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The Use of Big Data in Analytical Audit Procedures: A Literature Review

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ABSTRACT

Purpose: This study aims to analyze how Big Data and Big Data Analytics (BDA) are used to strengthen analytical audit procedures in accordance with ISA 520, while identifying the benefits, implementation challenges, and research development directions.

Research Method: The study used a Systematic Literature Review (SLR) approach with the PRISMA 2020 guidelines. The identification, selection, and thematic synthesis processes were carried out for 10 articles on Big Data, analytical procedures, and audits in accordance with professional standards.

Results and Discussion: Findings show that BDA strengthens analytical procedures at all stages of the audit, namely planning, substantive testing, and closing. Big data analytics enables comprehensive population analysis, more accurate expectations, and more precise anomaly detection than traditional techniques. Big Data can improve audit quality by enabling more accurate risk identification and greater process efficiency, potentially reducing audit delays. However, implementation faces obstacles related to auditor competence, infrastructure readiness, varying data quality, and privacy and information security risks.

Implications: This study clarifies the mechanism for integrating Big Data into analytical procedures in accordance with ISA 520. It supports the need for technical guidelines, analytical models, and the strengthening of auditors' digital audit capabilities.

Keywords: big data; big data analytics; analytical procedures; isa 520; audit quality; audit analytics.

Introduction

The development of information technology and the era of big data have fundamentally changed how business entities generate, store, and use financial and non-financial information. An IDC report (2023) estimates that the global data volume ("datasphere") will exceed 180 zettabytes by 2025, reflecting the acceleration of digitalization across all sectors, including accounting and auditing. In the context of auditing, these dynamics are driving a paradigm shift from traditional sampling-based

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approaches and manual procedures toward the use of Big Data Analytics (BDA) and Audit Data Analytics (ADA), which can process massive datasets in real time. This approach allows auditors not only to review a small portion of the data but also to evaluate the entire transaction population to detect anomalies, risks, and unusual patterns more quickly. On the other hand, International Standard on Auditing (ISA) 520 emphasizes that analytical procedures are an integral part of the entire audit process, from the planning stage (risk assessment) and substantive testing to the overall review at the end of the audit. ISA 520 defines analytical procedures as "the evaluation of financial information through the analysis of reasonable relationships between financial and non-financial data, as well as the investigation of fluctuations or inconsistent relationships." The integration of big data and analytical procedures is believed to improve audit efficiency and effectiveness, for example, by reducing audit delays, strengthening risk assessment, and enriching audit evidence. However, its implementation faces significant challenges, including the readiness of the technological infrastructure, limitations in auditor competence, and the need to adjust audit methodologies to applicable professional standards (ISA, 2020).

This phenomenon highlights the gap between the potential of technology and actual practices in the field, making research on the use of big data in analytical audit procedures essential to understand how this technology can improve the quality of audit evidence while maintaining compliance with international auditing standards. State-of-the-art research positions Big Data Analytics (BDA) as a data-based audit capability that expands the scope, depth, and accuracy of audit evidence compared to conventional techniques.

At the operational level, Kaya et al. (2018) show that Big Data analytics improves the effectiveness of internal audits, particularly by identifying anomalies and exceptions, thereby making audit procedures more sensitive to hidden patterns of deviation. From the perspective of the auditor's cognitive process, Ahmad (2019) asserts that Big Data analytics can reduce cognitive errors by helping auditors process complex information more systematically, thereby improving the quality of professional judgment when dealing with extensive, diverse data. The dimension of fraud detection is also strengthened; Tang & Karim (2019) emphasize that Big Data improves fraud detection by expanding the size of information and strengthening analytical procedures, enabling auditors to test reasonableness based on richer data relationships. The next key advancement is the shift from sampling to complete population analysis; Kend & Nguyen (2020) explain that this shift gives auditors more time for critical evaluation and professional judgment, supported by multi-perspective evidence from systematic reviews and empirical interviews. The literature also confirms the ability to generate insights and risk patterns (Sayedahmed et al. (2022) and the potential for fraud detection and enhanced business intelligence by Chu & Yong (2021), but it remains overshadowed by challenges in audit standards and client digital maturity (De Santis & D'Onza, 2021) as well as the need for continuous skill development (Herath & Hamm, 2023). Recent evidence is consistent: Ismail & Abdul Hamid (2024) reviewed 97 articles and confirmed the prospects for improved quality and transparency, while Almeida-Blacio (2025) emphasized continuous auditing and early detection; but Abdelwahed et al. (2024) highlight barriers to data standardization, infrastructure needs, and specialized training that make implementation vary according to company size.

Although contemporary literature has demonstrated the benefits of Big Data Analytics (BDA) for auditing, ranging from improved effectiveness in identifying anomalies (Kaya et al., 2018), reduction of auditor cognitive errors (Ahmad, 2019), to enhanced fraud detection through expanded information

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and analytical procedures (Tang & Karim, 2019), empirical and theoretical gaps remain evident. Empirically, most of the evidence summarized continues to focus on aggregate outcomes, such as improved audit quality and efficiency, as shown in the syntheses by Hezam et al. (2023) and Hosni et al. (2024). However, relatively few studies describe specific audit mechanisms, namely, how BDA changes the way auditors build expectations, assess fairness, and decide on follow-up actions when deviations are identified. As a result, findings on audit transformation often stop at claims of benefits, without a sufficiently detailed explanatory model of the audit evidence and reasoning process at the procedural level. From a theoretical perspective, the literature tends to position BDA as a technological innovation that adds to audit capabilities but has not yet fully integrated BDA into the normative-standard framework that governs analytical audit practices. While Kend & Nguyen (2020) emphasize the transition from sampling to full-population analysis, few studies have evaluated the methodological consequences of this transition for the quality of evidence, including the risks of false positives and false negatives, and the need for professional documentation when algorithms produce complex patterns. The challenges highlighted by De Santis & D'Onza (2021) regarding the lack of audit standards and client digital maturity, as well as the emphasis by Herath & Hamm (2023) on the need for skills development, show that adoption issues are not only technical but also institutional and competency related. The implementation barriers identified by Abdelwahed et al. (2024), namely data standardization, infrastructure, and specialized training, also indicate that the generalization of findings across contexts is still weak, necessitating a research agenda that tests the integration of BDA at the audit procedure level more measurably and consistently.

