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Moderating Effect of Sustainable Innovation on Internal Audit Effectiveness and Sustainability Auditing Practices: Evidence from Libya's Public Sector

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Abstract: This study aims to investigate how sustainable innovation (SI) influences the relationship between internal audit effectiveness (IAE) and sustainability auditing (SA) practices in Libya's public sector, providing valuable insights into its implications for public finance governance and financial regulation. Additionally, it examines how audit standards and principles (ASPs) on SA practices emphasising their role in enhancing transparency, environmental, social, and governance (ESG) compliance, and overall financial oversight. A quantitative, cross-sectional survey design was employed, collecting 500 valid responses from financial and governmental institutions in Libya. Hierarchical regression and partial least squares structural equation modeling (PLS-SEM) were used to evaluate the relationships among IAE, SI, ASP, and SA practices, with robustness checks ensuring the reliability of findings. The findings demonstrate that IAE significantly reinforces SA practices, improving ESG accountability and reporting. SI positively moderates this relationship, indicating that innovative processes and tools strengthen the impact of effective internal audits on sustainability outcomes. Although ASP contributes to SA practices, its influence is more pronounced when combined with robust internal audit functions and sustainability initiatives. The results underscore the need to integrate innovation and transparent regulatory frameworks to optimise sustainability auditing and public finance management. While the study is confined to Libya's public sector—potentially limiting broader generalizability—its insights may inform policy reforms and risk management strategies across diverse regulatory environments. Future research could include comparative analyses to investigate variations in other emerging or developed markets. This study adds to the literature by linking SI and ASP with internal audit frameworks, offering fresh perspectives on enhancing SA practices and ESG compliance in public finance settings.

Keywords: internal audit effectiveness; sustainable innovation; audit standards and principles; sustainability auditing practices; ESG compliance; public sector governance

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1. Introduction

IAE is widely recognised as a cornerstone of robust corporate governance, with numerous studies linking high-profile corporate failures to deficiencies in internal audit functions (Arena & Azzone, 2006; Schneider, 2003; Maletta, 1993). Over time, the scope of internal auditing has expanded from traditional oversight roles to include strategic contributions, aiding senior management in achieving operational and ethical objectives (Lenz & Hahn, 2015; Mihret et al., 2010). Concurrently, sustainability has emerged as a critical element of organisational strategy, driven by increasing attention to ESG considerations (DeSimone et al., 2021; Arena & Azzone, 2006). Public sector reforms have further

emphasised the integration of ethical values, transparency, and long-term goals to enhance efficiency and foster stakeholder trust (Cho et al., 2022; Brusca et al., 2018). Sustainability initiatives often align with strategic objectives, such as improving governmental reputation, strengthening public trust, and meeting legislative requirements (Alsayegh et al., 2020; Vieira & Radonjič, 2020).

Despite the global emphasis on ESG disclosures, Libya has yet to implement a comprehensive ESG regulatory framework. The Safeguarding and Advancement of the Environment Act (No. 15 of 2003) remains the primary legislative measure addressing environmental responsibilities. However, it does not mandate sustainability reporting for public or private institutions (Tarabot Law Firm, 2025). The social and governance aspects of ESG are partially governed by corporate governance codes issued by Libya's Central Bank and the Libyan Stock Market Authority, which promote transparency and accountability but lack enforceability regarding sustainability disclosures. These regulatory gaps lead to voluntary and inconsistent sustainability reporting, which in turn limits the effectiveness of ESG governance in the public sector. Like many in developing economies, Libya's public sector faces additional complexities, including regulatory inconsistencies, resource constraints, and political pressures, all of which hinder the adoption of effective sustainability auditing mechanisms (Santos et al., 2024). While previous studies have extensively examined IAE in corporate governance (Schneider, 2003; Mihret & Yismaw, 2007), there has been limited research on its intersection with sustainability auditing in the public sector. Even less attention has been given to the role of sustainable innovation (SI) in strengthening the impact of IAE on SA practices.

This study addresses this gap by investigating how SI moderates the relationship between IAE and SA practices in Libya's public sector. SI, which integrates innovative, sustainability-driven processes and technologies into governance frameworks, is increasingly recognised as a catalyst for improving audit quality and ESG compliance (Corazza et al., 2020; Kiesnere & Baumgartner, 2019). However, its moderating influence on the effectiveness of internal audits remains underexplored. Additionally, the study examines the role of audit standards and principles (ASP) in shaping SA outcomes, considering whether regulatory frameworks alone can drive meaningful sustainability practices in public governance (Ridley et al., 2011).

