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RESEARCH ARTICLE

Environmental Audits in Public Institutions: A Mechanism to Enhance Transparency and Sustainability

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ABSTRACT

To analyse environmental audits in public institutions to improve transparency and sustainability. Grounded in concepts such as institutional transparency, environmental sustainability, and regulatory compliance, the study positions audits as essential tools for efficient and sustainable public management. A quantitative, cross-sectional approach was adopted. Data were collected from 700 participants in regional and national public institutions using a structured questionnaire with a 7-point Likert scale. Analysis, conducted with SEM in SmartPLS, included validity and reliability tests, achieving AVE > 0.5 and Cronbach's Alpha > 0.7. The frequency of audits positively impacts environmental sustainability (coefficient = 0.770, p = 0.001) and institutional transparency (coefficient = 0.529, p = 0.001). In contrast, audit quality showed a negative impact on sustainability (coefficient = -0.333, p = 0.001) and a non-significant positive impact on transparency (coefficient = 0.258, p = 0.109). These findings underscore the necessity of frequent and high-quality audits. Provides recommendations to enhance environmental governance through regular and effective audits, targeting policymakers and experts. Contributes to knowledge on the impact of environmental audits in public institutions, offering guidance for sustainable and effective practices.

INTRODUCTION

Currently, over 65% of public institutions worldwide face increasing demands for sustainability and transparency, reflecting the expectations of a more critical citizenry and international commitments such as the Sustainable Development Goals (SDGs) (Asante-Appiah, 2020; Marwa et al., 2020). These demands have risen due to a 30% increase in environmental regulatory frameworks adopted over the past five years (Arif et al., 2020; Aslam et al., 2020; Hammami & Hendijani Zadeh, 2020). However, despite these advances, approximately 45% of implemented environmental policies lack effective control and monitoring mechanisms, limiting their real impact on sustainability (Amin et al., 2021; Siew et al., 2020; C. Zeng et al., 2020).

Among the main identified issues, nearly 50% of public institutions fail to fully comply with existing environmental regulations (Castka et al., 2020; Lee et al., 2020). This non-compliance, attributed to insufficient resources and corruption in 70% of cases, has led to significant consequences (Bassey, 2020; Hancu-Budui et al., 2020; Wu et al., 2020). For instance, inadequate solid waste management results in 2.5 million tonnes of annual waste in urban areas of developing countries, while water source pollution endangers the health of 40% of rural communities (Desjardins et al., 2021; Earnhart

& Harrington, 2021). These problems have led to a 25% loss in public trust, weakening the legitimacy of government entities and their capacity to ethically manage common goods (Arango et al., 2021; Earnhart & Friesen, 2021).

Another recurring challenge is the absence of systematic environmental audits. Only 20% of audits conducted in public institutions adopt a preventive approach, while 80% are limited to corrective actions (Sembayev, 2021; Shen et al., 2021). This reactive approach perpetuates inefficient practices, exacerbates environmental degradation, and increases compliance costs by 35%. Furthermore, a lack of transparency in audit results has contributed to a cycle of opacity, reported in more than 40% of analysed cases (Stalin & Kumar, 2021; Zhumabekova et al., 2023).

Recent studies estimate that inefficiency in public management increases environmental recovery costs by 50%, while 60% of ecosystems in urban areas show critical levels of degradation. This impact not only compromises environmental sustainability but also affects economic and social development, especially in vulnerable communities where poverty increases by 15% due to the degradation of natural resources (Saputra et al., 2022; Xin et al., 2022; H. Zeng et al., 2022).

In this context, environmental audits are positioned as a key mechanism. In institutions that adopted effective environmental audits, regulatory compliance improved by 40%, and sustainability indicators increased by an average of 25% (Paolone et al., 2023; H. Wang et al., 2022). These audits offer strategic tools for identifying critical areas, ensuring accountability, and promoting a public management model aligned with sustainability and transparency standards (Fuadah et al., 2022; Marrucci & Daddi, 2022; Plokhikh et al., 2023).

H1: The frequency of environmental audits has a significant positive impact on environmental sustainability in public institutions.

However, nearly 35% of public institutions still lack trained personnel to efficiently implement these audits (Akbar & Mahdi, 2023; Cozens et al., 2023). Additionally, 30% of resources allocated to environmental programmes remain unused due to planning weaknesses and poor inter-institutional coordination. These limitations amplify the risks of irreversible environmental damage and reinforce the perception of inefficiency in public management (Kaup et al., 2023; Moalla & Dammak, 2023).

The lack of environmental training within public entities represents another significant challenge. Although some organisations offer training programmes, these are often sporadic and do not address the technical needs of modern audits (Hichri, 2023; Weirich & Turner, 2023). This generates substantial gaps in the application of preventive methodologies and the auditors' capacity to address complex problems, perpetuating outdated and ineffective practices (Huang & Xie, 2023; Lee et al., 2023; Shamsadini et al., 2023).

Moreover, joint efforts among public agencies, non-governmental organisations, and private companies remain scarce (M. Wang, 2024; Zhang et al., 2023). The lack of coordination leads to task duplication, resource wastage, and limited impact of environmental programmes. Projects that successfully integrate these partnerships have shown positive results in reducing environmental impacts, highlighting the importance of structured joint planning (Chen et al., 2023; Yao et al., 2023).

Environmental audits also have a direct effect on public perception. When conducted transparently and their results are shared with the population, they generate trust and strengthen institutional legitimacy. However, in many cases, audit reports are not accessible to civil society, reinforcing a sense of opacity and limiting the active participation of communities in monitoring natural resources (Ferreira et al., 2024; Wambwa et al., 2023; Wu et al., 2024).

H2: The frequency of environmental audits has a significant positive impact on institutional transparency in public institutions.