This study examines the shift in focus from simply summarizing the benefits of Big Data Analytics (BDA) in general to developing a more procedural understanding of how BDA works in audit practice. This study offers a synthesis of the literature that maps the core mechanisms of BDA use in auditing, from how auditors build data-based expectations, evaluate the reasonableness of the relationship between financial and non-financial information, identify and classify anomalies, to determining the appropriate follow-up steps when deviations occur. In addition, this study positions the shift from sampling-based testing to complete population analysis as a methodological issue that must be discussed systematically, including the consequences for the quality of evidence, the potential for detection errors such as false positives/negatives, and the need for professional documentation of analytical model outputs so that audit conclusions remain accountable. On the other hand, this study integrates challenges that have been discussed separately, such as the lack of standardization, infrastructure inequality, client digital maturity, and the need to improve auditor competence, into a single conceptual framework that explains the prerequisites for credible and consistent BDA implementation. The objectives of this study are to compile a comprehensive literature review to clarify the role and mechanisms of BDA at the audit procedure level, formulate a conceptual integration framework that can be used as a reference for future practice and research, and identify a more measurable empirical research agenda so that the results of cross-context studies can be compared and generalized more robustly.

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Literature Review and Hypothesis Development

Analytical Procedures in Auditing Based on ISA 520

Analytical procedures in auditing, based on ISA 520, are procedures for evaluating financial information by analyzing reasonable relationships between financial and non-financial data, accompanied by an investigation of fluctuations or relationships that are inconsistent with other relevant information. Within this framework, ISA 520 positions analytical procedures not as a supplement, but as an audit tool that helps auditors build a pattern-based understanding and professionally accountable expectations, so that deviating findings can be systematically traced through questions, additional testing, and management explanations. The emphasis on "reasonable relationships" requires auditors to design rational expectations, for example, by comparing interperiod trends, ratios, or operational indicators that can explain the dynamics of certain accounts, while paying attention to the risk of material misstatement that may be hidden behind seemingly normal figures. In practice, analytical procedures are also seen as a mechanism to improve the audit's focus: auditors direct their attention to areas with significant deviations, making the audit more focused and efficient. The empirical findings of Al Qtaish et al. (2022) reinforce this idea by showing that the use of analytical procedures in line with ISA 520 is associated with improved audit quality; this improvement occurs because analytical procedures encourage consistent use of comparisons, more disciplined use of financial ratios, and more documented evaluations of reasonableness. This evidence is important because it confirms that analytical procedures are not merely computational techniques but rather a structured, professional-judgment-based audit assessment process. In the context of large-scale audit organizations, Nguyen (2023) describes how analytical procedures are practiced to obtain relevant and reliable audit evidence, especially when auditors seek to assess the reasonableness of accounts through expectations built from diverse data sources, then assess whether the differences that arise are acceptable within specific tolerances or indicate the need for additional audit procedures.

The conceptual strength of ISA 520 also lies in its flexibility of application at various stages of the audit, as well as in the demand for methodological rigor when auditors design and evaluate analytical procedures. Al-Hajaia (2022) emphasizes that the scope of application of analytical procedures can vary significantly in practice, including in limited liability companies, and that this variation is influenced by efficient factors such as auditor competence, data availability and reliability, and how auditors translate standard requirements into operational audit steps. This variation in implementation reminds us that the quality of analytical procedures is not determined solely by the presence of calculated ratios or trends, but rather by the design of expectations, the relevance of comparisons, and the adequacy of follow-up on deviations. In the logic of ISA 520, material or unexplained deviations should trigger an auditor response in the form of expanded procedures, requests for additional evidence, or reassessment of risk in related areas; therefore, "good" analytical procedures are not those that always produce consistent figures, but those that can accurately reveal irregularities and compel a disciplined investigation process. This is where the contribution of Al Qtaish et al. (2022) becomes relevant: when auditors consistently use analytical procedures in accordance with ISA 520—for example, through ratio comparisons and standards compiled on a clear basis—audit quality improves because auditors have a stronger foundation for concluding reasonableness or rejecting weak explanations. However, Al-Hajaia (2022) also highlights implementation barriers that should not be overlooked, such as methodological limitations, differences in practice maturity, and issues of auditor capability in

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integrating analytical procedures into the overall audit program; these obstacles imply the risk that analytical procedures are only carried out as a formality of documentation, rather than as an evaluative instrument that actually guides the collection of evidence. In the practice of large audit firms, Nguyen (2023) shows that analytical procedures can be designed more systematically to support the relevance and reliability of evidence, including by strengthening the documentation of the rationale for forming expectations and justifying follow-up on deviations.