The originality of this research lies in its comprehensive analysis of the interplay between IAE, SI, and SA practices, particularly in a context where sustainability reporting is voluntary and largely underdeveloped. Libya's evolving regulatory environment presents an opportunity to assess how internal audit functions contribute to ESG adoption in a setting where sustainability reporting is neither mandatory nor standardised. While sustainability auditing has gained prominence in jurisdictions such as South Africa, where it is integrated into corporate governance, Libya presents a unique case due to its evolving institutional structures and ongoing efforts to rebuild public accountability frameworks (Abuazza et al., 2015). This study extends prior research by demonstrating how integrating SI into internal audits can enhance ESG accountability in public sector governance, addressing challenges unique to emerging economies. To guide this investigation, the study seeks to answer the following research questions:

RQ1: How does internal audit effectiveness (IAE) influence sustainability auditing (SA) practices in Libya's public sector?
RQ2: What is the moderating effect of sustainable innovation (SI) on the relationship between IAE and SA practices?
RQ3: To what extent do audit standards and principles (ASP) impact SA practices, and how do they interact with SI and IAE?

By addressing these questions, the study contributes to the literature on sustainable auditing and internal audit effectiveness in the public sector, offering new insights into how innovation can enhance governance mechanisms.

The remainder of the paper is structured as follows: Section 2 reviews the relevant literature and develops hypotheses. Section 3 outlines the research methodology. Sections 4 and 5 present and discuss the empirical findings. Finally, Section 6 concludes with key findings, theoretical contributions, practical implications, limitations, and directions for future research.

2. Literature Review

2.1. Internal Audit Effectiveness and Corporate Governance

IAE has been extensively studied in the context of corporate governance, with earlier research primarily focusing on external auditors' evaluations of internal audit functions in terms of competence, objectivity, and alignment with professional standards (Maletta, 1993; Messier & Schneider, 1988). However, recent studies have expanded this perspective by examining how IAE contributes to strategic decision-making, ethical governance, and organisational sustainability (Lenz & Hahn, 2015; Mihret et al., 2010). Internal auditing has evolved from a compliance-based function to a governance tool that enhances organisational resilience, particularly in public sector institutions where regulatory complexities and political constraints present unique challenges (Santos et al., 2024; Abuazza et al., 2015). This shift underscores the need for a theoretical framework that integrates stakeholder and agency perspectives, as public institutions must balance competing interests while ensuring transparency and sustainability.

2.2. Sustainable Auditing and ESG Governance

The relevance of sustainability in auditing has driven the expansion of internal audit roles, particularly in public and not-for-profit organisations (Brusca et al., 2018; Santos et al., 2024). DeSimone et al. (2021) highlight the potential of internal auditors to enhance ESG performance by ensuring rigorous sustainability disclosures. However, sustainability auditing remains underdeveloped in many public sector institutions due to resource constraints and weak regulatory mandates (Swann & Deslatte, 2019). Abdelrahim and Al-Malkawi (2022) proposed a framework linking IAE to sustainability objectives, demonstrating how compliance-driven audits are transitioning into sustainability-focused oversight functions. Incorporating stakeholder and agency theories into sustainability auditing helps contextualise internal auditors' role in ensuring regulatory compliance and stakeholder accountability. The stakeholder perspective emphasises the need for ESG-focused governance, while the agency perspective highlights the importance of audit mechanisms in reducing asymmetric information and promoting responsible governance (Donaldson & Preston, 1995; Jensen & Meckling, 1976).

2.3. Stakeholder and Agency Theories in Public Sector Auditing

A cohesive theoretical framework that combines stakeholder and agency theories provides a robust foundation for understanding the role of internal audits in public sector sustainability governance. Stakeholder and agency theories provide critical insights into the role of internal audits in sustainability governance. The stakeholder theory posits that organisations must balance the expectations of multiple stakeholders—including investors, employees, regulatory bodies, and the public—to maintain legitimacy and ensure ethical governance (Donaldson & Preston, 1995; Freeman, 1984). Freeman (2010) argue that organisations engaged in sustainability governance must navigate complex stakeholder relationships to align governance structures with societal expectations. Within Libya's

public sector, stakeholder pressures from government agencies, international bodies, and local communities shape sustainability policies, making internal audits a key mechanism for ensuring accountability and compliance with ESG objectives (Samagaio & Diogo, 2022). Public sector organisations, particularly, are expected to integrate transparency and accountability measures to satisfy diverse stakeholder interests (Samagaio & Diogo, 2022). Agency theory further explains the necessity of internal audits in reducing information asymmetry between public officials (agents) and stakeholders (principals) (Jensen & Meckling, 1976). Government administrators often have discretionary power over public resources, increasing the risk of opportunistic behaviour (Healy & Palepu, 2001). Internal audit mechanisms mitigate these risks by ensuring rigorous financial oversight and sustainability accountability (H. Zhang et al., 2024; Perrow, 1986). By integrating these two theories, this study positions internal auditing as a governance tool that meets stakeholder demands for transparency and mitigates agency-related governance risks. This dual perspective enhances the theoretical rigour of the study, providing a clear framework for understanding the interactions between IAE, SI, and SA in Libya's public sector.

