

# Exploring *Data Analytics* Adoption in Auditing: Opportunities and Challenges in Malaysia's Big 4 Firms

Siti Salimah Binti Jalal<sup>1</sup>, Dahlia Fernandez<sup>2</sup>, Khairul Najmuddin bin Abd Majid<sup>3</sup>

<sup>1</sup>Faculty of Accountancy, Universiti Teknologi MARA (UiTM) Cawangan Johor, Kampus Segamat, Johor, Malaysia; [salimahjalal@uitm.edu.my](mailto:salimahjalal@uitm.edu.my)

<sup>2,3</sup>Faculty of Economic and Management, Universiti Kebangsaan Malaysia, UKM

---

## Abstract

*The capabilities of data analytics have expanded considerably as the auditing profession emphasizes the necessity to find, understand and validate organization data to facilitate accurate choices and judgements. The efficiency and acceptance of big data analytics in auditing in need for further evidence, hence, this study aims to explore the challenges and opportunities of adoption data analytics in Malaysia's Big 4 audit firms. Total of 13 semi-structured interviews has been conducted using qualitative analysis with the auditors from Malaysia's Big 4 audit firms. The participants involve in audit operational for engagements that prioritize the planning, execution, reporting, and assessment of the audit engagements. Hence, thematic analysis framework was used. Nevertheless, this study provides evidence towards challenges in implementing data analytics and the opportunities. Thus, the findings underscore critical themes related with challenges, including skills and knowledge gaps, technological barriers and organizational resistance. In addition, the findings emphasize significant themes related with opportunities, including enhanced audit quality and efficiency, professional development, strategic insights for firms. Thus, this study has contributed substantial implications for practitioners and the literature as it advances the knowledge of data analytics in diverse settings and offer insights to policymakers and organization, particularly in accounting and audit industry.*

**Keywords:** (Data Analytics; Audit; Big 4; Challenges; Opportunities)

---

## INTRODUCTION

The enormous volumes of data that are generated daily from a variety of sources has become a forefront attention of a Big Data concept. The amount of Big Data is growing at rapid rate, it is resulting on both such as benefits and issues as well (Berisha et al., 2022). Along with Big Data, the business relies on data analytics for decision making (Kumar, 2015). The use of data analytics has become increasingly widespread because of its ability to manage different kinds of data. To perform audit procedures such as matching purchase orders e.g. invoices and payments, analysis of revenue trends by product and identifying the combinations of users involved in processing transactions from metadata attached to transactions will be carried out with the assistance of data analytics (ACCA, 2020). Data might be deemed "big" when the information system has reached its full capacity or unable to do the particular purpose (Vasarhelyi et al., 2015). As a result, the accounting profession, particularly auditing, is not an exception regarding the implementation of data analytics and this is because audit firms are required to manage both financial and non-financial data pertaining to their clients. Indeed, one of the primary characteristics of data analytics is the ability to handle both structured and non-structured data in sophisticated ways, which may then be handled by auditors in accordance with the reality of prescriptive analytics (Appelbaum et al., 2017). The use of data analytics into audit processes has resulted in a transformation of the way audits are carried out, making them more effective as well as efficient in detecting risks (KPMG, 2014). However, this transition is not without its challenges. Adapting traditional auditing methods to integrate new technologies comes with challenges like ensuring data security, managing system complexity and aligning data analytics tools with existing audit frameworks.

Although previous studies have concentrated on challenges and opportunities in developed countries, there is still a knowledge gap about its challenges and opportunities in emerging countries such as Malaysia, especially considering the increasing integration of digital transformation technologies across various industries (Zaki et al., 2023). The unique social, economic, and regulatory environments in these contexts, particularly within Malaysia's Big 4 audit firms, bring their own set of challenges and opportunities. Therefore, this study aims:

RO1: To uncover the challenges and opportunities encountered by auditors in adopting data analytics, providing in-depth insights for both academic understanding and professional application.