The Concept of Big Data and Big Data Analytics in Auditing

Big Data in the context of auditing is a collection of data that is very large, fast-moving, diverse in format, and complex, to the extent that it cannot be effectively processed using conventional data management approaches. Therefore, Big Data Analytics (BDA) is a set of techniques, methods, and analytical capabilities for extracting patterns, relationships, and insights from large-scale data to support auditors' professional assessment. Dagilienė & Klovienė (2019) assert that Big Data has direct consequences for how external audits are conducted, as the sources of audit evidence are no longer limited to structured accounting data but also include operational data, system logs, and relevant external data. This perspective is further explored by Rozana et al. (2025), who map BDA as an analytical "enabler" that transforms the auditor's deliberation process, as the characteristics of Big Data encourage auditors to move from merely periodic summaries to more granular pattern reading. The conceptualization of Big Data characteristics, often formulated as volume, variety, velocity, veracity, and value, is explicitly presented in the empirical study by Abdelwahed et al. (2024), which shows that these dimensions are not just terminology, but the foundation for understanding why modern audit evidence requires more sophisticated processing. At this point, BDA in auditing is not synonymous with "using software," but rather encompasses data collection design, selection of analytical techniques, and interpretation of analysis results as relevant and reliable evidence. Hezam et al. (2023), through a literature synthesis, position BDA as a concept inherent to the digital audit transformation, as BDA enables auditors to build a richer understanding of the audited entity through pattern mapping, anomaly detection, and data-based reasonableness assessments. In line with this, Rozana et al. (2025) trace the evolution of BDA research in auditing and explain that the concept of BDA in auditing has evolved from the stage of exploring definitions to an implementation framework that emphasizes the relevance of BDA for improving the audit process, especially when auditors need to interpret complex and multi-source information.

In its conceptual practice, BDA in auditing is also understood as a transformation of how auditors convert data into evidence, rather than merely improving mechanical efficiency. Nasta et al. (2024) emphasize the multifaceted impact of BDA on auditing, including a shift away from traditional procedures, as analysis is no longer based on small data fragments but can cover transactions more comprehensively and in layers, tailored to assessment needs. On the other hand, literature also positions BDA as a concept that requires process orchestration: from data acquisition, cleaning, and integration to analytical modeling, visualization, and documentation of results to support audit conclusions. This "end-to-end" understanding is evident in the discussion by Narwal & Rai (2022), which highlights research design and the future agenda, suggesting that BDA requires a consistent methodological framework to ensure analysis results can be interpreted in an audit-relevant manner. Meanwhile, the systematic review by Hezam et al. (2023) identifies challenges as inherent to the concept of BDA in auditing, particularly regarding data quality, infrastructure availability, and competency readiness,

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because even powerful analytics will not yield meaningful evidence if the data inputs are unreliable or irrelevant. In the realm of application, Rozana et al. (2025) show that the concept of BDA in public audit firms cannot be separated from how audit organizations build analytical capabilities and embed them in work processes; in other words, BDA encompasses both technological and organizational and professional practice dimensions. Al-Ateeq et al. (2022) demonstrate a similar point when using the Technology Acceptance Model (TAM) to explain the consequences of BDA in auditing: the adoption of BDA is not merely a technical decision, but depends on perceptions of usefulness, ease of use, and user readiness, which ultimately influence the extent to which BDA is truly integrated into audit work. At a conceptual level, this means that BDA in auditing is a "socio-technical system": it requires alignment between data, analytical technology, auditor competence, and organizational acceptance. By linking the definition of Big Data and the 5V framework discussed by Abdelwahed et al. (2024) to the mapping of the role of BDA in auditor decision-making synthesized by Salijeni et al. (2021), it becomes clear that the core concept of BDA in auditing lies in its ability to transform data complexity into more evidence-based audit arguments, while also demanding control over new risks such as data veracity and misinterpretation.

Integration of Big Data into Analytical Procedures Based on ISA 520

The integration of Big Data into analytical procedures based on ISA 520 is the application of advanced analytical technology to process large, diverse, and complex volumes of data, enabling auditors to assess the fairness of financial and non-financial relationships more comprehensively. In this context, Big Data not only expands the scope of analytical procedures as described in ISA 520 but also changes the way auditors set expectations, identify deviations, and assess anomalies with greater precision. Foehr et al. (2025) explain that integrating Big Data through a process mining and predictive analytics approach enables auditors to trace transaction patterns and process flows in real time, allowing them to detect any unusual deviations more quickly than with traditional analytical methods. These findings reinforce Tušek et al.'s (2021) view that the analytical procedures in ISA 520 should now be understood as an adaptive system that can leverage information technology to evaluate relationships between accounts and non-financial variables in an integrated manner. Furthermore, Vitali & Giuliani (2024) assert that developments in digital technology, including big data analytics, open up opportunities for audit firms to utilize cross-system data—such as ERP, e-commerce, and digital financial platforms—as new sources of evidence that enhance the effectiveness of analytical procedures. This integration focuses not only on data processing speed but also on the validity of analysis results, as appropriate analytical algorithms can help auditors build more realistic expectations and scientifically assess the reasonableness of fluctuations. Thus, Big Data serves to expand the audit evidence base while improving the reliability of analytical procedures as stipulated by ISA 520, which requires a logical and consistent relationship between the data being examined.