2.4. The Role of Sustainable Innovation in Internal Audit Effectiveness

Sustainable innovation has significantly transformed internal auditing by integrating advanced technologies such as artificial intelligence (AI), blockchain, and big data analytics to enhance transparency, accountability, and risk mitigation (DeSimone et al., 2021; Karikari et al., 2022). AI-powered audit tools enable real-time risk detection and fraud prevention through predictive analytics, as seen in European Union government institutions where robotic process automation (RPA) streamlines compliance checks (Cho et al., 2022). Blockchain technology further strengthens sustainability audits by creating tamper-proof ESG records, ensuring transparency in corporate sustainability disclosures, as demonstrated in United Nations Development Programme (UNDP) supply chain audits (Villar et al., 2023). Additionally, big data analytics enables public sector auditors to track ESG performance metrics dynamically, with financial institutions in Singapore leveraging this technology to assess carbon footprints in investment portfolios (DeSimone et al., 2021). These innovations align with stakeholder theory, which emphasises organisational accountability to multiple stakeholders, and agency theory, which highlights the role of internal audits in preventing managerial opportunism through enhanced oversight (Donaldson & Preston, 1995). By integrating sustainable innovation, internal audits extend beyond traditional financial oversight, reinforcing their role as mechanisms for ensuring ESG compliance, strengthening governance, and fostering long-term institutional resilience. This study builds on the existing literature by demonstrating how emerging technologies operationalise innovation-driven audit strategies in public sector auditing, providing a framework for enhancing sustainability governance and regulatory compliance.

2.5. Hypothesis Development

Based on the integrated theoretical framework combining stakeholder and agency theories, and supported by empirical findings, the following hypotheses are proposed:

H_1: *Sustainable innovation (SI) has a positive influence on sustainability auditing (SA) practices, as innovation enhances sustainability assessments and broadens the scope of audits (DeSimone et al., 2021; Simoni et al., 2020).*

H_2: *The effectiveness of internal audit (IAE) positively impacts sustainability auditing (SA) practices by reinforcing transparency, ESG compliance, and governance oversight (Schneider, 2003; Mulyani et al., 2019).*

H_3: *Audit standards and principles (ASP) do not significantly influence sustainability auditing (SA) practices unless complemented by strong organisational commitment and innovation-driven strategies (Ridley et al., 2011).*

H_4: *The interaction between sustainable innovation (SI) and internal audit effectiveness (IAE) has a positive influence on sustainability auditing (SA) practices, demonstrating that innovation amplifies internal audit contributions to sustainability governance (Karikari et al., 2022).*

H_5: *The interaction between audit standards and principles (ASP) and sustainable innovation (SI) moderates the relationship between internal audit effectiveness (IAE) and sustainability auditing (SA) practices, reinforcing the importance of aligning regulatory frameworks with innovation (Hair et al., 2020).*

H_6: *The interaction between audit standards and principles (ASP) and internal audit effectiveness (IAE) has a positive influence on sustainability auditing (SA) practices. This indicates that well-structured audit standards can enhance ESG reporting and compliance when combined with effective internal audits (Mulyani et al., 2019).*

This study advances existing research by establishing a clear theoretical link between internal audit effectiveness, sustainable innovation, and sustainability auditing through the combined lenses of stakeholder and agency theories. It provides insights into how public sector organisations can enhance governance and accountability through integrated auditing frameworks, reinforcing stakeholder legitimacy and agency-driven oversight mechanisms.

3. Materials and Methods

A quantitative, cross-sectional survey design was employed, targeting publicly listed firms and government institutions as primary units of analysis. This methodological approach was chosen due to its ability to capture a broad range of audit practices and governance mechanisms across diverse institutional settings (Saunders et al., 2019). The survey instrument, adapted from established studies (DeSimone et al., 2021; Thabit et al., 2019), is detailed in Appendix A, Table A1. The selection of public sector entities acknowledges their critical role in shaping audit policy and implementation, as well as the bureaucratic challenges they face (Brusca et al., 2018).