Another significant obstacle is limited budget allocation (Harden et al., 2024). While the importance of environmental audits is recognised, financial resources for their execution are often insufficient. This prevents the hiring of specialists, the acquisition of modern technologies, and the execution of

audits at all levels of public administration. As a result, institutions are forced to prioritise specific areas, leaving critical sectors without adequate supervision (Lei et al., 2024; Rodrigues et al., 2024; Saputra & Paranoan, 2024). The impact of these deficiencies affects not only the environment but also economic and social development. The degradation of essential ecosystems, such as forests, water sources, and agricultural areas, reduces the availability of basic resources and jeopardises the livelihoods of the most vulnerable communities. Furthermore, the costs associated with environmental recovery are often significantly higher than the resources that could have been invested in preventive audits and clean technologies(Hancu-Budui & Zorio-Grima, 2024).

H3: The quality of environmental audits has a significant negative impact on environmental sustainability in public institutions.

Thus, it is essential to highlight that audits based on digital technologies emerge as a promising solution. These tools enable more efficient and accurate management, optimising execution times and facilitating real-time data analysis (Peng & Li, 2024; Tan et al., 2024). However, their adoption requires strong institutional commitment, accompanied by public policies that promote innovation and ensure long-term sustainability.

H4: The quality of environmental audits has a significant positive impact on institutional transparency in public institutions.

2 Theoretical Framework

2.1 Frequency of Environmental Audits

The frequency of environmental audits is conceptualised as the regularity with which public institutions conduct evaluations to monitor compliance with environmental regulations and practices (Bebbington & Larrinaga, 2024; Lawal et al., 2024). This variable reflects the institutional commitment to maintaining oversight and ensuring that operations align with environmental standards. Regular audits serve as a preventive mechanism, identifying potential risks before they escalate into significant environmental or administrative issues. A higher frequency of audits is often associated with enhanced monitoring, allowing institutions to respond proactively to challenges and maintain accountability in their environmental management (Gong et al., 2024; Xia, 2024).

Frequent audits also reinforce the credibility of public institutions by demonstrating consistency in their efforts to uphold sustainability standards. This regularity promotes a culture of continuous improvement, where lessons from previous audits inform future actions (Rakipi & D'Onza, 2024; Zhao et al., 2024). In addition, frequent evaluations provide a robust framework for tracking progress toward long-term goals, such as reducing emissions, conserving ecosystems, and adhering to international environmental agreements (Rabarison et al., 2024; J. Wang & Zeng, 2024).

2.2 Quality of Environmental Audits

The quality of environmental audits refers to the thoroughness, accuracy, and reliability of the evaluations conducted to assess environmental performance in public institutions. High-quality audits are characterised by the use of specialised tools, adherence to established methodologies, and the generation of detailed technical reports (Ghorbaniyan et al., 2024; Tan, Chan, et al., 2024). These factors ensure that the findings are actionable, providing clear recommendations for addressing deficiencies and enhancing environmental practices. Theoretical models on audit quality emphasise that robust evaluations lead to greater compliance with regulations and improved environmental outcomes (Jarboui & Moalla, 2024; Kolsi & Al-Hiyari, 2024; Li et al., 2024).

The quality of audits also plays a critical role in building institutional transparency and accountability. When audits are conducted with high standards, they inspire confidence among involved parties, including the public, policymakers, and regulatory bodies (Asante-Appiah, 2020; Marwa et al., 2020). High-quality audits not only uncover inefficiencies but also set benchmarks for best practices, fostering a culture of excellence in environmental governance. Furthermore, they support public institutions in aligning their operations with sustainable development objectives,

reinforcing their commitment to ethical and responsible management (Aslam et al., 2020; Hammami & Hendijani Zadeh, 2020).

2.3 Institutional Transparency

Institutional transparency is conceptualised as the ability of public entities to provide clear, accessible, and verified information regarding their decisions, operations, and outcomes. This concept is closely linked to accountability and public trust, which are essential for efficient and ethical public administration. In the context of environmental audits, institutional transparency involves making the results of evaluations publicly available, ensuring that findings and recommendations are accessible for civil society scrutiny (Amin et al., 2021; Arif et al., 2020). This level of openness not only fosters institutional legitimacy but also serves as a preventive mechanism against potential acts of corruption (Siew et al., 2020; C. Zeng et al., 2020).

Moreover, transparency enables public entities to strengthen their credibility by demonstrating active commitment to sustainability and compliance with environmental regulations. When environmental audits promote clear and verifiable processes, they create a stronger connection between institutions and citizens, encouraging participation and oversight. This concept is central to bridging the gap between public management and sustainable development goals, particularly in contexts where natural resources are at risk due to poor administrative practices (Bassey, 2020; Hancu-Budui et al., 2020; Wu et al., 2020; Jam et al., 2018).

2.4 Environmental Sustainability

Environmental sustainability is defined as the ability of institutions to responsibly manage natural resources, ensuring that their current actions do not compromise the environmental, social, and economic well-being of future generations (Earnhart & Harrington, 2021; Ariani et al., 2024). This concept encompasses practices such as waste reduction, efficient resource use, and ecosystem conservation, which are essential for achieving a balance between human development and environmental protection. In the institutional context, environmental sustainability is directly related to the implementation of policies that promote the mitigation of negative impacts on the natural environment (Arango et al., 2021; Earnhart & Friesen, 2021; Sembayev, 2021).

Environmental audits play a crucial role in promoting environmental sustainability by identifying inefficiencies in resource management and proposing strategies to improve existing practices (Stalin & Kumar, 2021). These evaluations enable public institutions to align their operations with international standards, such as the Sustainable Development Goals (SDGs), particularly those related to climate action and biodiversity protection. This approach not only contributes to environmental preservation but also reinforces the legitimacy of institutions by demonstrating their commitment to sustainable and responsible practices (Saputra et al., 2022; Xin et al., 2022; H. Zeng et al., 2022).