Integrating Big Data into analytical procedures requires methodological transformation and new competencies among auditors. Krieger et al. (2021) observed that the adoption of advanced data analytics continues to face structural barriers, such as human resource limitations and technological gaps within audit firms, despite its proven benefits for audit effectiveness. Ismail & Abdul Hamid (2024), through a systematic literature review, show that the use of big data analysis in financial audits can improve the accuracy of analytical procedure results, especially at the risk assessment and overall review stages at the end of the audit, as outlined by ISA 520. Meanwhile, Ismail & Abdul Hamid (2024)

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emphasize that the success of Big Data integration depends not only on the availability of data and analytical infrastructure, but also on auditors' ability to interpret analysis results as valid audit evidence. This is important because analytics that produce complex visualizations or correlation patterns need to be translated into a professional context and in line with the audit objectives. Föhr et al. (2025) add that the structure of Big Data Analytics implementation must follow a layered audit procedure framework—from analytical planning and substantive testing to final result evaluation—so that the analysis results remain in line with the principles outlined in ISA 520. On the other hand, Vitali & Giuliani (2024) highlight that audit firms need to ensure strong data governance, including controls over the integrity, security, and ethical use of data, so that the analytical results can truly serve as valid audit evidence. Therefore, the integration of Big Data into analytical procedures is not merely a technical change, but a conceptual and procedural transformation that places analytics at the core of the auditor's professional reasoning.

The Impact of Big Data Utilization on Audit Quality

The impact of Big Data utilization on audit quality can be defined as changes—both improvements and risks of decline—in the quality of audit processes and results when auditors use Big Data Analytics (BDA) or audit data analytics to obtain, test, and evaluate audit evidence more broadly, more deeply, and more timely than conventional approaches. In this operational definition, "audit quality" is not merely understood as the output of an opinion, but as the degree of reliability of the auditor's assessment supported by the adequacy and accuracy of evidence, the sharpness of misstatement identification, the consistency of documentation, and the effectiveness of review and supervision of audit work. A systematic review by Ismail & Abdul Hamid (2024) positions BDA as a catalyst that broadens the audit evidence base and strengthens auditors' evaluative capabilities, as big data enables the identification of patterns in transactions, behaviors, and relationships that were previously difficult to capture through sampling and manual testing. In the empirical realm, Abdelwahed et al. (2024) show that applying BDA is associated with stronger audit quality in the context of audit practice in Egypt, particularly when BDA is used to improve the accuracy of risk identification and to enrich the evidence auditors use in their conclusions. A similar argument is also evident in the context of Southeast Asia, where Haryanto & Setiawan (2024) assert that the use of BDA in public accounting firms in Vietnam is associated with better audit quality, as data analytics strengthens the auditor's assessment process in examining the fairness of information and tracing indications of irregularities. Thus, the conceptualization of "impact" here can be understood as strengthening evidence-based audit capabilities: auditors are increasingly able to examine reasonableness comprehensively, shorten the distance between detection and response, and build more transparent audit justifications under the pressure of modern data complexity, as also emphasized in the literature synthesis by Ismail & Abdul Hamid (2024).

However, this positive impact is not automatic, as audit quality is also influenced by how analytics are adopted, managed, and embedded into the audit workflow. Ditkaew & Suttipun (2023) show that data analytics auditing can strengthen audit quality while maintaining audit review continuity, which, conceptually, means that the process of reviewing and maintaining audit work continuity becomes stronger when analytical results are documented and traceable. Here, the value of BDA/ADA lies in its ability to enrich audit trails, making supervision and quality reviews more effective. However, Vitali & Giuliani (2024) remind us that digital technology—including BDA—brings both opportunities and challenges: opportunities in the form of increased efficiency, accuracy, and scope of testing;

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challenges in the form of infrastructure readiness, data integrity and security, and the need for auditors to have the competence to interpret analytical outputs appropriately. In this context, audit quality can be improved if audit firms ensure data governance, analytical model quality control, and continuous learning for auditors, as outlined in the implementation issues summarized by Ismail & Hamid (2024). In addition to internal factors within audit firms, market perceptions also shape expectations of audit quality. Sofyani et al. (2025) highlight how the Big 4 position Big Data Analytics in their public communications and the accompanying consequences; the implication is that when BDA is promoted as an added value to auditing, stakeholders may assume an improvement in the quality of procedures and thoroughness of examinations, so that the gap between "capability claims" and "implementation reality" has the potential to affect perceptions of audit quality.

Research Method

This study uses a Systematic Literature Review (SLR) to identify, evaluate, and synthesize scientific findings on the use of Big Data in analytical audit procedures in accordance with ISA 520. The SLR approach was chosen because it enables researchers to gain a comprehensive understanding of previous studies, both national and international, relevant to analytical auditing, Big Data Analytics (BDA), and ISA 520 standards. The SLR in this study follows the principles of transparency, replication, and systematicity, ensuring that every article selection process is clearly documented, from identification and screening to synthesis (Page et al., 2024). The articles reviewed in this study were sourced from various scientific documents that had been uploaded and analyzed, including studies on analytical procedures in auditing, research discussing the effectiveness of implementing ISA 520-based analytical procedures, literature reviewing the use of Big Data and Big Data Analytics in the audit process, as well as empirical research highlighting the influence of Big Data utilization on audit quality, including in the context of public sector audits. All articles were selected based on their relevance to the study's focus: the relationship between the use of Big Data and the application of auditor analytical procedures in accordance with applicable professional standards. The article search was conducted using the researcher's internal document database (uploaded PDF), focusing on the following keywords: "Big Data," "Big Data Analytics," "Analytical Procedures," "ISA 520," "Audit Quality," and "Audit Analytics."

To ensure that the studies included were relevant to the research objectives, explicit inclusion and exclusion criteria were applied:

Inclusion Criteria

Articles are included in the analysis if they meet the following criteria:

- Discussing Big Data or Big Data Analytics in the context of auditing
- Discussing analytical procedures or referring to the concept of ISA 520
- Providing empirical findings, theories, concepts, or analytical frameworks that support the relationship between Big Data and auditor analytical procedures.
- Written within the publication range of 2017–2024 according to file metadata
- Access to documents is available in fully searchable PDF format.

