JURNAL TATA KELOLA DAN AKUNTABILITAS KEUANGAN NEGARA

Check for updates

p-ISSN 2460-3937
e-ISSN 2549-452X

Jurnal Tata Kelola dan Akuntabilitas Keuangan Negara, Volume 11 Number 2, 2025: 211-228

Use of artificial intelligence in the internal audit of sustainable procurement

Mustofa Kamal*

Audit Training Center of the Financial and Development Supervisory Agency (BPKP), West Java, Indonesia

ABSTRACT

Internal auditors have not yet achieved optimal implementation of data analytics, and the limited progress of electronic-based government system audits has encouraged the use of big data analytics in internal auditing. This study aims to examine the application of artificial intelligence in sustainable public procurement audits for the development of Indonesia's new capital. An exploratory case study was employed using spreadsheet-based analysis and OpenAI tools to process data from 23 construction projects in 2023 and 841 Village Development Index observations in East Kalimantan. ChatGPT was used to identify ten sustainability-related risks, prepare corresponding audit programs, determine ten development areas, and generate seven recommendations, and the resulting outputs were reviewed using human professional judgment. The findings reveal a major risk of a lack of transparency in procurement planning documents and highlight the need for greater collaboration among procurement authorities, local governments, and village communities. The study concludes that AI can serve as an audit support tool for risk identification and audit planning, while human judgment remains essential to ensure contextual accuracy. The results provide practical implications for strengthening sustainable procurement oversight in public infrastructure projects. The novelty of this study lies in demonstrating a spreadsheet-based workflow that integrates AI into internal audit procedures for sustainable procurement.

KEYWORDS:
Artificial intelligence; big data analytics; ChatGPT; lack of transparency

HOW TO CITE:
Kamal, M. (2025). Use of artificial intelligence in the internal audit of sustainable procurement. *Jurnal Tata Kelola dan Akuntabilitas Keuangan Negara*, *11*(2), 211-228. https://doi.org/10.28986/jtaken.v11i2.1918

*Corresponding author's
Email: kamalopek.bpkp@gmail.com

ARTICLE HISTORY:

Received	: 11 January 2025	Accepted	: 14 July 2025	Published	: 18 December 2025
Revised	: 23 May 2025	Online Available	: 7 November 2025		

INTRODUCTION

Big data analytics (BDA) has emerged as a transformative force reshaping organizational decision-making and accountability frameworks (Vieira et al., 2017). In the auditing domain, BDA enhances analytical capacity by enabling pattern recognition, anomaly detection, and predictive insights without requiring a predetermined hypothesis (Vestoso, 2018). These capabilities reinforce the strategic role of internal audit functions, allowing them to improve efficiency (Valdavida, 2018), perform comprehensive risk assessments (Joshi, 2020), and evaluate control effectiveness and fraud risks across entire data populations (Smidt et al., 2019; Fotoh & Lorentzon, 2020; Handoko et al., 2020). Empirical evidence consistently demonstrates that BDA competency enhances audit performance and supports the strategic role of internal audit functions (Akbulut et al., 2018; Joshi, 2020; Rakipi et al., 2021). Studies from Thailand and the Middle East, for instance, reveal that BDA adoption facilitates audit planning, substantive testing, and a deeper understanding of the auditee's environment (Sanoran & Ruangprapun, 2023; Mousa et al., 2022). Moreover, the integration of machine learning and computational techniques allows auditors to identify emerging trends and predict potential irregularities with greater precision (Chen et al., 2022; Shabani et al., 2022).

Despite its global relevance, the application of BDA in the internal auditing context, as indicated by the 2021 data analytics research mapping, remains underexplored in Indonesia (Kamal, 2021). Many internal auditors still lack adequate understanding and technical competence in applying data analytics tools in audit assignments (Kamal, 2022). This situation underscores a widening capability gap between technological progress and auditors' professional readiness. Internal audit units continue to face systemic challenges related to data quality, data security, and user competence (Vieira et al., 2017), as well as technological disparities between auditors and auditees (Oldhouser, 2016). Consequently, developing BDA competencies has become imperative to enhance audit quality and accountability (Joshi & Marthandan, 2020). Moreover, BDA is expected to constitute a fundamental component of the continuous audit model framework (Feung & Thiruchelvam, 2020).

International experiences demonstrate that effective BDA adoption depends not only on technical skills but also on institutional support and governance mechanisms. For example, the Netherlands has institutionalized BDA integration through audit policy frameworks (Broeders et al., 2017), while Australian auditors frequently employ general audit software (Smidt et al., 2019). Conversely, experiences in the United States show that although BDA promotes transparency and analytical efficiency, it also raises concerns about data confidentiality and potential misuse (Houser & Sanders, 2017). These mixed outcomes suggest that BDA implementation must be adapted to organizational contexts, resource availability, and strategic priorities (Oyewo et al., 2021; Tang et al., 2017). Strengthening such contextual alignment is particularly crucial for public sector auditors in Indonesia, where digital transformation initiatives are advancing but audit innovation remains uneven.

Indonesia's ongoing digital transformation aims to strengthen governance, transparency, and public accountability. This agenda is particularly visible in the development of the new national capital (Ibu Kota Nusantara, IKN), envisioned as a "smart city" integrating advanced technology into daily governance and public service delivery (Otorita IKN, 2022). However, the average score of the Electronic-Based Government System (Sistem Pemerintahan Berbasis Elektronik, SPBE) index for local governments in East Kalimantan in 2022 was 2.276—below the national average of 2.31—indicating limited maturity in digital governance (Kemenpan, 2023). The SPBE architectural framework has not yet fully integrated policies related to the Internet of Things, big data, or artificial intelligence (AI) (Kemenpan, 2021). This condition highlights a misalignment between the

government's strategic digital vision and its operational implementation capacity.

As one of Indonesia's national strategic projects, IKN is expected not only to build physical infrastructure but also to develop a sustainable socio-technological ecosystem (BPKP, 2023). This vision aligns with the government's sustainable procurement policy, which mandates that procurement activities should generate economic efficiency while promoting social inclusion and environmental responsibility (Kamal, 2020; Gelderman et al., 2017). Sustainable procurement practices consider economic aspects—such as lifecycle cost efficiency—alongside social dimensions like small-business empowerment, fair labor conditions, and local community participation, as well as environmental factors such as pollution reduction and responsible resource use.

The supervision of sustainable procurement is one of the authorities of the Government Internal Supervisory Apparatus (Aparat Pengawasan Intern Pemerintah, APIP), as stipulated in Article 76 of Presidential Regulation Number 16 of 2018, in conjunction with Presidential Regulation Number 12 of 2021. Although the internal supervision guidelines for government procurement (BPKP, 2019) provide audit procedures for program and environmental aspects, they do not explicitly identify sustainable procurement risks or offer standardized audit programs to address them. Moreover, APIP's overall capability remains uneven—only 54.74% of APIP institutions achieved a capability level ≥3 in 2022, while 45.26% remain below the minimum professional standards (BPKP, 2023). This gap reflects the urgent need to modernize internal audit practices through digital transformation and data-driven approaches.