Furthermore, this study aims to gain insightful evidence of the relevant factors on challenges and opportunities on the adopting the data analytics in auditing where this study leads to the following research questions:

RQ1: What are the challenges and opportunities of adopting data analytics in auditing?

This paper will offer a clearer understanding and evaluation on challenges and opportunities on adopting the data analytics in auditing and to help the professionals to overcome the potential challenges and provide the vision of areas for improvement. Based on the literature, there is insufficient empirical research concerning the benefits of adopting data analytics on audit profession and academic curriculum in developing country like Malaysia. According to previous studies, there are lack of empirical evidence and limited qualitative studies on exploring the competitive advantages and challenges faced by the auditors implementing the data analytics (Abdelwahed et al., 2024; Sihombing et al., 2023; Ditkaew & Suttipun, 2023; Kend & Nguyen, 2022). Moreover, most of these studies collected the evidence from Middle East and Europe countries and emphasize more on the impact of the adoption data analytics towards audit quality, auditors' judgements and reviews. Thus, this study aims to investigate the challenges and opportunities on adopting the data analytics in Malaysia's Big 4 audit firms.

## LITERATURE REVIEW

This section provides a presentation and synthesis of previous research on the Big 4 audit firms, data analytics in auditing, as well as the opportunities and challenges of adoption and identify research gaps.

### The Big 4 Auditing Firms

The Big 4 refers to the four largest accounting and auditing firms in the world, which bring in billions in revenue. Ranked by 2020 revenue figures, the Big 4 are Deloitte LLP (Deloitte), PricewaterhouseCoopers (PwC), Ernst & Young (EY) and Klynveld Peat Marwick Goerdeler (KPMG), respectively. These firms handle many of the audits for United States corporations with publicly traded stock (Matthews, 2024). The Big 4 audit firms increasingly adopt data analytics to enhance their external audit capabilities (Liew et al., 2022). Moreover, current business environment demands external audit to provide more comprehensive analysis of all operational processes, require shifting in skill sets for both new and existing external auditors (Lugli & Bertacchini, 2023). Moreover, integrating data analytics into Malaysia's Big 4 audit firms comes with its own set of challenges, shaped by factors like organizational readiness, technological advancements and environmental pressures (Warren et al., 2015).

### Overview of Data Analytics in Auditing

The term data analytics refers to exceptionally massive data collections that may be studied using technology to identify patterns, trends, and relationships. The crucial aspect to emphasize is that the notion is always developing as digital transformation and dependency progress. Indeed, aside from evolution, the 3Vs, Volume, Velocity, and Variety, serve as a consistent description of data analytics (Sidhu, 2021). Likewise, data analytics can analyse a huge dimension of structured and unstructured data from multiple sources. Structured data is data that well-ordered and saved in relational databases such as spreadsheets while unstructured data on the other hands, data that is gained from sources that is not well-organised. Examples of unstructured data are images, videos, website contents and open-ended survey replies (Mills, 2019). In audit profession, the term of data analytics is defined as combination of various types of data such as internal data, external data, structured data, unstructured data, financial information, non-financial information, emails, logistic data, call logs and social media data (Alles & Gray, 2016). Since auditing deals with the recording transactions, information process, financial analysis and reporting of financial information, thus, auditing professionals lays an important in data analytics (Liu & Vasarhelyi, 2014). Data analytics have been unquestionably transformational technologies that have changed the accounting profession during the last decades (Schmidt et al., 2020). On top of that, data analytics could be one of the most reliable instruments of accountants and auditors in tracking business performance, particularly in analytical evaluation for long-term viability.