Exclusion Criteria

- Does not address the audit or is not relevant to the analytical procedure
- Not mentioning Big Data or analytics technology
- Not available in complete document form

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The article selection process in this study was conducted systematically by following the SLR workflow. The first stage was the identification of all scientific documents available in PDF format, including research on analytical audit procedures, ISA 520 standards, the use of Big Data Analytics in auditing, and public sector auditing and digital technology from 2017 to 2024. All documents were then examined for their titles and abstracts to ensure their relevance to the research focus, namely the relationship between Big Data and analytical procedures as defined in ISA 520. Articles that only discussed auditing in general or did not mention Big Data or analytical aspects were excluded at the screening stage. Furthermore, relevant articles were fully evaluated to assess their contribution to the research topic. Only articles containing theoretical discussions, analytical frameworks, or empirical findings regarding the use of Big Data in audit procedures were retained. In the final stage, the selected articles were analyzed and synthesized thematically to identify patterns, consistencies, and differences in findings between studies, thereby forming a comprehensive conceptual basis for this literature review.

To support the thematic synthesis, data extraction was conducted for 10 selected articles that met the inclusion criteria. The extraction included information on the author, year of publication, research object, method, study focus, and main findings. A summary of the extraction results is presented in (**Table A1 APPENDIX**).

This study used a Systematic Literature Review (SLR) approach, following the 2020 edition of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines by Page et al. (2021) to identify, select, and analyze articles. The analysis began by defining the inclusion and exclusion criteria to ensure that only relevant articles meeting scientific standards were included in the study.

Articles were included if they focused on Big Data or Big Data Analytics in the context of auditing, analytical procedures, or ISA 520. Conversely, articles were excluded if they were merely opinions or non-scientific, did not discuss auditing or analytical aspects, or were not available in full PDF format and could not be thoroughly analyzed. The article selection process was carried out in stages through the four phases of PRISMA.

The identification phase yielded 47 articles from various databases using a combination of keywords related to "Big Data," "analytics," "audit analytical procedures," "ISA 520," and "audit quality." In the title and abstract screening phase, 22 articles were eliminated because they were not relevant to the study's focus, such as those that discussed auditing in general without linking it to Big Data or analytical procedures. Next, 25 articles were read in full and assessed for suitability. A total of 15 articles were excluded because they had no direct connection to the context of analytical audit procedures or did not link the use of Big Data to ISA 520 standards. The final stage produced 10 articles that met all the criteria and became the basis for analysis in this study.

Data analysis was conducted using a thematic synthesis approach. Each article was extracted using a table containing key information, such as the title, author, year of publication, research objectives, analysis methods and techniques, focus variables, primary findings, and factors supporting and hindering the implementation of Big Data in analytical audit procedures. These findings were then given initial coding to identify patterns and categories. Next, several prominent themes were formed, such as: (1) the concept and role of analytical procedures in ISA 520; (2) the characteristics and potential of Big Data Analytics in auditing; (3) the integration of Big Data into analytical procedures; (4) the impact of using Big Data on audit quality; and (5) the challenges of implementing Big Data in an audit

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environment. From these themes, aggregate conclusions were drawn that reflected cross-research patterns.

To maintain the validity and reliability of the analysis, triangulation across articles was conducted, the entire selection process (audit trail) was fully documented, and the extraction results were cross-checked to minimize interpretation bias. With this approach, SLR provides a systematic, transparent, and comprehensive overview of how Big Data implementation has been studied and how it impacts Audit Analytical Procedures based on ISA 520.