Demands for the digital transformation of auditors' services have been raised by requiring them to gain adequate knowledge of information technology-based audit techniques (AAIPI, 2021) and BDA competencies, including the use of big data and analytics tools (Kamal & Elim, 2021). International best practice emphasizes data analytics as a key success factor in internal audits (Huang et al., 2022). However, the absence of a dedicated audit framework for sustainable procurement and the limited use of analytical tools among APIP auditors demonstrate a critical need for technological innovation in the public audit domain. This context opens a research opportunity to explore how AI can be applied as a practical instrument to strengthen sustainable procurement audits in IKN.

All these conditions—ranging from Indonesia's limited digital audit maturity to the absence of a specific framework for sustainable procurement audits—create an urgent need for innovation in the internal audit function. While big data analytics (BDA) has demonstrated its potential to enhance audit effectiveness globally, its integration into Indonesia's public sector audit practice remains at a formative stage. The challenge is not only technical but also institutional, involving the readiness of APIP auditors, the alignment of regulatory frameworks, and the availability of standardized audit methodologies that incorporate sustainability dimensions.

Recent advancements in AI, particularly the emergence of generative models such as ChatGPT, offer a promising avenue to overcome these constraints. AI-based systems can assist auditors in identifying risks, generating audit procedures, and analyzing textual procurement data more efficiently than traditional methods (Huang & Liu, 2024; Shukla et al., 2024). In this sense, ChatGPT can serve as a cognitive extension of auditors—supporting knowledge discovery, rationalization, and professional judgment through natural language processing and structured prompt engineering. These capabilities are particularly relevant for sustainable procurement audits, which often involve qualitative data, multidimensional indicators, and contextual policy interpretation.

However, as a decision-making support tool, AI must operate in conjunction with human

judgment to ensure contextual accuracy and ethical responsibility. As illustrated in Figure 1, AI can generate a set of possible actions that require professional scrutiny and validation using non-digital evidence and auditor expertise before a final decision is made (Mohapatra et al., 2023). This interaction between machine-generated insights and human reasoning underscores the principle that AI should augment, not replace, the auditor's evaluative capacity.

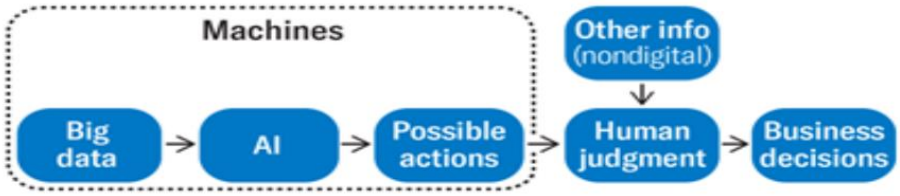

Figure 1. Combination of AI and Human Judgment in Decision-making
Source: *Mohapatra et al. (2023)*

Despite the growing global literature on AI-assisted auditing, there is a clear empirical and conceptual gap in understanding how such tools can be operationalized within Indonesia's public sector, particularly in the context of sustainable procurement and IKN development. Existing studies have primarily examined either BDA implementation (Kamal, 2021; Tušek et al., 2021) or digital audit competencies (Joshi & Marthandan, 2020; Awuah et al., 2022), without explicitly connecting them to sustainability-oriented auditing frameworks. Consequently, there is limited guidance for APIP auditors on integrating AI tools into audit planning, risk assessment, and program design for sustainable procurement.

Therefore, this study aims to explore the potential application of ChatGPT as an artificial intelligence–based support tool for sustainable procurement audits in Indonesia's new capital, IKN. Using an exploratory qualitative approach and secondary data, this study seeks to identify the potential benefits, risks, and control mechanisms necessary for responsible AI utilization in the public audit context. The expected contribution is twofold: (1) practically, the research provides a prototype framework for AI-assisted audit design aligned with Indonesia's regulatory and institutional landscape; and (2) theoretically, it expands the discourse on digital governance and sustainable auditing by linking BDA and AI integration with public sector accountability and policy implementation.

RESEARCH METHOD

This study employed an exploratory case study approach (Benoit, 2023) to examine the potential application of AI and BDA in internal audits of sustainable procurement for the development of IKN. The exploratory approach was chosen because it enables a comprehensive understanding of emerging technological phenomena within a limited empirical context (Yin, 2018). The study integrates four streams of literature: (1) public sector and sustainability audit studies (Alshurafat, 2023; Haleem et al., 2022), (2) big data analytics in auditing (Sanoran & Ruangprapun, 2023), (3) artificial intelligence and decision support systems (Giudici et al., 2024), and (4) OpenAI tools and applications (Gu et al., 2023; George et al., 2023). These references informed the conceptual and procedural basis for testing the integration of AI and BDA tools in an audit setting.

Two complementary data analytics techniques were applied—statistical analysis and visualization analysis—consistent with the Computer-Assisted Generalized Information (CAGI) approach (CAGI, 2017). Microsoft Excel and related spreadsheet software were selected as the

primary analytical platforms, reflecting their widespread adoption among internal auditors for basic BDA applications (IIA, 2019; McKee, 2021; Poon et al., 2024; Diamant, 2024; Febrian, 2021).

Research Design

The research process followed five sequential stages designed to ensure methodological rigor and alignment with the study's exploratory objectives. It began with a literature and normative review to establish the theoretical foundation and regulatory context of sustainable procurement audits within Indonesia's public sector. This stage clarified the conceptual links between governance, BDA, and AI applications in internal auditing. The second stage involved an exploratory study, which examined the contextual characteristics of IKN's development and the potential sustainability-related audit issues that arise in large-scale public projects.

The third stage focused on the OpenAI application, where ChatGPT was operationalized through a Google Sheets extension to simulate the use of generative AI as an audit support tool. The fourth stage entailed data analytics and visualization, employing descriptive statistics, pivot tables, and graphical representations to analyze procurement and regional development data. Finally, the conclusion and synthesis stage integrated the findings into a conceptual framework illustrating how AI and BDA can enhance the efficiency, relevance, and strategic value of sustainable procurement audits in the IKN context. The overall research workflow is illustrated in Figure 2, which outlines the logical progression from conceptual review to analytical synthesis.