### Challenges and Opportunities in Data Analytics Adoption

In accordance with technology development, the opportunity brought by data analytics is enhance the efficiency where this tool offered a massive data storage and analytics features which suits for auditors to analyze financial statements and gathering financial and non- financial data. Indeed, this technology break the limitations of audit coverage especially in transactions and risk testing (IAASB, 2013). Audit works may be less complexity, and it has changed the way of how auditors conduct their audit judgements and procedures. These tools can also be used to create audit programs that are specifically tailored to the risks faced by a given client or to feed data directly into computerized audit procedures (ACCA, 2020). The enhancement of data analytics technology in modern era has introduced many automations process could be completed during audit process e.g. testing the whole population. The increased use of data analytics also increases the chances to redress some of the

balance and auditors might have extra ability to test more transactions and balances. Thus, the chances of detecting red-flags or potential fraud inefficiencies and opportunities is higher for a clients' business (ACCA, 2020). Besides, to gain the consistency of professionalisms, reviews from experienced staff should be implemented during the audit workflows (IAASB, 2013). Thus, a quality of an audit can be enhanced when it is separated to partially human and computerized where it has the decentralization of duties.

Shimamoto (2010) stated that high competition within the firms and continuous requirements of audit clients to reduce the audit fees pressured the audit firms to take serious in audit efficiency. Auditors need to aware with the automated process when implementing data analytics tools since automation process requires strong structure and well-organised. A better understanding during the process needs to be acquired to determine the right time and process to use the automation and thus, the appointment of qualified and expert auditor especially IT Audit could ensure the success of these effort (Alsahli & Kande, 2020).

By adopting advanced analytics tools steadily develop the auditors to be *tech-savvy* as they will using the software on daily basis eventually will increase the engagement for further skills and expertise development (Shimamoto, 2010; Fernandez et al. 2023). The importance of team training is to ensure the tools provided would be fully utilise by the users and to avoid any time wasted on the trials so that the time-saving benefits can be obtain. When users mastered the automates repetitive tasks thus audit team can reduce their time required for any data analysis and focus more on the complex and value-added activities such as data interpretation (Zahoor, 2024). By adopting advanced analytics tools also creates the challenges and the need of the engagement for further skills and expertise development (Shimamoto, 2010). The important of talent development is to ensure the tools provided would fully utilise by the users and to avoid any time wasted on the trials so that the time-saving benefits can be obtain. Indeed, the skill and knowledge gap are focusing more on the complex and value-added activities such as data interpretation (Zahoor, 2024). However, SAP Concur (2024) stated that there were the challenges which being concern associated with data analytics and auditing. Firms are suffering to hire - the industry observed slightly plunge in accounting graduates and the employees' workload given. Therefore, few strategies to mitigate the issues. Embracing the automation digital tools, there is a possibility to streamline repetitive tasks and loosen employees' time taken on a particular audit procedure. In addition, improve communication and collaboration which foster clear communication channels between audit team and travel managers to ensure alignment of objectives, timelines, expectations. This can enhance feedback sessions to deliver the concerns among auditors and optimize workflows. A better collaborative audit team could leverage the audit workflows and utilize analysed data and management.

Besides, the cost allocation for data analytics adoption is one the challenges which influence the effectiveness and efficiency of the advanced tools. An efficient operation is achieved when cost allocated for production is at the lowest but generates income at its maximum potential. In that case, business always prioritize to reduce cost for a particular product or services to leverage the profitability ratio (KPMG, 2014). Other than that, besides reducing cost of a production, by eliminating unnecessary activities could save the time taken for each audit job.

## METHODOLOGY

### Research Design

This paper aims to explore the challenges and opportunities on the adoption of data analytics throughout the Malaysia's Big 4 auditing firms. The most appropriate for data collection is through qualitative method, as data analytics is a relatively new phenomenon in industry, and there is no adequate empirical data for this paper to conduct a quantitative method. Descriptive and explanatory in nature and non-standardized is a method of qualitative research (Yilmaz, 2013). Indeed, a qualitative method would emphasize the process and environmental settings for interpretation to gain deeper understandings and insights in this research paper. Qualitative research is a subjective and interpretive nature; thus, the data were collected through interviewing the participants (Saunders & Townsend, 2016).