3.1. Data and Sampling

A stratified random sampling method was employed to ensure the representativeness of the selected institutions within Libya's public sector, considering variations in organisational size, industry sector, and regulatory compliance level (Sekaran & Bougie, 2020). This approach mitigates potential biases associated with convenience sampling by systematically categorising entities based on predefined selection criteria. The initial study population comprised 75 publicly listed financial institutions and government entities that play a pivotal role in audit oversight and sustainability governance. The selection criteria were established to ensure institutional relevance and governance consistency, including:

- Entities with at least five years of operational history, ensuring governance stability and allowing for a more reliable assessment of internal audit effectiveness and sustainability auditing practices.

- Firms with well-documented internal audit functions, as verified through annual reports, corporate disclosures, and regulatory filings, ensuring alignment with the study's objectives.
- Government institutions directly involved in audit oversight, financial governance, or sustainability reporting, reflecting the broader public sector context.

Thirty-six firms returned usable questionnaires from the identified population, yielding a 69% response rate. The final sample included 18 commercial banks, 15 insurance companies (covering life and non-life assurance), and 3 micro-deposit-taking institutions, representing key financial actors within Libya's public sector auditing framework. Categories such as savings and credit cooperative societies and foreign exchange bureaus were excluded due to their classification as small and medium-sized enterprises (SMEs), which operate under different regulatory frameworks and exhibit limited relevance to audit oversight.

To ensure data quality and reliability, 588 questionnaires were distributed, with 500 deemed valid and retained for analysis following rigorous screening for completeness and consistency. Non-response bias was assessed using a wave analysis methodology, comparing early and late respondents (Armstrong & Overton, 1977), with no significant differences detected, ensuring that systematic response patterns do not skew the results.

G*Power analysis was conducted to validate the adequacy of the sample size further, confirming that the study met the recommended sample size thresholds for detecting medium-sized effects (Cohen, 1988). This statistical verification supports the reliability of the research findings, ensuring that conclusions drawn from the dataset are robust and generalisable to similar public sector contexts. Data collection was conducted over four months using a mixed-mode approach—both online and in-person distribution—ensuring accessibility for respondents across varying technological access levels. This method helped mitigate accessibility constraints in the Libyan public sector, where digital infrastructure varies across institutions. The survey instrument followed Torrejon Guirado et al. (2024) guidelines to ensure clarity, relevance, and measurement reliability, reinforcing the study's methodological rigour.

3.2. Variable Description, Research Model, and SPSS Implementation

A conceptual research model has been developed to visually illustrate the relationships between IAE, SI, ASP, and SA, representing the study's hypotheses and the interactions among these variables within the sustainability auditing framework. All survey responses were coded and processed using SPSS (version 18), ensuring data accuracy through preliminary cleaning, validation, and descriptive statistics. Reliability was tested using Cronbach's Alpha ($\geq$0.70) for internal consistency (Weakley et al., 2021), while Fornell and Larcker's (1981) AVE threshold ($\geq$0.60) confirmed convergent validity. Hierarchical regression analysis was applied to assess the direct effects of IAE, SI, and ASP on SA, complemented by Partial Least Squares Structural Equation Modeling (PLS-SEM), which effectively handles measurement errors and complex structural relationships (Hair et al., 2019, 2022). Variance Inflation Factors (VIF) were calculated to detect and mitigate multicollinearity issues. The Durbin–Watson test further ensured model robustness, indicating no significant serial correlation among the predictors. Missing data patterns were analysed, and deletion was applied listwise where necessary (Hair et al., 2020). The structured framework, which defines dependent, predictor, and control variables along with their measurement methods, is presented in Table 1, providing a foundation for empirical analysis.

Table 1. Variable description and measurement.

Variable	Acronym	Description	Measurement	Source
		Dependent variable		
Sustainable auditing practices	SA	Measures that integrate ESG factors into audit processes, the frequency of sustainability-related audits, and the level of assurance on non-financial disclosures.	Composite index, Likert-scale items.	Ridley et al. (2011); DeSimone et al. (2021).
		Predictor variable		
Internal audit effectiveness	IAE	Evaluate audit independence, competence, resources, and alignment with risk management.	Auditor qualifications, audit frequency, governance alignment.	Institute of Internal Auditors (2012); Abuazza et al. (2015); Mulyani et al. (2019).
Sustainable innovation	SI	Adoption of environmental and social innovations in operations.	R&D investments, sustainability-driven policies.	DeSimone et al. (2021); Simoni et al. (2020).
Audit standards and principles	ASP	Adherence to international/local auditing frameworks and ESG compliance standards.	Compliance tracking and regulatory alignment.	Ridley et al. (2011); Institute of Internal Auditors (2012).
		Control variable		
Firm age	FAGE	Categorical variable based on years of operation.	Categorical (0–3)	Mulyani et al. (2019).
Firm size	FSIZE	Dummy variable based on employee count.	Binary (0–1)	Karikari et al. (2022).
Auditor type	ATYPE	Dummy variable based on auditor type (Big Four vs. small or medium-sized practices).	Categorical (0–2)	Soh and Martinov-Bennie (2018).
Leverage	LEV	The ratio of total debt to assets.	Continuous variable	Y. Zhang et al. (2020).