3 METHODOLOGY

This research is applied in nature and adopts a quantitative, explanatory design focused on analysing environmental audits in public institutions (Fuadah et al., 2022; Marrucci & Daddi, 2022). Structural Equation Modelling (SEM) was employed using the SmartPLS software to examine the relationships between the latent and observed variables defined in the theoretical framework (Cozens et al., 2023; Mahdi, 2023). This methodology allowed for the identification of both direct and indirect effects among the constructs, ensuring a comprehensive analysis of the proposed hypotheses (Hichri, 2023; Kaup et al., 2023; Weirich & Turner, 2023).

The sample consisted of 700 participants from public institutions involved in environmental management at regional and national levels (Huang & Xie, 2023; Shamsadini et al., 2023). The participants included decision-makers, environmental auditors, and operational staff, representing diverse roles and responsibilities. The sample was stratified to include institutions with varying levels of frequency and quality in their environmental audits, providing a balanced representation

(Chen et al., 2023; Yao et al., 2023). In terms of demographic composition, 52% of the participants were men, and 48% were women.

The research instrument was a structured questionnaire based on the latent and observed variables (Ferreira et al., 2024; Wambwa et al., 2023; Wu et al., 2024). The questionnaire was divided into sections, each addressing key constructs such as the frequency of audits, the quality of audits, institutional transparency, and environmental sustainability. Respondents were asked to rate their agreement with statements on a 7-point Likert scale, where 1 represented "never" and 7 represented "always." A pilot test was conducted with 50 participants to ensure the clarity and reliability of the instrument, leading to minor adjustments before large-scale data collection (Lei et al., 2024; Rodrigues et al., 2024).

Data collection was carried out over a two-month period, using both in-person and online surveys to maximise the response rate. The responses were subjected to validity and reliability tests, including Cronbach's alpha, rho_A, and composite reliability, to ensure the robustness of the instrument (Bebbington & Larrinaga, 2024; Lawal et al., 2024; PENG & LI, 2024). The SmartPLS algorithm was used to verify model convergence and test the structural relationships. These methodologies ensured that the findings accurately represent the dynamics of environmental audits in promoting transparency and sustainability within public institutions (Ghorbaniyan et al., 2024; Jarboui & Moalla, 2024; Li et al., 2024).

Table 1; ***Constructs: Latent and Observed Variables***

Variable	Latent Variables	CODE	Observed Variables	Question
Exógenas	Frequency of Environmental Audits	FA1	Number of Audits	How often are environmental audits conducted in your institution?
		FA2	Completed Audits	How often are the scheduled environmental audits fully completed?
		FA3	Planned Audits	How often are environmental audits planned in a timely manner?
	Quality of Environmental Audits	QA1	Regulatory Compliance	How often do audits ensure compliance with environmental regulations?
		QA2	Tools Used	How often are specialised tools used during environmental audits?
		QA3	Technical Report	How often do audits generate detailed technical reports?
Endógenas	Institutional Transparency	IT1	Public Reports	How often are audit results published and accessible to the public?
		IT2	Citizen Perception	How often do citizens perceive transparency in the environmental processes of your institution?
		IT3	Process Clarity	How often are audited processes clear and understandable for relevant parties?
	Environmental Sustainability	ES1	Waste Reduction	How often have audits promoted waste reduction in the institution?
		ES2	Efficient Resource Use	How often do audits contribute to the efficient use of resources like water or energy?
		ES3	Controlled Emissions	How often do audits foster the control of pollutant emissions?
		ES4	Ecosystem Conservation	How often do audits promote actions contributing to ecosystem conservation?

Note: Prepared by the authors.

The table outlines the relationship between latent variables and their respective observed variables, each linked to specific questions designed to measure their performance. Exogenous variables, such as the frequency and quality of environmental audits, are represented by indicators like the number

of audits, regulatory compliance, and technical reports. Endogenous variables, such as institutional transparency and environmental sustainability, focus on observed aspects like public reports, waste reduction, and ecosystem conservation. The questions provide a framework for capturing data on how effectively these constructs operate within institutions. This structure ensures a clear alignment between theoretical constructs and measurable outcomes.

Model Convergence

Model convergence was assessed to confirm the reliability and stability of the structural equation model used in this study on environmental audits within public institutions. The SmartPLS algorithm successfully converged within the configured limit of 300 iterations, stabilising at the 12th iteration. This indicates that the differences in parameter estimates across iterations were minimal, achieving a stable solution. The convergence process verifies that the relationships among latent variables, such as the frequency and quality of environmental audits, institutional transparency, and environmental sustainability, are well-represented and consistent with the data. The rapid convergence reflects the appropriateness of the model's structure and the alignment of the theoretical framework with empirical observations, ensuring that the results are robust and suitable for hypothesis testing.

3.1 Ethical Aspects

This study adhered to strict ethical standards to ensure the integrity and credibility of the research process. Ethical considerations were prioritised during the design, data collection, and analysis phases, in compliance with national regulations and international guidelines on research ethics. The primary focus was to safeguard the rights, privacy, and dignity of participants while maintaining the transparency and reliability of the findings.

Participation in the study was entirely voluntary, and informed consent was obtained from all respondents prior to data collection. Participants were provided with a detailed explanation of the study's objectives, their role, and the measures implemented to protect their anonymity and confidentiality. No personally identifiable information was collected, and all responses were coded to ensure that individual identities could not be traced. This approach ensured that participants could respond freely and honestly without fear of repercussions.

The study also adhered to ethical principles in the handling and analysis of data. The data were used exclusively for research purposes and were securely stored to prevent unauthorised access. Biases were minimised through the use of rigorous statistical methods, ensuring that the results were objective and accurately reflected the relationships between variables. Additionally, potential conflicts of interest were disclosed, and the research process was conducted with complete transparency to uphold the highest standards of academic integrity.

Finally, the findings and recommendations derived from the study are aimed at promoting positive changes, particularly in strengthening sustainability and transparency in public institutions.