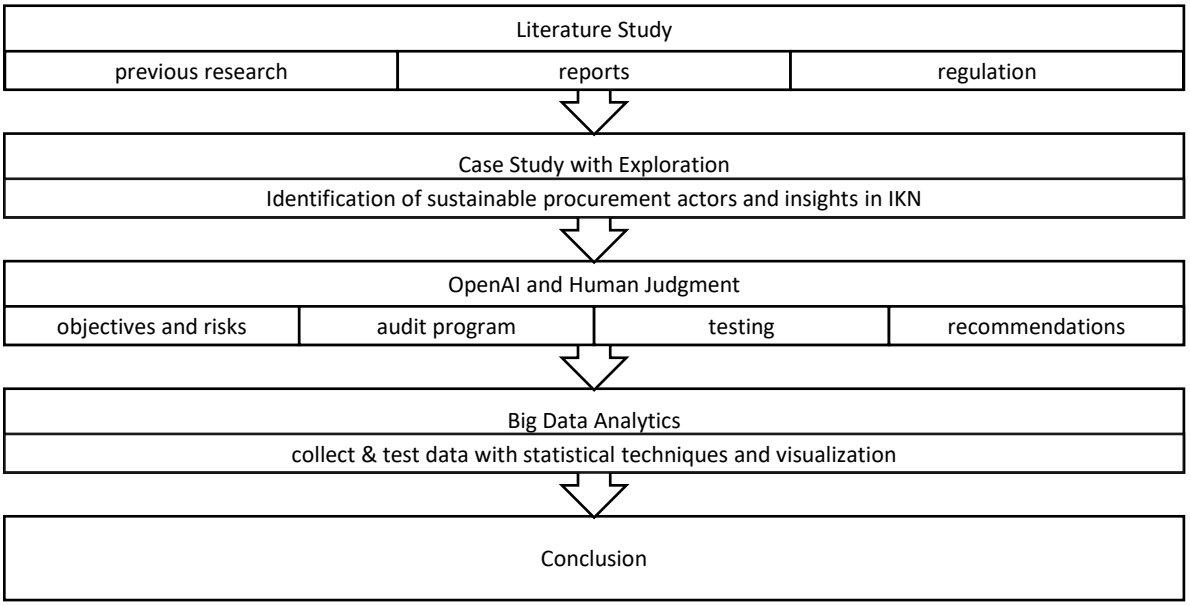

Figure 2. Research Process

This study operationalized OpenAI's ChatGPT as an exploratory audit support tool to simulate its potential role in internal audit analytics. ChatGPT was integrated through a Google Sheets extension, enabling real-time interaction with the GPT-3.5 Turbo model via structured prompts. This configuration allowed the generation of context-specific audit insights directly within the spreadsheet environment, aligning with the analytical workflow used by internal auditors in practice. The integration was executed using the following prompt formula:

Formula "=GPT_LIST(A1)"

Where A1 contains a question relevant to internal audit procedures. The prompts were designed around key audit dimensions—risk identification, audit program formulation,

development areas, and recommendation generation—to assess ChatGPT's capacity to support cognitive tasks in audit planning and execution. This procedure mirrors the concept of AI-augmented human judgment, where machine-generated outputs are critically reviewed and refined by auditors to ensure contextual validity and professional skepticism, as illustrated in the AI–human decision-making model proposed by Mohapatra et al. (2023).

Data Sources and Analysis

The secondary data for this study were collected from official websites of relevant ministries and institutions, namely the National Public Procurement Agency (Lembaga Kebijakan Pengadaan Barang/Jasa Pemerintah, LKPP) and the Ministry of Villages (Kementerian Desa dan Pembangunan Daerah Tertinggal, Kemendesa). The data sources consisted of:

1. Procurement data, consisting of 23 construction work plans for the fiscal year 2023, retrieved from the General Procurement Plan System (LKPP, 2023d). These records document procurement activities for infrastructure development within the IKN project area.
2. Village Development Index (Indeks Desa Mandiri, IDM) data, comprising 841 village-level observations from East Kalimantan for 2022 (Kemendesa, 2023), reflecting the socio-economic and sustainability context surrounding the IKN region.

These datasets were analyzed to identify procurement trends, sustainability indicators, and potential risk areas associated with sustainable development and procurement oversight. Following the BDA framework, the analysis used descriptive analytics and data visualization techniques in Microsoft Excel, including pivot tables and simple aggregations. These methods were chosen for their accessibility and compatibility with the existing analytical practices of government internal auditors (IIA, 2019; Febrian, 2021; McKee, 2021; Poon et al., 2024).

The use of BDA in this stage enabled the identification of patterns and relationships between procurement activities and regional sustainability indicators. Meanwhile, integrating OpenAI provided complementary insights, including potential risk identification and recommendation formulation. Together, these analytical processes supported the exploratory assessment of AI-assisted sustainable procurement audits within the IKN context.

RESULT AND DISCUSSION

This section presents the findings of the exploratory case study, which simulated the application of AI and BDA tools in internal audit procedures for sustainable procurement in IKN. The analysis follows the logical sequence of the internal audit process, starting from defining audit objectives, identifying key actors and risks, developing audit programs, and testing audit procedures, to evaluate how AI-assisted tools such as ChatGPT can support auditors' judgment and enhance the comprehensiveness of sustainability audits.

Internal Audit Objectives

According to Anderson et al. (2017), establishing clear audit objectives is a critical step in ensuring the alignment between internal audit assignments and organizational goals. In this study, the internal audit of sustainable construction work in IKN was designed to verify whether the economic, social, and environmental dimensions of sustainability had been adequately disclosed in construction work plans. The audit aimed to identify and test the occurrence of sustainability-related procurement risks and assess the degree to which these risks could hinder the achievement

of sustainable development outcomes.

The resulting audit objectives therefore emphasized (1) evaluating the disclosure of sustainability information in procurement planning, (2) identifying relevant risks, and (3) developing evidence-based recommendations to improve transparency and accountability in IKN's procurement processes.

Identification of Sustainable Procurement Actors

Identifying actors in sustainable procurement is essential to determining accountability and the scope of the internal audit (Gelderman et al., 2017). These actors are typically aligned with sectoral mandates defined in government regulations, which establish the respective authorities of central and local institutions. As summarized in Table 1, the actors involved in sustainable procurement policies can be categorized into three key aspects—economic, social, and environmental—each with specific leading sectors and procurement authorities (Kamal, 2020). This classification establishes the institutional framework for assessing coherence and coordination in sustainable procurement implementation.

In the context of the IKN construction audit, the analysis focuses on the planning phase of construction projects funded in the 2023 fiscal year. The Ministry of Public Works and Housing (Kementerian Pekerjaan Umum Republik Indonesia, PUPR) serves as the leading actor, managing the largest portion of the IKN budget (Lida, 2023), and is thus primarily responsible for ensuring compliance with sustainable procurement mandates. Meanwhile, local government actors in East Kalimantan—both at the provincial and district/city levels—serve as supporting beneficiaries and stakeholders whose participation is essential to achieving sustainability outcomes. The inclusion of local actors in the data analysis reinforces intergovernmental coordination and strengthens the evaluation of how sustainability principles are operationalized at multiple governance levels.