Source(s): Authors' data information, 2024.

3.2.1. Dependent Variable

The dependent variable, SA practices, measures how organisations integrate ESG factors into their audit processes. This construct serves as a comprehensive indicator of sustainability governance, encompassing both regulatory compliance and strategic sustainability initiatives (Ridley et al., 2011; DeSimone et al., 2021). Given the increasing emphasis on transparency, accountability, and ESG performance, SA practices provide a holistic measure of how internal audits contribute to sustainability oversight. The operationalisation of SA is based on established ESG auditing frameworks (Gray, 2010; Adams & McNicholas, 2007) and employs a seven-point Likert scale, capturing the degree to which organisations align their audit mechanisms with sustainability objectives. This approach ensures reliability, validity, and consistency in assessing the impact of IAE, SI, and ASP on sustainability governance outcomes.

3.2.2. Predictor Variable

IAE evaluates the independence, competence, and adequacy of the internal audit function's resources. Measurement indicators include auditor qualifications, frequency of audit reviews, alignment with organisational risk management, and perceived influence on

governance practices (Institute of Internal Auditors, 2012; Abuazza et al., 2015; Mulyani et al., 2019). SI represents an organisation's efforts to integrate environmentally and socially responsible innovations into its operations. Measurement proxies include R&D investments in green technologies, sustainability-driven process improvements, and the adoption of eco-friendly policies (DeSimone et al., 2021; Simoni et al., 2020). ASP assesses the degree of adherence to recognised auditing frameworks (e.g., International Standards for the Professional Practice of Internal Auditing, IFRS) and local sustainability regulations, with emphasis on consistency, comprehensiveness, and responsiveness to ESG-related audit challenges (Mulyani et al., 2019; Ridley et al., 2011).

3.2.3. Control Variable

Control variables account for organisational heterogeneity that may influence SA outcomes. They were derived from annual reports, structured questionnaire items, and financial disclosures. Firm-specific financial and governance indicators were included to reduce omitted variable bias and address variations in audit practices across organisations. FAGE (firm age), FSIZE (firm size), ATYPE (audit type), and LEV (leverage) are incorporated to account for organisational heterogeneity that may influence sustainability auditing (SA) outcomes. Older entities (FAGE) often possess entrenched governance frameworks (Mulyani et al., 2019), whereas larger firms (FSIZE) typically have more comprehensive resources for implementing systematic sustainability audits (Karikari et al., 2022). ATYPE distinguishes between internal and external audit services, which can impact the audit scope and perceived legitimacy (Soh & Martinov-Bennie, 2018). LEV, measured as the ratio of total debt to assets, may drive more rigorous auditing demands from creditors (Y. Zhang et al., 2020). To ensure comprehensive data collection, Table A6 includes specific statements related to firm age, firm size, audit type, leverage, and additional institutional characteristics, allowing respondents to provide insights into these variables. This dual approach—combining data from annual reports with direct questionnaire responses—enhances the robustness of the data and ensures alignment with the study's objectives.

3.3. Econometric Modelling

Kennedy (2008) highlights that endogeneity arises when an independent variable is correlated with the structural error term, potentially biasing the estimates. A correlation matrix confirms the absence of severe multicollinearity or endogeneity risks, and the Durbin–Watson test indicates no significant serial correlation among the predictors. Missing data were examined to prevent distortions (Hair et al., 2020). The regression model applied in hypothesis testing is:

$$SA_i = \beta_0 + \beta_1\,(IAE_i) + \beta_2\,(SI_i) + \beta_3\,(ASP_i) + \beta_4\,(IAE_i \times SI_i) + \beta_5\,(IAE_i \times ASP_i) + \beta_6\,(FAGE_i) + \beta_7\,(FSIZE_i) + \beta_8\,(ATYPE_i) + \beta_9\,(LEV_i) + \varepsilon_i \quad (1)$$

Testing involves principal coefficients such as β_2 to ascertain whether SI positively affects SA, β_1 to gauge whether IAE elevates SA, and β_3 to determine whether ASP significantly influences SA. β_4 and β_5 determine the interaction effect between IAE, SI, and ASP. β_6 to β_9 represent the control variables that account for additional factors potentially influencing sustainability auditing (SA). β_0 (constant) and ε_i (error term) refer to the baseline intercept and the unexplained variance, respectively, ensuring that both observable and latent factors are accounted for in subsequent empirical analyses. Ensuring robust measurement instrumentation is essential for methodological rigor (Belur et al., 2021). Consequently, Cronbach's Alpha was employed to verify internal consistency, adhering to the threshold of $\geq$0.70 (Weakley et al., 2021). Table 2 presents the PLS-SEM outcomes, confirming satisfactory variable loadings ($\geq$0.70) and strong CR and CA values, in line with

Hair et al. (2020). Indicators exceeding an AVE threshold of 0.60 demonstrate convergent validity, as recommended by Fornell and Larcker (1981).