4 RESULTS AND DISCUSSIONS

Table 2. ***Construct Validity and Reliability***

Variable	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Environmental Sustainability	0.802	0.944	0.869	0.634
Frequency of Environmental Audits	0.818	0.895	0.892	0.737
Institutional Transparency	0.898	0.984	0.935	0.829

Quality of Environmental Audits	0.84	0.967	0.898	0.748

Note: Prepared by the authors.

The table evaluates construct validity and reliability using Cronbach's Alpha, rho_A, Composite Reliability (CR), and Average Variance Extracted (AVE). All variables meet the thresholds of Cronbach's Alpha ≥ 0.70, CR ≥ 0.70, and AVE ≥ 0.50, indicating strong reliability, internal consistency, and convergent validity for the constructs.

Table 3. ***Discriminant Validity***

Variable	Environmental Sustainability	Frequency of Environmental Audits	Institutional Transparency	Quality of Environmental Audits
Environmental Sustainability	0.796	0.476	0.413	0.349
Frequency of Environmental Audits	0.476	0.859	0.757	0.885
Institutional Transparency	0.413	0.757	0.911	0.725
Quality of Environmental Audits	0.349	0.885	0.725	0.865

Note: Prepared by the authors.

The table demonstrates discriminant validity using the Fornell-Larcker criterion, where the diagonal values (square root of AVE) exceed the inter-construct correlations (off-diagonal values). This confirms that each construct shares more variance with its own indicators than with others, ensuring their conceptual distinction.

Theoretical Model

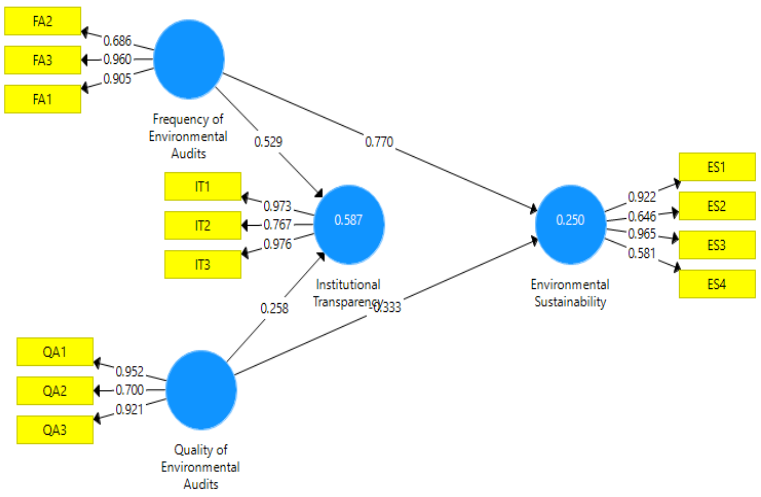

Figure 1. ***Relationship between Variables in a Reflective Model***

Note: Prepared by the authors.

The structural model illustrates the relationships between the latent variables Frequency of Environmental Audits, Quality of Environmental Audits, Institutional Transparency, and Environmental Sustainability, supported by their observed indicators. The Frequency of Environmental Audits shows a strong positive influence on both Institutional Transparency (path

coefficient = 0.529) and Environmental Sustainability (path coefficient = 0.770), indicating its significant role in promoting these outcomes. Conversely, the Quality of Environmental Audits has a smaller positive impact on Institutional Transparency (path coefficient = 0.258) and a negative relationship with Environmental Sustainability (path coefficient = -0.333), suggesting its less consistent effect in the model. The outer model demonstrates strong loadings for most observed variables, with indicators like FA2 (Completed Audits, loading = 0.960) and IT1 (Public Reports, loading = 0.973) reflecting the strength of their respective latent variables. Similarly, Environmental Sustainability is well-represented by indicators such as ES1 (Waste Reduction, loading = 0.922) and ES3 (Controlled Emissions, loading = 0.965). The R^2 values show that Institutional Transparency explains 58.7% of its variance, indicating strong predictive power, while Environmental Sustainability explains 25%, representing moderate predictive strength. Overall, the model highlights the critical role of the Frequency of Environmental Audits in driving outcomes, while the Quality of Environmental Audits requires further analysis to understand its inconsistent effect, particularly its negative relationship with Environmental Sustainability.

Table 4. ***Path Coefficients***

Path	**Original Sample (O)**	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**
Frequency of Environmental Audits -> Environmental Sustainability	0,770	0,768	0,226	3,406	0,001
Frequency of Environmental Audits -> Institutional Transparency	0,529	0,530	0,165	3,212	0,001
Quality of Environmental Audits -> Environmental Sustainability	-0,333	-0,310	0,231	1,438	0,001
Quality of Environmental Audits -> Institutional Transparency	0,258	0,267	0,161	1,604	0,109

Note: Prepared by the authors.

The results indicate that the frequency of environmental audits has a significant positive impact on both environmental sustainability (0.770, p=0.001) and institutional transparency (0.529, p=0.001), suggesting that greater regularity in conducting audits substantially contributes to improving these aspects. In contrast, the quality of environmental audits shows a negative relationship with environmental sustainability (-0.333, p=0.001), indicating potential inconsistencies or adverse factors in the execution of high-quality audits that require further analysis. Additionally, its effect on institutional transparency (0.258, p=0.109) is not significant, implying that audit quality may not be a decisive factor in enhancing transparency within the current model. These findings highlight the importance of audit frequency as a key factor and underscore the need for further exploration of audit quality and its effects.

Figure 2. ***Word cloud***

Note: Prepared by the authors.

The word cloud visually represents the importance of key concepts related to environmental audits in public institutions. Terms such as "Audit" and "Environmental" stand out, highlighting the central focus on evaluation and environmental management processes. Additionally, words like "Sustainability," "Transparency," and "Management" underscore the fundamental objectives of audits, aimed at promoting responsible practices and ensuring accountability. The presence of terms such as "Resources," "Institutions," and "Public" emphasizes the institutional context in which these practices are developed, as well as their impact on resource conservation and environmental governance. This representation reinforces the relevance of the analyzed concepts and their interconnectedness to drive sustainable and transparent public management.