Table 1. Examples of Sustainable Procurement Policy Actors

Aspect	Government Actors		
	Leading Sector		Leading
	Central Government	Local Government	Procurement
Economic	Ministry of PUPR	Work units according to	LKPP
	Ministry of Industry	the leading sectors in:	
	Ministry of Trade	• Province	
Social	Ministry of Cooperatives and SMEs	• Regency	
	Ministry of Manpower	• City	
	Ministry of Social		
Environmental	Ministry of Health		
	Ministry of Environment & Forestry (LHK)		
	Ministry of Energy and Mineral Resources (ESDM)		

Identified Risks in Sustainable Procurement

Risk management, including risk identification, constitutes a key component of internal auditing (Anderson et al., 2017). This study applied AI-based techniques to enhance risk identification (Giudici et al., 2024). Using OpenAI's ChatGPT integrated into Google Sheets, ten potential risks in sustainable procurement were identified, summarized in Table 2. These risks were generated by entering the formula =GPT_LIST(A1), in which cell A1 contained the prompt "provide

risks in sustainable public procurement."

Researchers then applied human judgment (Mohapatra et al., 2023) to assess the relevance of each identified risk to the audit objectives and to verify whether similar descriptions existed in the risk management documentation of the PUPR Procurement Work Unit (Manajemen Risiko Unit Kerja Pengadaan Barang/Jasa, MR UKPBJ). A review of Table 2 reveals that most risks are associated with the three aspects of sustainable procurement. Only three risks were unrelated: "non-compliance with environmental and social standards," "inadequate consideration of social and environmental impacts," and "inadequate consideration of life cycle costs," which relate primarily to specific sustainability dimensions.

Table 2. Risk Identification from ChatGPT

Result of ChatGPT	Sustainable Procurement Aspect		
	Economic	Social	Environmental
Risk in Sustainability Public Procurement:			
Lack of transparency	V	V	V
Corruption	V	V	V
Inadequate supplier capacity	V	V	V
Limited competition	V	V	V
Inadequate monitoring and evaluation	V	V	V
Non-compliance with environmental and social standards		V	V
Inadequate stakeholder engagement	V	V	V
Inadequate risk management	V	V	V
Inadequate consideration of life cycle costs	V		
Inadequate consideration of social and environmental impacts		V	V

In addition, statistical data from Indonesia's Corruption Eradication Commission indicate that procurement-related corruption ranks as the most frequent type of corruption case (KPK, 2023). Therefore, the "corruption" risk identified by ChatGPT aligns with contextual realities in Indonesia's procurement environment. Supporting data from the Procurement Service Unit Information System (Sistem Informasi Unit Kerja Pengadaan Barang/Jasa, SIUKPBJ) PUPR (LKPP, 2023a; 2023b; 2023c) were reviewed, including risk identification and mitigation documents. The review found that none of the ten AI-generated risks were explicitly included in the MR UKPBJ PUPR documents.

Hence, combining AI-generated insights with auditor judgment yields a more comprehensive risk landscape. The ten identified risks are therefore considered highly probable and relevant to sustainable procurement in IKN. These risks could hinder the realization of economic, social, and environmental objectives and should be incorporated into IKN's formal risk register to enhance the coverage and effectiveness of future internal audits.

Program Audit

Consistent with auditing standards, auditors must develop an audit program outlining procedures to test identified risks (Anderson et al., 2017). Based on the ten risks identified in the previous stage, an audit program was designed to assess how sustainable procurement is managed and monitored within the IKN project. The AI-assisted audit process was conducted using the

ChatGPT prompt formula =GPT_LIST(A1), where cell A1 contained the instruction "prepare audit program for sustainable procurement audit." This prompt generated a structured list of 10 key audit procedures, summarized in Table 3. The resulting output shows that ChatGPT successfully generated relevant audit procedures for seven risks, while three required prompt modification for more specific results.

Table 3. Program Audit for each risk for sustainable procurement

Number	Risks identified (ChatGPT-1)	Audit program (ChatGPT-2)	Description (ChatGPT-3)
1	Lack of transparency	Applicable	
2	Corruption	Not	Need to modify the question
3	Inadequate supplier capacity	Applicable	
4	Limited competition	Not applicable	Need to modify the question
5	Inadequate monitoring and evaluation	Applicable	
6	Non-compliance with environmental and social standards	Applicable	
7	Inadequate stakeholder engagement	Applicable	
8	Inadequate risk management	Not applicable	Need to modify the question
9	Inadequate consideration of life cycle costs	Applicable	
10	Inadequate consideration of social and environmental impacts	Applicable	

Each procedure was then reviewed and refined using human judgment (Mohapatra et al., 2023) to ensure alignment with Indonesia's internal audit standards and sustainable procurement principles. To illustrate, the audit program for the first risk, "lack of transparency," was implemented as a pilot test at the procurement planning stage. The procedures included: (1) reviewing procurement policies and procedures, (2) analyzing procurement data for transparency and sustainability criteria, (3) conducting interviews with procurement staff and stakeholders, (4) assessing the level of transparency in procurement decision-making, (5) identifying potential risks and areas for improvement, and (6) developing recommendations for increasing transparency and sustainability in procurement processes.

Each step was subsequently validated through human judgment (Mohapatra et al., 2023) and cross-referenced with nondigital data—specifically Presidential Regulation Number 16 of 2018 and Number 12 of 2021. Steps (1) and (2) were found particularly relevant and implementable, while later steps supported evaluation and evidence collection. This aligns with prior studies demonstrating AI's potential to assist in developing audit procedures (Gu et al., 2023; Huang & Liu, 2024; Shukla et al., 2024; Suarez et al., 2024).

Audit Testing Steps

Audit testing was conducted to simulate the implementation of the AI-assisted audit program. The procedures focused on the risk of a lack of transparency and evaluated sustainable procurement disclosures in IKN construction projects. Testing used data from the Sistem Rencana Umum Pengadaan (LKPP, 2023d) and was supported by descriptive analytics in Microsoft Excel. To validate the audit program generated through AI-assisted exploration, the first testing step involved a review of procurement policies and procedures. Procurement planning at the Ministry PUPR adheres to the guidelines established under LKPP Regulation Number 11 of 2021, which mandates the integration of economic, social, and environmental dimensions into sustainable procurement.

Accordingly, the internal audit process adopted a checklist derived from Presidential Regulation Number 16 of 2018 in conjunction with Presidential Regulation Number 12 of 2021. The checklist covered three core dimensions: (1) economic, including projected life-cycle costs of goods and services; (2) social, encompassing local business empowerment, job security, community participation, equality, and diversity; and (3) environmental, covering the mitigation of negative impacts on air, soil, and water quality, as well as the responsible use of natural resources. This operational framework served as the reference for subsequent testing procedures.