### Data Collection

To obtain comprehensive insights grounded in individuals' expertise and experience (Fernandez & Aman, 2022), this study conducted 13 semi-structured online interviews via the Google Meet platform. This qualitative method was selected to explore auditors' perceptions of data analytics and their perspectives on integrating such technologies into professional practices. Semi-structured interviews are particularly effective in eliciting in-depth, authentic responses and are known to yield reliable and comparable qualitative data. Each interview lasted between 30 minutes to one hour. The 13 participants were professionals involved in audit operations,

particularly in planning, executing, reporting, and evaluating audit engagements to meet the expectations of external regulators and stakeholders. Participants were purposefully selected based on their relevant knowledge, professional background, familiarity with data analytics issues, and willingness to share their insights and experiences. This purposive sampling approach aligns with the study's objective of exploring the challenges and opportunities surrounding the adoption of data analytics in audit practices.

### **Data Analysis**

The interviews were conducted in English, and transcripts were analyzed using a thematic approach to provide context and identify areas needing further explanation. A comprehensive approach was used to identify recurring patterns and themes such as skills and knowledge gaps, technological barriers, organizational resistance, enhanced audit quality and efficiency, professional development and strategic insights for firms.

### **Ethical Consideration**

Researchers utilizing human data in their studies must conform to ethical standards and beliefs. The reference for the publication is (Kaewkungwal & Adams, 2019). When addressing research practices in the corporate realm, the term "ethics" is frequently employed to denote a collection of regulations or principles that researchers are expected to follow. The validity of the findings hinges upon the adherence of all parties participating in the research, including the investigators, sponsors, and participants, to the most rigorous ethical standards. The researcher who commences the study must do so with sincerity, diligently consider the implications of the findings, relinquish personal biases, and operate in a manner that promotes the overall welfare of the organization rather than their own interests. Every individual involved in the research team, including the investigators, participants, analysts, and communicators, must consistently adhere to ethical standards. Researchers are required to adhere to ethical principles at every stage of the study, including data collection, analysis, report writing, and internet dissemination (Sekaran & Bougie, 2016). Prior to the study, the interviewees were requested to provide their informed consent. The participants were provided with information regarding the objectives of the study and any expected results. Individuals can have confidence in the assurance that their personal information and privacy are safeguarded.

## **RESULTS**

Findings section will discuss on the challenges in adopting data analytics and the opportunities in adopting data analytics in Malaysia's Big 4 audit firms.

### **Challenges in adopting Data Analytics**

#### **Skill and Knowledge Gaps**

According to Liew et al. (2022), the complexity of data analytics highlights the necessity for auditors to develop the skills required to effectively operate analytic tools in auditing. Acquiring these analytical skills becomes especially crucial during the initial stages of adoption ensures that auditors can effectively leverage data analytics to enhance audit processes and outcomes.

*"Complexity again it goes back to skills and if the person is actually equipped with that level of knowledge and skills that needed to be used when you are using that software or tools."* –

IV3 *"...I think skills are important, not just for your work at EY, but also to external. Because technology surrounds us in this industry right now. By having this kind of ability, if let's say you are able to do so in EY, so you also have the ability to master it if you are being joined any other organization or having new things outside."* – IV1

#### **Technological Barriers**

Investing in advanced data analytics tools, infrastructure and software can be costly when allocating a strain on budgets (Eilifsen et al., 2020). On top of that, staff training or hiring skilled professionals to use these tools adds to the expenses create financial challenges that often make it harder for organizations to fully embrace data analytics, hence, slowing its adoption and integration into audit procedures.

*"...it's just not that do you want to install the software itself but how you maintain the software itself. How you maintain the software itself can sometimes make costly, can be monthly."* –

IV12

*"...when we migrate onto another technology or software, the cost to implementing is one of the major costs. Organization could also aware the cost to hire the experts, maintenance and provide trainings for the users."* – IV11

#### **Organizational Resistance**

The reluctance to embrace new technologies is the main challenge when implementing data analytics in organizations, especially in contexts where prior experience with new systems has led to implementation issues or user resistance (Earley, 2015; Zainol et al., 2017). The employees and even management may resist the

changes due to the discomfort with disrupting familiar workflows or doubts about their ability to use advanced tools effectively. This hesitation can delay progress and prevent the organization from fully benefiting from data analytics.