5 FINAL CONSIDERATIONS

Statistical analysis revealed that the frequency of environmental audits has a highly significant effect on environmental sustainability, with a path coefficient of 0.770 ($p = 0.001$). This result highlights that consistent and structured monitoring effectively identifies opportunities for improvement and mitigates environmental risks. The strong correlation between frequent audits and environmental sustainability, validated by an AVE of 0.737 for frequency, underscores its predictive capacity. This finding calls for institutionalising audit regularity as a strategic component of environmental management in public institutions.

Institutional transparency improves significantly with increased frequency of environmental audits, reflected in a path coefficient of 0.529 ($p = 0.001$). This direct relationship, supported by an AVE of 0.859, demonstrates that frequent audits not only strengthen internal controls but also enhance public perception of trust and accountability. These findings indicate that audit frequency acts as a key driver of institutional legitimacy, emphasising the importance of sharing audit results with communities as an essential practice to foster public trust.

Contrary to expectations, a significant negative impact was found between audit quality and environmental sustainability, with a path coefficient of -0.333 ($p = 0.001$). Despite the AVE of 0.748 indicating a strong representation of quality, this result suggests that elevated standards may be associated with complex processes that create delays or limit the implementation of recommendations. This finding presents a methodological challenge, highlighting the need to balance technical quality with practicality and accessibility in audit processes to maximise environmental benefits.

The quality of environmental audits has a significant positive effect on institutional transparency, with a path coefficient of 0.258 and an AVE of 0.911, though with a more moderate relevance

compared to frequency. This result highlights that while quality enhances perceptions of trust and credibility, its full impact is achieved when accompanied by effective and accessible communication mechanisms. To strengthen this relationship, institutions should prioritise not only technically robust audits but also strategies to enhance the dissemination and understanding of results among citizens.

Together, these findings underline the strategic importance of both the frequency and quality of environmental audits, providing a robust foundation for enhancing sustainability and transparency in public governance.

5.1 Authors' Contributions

MR conceptualised the initial idea of the study, designed the methodology, and led the development of the manuscript, ensuring cohesion across all sections. Additionally, MR supervised the overall structure of the document and contributed to the writing of the conclusions. LB actively collaborated in the development of the theoretical framework, selected key references, and participated in drafting the discussion, offering a critical perspective to the analysis. ET conducted an in-depth statistical analysis, ensuring the validity of the results, and wrote the methodological section, precisely detailing the procedures employed. AB led the critical review of the manuscript, identifying areas for improvement and suggesting substantial modifications to enhance the clarity and scientific quality of the article. Finally, RA supervised the project at all stages, meticulously reviewed the manuscript, and provided key contributions to the conclusions and the final orientation of the study. All authors actively participated in the planning, execution, and writing of the manuscript. Each contributed specialised knowledge that strengthened the article. Additionally, all authors reviewed and approved the final version of the manuscript, taking responsibility for its content and scientific rigour.

REFERENCES

Akbar, N. B. A., & Mahdi, F. S. (2023). THE INTEREST OF THE SUPREME AUDIT INSTITUTION IN SUSTAINABLE ECONOMIC, SOCIAL AND ENVIRONMENTAL DEVELOPMENT ON THE AUDIT QUALITY PERFORMANCE | O INTERESSE DO INSTITUIÇÃO SUPREMA DE AUDITORIA NO DESENVOLVIMENTO ECONÔMICO, SOCIAL E AMBIENTAL SUSTENTÁVEL NO . International Journal of Professional Business Review, 8(1). https://doi.org/10.26668/businessreview/2023.v8i1.1164

Amin, S., Aslam, S., Aslam, S., & Imran, M. K. (2021). Testing the Moderating Role of Environmental Audits in the Relationship Between the Carbon Tax and Renewable Energy Consumption: Evidence from Japanese Manufacturing Firms. Pakistan Journal of Commerce and Social Sciences, 15(4), 663–683.

Arango, Y. A., Escobar, E. C., & Ospina, D. E. R. (2021). Certifications and sustainability initiatives in the coffee sector: An analysis from the environmental audit in Caldas, Colombia | Certificaciones e iniciativas de sostenibilidad en el sector cafetero: Un análisis desde la auditoría ambiental en el depart. Contaduria y Administracion, 66(4), 1–31. https://doi.org/10.22201/fca.24488410e.2021.2488

Ariani, M., Miswaty, M., Yuliani, T., & Husniyah, H. (2024). Empowering MSMEs to Support Local Economic Development: Case Study of Processed Mangrove Fruit Products. *Pakistan Journal of Life and Social Sciences (PJLSS)*, *22*(2).

Arif, M., Sajjad, A., Farooq, S., Abrar, M., & Joyo, A. S. (2020). The impact of audit committee attributes on the quality and quantity of environmental, social and governance (ESG) disclosures. Corporate Governance (Bingley), 21(3), 497–514. https://doi.org/10.1108/CG-06-2020-0243

Asante-Appiah, B. (2020). Does the severity of a client's negative environmental, social and governance reputation affect audit effort and audit quality? Journal of Accounting and Public Policy, 39(3). https://doi.org/10.1016/j.jaccpubpol.2019.106713

Aslam, S., Rehman, R. U., & Asad, M. (2020). Linking environmental management practices to environmental performance: The interactive role of environmental audit. Pakistan Journal of Commerce and Social Sciences, 14(1), 99–119.