The second step analyzed procurement data to assess transparency and sustainability criteria, using information extracted from the General Procurement Plan System (LKPP). Data were filtered using the keywords PUPR, construction work, and IKN, resulting in 23 identified construction work packages with a total budget of IDR 10.87 trillion. When the sustainability checklist described above was applied, none of the 23 construction planning documents disclosed information related to the economic, social, or environmental aspects of sustainable procurement. These findings are summarized in Table 4, which represents the audit working paper (AWP) format used to assess the level of disclosure. The results confirmed that all 23 packages scored "0," meaning the sustainability criteria were not transparently presented in any of the procurement planning documents.

Table 4. Audit Working Paper for Transparency and Sustainability Criteria Analysis

Aspects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Economic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Social	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Environmental	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fulfillment level of three aspects of sustainable procurement: 0																							

To further validate these findings, documentary audit evidence was reviewed on the Electronic Procurement Service (Layanan Pengadaan Secara Elektronik, LPSE) PUPR website. The analysis covered 13 construction work tenders related to IKN development. Although these tenders included detailed job descriptions, none provided explicit information on sustainable procurement. For instance, the IKN Toll Road Karangjoang–KKT Kariangau Segment, valued at IDR 1.64 trillion and last updated on March 13, 2023, explicitly stated "no" in the sustainable procurement column for all three aspects—economic, social, and environmental (see Appendix). This indicates that the principle of transparency, as mandated in Presidential Regulation Number 16 of 2018, has not been adequately realized in the planning stage.

Because field interviews were not conducted in this study, alternative "data interrogation" was performed through the analysis of quantitative indicators representing stakeholders' socio-economic conditions. The first analysis used regional financial data from the Ministry of Finance to assess the fiscal independence of East Kalimantan's local governments. The results showed a significant decline in local own-source revenue (Pendapatan Asli Daerah, PAD) growth by −0.5062, while transfer funds increased by 0.3318, indicating persistent dependency on central government

support (Kemenkeu, 2023). The regional independence ratio also declined from 41% to 15% between 2021 and 2022. This condition suggests that local governments have limited fiscal capacity to support sustainable development initiatives in the IKN area independently.

The second analysis used the IDM dataset from the Ministry of Villages (Kemendesa, 2023), which comprises 841 villages in East Kalimantan. The findings revealed that 585 villages (69.56%) did not achieve the targeted IDM level in 2022, as illustrated in Figure 5. These results indicate that the development of IKN has not optimally improved the economic, social, and environmental aspects of village communities in the IKN location and East Kalimantan Province.

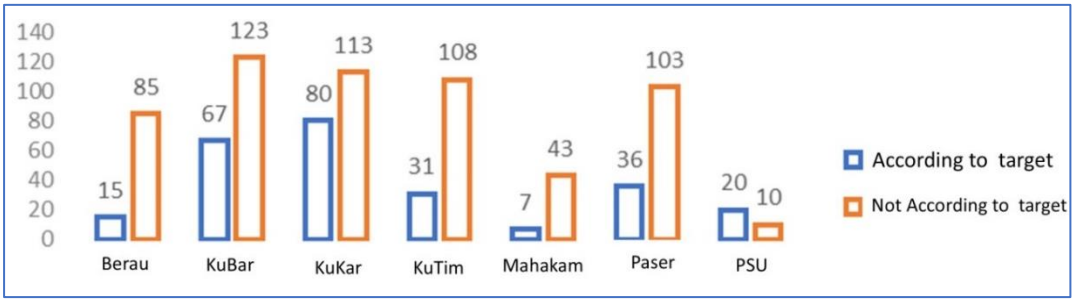

Figure 5. Achievement of IDM 2022 for East Kalimantan Province
Source: *Kemendesa (2023)*

In assessing the sustainability context of the IKN region, this study refers to the Village Development Index (Indeks Desa Membangun or IDM) published by the Ministry of Villages. The IDM represents a composite measure of a village's development capacity and is constructed from three sub-indices: the Social Index (IKS), the Economic Index (IKE), and the Environmental Index (IKL). The IKS captures social resilience indicators such as education, health, and community participation; the IKE measures economic resilience through employment opportunities, infrastructure, and productive activity levels; and the IKL reflects environmental resilience, including resource management, waste control, and disaster preparedness. The overall IDM score is calculated as a weighted aggregation of these three indices, with higher values indicating stronger village independence and sustainability. This multidimensional framework aligns closely with the three pillars of sustainable procurement—economic, social, and environmental—thus providing a relevant empirical proxy for evaluating the sustainability conditions surrounding IKN.

A descriptive analysis of the 585 villages that did not reach the target shows that the general villages in East Kalimantan Province have weak economic development, as depicted by Table 7. However, if examined from the "minimum" or the 20% lowest-ranking (117 villages), the development priorities of the underdeveloped villages are economic and environmental aspects, at 0.7 and 0.6, respectively. This range indicates inequality in "economic and environmental" development between the 585 villages.

Based on these analyses, the overall assessment (Step 4) concluded that the transparency of sustainable procurement in IKN construction projects is inadequate. This lack of disclosure increases the potential for risks in governance, sustainability compliance, and stakeholder engagement. Consequently, Step 5 involved exploring these potential risks and areas for improvement through ChatGPT-assisted analysis. ChatGPT was employed to generate insights in response to the prompt: "If the condition of transparency in sustainable procurement is poor, what are the potential risks and areas for improvement?" The AI-generated output identified 10 potential risks, including a lack of stakeholder trust, negative impact on institutional reputation, regulatory noncompliance, limited visibility into supply chain performance, missed opportunities for innovation, and inadequate training for procurement personnel. These risks were reviewed using

human judgment, as suggested by Mohapatra et al. (2023), and validated against contextual data derived from fiscal and village-level indicators in East Kalimantan.

Table 7. Descriptive Statistical Results of the 585 IDM in 2022

Descriptive statistic	IKS 2022	IKE 2022	IKL 2022	IDM 2022
Mean	0.7859	**0.6189**	0.7290	**0.7112**
Median	0.7886	0.6167	0.6667	0.7016
Mode	0.8057	0.6167	0.6667	0.6944
Standard deviation	0.0672	0.1147	0.1201	0.0644
Range	0.4285	**0.7**	**0.6**	0.318
Minimum	0.5486	0.25	0.4	0.513
Maximum	0,9771	0.95	1	0.831
Count	585	585	585	585
Largest (117)	0.8457	0.7167	0.8667	0.7786
Smallest (117)	0.7257	**0.5167**	**0.6**	**0.6548**

The integration of human interpretation revealed that one of the most critical challenges was insufficient collaboration between procurement agencies, local suppliers, and regional stakeholders. This aligns with earlier findings showing weak fiscal independence among local governments and low economic resilience (IKE) at the village level. The social dimension of sustainable procurement emphasizes fairness, inclusivity, and the empowerment of local small enterprises. However, employment data from the Central Bureau of Statistics (BPS, 2023) show that employment in the micro and small business sectors declined by −0.703 between 2020 and 2021 (Table 8), reflecting limited participation of local labor in the IKN development process.