Table 2. Evaluation of construct and indicator reliability, as well as convergent validity.

Variables	Loading	Cronbach's Alpha (CA)	Composite Reliability (CR)	Variance Extracted (AVE)
SA		0.903	0.910	0.785
SA1	0.812			
SA2	0.790			
SA3	0.831			
SA4	0.789			
SA5	0.812			
SA6	0.830			
SA7	0.866			
IAE		0.956	0.952	0.807
IAE1	0.921			
IAE2	0.890			
IAE3	0.895			
IAE4	0.930			
IAE5	0.910			
IAE6	0.922			
IAE7	0.913			
SI		0.924	0.919	0.835
SI1	0.861			
SI2	0.892			
SI3	0.920			
SI4	0.886			
SI5	0.914			
SI6	0.921			
ASP		0.948	0.947	0.813
ASP1	0.875			
ASP2	0.890			
ASP3	0.883			
ASP4	0.849			
ASP5	0.852			

Note(s): SA: Sustainability audits practices; SI: Sustainability innovation; IAS: Internal audit effectiveness; ASP: Audit standards and principles. Source(s): Authors' own calculations.

4. Statistical Analysis

4.1. Sample Characteristics

Table 3 outlines the demographic attributes of the resulting sample. The male respondents comprised 64%, while the females accounted for 36%. Roles ranged from chairpersons of the board (9.6%) and chief executive officers (7.8%) to various managerial and auditing positions, including department heads (24.8%) and internal auditors (8.4%). Educational levels predominantly encompassed undergraduate or professional qualifications, with a smaller proportion holding postgraduate degrees (8.4%). Work experience was primarily between 11 and 15 years (40.2%), followed by those with experience exceeding 15 years (27.2%). This variety of gender, professional roles, and experience amplifies the dataset's robustness, aligning with earlier recommendations on capturing broad stakeholder insights in public-sector auditing research (Brusca et al., 2018).

Table 3. Profile of respondents.

Category	Criteria	Frequency	Percentage (%)
Gender	Male	320	64
	Female	180	36
Job Title	CFO	48	9.6
	CEO	39	7.8
	Manager Head of Department	124	24.8
	Financial manager	71	14.2
	Internal auditor	42	8.4
	External auditor	58	11.6
	Accountants	118	23.6
Educational Qualification	Diploma	67	13.4
	Graduate	276	55.2
	Post-graduate	42	8.4
	Professional	115	23
Work Experience (Years)	1 to 5 years	36	7.2
	6–10 years	127	25.4
	11–15 years	201	40.2
	Above 15 years	136	27.2

Source(s): Authors' own calculations.

4.2. Descriptive Statistics

Table 4 presents the descriptive statistics for all key variables, revealing moderate engagement with SA and SI among the surveyed organisations. The mean score for SA is 4.23 (SD = 1.42), indicating a balanced incorporation of ESG considerations into audit frameworks (DeSimone et al., 2021). GOI exhibits a higher mean of 4.55 compared to social (SOI, 3.98) and environmental (ENI, 4.11) indicators, suggesting that governance receives more immediate organisational attention. This aligns with Ridley et al. (2011), who emphasise prioritising governance structures in enhancing accountability. Additionally, Internal Audit Effectiveness (IAE) demonstrates a mean of 4.62 (SD = 1.39), supporting the Institute of Internal Auditors' (2012) assertion that competent and independent internal auditors significantly enhance audit quality. The skewness and kurtosis values for all variables remain within acceptable ranges (e.g., SA skewness at −0.15, kurtosis at 0.42), validating the suitability of parametric analyses (Hair et al., 2020).

4.3. Correlation Matrix

Table 5 presents the correlation matrix, which highlights the pivotal roles of IAE, SI, and GOI in reinforcing SA, with correlation coefficients of 0.406, 0.429, and 0.374, respectively, all of which are significant at the 0.05 level. The strong association between R&D and SI (r = 0.548, $p < 0.05$) corroborates Simoni et al. (2020), highlighting that increased R&D investments facilitate innovative, eco-friendly, and socially responsible initiatives. Conversely, FAGE and LEV exhibit lower correlations with SA (0.167 and 0.041, respectively), indicating that organisational maturity and debt levels have a minimal direct impact on sustainability audit adoption (Mulyani et al., 2019). ASP shows a moderate correlation of (0.351, $p < 0.05$), reinforcing the notion that adherence to recognised frameworks can enhance ESG disclosure and verification processes (Ridley et al., 2011). These interrelationships suggest that while structural factors, such as firm size and auditor type, play a role, the effectiveness of internal audits and innovative practices is more influential in driving sustainability auditing.