Bassey, N. (2020). Concerning environmental audits in the Nigeria Extractive Industries Transparency Initiative. Extractive Industries and Society, 7(3), 786–789. https://doi.org/10.1016/j.exis.2019.08.007

Bebbington, J., & Larrinaga, C. (2024). The influence of Power's audit society in environmental and sustainability accounting. Qualitative Research in Accounting and Management, 21(1), 21–28. https://doi.org/10.1108/QRAM-01-2022-0007

Castka, P., Searcy, C., & Mohr, J. (2020). Technology-enhanced auditing: Improving veracity and timeliness in social and environmental audits of supply chains. Journal of Cleaner Production, 258. https://doi.org/10.1016/j.jclepro.2020.120773

Chen, Z., Zhou, L., Jia, C., & Guo, X. (2023). Effect of mandatory cleaner production audits on manufacturing firms' environmental efficiency in China: Renovation or innovation? Journal of Cleaner Production, 417. https://doi.org/10.1016/j.jclepro.2023.137855

Cozens, P., Babb, C., & Stefani, D. (2023). Exploring and developing crime prevention through environmental design (CPTED) audits: an iterative process. Crime Prevention and Community Safety, 25(1), 1–19. https://doi.org/10.1057/s41300-022-00170-0

Desjardins, E., Higgins, C. D., Scott, D. M., Apatu, E., & Páez, A. (2021). Using environmental audits and photo-journeys to compare objective attributes and bicyclists' perceptions of bicycle routes. Journal of Transport and Health, 22. https://doi.org/10.1016/j.jth.2021.101092

Earnhart, D., & Friesen, L. (2021). Use of competitive endogenous audit mechanisms by federal and state inspectors within environmental protection agencies. Journal of Environmental Economics and Management, 109. https://doi.org/10.1016/j.jeem.2021.102476

Earnhart, D., & Harrington, D. R. (2021). Effects of audit frequency, audit quality, and facility age on environmental compliance. Applied Economics, 53(28), 3234–3252. https://doi.org/10.1080/00036846.2020.1854449

Ferreira, A. B. S., Sebastiani, R. T., Nascimento, L. D., de Oliveira, K. J., Carballo, F. P., de Sá Zarpellon, C. S., Vitaliano, F. C. B., e Silva, A. P. S., do Nascimento, G. G., & Almeida-Bezerra, J. W. (2024). ENVIRONMENTAL AUDIT AS A TOOL FOR MANAGEMENT AND SUSTAINABILITY: A QUALITATIVE STUDY | AUDITORIA AMBIENTAL COMO FERRAMENTA PARA A GESTÃO E SUSTENTABILIDADE: UM ESTUDO QUALITATIVO | LA AUDITORÍA AMBIENTAL COMO HERRAMIENTA DE GESTIÓN Y SUSTENTABILIDAD: UN E. Revista de Gestao Social e Ambiental, 18(3). https://doi.org/10.24857/rgsa.v18n3-078

Fuadah, L. L., Mukhtaruddin, M., Andriana, I., & Arisman, A. (2022). The Ownership Structure, and the Environmental, Social, and Governance (ESG) Disclosure, Firm Value and Firm Performance: The Audit Committee as Moderating Variable. Economies, 10(12). https://doi.org/10.3390/economies10120314

Ghorbaniyan, A., Abdoli, M., Valiyan, H., & Boudlaie, H. (2024). Corporate citizen internal audit model: evidence from environmental functions Iran. Journal of Facilities Management, 22(5), 920–948. https://doi.org/10.1108/JFM-06-2022-0066

Gong, J., Song, J., & Zhou, J. (2024). Can audit committees' environmental background promote corporate green innovation? Evidence from China. Applied Economics. https://doi.org/10.1080/00036846.2024.2425115

Hammami, A., & Hendijani Zadeh, M. (2020). Audit quality, media coverage, environmental, social, and governance disclosure and firm investment efficiency: Evidence from Canada. International Journal of Accounting and Information Management, 28(1), 45–72. https://doi.org/10.1108/IJAIM-03-2019-0041

Hancu-Budui, A., & Zorio-Grima, A. (2024). New Public Governance and Public Value Co-creation: The Case of the European Court of Auditors Environmental Audits. Revista de Contabilidad-Spanish Accounting Review, 27(2), 275–287. https://doi.org/10.6018/rcsar.519241

Hancu-Budui, A., Zorio-Grima, A., & Blanco-Vega, J. (2020). Audit institutions in the European Union: Public service promotion, environmental engagement and COVID crisis communication

through social media. Sustainability (Switzerland), 12(23), 1–32. https://doi.org/10.3390/su12239816

Harden, S. R., Schuurman, N., Larson, H., & Walker, B. B. (2024). The utility of street view imagery in environmental audits for runnability. Applied Geography, 162. https://doi.org/10.1016/j.apgeog.2023.103167

Hichri, A. (2023). Integrated reporting, audit quality: presence of environmental auditing in an international context. European Business Review, 35(3), 397–425. https://doi.org/10.1108/EBR-03-2022-0044

Huang, R., & Xie, X. (2023). Accountability audit of natural resources and regional environmental quality: Based on the perspective of natural resources endowment |Resources Science, 45(6), 1091–1106. https://doi.org/10.18402/resci.2023.06.01

Jam, F. A., Singh, S. K. G., Ng, B., & Aziz, N. (2018). The interactive effect of uncertainty avoidance cultural values and leadership styles on open service innovation: A look at malaysian healthcare sector. *International Journal of Business and Administrative Studies*, *4*(5), 208-223.

Jarboui, A., & Moalla, M. (2024). Does media exposure and media legitimacy moderate the relationship between environmental audit committee and environmental disclosure quality? Journal of Financial Reporting and Accounting, 22(5), 1284–1313. https://doi.org/10.1108/JFRA-11-2021-0403

Jibril, R. S., Isa, M. A., Maigoshi, Z. S., & Hamid, K. T. (2024). Audit committee attributes, board of director's independence and energy disclosure for environmental sustainability in Nigeria. International Journal of Innovation Science, 16(2), 391–419. https://doi.org/10.1108/IJIS-08-2022-0149

Kaup, M. L., Calkins, M. P., Davey, A., & Wrublowsky, R. (2023). The Environmental Audit Screening Evaluation: Establishing Reliability and Validity of an Evidence-Based Design Tool. Innovation in Aging, 7(5). https://doi.org/10.1093/geroni/igad039