If approximately 20.09% of total construction costs are typically allocated to labor (Hawari et al., 2021), then the estimated labor cost for the 23 IKN construction projects—worth IDR 10.87 trillion in total—amounts to around IDR 2.18 trillion. This potential expenditure represents a substantial opportunity to stimulate local economic growth and improve livelihoods if transparency and local involvement are enhanced.

Table 8. Growth of Local Workforce in Micro and Small Businesses

Province	Number of employees in the province						Employee growth			
	Micro			Small			Micro		Small	
	2019	2020	2021	2019	2020	2021	19 - 20	20 -21	19 - 20	20 - 21
East Kalimantan	56,051	43,633	47,201	8812	10,348	3076	−0.222	0.082	0.174	−0.703
Indonesia	7,363,163	6,953,975	7,304,554	2,212,283	2,693,567	1,804,743	−0.056	0.050	0.218	−0.330

Source: *BPS (2023)*

Building upon these insights, Step 6 focused on developing recommendations for enhancing transparency and sustainability in procurement. ChatGPT was prompted with the question “What are the recommendations for increasing transparency and sustainability in procurement processes?” The model produced seven recommendations, which were subsequently evaluated using human judgment. The recommendations emphasize: (1) implementing a clear and comprehensive procurement policy that integrates sustainability criteria; (2) ensuring open and competitive bidding to promote fairness and accountability; (3) providing structured training programs for procurement officials on sustainable procurement practices; (4) engaging suppliers to adopt transparent and sustainable operational standards; (5) regularly monitoring and reporting procurement outcomes against sustainability targets; (6) incorporating life-cycle cost analysis in

procurement decision-making; and (7) strengthening collaboration with local governments, communities, and other stakeholders to share best practices and promote sustainability.

Among these, the recommendation to "collaborate with local governments and communities around IKN" is particularly critical. It aligns with prior findings that highlight weak fiscal and development capacity in the region and supports the argument for cross-sector partnerships to achieve sustainable outcomes. These results also corroborate earlier studies emphasizing that AI can assist in exploring audit procedures and risk testing (Huang & Liu, 2024; Shukla et al., 2024; Suarez et al., 2024), while BDA facilitates risk assessment (Giudici et al., 2024; Joshi, 2020), audit planning (Sanoran & Ruangprapun, 2023), and deepens understanding of internal and external environments (Mousa et al., 2022).

Moreover, the integration of OpenAI within spreadsheet environments, as demonstrated in this study, is consistent with prior applications of general audit software (Smidt et al., 2019) and represents a feasible technological step for AI-augmented auditing (Gu et al., 2023). Finally, the combination of AI-driven analytics and human professional judgment—as conceptualized by Mohapatra et al. (2023)—proves to be a critical approach for ensuring that machine-generated insights are interpreted within ethical and contextual boundaries.

Nevertheless, this study has several limitations. Not all types of sustainability-related risks were examined or accompanied by audit step examples; stakeholder interviews were not conducted; and risk probabilities and impacts on sustainable procurement objectives were not quantitatively assessed. These limitations present opportunities for further research, including multi-stakeholder validation, probabilistic risk modeling, and the use of more advanced AI tools to strengthen audit analytics and sustainability assurance in the public sector.

CONCLUSION

This study explored the application of AI in sustainable procurement audits within IKN, focusing on the planning stage of construction projects. The findings demonstrate that OpenAI's ChatGPT can be embedded within spreadsheet environments to identify ten sustainability-related risks, generate corresponding audit programs, formulate development areas, and propose actionable recommendations. This provides a concrete example of an AI-assisted audit workflow in sustainable procurement. However, the study also emphasizes that AI-generated outputs must be complemented with human professional judgment to ensure contextual relevance, ethical interpretation, and reliable decision-making in subsequent audit steps.

The analysis revealed a major risk of a lack of transparency in the planning documents for 23 construction projects in IKN. This transparency gap highlights the need for stronger collaboration among procurement authorities, local governments with limited fiscal independence, and village administrations characterized by weak economic and environmental development. The study recommends that the PUPR strengthen coordination with East Kalimantan's local governments and actively promote inclusive partnerships with surrounding villages to enhance sustainable procurement outcomes.

Beyond its empirical insights, this study contributes to both theory and practice by demonstrating how AI can function as a cognitive co-pilot in public sector internal audits, particularly for risk identification, audit program design, and recommendation development. It also provides practical input for revising internal audit supervision guidelines (BPKP, 2019), especially regarding sustainability-related risks, audit procedures, and reporting mechanisms, and offers

implications for improving the disclosure of sustainable procurement criteria in IKN project planning. Overall, the study presents a practical demonstration of AI-assisted internal auditing in the public sector and shows how such tools can strengthen sustainable procurement oversight in the IKN context.

REFERENCES

AAIPI. (2021). Standar Audit Intern Pemerintah Indonesia. Asosiasi Auditor Intern Pemerintah Indonesia

Akbulut, D. H., Ozoner, K., & Kaya, I. (2018). Big data analytics in internal audit. *Pressacademia, 7*(1), 260-262. https://doi.org/10.17261/pressacademia.2018.893

Alshurafat, H. (2023). The usefulness and challenges of chatbots for accounting professionals: Application on ChatGPT. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4345921

Anderson, U. L., Head, M. J., Ramamoorti, S., Riddle, C., Salamasick, M., & Sobel, P. J. (2017). *Internal auditing: Assurance & advisory services* (Fourth Ed.). The Internal Audit Foundation.