Table 4. Descriptive statistics.

Variable	Observations	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
						Statistic	Std. Error	Statistic	Std. Error
SA	500	1.00	7.00	4.23	1.42	−0.15	0.11	0.42	0.22
ENI	500	1.00	7.00	4.11	1.26	0.12	0.11	0.63	0.22
SOI	500	1.00	7.00	3.98	1.38	0.05	0.11	1.21	0.22
GOI	500	1.00	7.00	4.55	1.09	0.14	0.11	0.87	0.22
IAE	500	1.00	7.00	4.62	1.39	−0.19	0.11	0.74	0.22
SI	500	1.00	7.00	4.01	1.56	0.09	0.11	−0.34	0.22
R&D	500	0.00	7.00	2.76	1.66	0.21	0.11	1.02	0.22
ASP	500	1.00	7.00	3.87	1.22	−0.09	0.11	0.98	0.22
FAGE	500	0.00	3.00	1.87	0.89	−0.18	0.11	−0.49	0.22
FSIZE	500	0.00	1.00	0.57	0.50	−0.29	0.11	−1.97	0.22
ATYPE	500	0.00	2.00	0.68	0.76	0.53	0.11	−0.42	0.22
LEV	500	0.05	0.95	0.37	0.19	0.30	0.11	−0.12	0.22

Note(s): SA: Sustainability audits practices; SI: Sustainability innovation; IAS: Internal audit effectiveness; ASP: Audit standards and principles; ENI: Environmental indicators; SOI: Social indicators; GOI: Governance indicators; R&D: Research and development; FSIZE: Firm size; ATYPE: Auditor type; LEV: Leverage. Source(s): Authors' own calculations.

Table 5. Correlation analysis results.

Variable	SA	ENI	SOI	GOI	IAE	SI	R&D	ASP	FAGE	FSIZE	ATYPE	LEV
SA	1.000											
ENI	0.312 *	1.000										
SOI	0.218 *	0.298 **	1.000									
GOI	0.374 **	0.215 *	0.276 **	1.000								
IAE	0.406 **	0.267 **	0.355 **	0.383 **	1.000							
SI	0.429 **	0.324 **	0.396 **	0.401 **	0.429 **	1.000						
R&D	0.321 **	0.299 *	0.187	0.258 **	0.392 **	0.548 **	1.000					
ASP	0.351 **	0.202 *	0.311 **	0.364 **	0.387 **	0.359 **	0.276 **	1.000				
FAGE	0.167	0.090	0.063	0.105	0.124	0.182 *	0.092	0.155	1.000			
FSIZE	0.266 *	0.111	0.205 *	0.115	0.286 **	0.296 **	0.108	0.289 **	0.198 *	1.000		
ATYPE	0.081	0.105	0.042	0.136	0.158	0.104	0.116	0.081	0.129	0.162	1.000	
LEV	0.041	0.026	0.054	0.043	0.038	0.066	0.041	0.093	0.045	0.032	0.022	1.000

Note(s): SA: Sustainability audits practices; SI: Sustainability innovation; IAS: Internal audit effectiveness; ASP: Audit standards and principles; ENI: Environmental indicators; SOI: Social indicators; GOI: Governance indicators; R&D: Research and development; FSIZE: Firm size; ATYPE: Auditor type; LEV: Leverage. * $p < 0.05$, ** $p < 0.01$. Correlation is significant at the 0.1 level (2-tailed). Source(s): Authors' own calculations.

4.4. Hypotheses Testing

Table 6 indicates hierarchical regression results that further illuminate IAE, SI, and ASP contributions to SA. Model 1 reveals that IAE alone accounts for 25.6% of the variance in SA ($R^2 = 0.256$, $p < 0.01$), underscoring the critical role of effective internal audits in fostering sustainable practices (Institute of Internal Auditors, 2012). This finding aligns with Schneider (2003), who highlights the importance of internal audit functions in ensuring transparency and accountability in ESG reporting. Model 2 introduces SI, increasing the model's explanatory power to $R^2 = 0.399$. The positive coefficient of SI ($\beta = 0.279$, $p < 0.01$) supports the argument that innovation-driven strategies significantly enhance sustainability auditing outcomes (DeSimone et al., 2021). This is consistent with Simoni et al. (2020), who assert that organisations leveraging innovative approaches are better equipped to address complex sustainability challenges. Model 3 incorporates ASP, resulting in a modest increase in R^2 to 0.416. While including ASP adds explanatory power, its impact is relatively limited compared to IAE and SI (Ridley et al., 2011). The coefficient for ASP ($\beta = 0.124$, $p < 0.05$) suggests that adherence to standardised frameworks alone is insufficient to drive significant improvements in sustainability auditing practices. This finding is corroborated by Mulyani et al. (2019), who argue that standardised frameworks must