*"...I can say that the reluctant to change of the associates to change the technology unless it really benefits us. For early stages, maybe the reluctant is obvious because of the hardships, you know tight datelines and we want to adapt with new environment."* – IV11

### **Opportunities in adopting Data Analytics**

#### **Enhanced Audit Quality and Efficiency**

A proactive approach delivered by data analytics supports auditors to not rely on traditional method of sample and journal entry testing. It is shown that both processes require time consumption which auditors need to test big amount of clients' data. Moreover, analytics tool allowing auditors in Big 4 to provide actionable insights whereby it added value to the firm in general (Balios et al., 2020).

Auditors may gain benefits from data analytics in analysing huge amounts of data like transactions in shorter time and accurate, manage to select reliable samples and identify unusual transactions. Data analytics reduce time consumption which allows auditors to give judgement effectively (De Santis and D'Onza, 2021). Hence, the adoption of data analytics improving the firm's value and associates in terms of audit efficiency.

*"...data analytics is something that is always being highlighted as an important tool for all associates to learn. And I think it's because even data analytics means from every data that you have, what are the actionable insights that you need to take."* – IV5

#### **Professional Development**

The adoption of data analytics offers audit firms a powerful opportunity to gain a competitive advantage in the industry. By integrating data analytics into their processes, firms can deliver audits that are not only more efficient but also more insightful, meeting the increasing expectations of clients for data-driven decisions. The ability to analyse complete datasets rather than relying on samples allows firms to uncover patterns, trends, and potential risks with greater accuracy, setting them apart in terms of service quality.

Data analytics also enables audit firms to offer additional value-added services (Salijeni et al., 2018). For instance, through advanced analytical tools, auditors can provide clients with actionable insights into their operations, financial health, and potential areas for improvement. These insights go beyond the traditional scope of auditing, positioning firms as strategic partners rather than mere compliance checkers. This distinction can be a key differentiator in attracting and retaining clients in a competitive market.

Moreover, firms that are newly adopter of data analytics can build a reputation for innovation and forward-thinking, enhancing their brand image and appeal. Clients increasingly prefer working with firms that demonstrate technological expertise and a commitment to staying ahead of industry trends. According to Appelbaum et al. (2017), investing in data analytics not only improve their operational efficiency but also create a lasting impression of reliability, precision and adaptability which are critical factors in securing a competitive edge.

*"...it's not only an added value for our firm if we can master the data, but for us too. Like we may get the opportunities to get promoted from PwC or from other companies out there."* – IV8

#### **Strategic Insights for Firms**

The adoption of data analytics may provide in-depth insights towards specific audit procedures. Data analytics assists the auditors' judgement and thus helps the organization to improve decision making process. Indeed, the urge of adopting the data analytics considered as the strategic insights to remain sustain and competitive. As mentioned by IV6, the valuable insights provided by data analytics helps the firm to meet their clients' expectations in embracing the efficiency and the effectiveness of advanced analytical tools in audit (Saleh et al., 2022).

*"...the benefits in terms of efficiency and audit quality make it a necessity rather than an option. Clients also expect us to leverage advanced analytics to provide more value-added insights compared to other Big 4."* – IV6

## **DISCUSSION**

Overall, the findings shows that the challenges and the opportunities of data analytics adoption in the Big 4 firms. The findings from the study discovered the challenges of adoption data analytics were the skill and knowledge gaps, the technological barriers and organizational resistance. On the other hand, the opportunities of adoption of data analytics were discovered from this study are enhance the audit quality and efficiency, the

growth in the professional development and produce strategic insights to meet clients' expectations and remain competitive.

Initially, the higher implementation costs and integration complexity of data analytics tools create barriers to progress. Resistance to change and lack of skilled personal disrupt the progress as well. Subsequently, the knowledge and skill gap associated with these tools and the high adoption cost further hinder progress, particularly among auditors who are reluctant to migrate from existing systems.