Kolsi, M. C., & Al-Hiyari, A. (2024). Does internal audit function outsourcing policy matter for environmental, social and governance performance score? Evidence from Bursa Malaysia. Sustainability Accounting, Management and Policy Journal, 15(6), 1442–1459. https://doi.org/10.1108/SAMPJ-01-2024-0013

Lawal, O. A., Jimoh, A. A., Abdullah, K. A., Bello, B. A., & Awoyemi, E. D. (2024). Economic and environmental impact of energy audit and efficiency: A report from a Nigeria household. Energy for Sustainable Development, 79. https://doi.org/10.1016/j.esd.2024.101387

Lee, S., Lee, C., Nam, J. W., Abbey-Lambertz, M., & Mendoza, J. A. (2020). School walkability index: Application of environmental audit tool and GIS. Journal of Transport and Health, 18. https://doi.org/10.1016/j.jth.2020.100880

Lee, S., Lee, C., Won Nam, J., Vernez Moudon, A., & Mendoza, J. A. (2023). Street environments and crime around low-income and minority schools: Adopting an environmental audit tool to assess crime prevention through environmental design (CPTED). Landscape and Urban Planning, 232. https://doi.org/10.1016/j.landurbplan.2022.104676

Lei, X., Wang, H., Deng, F., Li, S., & Chang, W. (2024). Sustainability Through Scrutiny: Enhancing Transparency in Chinese Corporations via Environmental Audits. Journal of the Knowledge Economy. https://doi.org/10.1007/s13132-024-02106-5

Li, F., Na, P., Wang, X., & Li, X. (2024). Environmental protection taxes, audit fees and corporate ESG performance. Finance Research Letters, 69. https://doi.org/10.1016/j.frl.2024.106058

Mahdi, F. S. (2023). DESIGNING AN ENVIRONMENTAL AUDIT PROGRAM FOR HEALTH INSTITUTIONS TO CONFRONT THE EPIDEMIC | DESENHANDO UM PROGRAMA DE AUDITORIA AMBIENTAL PARA INSTITUIÇÕES DE SAÚDE PARA ENFRENTAR A EPIDEMIA. International Journal of Professional Business Review, 8(4). https://doi.org/10.26668/businessreview/2023.v8i4.1235

Marrucci, L., & Daddi, T. (2022). The contribution of the Eco-Management and Audit Scheme to the environmental performance of manufacturing organisations. Business Strategy and the Environment, 31(4), 1347–1357. https://doi.org/10.1002/bse.2958

Marwa, M., Salhi, B., & Jarboui, A. (2020). Environmental audit and environmental disclosure quality. Scientific Annals of Economics and Business, 67(1), 93–115. https://doi.org/10.2478/saeb-2020-0007

Moalla, M., & Dammak, S. (2023). Do media coverage and audit quality of US companies affect their Environmental, Social and Governance transparency? Journal of Financial Reporting and Accounting. https://doi.org/10.1108/JFRA-09-2022-0353

Paolone, F., Pozzoli, M., Cucari, N., & Bianco, R. (2023). Longer board tenure and audit committee tenure. How do they impact environmental performance? A European study. Corporate Social Responsibility and Environmental Management, 30(1), 358–368. https://doi.org/10.1002/csr.2359

PENG, L., & LI, H. (2024). Environmental governance and firm's environmental investment: Evidence from the natural resources and assets accountability audit of outgoing officials. Finance Research Letters, 65. https://doi.org/10.1016/j.frl.2024.105545

Plokhikh, R., Shokparova, D., Fodor, G., Berghauer, S., Tóth, A., Suymukhanov, U., Zhakupova, A., Varga, I., Zhu, K., & Dávid, L. D. (2023). Towards Sustainable Pasture Agrolandscapes: A Landscape-Ecological-Indicative Approach to Environmental Audits and Impact Assessments. Sustainability (Switzerland), 15(8). https://doi.org/10.3390/su15086913

Rabarison, M. K., Siraj, I., & Wang, B. (2024). Environmental policy and audit pricing. Journal of Business Finance and Accounting, 51(9–10), 2820–2847. https://doi.org/10.1111/jbfa.12799

Rakipi, R., & D'Onza, G. (2024). The involvement of internal audit in environmental, social, and governance practices and risks: Stakeholders' salience and insights from audit committees and chief executive officers. International Journal of Auditing, 28(3), 522–535. https://doi.org/10.1111/ijau.12341

Rodrigues, K. C. B. T., Marques, F. R. V., dos Santos Mariano, W., Saldanha, E. S., da Costa Souza, J. P., da Silva, J. A. M., Silva, C. C., Gil, L. M. P. R., da Silva, C. M., & da Silva, G. P. G. (2024). SOCIO-ENVIRONMENTAL MANAGEMENT: THE IMPORTANCE OF ENVIRONMENTAL AUDIT FOR ORGANIZATIONAL SUSTAINABILITY | GESTÃO SOCIOAMBIENTAL: A IMPORTÂNCIA DA AUDITORIA AMBIENTAL PARA A SUSTENTABILIDADE ORGANIZACIONAL | GESTIÓN SOCIOAMBIENTAL: LA IMPORTANCIA DE LA AUD. Revista de Gestao Social e Ambiental, 18(6). https://doi.org/10.24857/rgsa.v18n6-098

Saputra, K. A. K., & Paranoan, S. (2024). Do Cyber security, Digitalisation and Data Visualisation Affect the Quality of Internal Environmental Audits? Australasian Accounting, Business and Finance Journal, 18(2), 158–174. https://doi.org/10.14453/aabfj.v18i2.10

Saputra, K. A. K., Subroto, B., Rahman, A. F., & Saraswati, E. (2022). Eco-Efficiency and Energy Audit to Improve Environmental Performance: An Empirical Study of Hotels in Bali-Indonesia. International Journal of Energy Economics and Policy, 12(6), 175–182. https://doi.org/10.32479/ijeep.13565