Awuah, B., Onumah, J. M., & Duho, K. C. T. (2022). Determinants of adoption of computer-assisted audit tools and techniques among internal audit units in Ghana. *Electronic Journal of Information Systems in Developing Countries, 88*(2). https://doi.org/10.1002/isd2.12203

Benoit, J. R. A. (2023, February 8). ChatGPT for clinical vignette generation, revision, and evaluation. *MedRxiv*. https://doi.org/10.1101/2023.02.04.23285478

BPKP. (2019). Pedoman Pengawasan Intern atas Pengadaan Barang dan Jasa Pemerintah. https://peraturan.bpk.go.id/Details/228512/peraturan-bpkp-no-3-tahun-2019

BPKP. (2023). Laporan Kinerja BPKP Tahun 2022. https://bpkp.go.id/id/unitKerja/3/informasiPublik/laporanKeuanganKinerja/kinerja/6

BPS. (2023). Jumlah tenaga kerja industri skala mikro dan kecil menurut provinsi (orang). https://www.bps.go.id/id/statistics-table/2/NDQxIzI=/jumlah-tenaga-kerja-industri-skala-mikro-dan-kecil-menurut-provinsi.html

Broeders, D., Schrijvers, E., van der Sloot, B., van Brakel, R., de Hoog, J., & Hirsch Ballin, E. (2017). Big Data and security policies: Towards a framework for regulating the phases of analytics and use of Big Data. *Computer Law and Security Review, 33*(3). https://doi.org/10.1016/j.clsr.2017.03.002

CAGI. (2017). *Guidelines on data analytics* (first edit). Office of the Comptroller and Auditor General of India.

Chen, Y., Wu, Z., & Yan, H. (2022). A full population auditing method based on machine learning. *Sustainability (Switzerland), 14*(24). https://doi.org/10.3390/su142417008

Diamant, A. (2024). Introducing prescriptive and predictive analytics to MBA students with Microsoft Excel. *INFORMS Transactions on Education, 24*(2). https://doi.org/10.1287/ited.2023.0286

Febrian, F. (2021). Audit data analytics dengan MS Excel: Use case pemeriksaan pajak. *Jurnal Pajak Indonesia (Indonesian Tax Review), 5*(1). https://doi.org/10.31092/jpi.v5i1.1238

Feung, J. L. C., & Thiruchelvam, I. V. (2020). A framework model for continuous auditing in financial statement audits using big data analytics. *International Journal of Scientific and Technology Research, 9*(4).

Fotoh, L. E., & Lorentzon, J. I. (2020). Critical issues of the audit expectation gap in the era of audit digitalisation. In *Proceedings of Hawai'i Accounting Research Conference (HARC)*, 1–32. https://scholarspace.manoa.hawaii.edu/items/49c8cdcd-d14c-493c-9dad-063a9ccb4d1a

Gelderman, C. J., Semeijn, J., & Vluggen, R. (2017). Development of sustainability in public sector procurement. *Public Money and Management, 37*(6), 435-442. https://doi.org/10.1080/09540962.2017.1344027

George, S. A., George, H. A., & Martin, A. S. G. (2023). A review of ChatGPT AI's impact on several business sectors. *Partners Universal International Innovation Journal, 1*(1), 9–23. https://doi.org/10.5281/zenodo.7644359

Giudici, P., Centurelli, M., & Turchetta, S. (2024). Artificial intelligence risk measurement. *Expert Systems with Applications, 235*. https://doi.org/10.1016/j.eswa.2023.121220

Gu, H., Schreyer, M., Moffitt, K., & Vasarhelyi, M. A. (2023). Artificial intelligence co-piloted auditing. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4444763

Haleem, A., Javaid, M., & Singh, R. P. (2022). An era of ChatGPT as a significant futuristic support tool: A study on features, abilities, and challenges. *BenchCouncil Transactions on Benchmarks, Standards and Evaluations, 2*(4). https://doi.org/10.1016/j.tbench.2023.100089

Handoko, B. L., Mulyawan, A. N., Tanuwijaya, J., & Tanciady, F. (2020). Big data in auditing for the future of data-driven fraud detection. *International Journal of Innovative Technology and Exploring Engineering, 9*(3), 2902–2907. https://doi.org/10.35940/ijitee.B7568.019320

Hawari, R. A., Oktaviani, C. Z., & Nurisra, N. (2021). Komposisi biaya sumber daya material dan tenaga kerja pada proyek konstruksi bangunan gedung sederhana. *Journal of The Civil Engineering Student, 3*(2). https://doi.org/10.24815/journalces.v3i2.14448

Houser, K. A., & Sanders, D. (2017). The use of big data analytics by the IRS: Efficient solutions or the end of privacy as we know it? *Vanderbilt Journal of Entertainment & Technology Law, 19*(4). https://scholarship.law.vanderbilt.edu/jetlaw/vol19/iss4/2

Huang, F., No, W. G., Vasarhelyi, M. A., & Yan, Z. (2022). Audit data analytics, machine learning, and full population testing. *Journal of Finance and Data Science, 8*, 138-144. https://doi.org/10.1016/j.jfds.2022.05.002

Huang, L., & Liu, D. (2024). Towards intelligent auditing: Exploring the future of artificial intelligence in auditing. *Procedia Computer Science 247*, 654–663. https://doi.org/10.1016/j.procs.2024.10.079

IIA. (2019). Data analysis technologies IPPF-Practice guide. https://www.theiia.org/en/content/guidance/recommended/supplemental/gtags/gtag-data-analysis-technologies/

Joshi, P. L. (2020). Determinants Affecting Internal Audit Effectiveness. EMAJ: Emerging Markets Journal, 10(2). https://doi.org/10.5195/emaj.2020.208

Joshi, P. L., & Marthandan, G. (2020). Continuous internal auditing: Can big data analytics help? *International Journal of Accounting, Auditing and Performance Evaluation, 16*(1), 25–42. https://doi.org/10.1504/IJAAPE.2020.106766

Kamal, M. (2020). Analisis kebijakan pengadaan barang dan jasa berkelanjutan. *Jurnal Transformasi Adminstrasi, 10*(02), 131–142. https://doi.org/10.56196/jta.v10i02.162

Kamal, M. (2021). Pemetaan riset data analytics di Indonesia. In RR Tien Danarti Mesra & Muhaimin (Eds.), *PIN 4.0; Akselerasi pemulihan ekonomi nasional melalui pengembangan kompetensi ASN* (pp. 137–141). Pusdiklat Perdagangan Kementerian Perdagangan.