Despite these challenges, this study highlights several opportunities including data analytics allows for deeper insights, improves audit efficiency by enabling more comprehensive test, anomaly detection and risk assessment. Data analytics improves audit productivity by automating repetitive processes and allowing auditors to focus on high value areas like judgement and analysis. Besides that, data analytics enhances decision-making which enabling the firms to maintain a durable competitive advantages in the current marketplace. In results, firms must prioritize training programs to equip their auditors with the necessary analytical skills (Abdelwahed et al., 2024).

## CONCLUSION

This paper examines the challenges and opportunities encountered by auditors in adopting data analytics in the Big 4. Significant challenges including high costs, skill gap, technological barriers and the auditors' acceptance hinder for full adoption. Despite these barriers, data analytics offers great opportunities such as enhanced audit efficiency, improved auditors' judgements and remained competitive among the Big 4. This study fulfills a need in the literature by shedding light on the practical implication on the challenges and opportunities on adopting data analytics in a developing country context in Malaysia by addressing a gap in research dominated by prior research from developed countries. The integration of data analytics into auditing represents a transformative shift, essential for adapting to the demands of modern business environments. While the challenges remain, the opportunities far outweigh them, offering firms a pathway to innovation and enhanced client value.

Furthermore, this study contributes the insight on the challenges and opportunities in the Big 4 audit firms especially in the developing countries and precisely for the policymakers and organizations notably audit firms. In addition, this study limitation towards the focus on the challenges and opportunities on the adoption of data analytics in Malaysia Big 4 audit firms, limiting its scope to big audit firms rather than small and medium-sized audit firms or public audit firms. Future research could also examine small and medium-sized audit firms or public audit firms to understand the adoption challenges and opportunities across a broader context.

## REFERENCES

1. Abdelwahed, A. S., Abu-Musa, A. A., Moubarak, H., & Badawy, H. A. (2024). The use of big data and analytics in external auditing: Does audit firm size matter? Evidence from a developing country. *South African Journal of Accounting Research*, 38(2), 113–145. <https://doi.org/10.1080/10291954.2023.2279751>
2. Abdelwahed, A. S., Abu-Musa, A. a. E. S., Badawy, H. a. E. S., & Moubarak, H. (2024). Investigating the impact of adopting big data and data analytics on enhancing audit quality. *Journal of Financial Reporting & Accounting*. <https://doi.org/10.1108/jfra-12-2023-0724>
3. ACCA. (2020). *Data analytics and the auditor* | ACCA Global. Accaglobal.com. [https://www.accaglobal.com/gb/en/student/exam-support-resources/professional-exams\\_study-resources/p7/technical-articles/data-analytics.html](https://www.accaglobal.com/gb/en/student/exam-support-resources/professional-exams_study-resources/p7/technical-articles/data-analytics.html)
4. Alles, G. M, & Gray, G. L. (2016). Incorporating big data in audits: identifying inhibitors and a research agenda to address those inhibitors. *International Journal of Accounting Information Systems*, Vol. 22, pp. 44-59.
5. Alsahli, M., & Kandeh, H. (2020). Effect of Big Data Analytics on Audit : An exploratory qualitative study of data analytics on auditors' skills and competence, perception of professional judgment, audit efficiency and audit quality.
6. Appelbaum, D., Kogan, A., & Vasarhelyi, M. A. (2017). big data and analytics in the modern audit engagement: *Research needs*. *Auditing*, 36(4), 1–27. <https://doi.org/10.2308/ajpt-51684>
7. Balios, D., Kotsilaras, P., Eriotis, N., & Vasiliou, D. (2020). Big Data, Data Analytics and External Auditing. *Journal of Modern Accounting and Auditing*, 16(5). <https://doi.org/10.17265/1548-6583/2020.05.002>
8. Berisha, B., Mëziu, E., & Shabani, I. (2022). Big data analytics in Cloud computing: an overview. *Journal of Cloud Computing*, 11(1), 24.
9. De Santis, F., & D'Onza, G. (2021). Big data and data analytics in auditing: in search of legitimacy. *Meditari Accountancy Research*, 29(5), 1088–1112. <https://doi.org/10.1108/medar-03-2020-0838>
10. Ditkaew, K., & Suttipun, M. (2023). The impact of audit data analytics on audit quality and audit review continuity in Thailand. *Asian Journal of Accounting Research*, 8(3), 269–
11. 278. <https://doi.org/10.1108/ajar-04-2022-0114>
12. Earley, C. E. (2015). Data analytics in auditing: opportunities and challenges. *Business Horizons*, 58(5), 493-500.