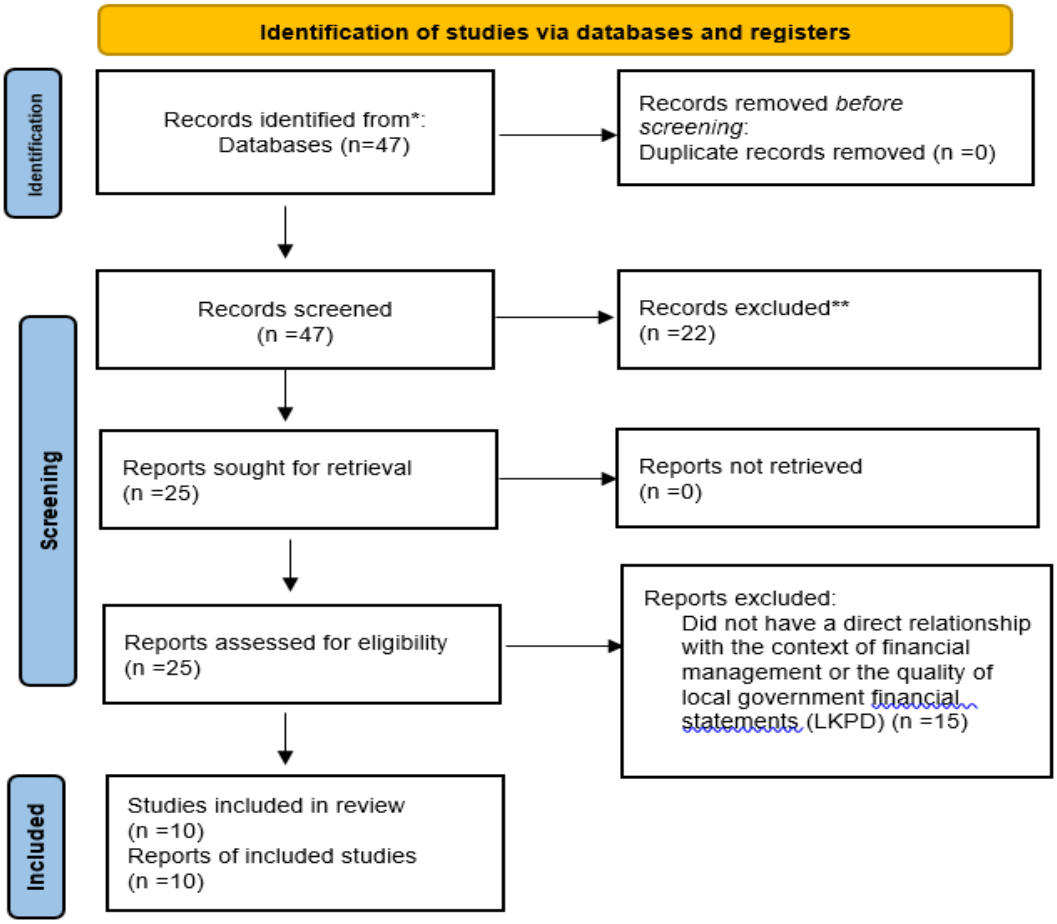

Figure 1. PRISMA 2020 Flow Diagram for Systematic Reviews

Results and Discussion

Analysis Result

A systematic literature review of 10 articles finds that integrating Big Data into analytical audit procedures significantly improves the effectiveness, accuracy, and quality of the audit process. In general, the literature shows that the use of Big Data-based analytical techniques expands auditors' capacity to understand transaction patterns, build more precise expectations, and detect irregularities with a broader scope of evidence than traditional analytical procedures. The findings of this SLR can be categorized into the following main aspects:

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Strengthening Analytical Procedures throughout All Stages of the Audit

Big Data Analytics strengthens analytical procedures from the planning stage by enabling auditors to build a more granular understanding of entities and their business environments. Instead of relying on periodic summaries and sample-based observations, auditors can trace transaction patterns in greater detail across time, across organizational units, and across data types (financial and non-financial) to map areas that may be prone to misstatement risk. The main strength at this stage lies in the ability of analytics to extract "normal" patterns from historical data and compare them with actual patterns for the current period, so that indicators of deviation can be identified earlier and more accurately. Thus, analytical procedures not only serve as a "screening" tool but also form the basis for audit decision-making on testing focus, materiality determination, and the design of an audit strategy that is better adapted to the characteristics of the client's data and business processes.

In the substantive testing and closing stages, Big Data Analytics extends the analytical procedures beyond simply comparing trends and ratios to evaluating reasonableness using models and richer data relationships. Auditors can develop data-based expectations with greater reliability, for example, by modeling the relationships among sales volume, shipments, returns, discounts, and cash receipts, so that the reasonableness of balances and transactions is assessed through cross-process consistency rather than just financial statement figures. When deviations occur, auditors can drill down to the transaction, time, or specific party level to understand their source and determine whether additional procedures are necessary. At the closing stage, analytics help auditors conduct a more thorough overall review because the reasonableness assessment does not merely repeat the planning procedures but also validates whether the patterns and relationships in the data, after audit adjustments, are reasonable and consistent with the auditor's understanding of the entity. In this way, Big Data Analytics embeds analytical procedures throughout the audit as a continuous assessment mechanism, providing more substantial evidence than manual methods.

Improving the Quality and Depth of Audit Evidence

The use of Big Data improves the quality and depth of audit evidence by allowing auditors to analyze the entire data population rather than just a sample, thereby making the examination's scope much more representative. In traditional audits, the main risk is the existence of misstatements hidden in unsampled data, especially when transaction patterns are heterogeneous or when irregularities occur in a fragmented manner across many small transactions. Population-based analysis reduces this "blind spot" because auditors can assess the entire series of transactions and identify unusual patterns, whether extreme (outliers) or systematic (e.g., transaction splitting patterns, repetition of specific vendors, or transactions concentrated on certain hours and days). Substantively, audit evidence becomes richer because auditors look not only at the final account value, but also at the data structure that forms the account, including distribution, frequency, inter-variable relationships, and cross-system consistency.

In addition to expanding the scope, Big Data also deepens audit evidence by combining diverse data sources and assessing the consistency of processes. Auditors can test reasonableness more contextually, for example, by matching sales transactions with shipping data, cash receipt records, and system logs that record specific data changes or authorizations. When anomalies occur, auditors can

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examine the end-to-end "trail" of transactions, so that the evidence collected is not only in the form of supporting documents, but also in the form of data behavior patterns that indicate risks or errors. The practical implication is an improvement in audit quality because auditor decisions are supported by more comprehensive, consistent, and traceable evidence. In both the private and public sectors, this approach helps auditors assess fairness more objectively, especially in environments with massive, repetitive, and distributed transactions, so that audits do not rely solely on "indications. However, it can more convincingly demonstrate fairness or unfairness.

Audit Process Efficiency and Audit Delay Reduction

Big Data Analytics improves audit efficiency by accelerating the collection, processing, and filtering of information that previously required significant time using manual procedures. Many traditionally repetitive audit activities, such as reconciliation, transaction sorting, and basic testing of data completeness, can be accelerated through analytical automation and large-scale data processing. As a result, auditors can allocate more time to high-value-added areas, such as professional evaluation, discussion of findings with management, and determination of the implications of the findings on financial statements. This efficiency is particularly relevant for clients with large transaction volumes and complex information systems, as audit delays often stem from delays in data extraction, data cleansing, and the need to trace findings manually. With structured analytics, the initial audit process can be condensed without sacrificing coverage, allowing for more controlled audit schedules.