Kamal, M. (2022). Optimasi penerapan data analytics untuk akselerasi transformasi digital di lembaga pelatihan. *Jurnal Kewidyaiswaraan, 7*(2), 132–143. http://jurnalpjf.lan.go.id/index.php/jurnalkewidyaiswaraan

Kamal, M., & Elim, J. (2021). The strategy to optimize the role of government internal supervisory apparatus (APIP) in procurement fraud risk management in industry 4.0. *Jurnal Tata Kelola Dan Akuntabilitas Keuangan Negara, 7*(2), 151–168. https://doi.org/10.28986/jtaken.v7i2.588

Kemendesa. (2023). *Indeks desa membangun*. https://idm.kemendesa.go.id/view/detil/3/Publikasi

Kemenkeu. (2023). APBD Provinsi Kaltim 2021 - 2022. https://djpk.kemenkeu.go.id/portal/data/apbd

Kemenpan. (2021). Pedoman teknis pelaksanaan pemantauan dan evaluasi SPBE. https://jdih.menpan.go.id/dokumen-hukum/PEDOMAN%20MENTERI/jenis/1848?PEDOMAN%20MENTERI

Kemenpan. (2023). Hasil pemantauan dan evaluasi spbe pada instansi pusat dan pemerintah daerah tahun 2022. https://jdih.esdm.go.id/common/dokumen-external/INDEKS_SPBE_Kepmen_Nomor_108_Tahun_2023_Tentang_Hasil_Tauval_Tahun.pdf

KPK. (2023, January 27). TPK berdasarkan jenis perkara. https://www.kpk.go.id/id/publikasi-data/statistik/penindakan-2

Lida, P. (2023, March 22). Kemenkeu ungkap PUPR ajukan tambahan anggaran IKN hingga Rp 8 Triliun. *Republika*. https://ekonomi.republika.co.id/berita/rrvu4n502/kemenkeu-ungkap-pupr-ajukan-tambahan-anggaran-ikn-hingga-rp-8-triliun

LKPP. (2023a). Dokumen identifikasi dan mitigasi risiko Kementerian Pekerjaan Umum dan Perumahan Rakyat. https://siukpbj.lkpp.go.id/files/file-27-34-3b3dc038d01b.pdf

LKPP. (2023b). Risiko balai pelaksana pemilihan jasa konstruksi. https://siukpbj.lkpp.go.id/files/file-27-30-d2500dc3dd87.pdf

LKPP. (2023c). Hasil pengisian penilaian mandiri tingkat kematangan organisasi UKPBJ Kementerian Pekerjaan Umum dan Perumahan Rakyat. https://siukpbj.lkpp.go.id/summary-report/27

LKPP. (2023d). Jenis pekerjaan konstruksi di IKN-PUPR 2023. https://sirup.lkpp.go.id/sirup/caripaketctr/index

McKee, T. E. (2021). Analyzing an audit population via either Excel pivot tables and/or R language cluster analysis. *Current Issues in Auditing, 15*(1), 11–114. https://doi.org/10.2308/CIIA-2019-502

Mohapatra, A., Mohammed, A. R., & Panda, S. (2023). Role of artificial intelligence in the construction industry – a systematic review. *IJARCCE, 12*(2), 24-29. https://doi.org/10.17148/ijarcce.2023.12205

Mousa, A., Abdullah, A., & Omar, Z. (2022). The impact of big data analytics on audit procedures: evidence from the Middle East. *Journal of Asian Finance,* 9(2), 93-102. https://doi.org/10.13106/jafeb.2022.vol9.no2.0093

Oldhouser, M. C. (2016). *The effects of emerging technologies on data in auditing* [Thesis, University of South Carolina, Columbia]. University Libraries-University of South Carolina. https://scholarcommons.sc.edu/senior_theses/68

Otorita IKN. (2022, August 18). Siapkan smart city, kepala otorita ikn ingin teknologi dapat mempermudah kehidupan di IKN. https://ikn.go.id/storage/press-release/2022/182022.0818.siaran-pers-siapkan-smart-city-kepala-otorita-ikn-ingin-teknologi-dapat-mempermudah-kehidupan-di-ikn.pdf

Oyewo, B., Ajibola, O., & Ajape, M. (2021). Characteristics of consulting firms associated with the diffusion of big data analytics. *Journal of Asian Business and Economic Studies, 28*(4), 281-302. https://doi.org/10.1108/JABES-03-2020-0018

Poon, P. L., Lau, M. F., Yu, Y. T., & Tang, S. F. (2024). Spreadsheet quality assurance: a literature review. *Frontiers of Computer Science, 18*(2), 1-22. https://doi.org/10.1007/s11704-023-2384-6

Rakipi, R., De Santis, F., & D'Onza, G. (2021). Correlates of the internal audit function's use of data analytics in the big data era: Global evidence. *Journal of International Accounting, Auditing and Taxation, 42*. https://doi.org/10.1016/j.intaccaudtax.2020.100357

Sanoran, K., & Ruangprapun, J. (2023). Initial implementation of data analytics and audit process management. *Sustainability, 15*(3). https://doi.org/10.3390/su15031766

Shabani, N., Munir, A., & Mohanty, S. P. (2022). A study of big data analytics in internal auditing. *Lecture Notes in Networks and Systems, 295,* 362-374. https://doi.org/10.1007/978-3-030-82196-8_27

Shukla, A., Fathima, B. A. A., Mohan, C. R., Sidhu, K. S., Balavenu, R., & Gupta, S. (2024). Artificial intelligence in financial auditing: Innovating traditional practices for enhanced accuracy. *Journal of Informatics Education and Research, 4*(3). https://doi.org/10.52783/jier.v4i3.1630

Smidt, L. A., Van Der Nest, D. P., Steenkamp, L., Lubbe, D. S., & Ahmi, A. (2019). An assessment of the purpose of the use of generalised audit software: A perspective of internal audit functions in Australia. *14th Iberian Conference on Information Systems and Technologies (CISTI), Coimbra, Portugal,* 2019, pp. 1–6. https://doi.org/10.23919/CISTI.2019.8760882

Suarez, S. R., Huamani, B. M., Meléndez, M. A., & Ovalle, C. (2024). Methodology applied to computer audit with artificial intelligence: a systematic review. *IAES International Journal of Artificial Intelligence, 13*(4), 3727–3738. https://doi.org/10.11591/ijai.v13.i4.pp3727-3738

Tang, F., Norman, C. S., & Vendrzyk, V. P. (2017). Exploring perceptions of data analytics in the internal audit function. *Behaviour and Information Technology, 36*(11), 1125–1136. https://doi.org/10.1080/0144929X.2017.1355014

Tušek, B., Ježovita, A., & Halar, P. (2021). Critical auditors' expertise for blockchain-based business environment. *Zagreb International Review of Economics and Business, 24*(s1), 49-61. https://doi.org/10.2478/zireb-2021-0019

Valdavida, M. C. (2018). Auditoría digital: el reto del siglo XXI. *Dialnet Plus, 91*, 135-151.

Vestoso, M. (2018). The GDPR beyond privacy: Data-driven challenges for social scientists, legislators and policy-makers. *Future Internet, 10*(7). https://doi.org/10.3390/fi10070062

Vieira, V., Pedrosa, I., & Soares, B. H. (2017). Big data & analytics: An approach using audit experts' interviews. *12th Iberian Conference on Information Systems and Technologies (CISTI), Lisbon, Portugal*, 2017, pp. 1–6. https://doi.org/10.23919/cisti.2017.7976069

Yin, R. K. (2018). Case Study research and applications: Design and methods (6th ed.). Thousand Oaks, CA: Sage.

APPENDIX

Validity Test Results