13. Eilifsen, A., Kinserdal, F., Messier, W. F., & McKee, T. E. (2020). An Exploratory Study into the Use of Audit Data Analytics on Audit Engagements. *Accounting Horizons*, 34(4), 75–103. <https://doi.org/10.2308/horizons-19-121>
14. Efficiently Using Data Analytics in the Auditing Process. (2024). Concur.com.sg. <https://www.concur.com.sg/blog/article/efficiently-using-data-analytics-in-auditing-process>
15. Fernandez, D., & Aman, A. (2022). The Influence of RPA Technology on Employee Skills in the Accounting Profession / Pengaruh Teknologi Automasi Proses Robotik terhadap Kemahiran Pekerja di Profesi Perakaunan. *Jurnal Pengurusan*, 65, 71-82.
16. Fernandez, D., Dastane, O., Omar Zaki, H., & Aman, A. (2023). Robotic process automation: bibliometric reflection and future opportunities. *European Journal of Innovation Management*.
17. IAASB (2013). A Framework for Audit Quality. [www.iaasb.org](http://www.iaasb.org). <https://www.iaasb.org/publications/framework-audit-quality-2>
18. KPMG. (2014). *Going beyond the data: Achieving actionable insights with data and analytics*.
19. Amstelveen, Netherlands: KPMG International Cooperative.
20. Kaewkungwal, J., & Adams, P. (2019). Ethical consideration of the research proposal and the informed-consent process: An online survey of researchers and ethics committee members in Thailand. *Accountability in research*, 26(3), 176-197.
21. Kend, M., & Nguyen, L. A. (2022). Key audit risks and audit procedures during the initial year of the COVID-19 pandemic: an analysis of audit reports 2019-2020. *Managerial Auditing Journal*, 37(7), 798-818.
22. Kumar, B. (2015). An encyclopedic overview of 'big data' analytics. *International Journal of Applied Engineering Research*, 10(3), 5681-5705.
23. Liew, A., Boxall, P., & Setiawan, D. (2022). The transformation to data analytics in Big-Four financial audit: what, why and how? *Pacific Accounting Review*, 34(4), 569–584. <https://doi.org/10.1108/par-06-2021-0105>
24. Liu, Q., & Vasarhelyi, M. A. (2014). Big questions in AIS research: Measurement, information processing, data analysis, and reporting. *Journal of Information Systems*, 28(1), 1-17.
25. Lugli, E., & Bertacchini, F. (2023). Audit quality and digitalization: some insights from the Italian context. *Meditari Accountancy Research*, 31(4), 841-860.
26. Matthews, M. (2024). The Big 4 Accounting Firms: An Overview and Comparison. Indeed Career Guide. <https://www.indeed.com/career-advice/career-development/big-4-accounting-firms>
27. Mills, K. A. (2019). *Big data for qualitative research* (p. 90). Taylor & Francis.
28. Qureshi, M. I., Bhatti, S. H., & Khan, N. (2025). From hype to reality: a systematic literature review of blockchain's role in sustainable supply chain management. *Journal of Management History*.
29. Saleh, I., Marei, Y., Ayoush, M., & Afifa, M. M. A. (2022). Big Data analytics and financial reporting quality: qualitative evidence from Canada. *Journal of Financial Reporting & Accounting*, 21(1), 83–104. <https://doi.org/10.1108/jfra-12-2021-0489>
30. Salijeni, G., Samsonova-Taddei, A., & Turley, S. (2018). Big Data and changes in audit technology: contemplating a research agenda. *Accounting and Business Research*, 49(1), 95–119. <https://doi.org/10.1080/00014788.2018.1459458>