Audit delays are also reduced because analytical techniques such as outlier detection, exception reporting, and automated analytics enable auditors to detect issues earlier and take follow-up action more quickly. When anomalies arise, auditors do not have to wait until the final stage to become aware of problems, as risk signals can be detected as early as the data is processed. This speeds up the cycle of clarification, additional evidence gathering, and finding resolution, making the internal review process within the audit team smoother. In addition, analytics automation improves audit process consistency because the same procedures can be rerun with clear parameters, minimizing differences in results due to variations in initial assessments or differences in working methods between auditors. Ultimately, the resulting efficiency not only speeds up work but also improves the accuracy of audit resource allocation, reduces rework, and strengthens documentation discipline, thereby contributing to timely audit completion and reduced audit delays.

Support for the Implementation of ISA 520 Standards

The use of Big Data is essentially in line with the core objective of ISA 520, which is to enable auditors to evaluate financial information by analyzing reasonable relationships between financial and non-financial data and to follow up on fluctuations or inconsistent relationships. Within this framework, Big Data enriches the sources and depth of information auditors use to build credible expectations. While traditional analytical procedures often rely on aggregate data such as annual trends, ratios, or budget-to-actual comparisons, Big Data allows auditors to build expectations at a granular level, for example, based on daily transaction patterns, customer segmentation, location, or type of product/service. This granularity strengthens the logic of reasonableness because auditors see not only the "total figures," but also the consistency of the data behavior that forms those figures. In addition, Big Data enables a broader evaluation of relationships between data, including cross-business process and cross-system relationships, so that analytical procedures can assess reasonableness not only from

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a financial statement perspective, but also from non-financial evidence such as production volume, logistics data, working hours, and other operational indicators relevant to explaining account variations. In other words, Big Data expands the ability of ISA 520 to test "whether the numbers make sense" through more substantial and more measurable cause-and-effect relationships.

Although ISA 520 does not explicitly mention Big Data, its compatibility arises because the standard is principle-based and allows auditors to select techniques and approaches as long as the audit objectives, professional judgment, and sufficiency of evidence are met. This methodological flexibility allows advanced analytical techniques to be positioned as an extension of traditional analytical procedures rather than a replacement for the standard. In practice, Big Data helps auditors meet ISA 520's requirements for developing expectations and assessing deviations: analytical algorithms can help build a more stable baseline for distinguishing between normal variation and variation that indicates a risk of misstatement. When deviations are identified, the "investigation" process emphasized by ISA 520 can also be conducted more systematically, as auditors can perform a multi-level trace from summary to transaction, from transaction to data source, and to the authorization trail or system log that explains the origin of the deviation. At the audit closing stage, Big Data also supports the overall review by verifying whether the final pattern after audit adjustments is consistent with rational expectations. Thus, Big Data is not only technically "compatible," but also strengthens substantive compliance with ISA 520 because it helps auditors build stronger audit arguments, based on richer data relationships, and better documented.

Support for the Implementation of ISA 520 Standards

Although offering significant benefits, SLR also revealed that integrating Big Data into audit analytical procedures poses multidimensional challenges that can hinder the realization of these benefits. The most fundamental challenge is auditor competence in analytical technology. Many auditors have a strong command of professional standards and assessments. However, they may not have sufficient data literacy to understand data extraction, data cleaning, selecting analytical techniques, and interpreting model outputs. This gap becomes more apparent when the audit process requires an understanding of data quality, data bias, or algorithm limitations, as errors in the early stages can lead to misleading conclusions. In addition to competency, infrastructure limitations are also a significant obstacle, especially when audit organizations do not yet have systems capable of securely and consistently accessing and processing large-scale data. In client environments with uneven levels of digitization, auditors often encounter data scattered across multiple systems, inconsistent formats, or incomplete records, resulting in varying data quality and costly integration processes in terms of both time and expense. These challenges can reduce the effectiveness of analytical procedures because expectations built on "dirty" or unrepresentative data can potentially trigger false findings or mask actual anomalies.

In addition to technical challenges, data privacy and security issues are critical aspects that cannot be separated from the use of Big Data in auditing. When auditors process detailed transaction data, customer data, or internal operational data, the risk of leakage and misuse increases, underscoring the need for access controls, encryption, audit trails, and compliance with data protection policies. Security challenges are also related to data governance, namely ensuring that the data used by auditors is complete, unmanipulated, and has a verifiable audit trail. Furthermore, the skills gap between novice and experienced auditors can complicate implementation: junior auditors may be more adaptable to

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technology but lack maturity in audit considerations; senior auditors may be strong in judgment but need support in adopting analytical tools. This imbalance calls for layered training designs, adequate technical support, and more detailed methodological guidelines so that Big Data integration does not become a mere formality in tool use, but rather a practice that genuinely improves the quality of evidence in analytical procedures. Thus, these challenges underscore the need for an organizational strategy that includes competency development, infrastructure investment, strengthened data governance, and adjustments to audit methodologies to ensure the effective, secure, and consistent use of Big Data.

Conclusion

This study presents a Systematic Literature Review of 10 articles to answer the question of how the use of Big Data and Big Data Analytics strengthens analytical audit procedures as stipulated in ISA 520. Conceptually, thematic synthesis confirms that Big Data is positioned as a source and analytical mechanism that expands the way auditors build expectations, evaluate relationships between financial and non-financial data, and trace indications of irregularities through a more population-based and pattern-oriented approach. This study also places the integration of Big Data in all stages of auditing as part of the development of modern auditing methodologies that enrich the role of analytical procedures, while underlining the prerequisites for implementation, such as competency readiness, infrastructure, and data governance, so that the use of analytics can be consistent and accountable.

