014). The audit opinion is therefore affected by big data discrepancies between auditors and clients. According to Earley (2015), an audit-client relationship is improved through big data auditing. The major inhibition to the adoption of big data in business and auditing despite its benefits is the lack of skills required to successfully implement big data to auditors and businesses. This situation is worsened by the high cost of training available for auditors. Dagilien and Klovien (2019) opined that audit firms' financial constraints are a major determinant in ascertaining the ability to implement big data auditing.

Challenges associated with cloud computing on the audit profession

Cloud computing is a system that offers virtual products such as storage and applications, among others. It offers auditors the opportunity to offer services to both service providers and users (Schmidt et al., 2016) as well as use the products (Hu et al., 2018). Cloud systems are practically essential to audit practice.

The main challenges faced by audit practitioners with regard to cloud technology are information confidentiality and data privacy towards public cloud services (Yigitbasioglu, 2015). Chou, 2015 established that data restriction as a result of client data privacy can make auditing cloud computing systems complicated.

Bibliometric Findings

The bibliometric findings show that there is a positive relationship between information technologies and auditing, in that, the auditing profession has evolved over the years to incorporate varying technological systems in the practice. This is consistent with the results of Thottoli, Thomas and Essia, (2019) in which it was concluded that a strong relationship exist between information communication technology and the software used in auditing. This makes the profession relevant to meet the demands of modern business.

Degree of information on IT auditing available for practitioners, students and researchers

There are several studies on information technology and auditing, dating back as far as 1990. The increasing level of research available reached its peak in 2021 and began to decline in 2022. The decline is due to the advancement of the profession into other aspects of technology such as block chain, cloud computing, data security among others. The United States of America dominated the research streams with 174 documents cited 4,054 times. This was followed by the United Kingdom, with a total of 46 documents, cited 1,257 times. South Africa was the highest linked African country with 18 documents sighted 465 times. This implies that African researchers have not done a lot of research on information technology and auditing. However, students and practitioners all over the world can conveniently have access to studies and information through the internet. The internet provides an avenue for practitioners to learn and businesses to explore the latest software and opportunities in the form of training available for them. Students and researchers can access the information they require to inform future research on auditing.

Impact of Information Technology on auditing

Information technology has revolutionised auditing by providing practitioners systems to help in the discharge of their duties. The study showed that audit is adopting to the different tenants of information technology introduced into the business environment. The analysis showed researchers assessing the practice of audit in diverse technological environments and businesses. Information technology has changed the methods through which auditors analyse and report transactions as well as the practical methods of implementing standards of practice.

Challenges associated with Information Technology auditing

The study revealed that the main challenges associated with implementing information technology audit practices are cost and training. The cost of implementing a computerised system is seen to be high for most local audit firms and small to medium organisations. The decision to use a computerised system or software depends largely on the nature of the clients' business or operating methods of the firm being audited and the auditing firm's acceptable procedures for service delivery. The ability of an auditor to use information technology in his work or work in a technologically inclined organisation will influence the use of information technology. The other challenges identified include security and privacy threats.

Discussion

Information technology plays a vital role in the achievement of organisational objectives by providing systems that make operations effective. In applying the agency theory to this study, the responsibility of management and auditors in the achievement of organisational objectives is assessed. The responsibility of management to detect and prevent fraud implies implementing computerised systems that will ensure effective and efficient suggestions without exposing the organisation to risks. Management of a technologically inclined business should put in place controls to prevent unauthorised access, data security, among others.

The use of information technology in audit processes is more efficient in an environment where management has implemented technology in its operations and implements a system of internal controls to ensure efficient implementation. With regards to the policeman theory, the study evaluates the level of knowledge on the responsibility of the auditor available to the public to help bridge the expectation gap in the profession. The theory suggests that, whether the auditor is applying traditional/manual practices or computerised practices, the auditor is responsible for the detection and prevention of fraud. Auditors however apply professional judgement in discharging duties. The study found that several attempts have been made and still being made by researchers in support of standard setters to provide information on the role of information technology in the work of the auditor. This will help close the 'expectations gap' and enhance public confidence in auditors.

Some studies have also attempted to delve into new aspects of information technology by linking the audit practice to businesses operating in computerised environments and auditors appointed to work in such environments.

According to Solvito (2016), despite the level of efficiency associated with technologically controlled environments, over dependence on them raise concerns of system failure risks. The study found that, lack of expertise to implement technological audit procedures can hamper an auditor's ability to effectively assess computer systems to give an opinion. Auditing involves the application of professional judgement in deciding the procedures to apply on an audit. Auditors rely on their skills, experience and professional code of ethics in making professional judgement. I.T skills in auditing should be applied in audit assignments to produce reliable audit findings and reports.

Conclusion

This study has offered the current state of research concerning the influence of information technology on auditing. It was revealed that the effect of digital technologies on auditing have changed a lot overtime, with a lot more research happening in business, economics, computer science and information systems. Technology assisted audit practices have grown over the years with little studies done in Africa and most carried out in the USA. The assessment of journal publications revealed that, the five leading journal publications in the field are the Journal of Information Systems, International Journal of Accounting, ACM International Conference, Computers and Security and Decision Support System. The increasing level of research available reached its peak in 2021 and began to decline in 2022. The decline is due to the advancement of the profession into other aspects of technology such as block chain, cloud computing, data security among others. The United States of America dominated the research streams. This was followed by the United Kingdom with limited research from Africa. This implies that African researchers have not done a lot of research on information technology and auditing.

The study contributes to auditing literature by providing a review of the auditing profession with regards to the information technology demands of modern society. The dominance in research by the USA calls for studies from other countries and continents around the world. Collaboration among researchers and institutions should be encouraged so as knowledge sharing.

Notwithstanding the above, the limitation to this study relates to the use of data extracted solely from the Scopus database. Other social sciences journals that have in-depth publications on the topic are not catalogued within the Scopus database. Hence, these published articles were not included in this study. It is thus recommended that future research endeavours encompass the inclusion of documents emanating from both the Scopus and web of science databases.

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