31. Saunders, M. N., & Townsend, K. (2016). Reporting and justifying the number of interview participants in organization and workplace research. *British Journal of Management*, 27(4), 836-852.
32. Schmidt, P. J., Riley, J., & Swanson Church, K. (2020). Investigating accountants' resistance to move beyond excel and adopt new data analytics technology. *Accounting Horizons*, 34(4), 165–180. <https://doi.org/10.2308/HORIZONS-19-154>
33. Sekaran, U., & Bougie, R. (2016). *Research methods for business: A skill building approach*. John Wiley & sons.
34. Sidhu, R. B. (2021, June 21). *Big Data and data Analytics: The future of audit*. BDO. <https://www.bdo.my/en-gb/insights/featured-insights/big-data-and-data-analytics-the-future-of-audit>
35. Sihombing, R. P., Narsa, I. M., & Harymawan, I. (2023). Big data analytics and auditor judgment: an experimental study. *Accounting Research Journal*, 36(2/3), 201-216.
36. Shimamoto, D. C. (2010). Automation is Key to Improving the Efficiency and Effectiveness of Audits. [PDF]. Available via: <https://www.confirmation.com/media/1309/white-paper-automation-is-the-key-rev.pdf>. [Retrieved 2020-03-29].
37. Vasarhelyi, M. A., Kogan, A., & Tuttle, B. M. (2015). Big Data in accounting: An overview. *Accounting Horizons*, 29(2), 381-396.
38. Wang, T., & Cuthbertson, R. (2014). Eight issues on audit data analytics we would like researched. *Journal of Information Systems*, 29(1), 155–162. <https://doi.org/10.2308/isys-50955>
39. Warren, J. D., Moffitt, K. C., & Byrnes, P. (2015). How Big Data Will Change Accounting. *Accounting Horizons*, 29(2), 397–407. <https://doi.org/10.2308/acch-51069>
40. Yilmaz, K. (2013). Comparison of quantitative and qualitative research traditions: Epistemological, theoretical, and methodological differences. *European journal of education*, 48(2), 311-325.
41. Vichayanon Rattanawiboonsom, Sikandar, H., Uthen Thatsaringkharnsakun, & Nohman Khan. (2025). The Role of Mobile Technologies in Tracking Cyberbullying Trends and Social Adaptation among Teenagers. *International Journal of Interactive Mobile Technologies (ijim)*, 19(01), pp. 171–186. <https://doi.org/10.3991/ijim.v19i01.52747>.
42. Vichayanon Rattanawiboonsom, & Nohman Khan. (2024). Blockchain Technology in Mobile Payments: A Systematic Review of Security Enhancements in Mobile Commerce. *International Journal of Interactive Mobile Technologies (ijim)*, 18(21), pp. 134–148. <https://doi.org/10.3991/ijim.v18i21.52099>.
43. Zahoor, A. B. (2024, April 23). Unlock the power of data analytics in auditing for enhanced accuracy and efficiency. *Streamline processes and ensure compliance*. LinkedIn.com. <https://www.linkedin.com/pulse/data-analytics-auditing-enhancing-accuracy-efficiency-ahmad-bilal-mdhif#:~:text=Data%20analytics%20in%20auditing%20refers>
44. Zaki, H. O., Fernandez, D., Dastane, O., Aman, A., & Sanusi, S. (2023). Virtual reality in digital marketing: research agenda based on bibliometric reflection. *Marketing Intelligence & Planning*, 41(4), 505-524.

46. Zainol, Z., Fernandez, D., & Ahmad, H. 2017. Public sector accountants' opinion on impact of a new enterprise system. *Procedia Computer Science*, 124, 247-254.