The value of this research for science lies in the compilation of an integrated mapping of the links between Big Data and analytical procedures in ISA 520, so that the scattered discourse across various studies can be summarized into a more systematic and operational framework of understanding. From a practical and policy perspective, its main contribution is to provide strategic references for audit organizations to develop an analytics adoption roadmap that is aligned with analytical procedure requirements, including the establishment of internal work standards, strengthening quality control, and developing auditor competencies to be able to interpret analytical outputs as valid audit evidence. The practical and managerial implications include the need for audit firm or inspection agency management to allocate investment in analytical tools, develop SOPs and technical guidelines for the use of big data, and strengthen data risk management through strict security and privacy policies. With this approach, audit organizations can improve work efficiency, enhance documentation quality, and sharpen audit focus without sacrificing the principles of prudence and professional accountability.

This study has limitations that should be noted. First, the literature scope is limited to ten articles available in PDF format. Hence, the synthesis results are highly dependent on document availability and do not fully represent the global research population. Second, the variation in context and research methodology across the reviewed articles limits the generalizability of the findings across countries, sectors, and audit organization characteristics. Third, the focus on literature that explicitly links Big Data, analytical procedures, and ISA 520 may have led to relevant studies using different terminology going unnoticed. Fourth, this study uses thematic synthesis rather than meta-analysis, so it cannot estimate the magnitude of the effect statistically. Given these limitations, the recommended agenda for further research includes expanding the study base through a more comprehensive database search, quantitative empirical testing of the level of Big Data utilization in analytical procedures and in audit evidence quality, and cross-sector and cross-country comparative studies to understand variations in adoption and the associated contingency factors. In addition, future research should explore the most

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effective operational standards, quality control mechanisms, and data governance and security frameworks to ensure that Big Data integration not only improves efficiency but also maintains the reliability of evidence and compliance with audit standards.

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APPENDIX

Table 1. Selected Articles

No.	Author (Years)	Title	Method	Results
1	Kritzinger & Barac (2017)	The Application of analytical procedures in the audit process: A South African Perspective	Qualitative-descriptive	Auditors in South Africa recognize that analytical procedures add value to audits and enhance audit efficiency and effectiveness.
2	Hezam et al. (2023).	Big Data Analytics and Auditing: A Review and Synthesis of Literature	Literature study or literature review	The results of this article's research show that big data analytics has great potential to improve quality, efficiency, transparency, and trust in the auditing process. However, the application of big data analytics in auditing is still in its infancy and has not been widely adopted.
3	Sinosi et al. (2022)	Implementasi Big Data Analytics Dalam Praktik Audit Pada Perusahan: Literature Review	Qualitative Narrative	Research results show that, through its capabilities, big data can enhance forensic auditing to detect fraud.
4	Shalihah & Ramadhanti (2025)	Kontribusi Big Data Analytics dalam Proses Audit Terhadap Audit Delay dan Kualitas Audit	Literature Review	The findings of this article indicate a lack of research that comprehensively examines the relationship between Big Data Analytics (BDA), audit delay, and audit quality. Most previous studies have focused solely on technical aspects or process efficiency, without examining the impact of BDA on the overall audit process and results, including its role in fraud detection and its effect on audit delays.
5	Al Qtaish et al. (2022)	The Effect of Auditor's Use of Analytical Procedures in the Light of ISA 520 on Audit Quality: Evidence from Jordan	Cronbach's alpha method, simple statistical methods, one-sample T-test, and one-way ANOVA.	The results of this study indicate that auditors' use of analytical procedures has a statistically significant effect on audit quality. In particular, auditors' use of financial ratios also significantly affects audit quality.
6	Pratama & Komariyah (2023)	Examining the Auditors' Acceptance of Big Data Analytics Technology Platform: Evidence from Government Auditors in Indonesia	Quantitative with a survey of 83 government auditors.	The three UTAUT constructs (effort expectancy, performance expectancy, and facilitating conditions) influence auditors' acceptance of BDA technology. Social influence and trust do not influence acceptance.

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No.	Author (Years)	Title	Method	Results
7	Putra et al. (2023)	Hubungan Big Data Analytics terhadap Kualitas Audit: Penerapan pada Instansi Pemerintah	Quantitative with a survey of 170 BPK-RI auditor respondents.	The use of analytical audit procedures helps auditors plan and time audits and detect manipulation. Lack of training is an obstacle for Iraqi auditors.
8	Matrood & Khilkhal (2019)	The Impact of Applying Analytical Procedures by External Auditor In Accordance with ISA 520 on Audit Performance Improvement: An Exploratory Study in The Iraqi Audit Firms and Companies	An exploratory study in audit firms and Iraqi companies.	The use of analytical audit procedures helps auditors plan and time audits and detect manipulation. Lack of training is an obstacle for Iraqi auditors.
9	Tušek et al. (2021)	The importance and differences of analytical procedures' application for auditing blockchain technology between external and internal auditors in Croatia	Quantitative and statistically tested	It generally focuses on the importance and differences in the application of analytical procedures for auditing blockchain technology by external and internal auditors in Croatia. The overall results show that the model statistically predicts significantly.
10	(Kuusinen & Miettinen, 2023)	The Role of Data Analytics in Audit Risk Assessment	Semi-structured interviews with industry experts from Big Four companies.	General ledger analysis and process mining are used in the planning phase. The use of the ADA leads to a better understanding of the entity and helps auditors identify areas of risk, enabling more appropriate audit actions and avoiding unnecessary substantive procedures. The findings regarding auditing standards contradict previous research.