Sembayev, D. (2021). Audit efficiency and influence of environmental factors to state bodies: Evidence of kazakhstan doi: Https://doi.org/10.14505/jemt.v8.3(19).01. Journal of Environmental Management and Tourism, 12(5), 1307–1323. https://doi.org/10.14505/jemt.v12.5(53).16

Shamsadini, K., Askari Shahamabad, M., & Askari Shahamabad, F. (2023). Analysis of factors affecting environmental audit (EA) implementation with DEMATEL method. Social Responsibility Journal, 19(5), 777–796. https://doi.org/10.1108/SRJ-03-2021-0097

Shen, H., Wu, H., Wu, X., & You, J. (2021). Once Bitten, Twice Shy: The Effect of Experiencing a Client with an Environmental Accident on Audit Effort. Auditing, 40(4), 149–170. https://doi.org/10.2308/AJPT-2020-005

Siew, E.-G., Rosli, K., & Yeow, P. H. P. (2020). Organizational and environmental influences in the adoption of computer-assisted audit tools and techniques (CAATTs) by audit firms in Malaysia. International Journal of Accounting Information Systems, 36. https://doi.org/10.1016/j.accinf.2019.100445

Stalin, J. L., & Kumar, K. S. (2021). Application of UAV Remote Sensing Technology for Sand Quarry Volumetric Audit and Environmental Impact Assessment: A Case Study Done in Neyvasal Sand Quarry, Cuddalore District, Tamil Nadu—India. Journal of the Indian Society of Remote Sensing, 49(2), 179–191. https://doi.org/10.1007/s12524-020-01160-1

Tan, J., Chan, K. C., & Niu, R. (2024). Do anticipated government environmental audits promote corporate social responsibility? Evidence from China. Corporate Social Responsibility and Environmental Management, 31(5), 3884–3901. https://doi.org/10.1002/csr.2780

Tan, J., Hua, M., & Chan, K. C. (2024). Do anticipated government environmental audits improve firm productivity? Evidence from China. Finance Research Letters, 61. https://doi.org/10.1016/j.frl.2024.104985

Wambwa, D., Mundike, J., & Chirambo, B. (2023). Environmental Protection Fund audits in Zambia: A strategy for ensuring regulatory compliance in Zambia's mining sector. Extractive Industries and Society, 16. https://doi.org/10.1016/j.exis.2023.101353

Wang, H., Huang, M., & Wang, H. (2022). Fourth-Party Logistics Environmental Compliance Management: Investment and Logistics Audit. Sustainability (Switzerland), 14(16). https://doi.org/10.3390/su141610106

Wang, J., & Zeng, X. (2024). Corporate environmental, social, and governance information disclosure and audit governance in the context of green development. Journal of Cleaner Production, 476. https://doi.org/10.1016/j.jclepro.2024.143763

Wang, M. (2024). Can environmental regulations change the environmental behaviour of local leaders and enterprises? Evidence using the accountability audit of natural resources in China. Local Government Studies, 50(2), 352–374. https://doi.org/10.1080/03003930.2023.2206652

Weirich, T. R., & Turner, L. (2023). Expanding the Concept of Materiality to Environmental, Social, and Governance: Audit Issues and Implications. Current Issues in Auditing, 17(1), A50–A58. https://doi.org/10.2308/CIIA-2022-010

Wu, X., CAO, Q., Tan, X., & Li, L. (2020). The effect of audit of outgoing leading officials' natural resource accountability on environmental governance: evidence from China. Managerial Auditing Journal, 35(9), 1213–1241. https://doi.org/10.1108/MAJ-08-2019-2378

Wu, X., Luo, L., & You, J. (2024). Actions speak louder than words: environmental law enforcement and audit fees. Review of Accounting Studies. https://doi.org/10.1007/s11142-024-09823-x

Xia, Y. (2024). Impact of an official accountability audit on industrial structure adjustment: a case study of environmental regulation in China. Chinese Journal of Population Resources and Environment, 22(2), 167–175. https://doi.org/10.1016/j.cjpre.2024.06.007

Xin, C., Hao, X., & Cheng, L. (2022). Do Environmental Administrative Penalties Affect Audit Fees? Results from Multiple Econometric Models. Sustainability (Switzerland), 14(7). https://doi.org/10.3390/su14074268

Yao, S., Wei, S., & Chen, L. (2023). Do clients' environmental risks affect audit pricing? Evidence from environmental violations in China. Managerial Auditing Journal, 38(5), 634–658. https://doi.org/10.1108/MAJ-08-2021-3282

Zeng, C., Zhang, L., & Li, J. (2020). The impact of top management's environmental responsibility audit on corporate environmental investment: evidence from China. Sustainability Accounting, Management and Policy Journal, 11(7), 1271–1291. https://doi.org/10.1108/SAMPJ-09-2018-0263

Zeng, H., Li, X., Zhou, Q., & Wang, L. (2022). Local government environmental regulatory pressures and corporate environmental strategies: Evidence from natural resource accountability audits in China. Business Strategy and the Environment, 31(7), 3060–3082. https://doi.org/10.1002/bse.3064

Zhang, Y., Zhang, Q., Hu, H., Wang, C., & Guo, X. (2023). Accountability audit of natural resource, government environmental regulation and pollution abatement: An empirical study based on difference-in-differences model. Journal of Cleaner Production, 410. https://doi.org/10.1016/j.jclepro.2023.137205

Zhao, X., Zhu, R., Li, Q., & Hu, J. (2024). Unleashing the impact of environmental information disclosure on corporate green innovation: The role of audit quality and media attention. Environmental Development, 52. https://doi.org/10.1016/j.envdev.2024.101078

Zhumabekova, G. Z., Barysheva, S. K., Yesturliyeva, A. I., Akimova, B. Z., & Korabayev, B. S. (2023). Comparative Analysis of the Development Areas of Environmental Audit in International Practice and in the Republic of Kazakhstan. Journal of Environmental Accounting and Management, 11(2), 161–168. https://doi.org/10.5890/JEAM.2023.06.003