be complemented by proactive organisational commitment and stakeholder engagement to achieve meaningful outcomes. Model 4 provides that the interaction term (IAE × SI) further increases R^2 to 0.438, demonstrating the synergistic effect of innovation and internal auditing on sustainability practices (Karikari et al., 2022). Model 5 introduces the interaction term (IAE × ASP) to examine whether the combined effect of internal audit effectiveness and audit standards amplifies their influence on SA practices. The results reveal a significant positive interaction effect ($\beta = 0.075$, $p < 0.05$), which increases R^2 to 0.462, suggesting that aligning audit standards with internal audit effectiveness enhances sustainability outcomes (Mulyani et al., 2019). This supports H_5 and H_6, which posit that the interaction between audit standards and principles and sustainable innovation moderates the relationship between internal audit effectiveness and sustainability auditing practices. Model 6 includes control variables such as FAGE, FSIZE, ATYPE, and LEV, achieving the highest R^2 of 0.482. This highlights the importance of organisational capacity and resources in enhancing the effectiveness of sustainability audits (Karikari et al., 2022). The coefficients for FSIZE ($\beta = 0.122$, $p < 0.05$) and ATYPE ($\beta = -0.073$, $p < 0.05$) indicate that larger firms and specific auditor types contribute to the variance in SA, while FAGE and LEV show no significant impact. The acceptable levels of tolerance and VIF across all models indicate minimal multicollinearity, reinforcing the reliability of the regression estimates (Hair et al., 2020).

Table 6. Hierarchical Regression Analysis Results.

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Tolerance	VIF
Constant	1.056 (0.212) ***	0.902 (0.195) ***	0.867 (0.194) ***	0.812 (0.198) ***	0.789 (0.201) ***	0.745 (0.208) ***	–	–
IAE	0.316 (0.057) ***	0.295 (0.052) ***	0.288 (0.052) ***	0.271 (0.053) ***	0.263 (0.054) ***	0.254 (0.056) ***	0.691	1.445
SI	–	0.279 (0.046) ***	0.266 (0.045) ***	0.251 (0.047) ***	0.242 (0.048) ***	0.234 (0.049) ***	0.685	1.460
ASP	–	–	0.124 (0.062) *	0.112 (0.063) *	0.109 (0.064) *	0.109 (0.066) *	0.849	1.177
IAE x SI	–	–	–	0.087 (0.039) *	0.082 (0.040) *	0.075 (0.041) *	0.723	1.383
IAE x ASP	–	–	–	–	0.075 (0.038) *	0.070 (0.039) *	0.712	1.404
Control variables								
FAGE	–	–	–	–	–	0.048 (0.028)	0.792	1.263
FSIZE	–	–	–	–	–	0.122 (0.052) *	0.768	1.302
ATYPE	–	–	–	–	–	−0.073 (0.043) *	0.864	1.157
LEV	–	–	–	–	–	0.036 (0.024)	0.892	1.121
Model summary								
Model F	39.312 ***	50.791 ***	38.889 ***	36.452 ***	34.678 ***	33.955 ***	–	–
R^2	0.256	0.399	0.416	0.438	0.462	0.482	–	–
Adjusted R^2	0.247	0.387	0.404	0.425	0.448	0.465	–	–
F Change	39.312 ***	16.479 ***	6.152 **	5.678 **	5.226 **	4.983 **	–	–
R^2 Change	0.256	0.143	0.017	0.022	0.024	0.020	–	–
Durbin–Watson	–	–	–	–	–	1.911	–	–

Note(s): SA: Sustainability audits practices; SI: Sustainability innovation; IAS: Internal audit effectiveness; ASP: Audit standards and principles; FSIZE: Firm size; ATYPE: Auditor type; LEV: Leverage. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.1$. Source(s): Authors' own calculations.

Table 7 consolidates the SEM results, testing all six hypotheses (H_1–H_6). H_1 posits that SI has a positive influence on SA practices. The findings support this hypothesis, with SI exerting a significant total effect (TE = 0.309, t = 3.665, $p < 0.01$). This aligns with DeSimone et al. (2021) and Simoni et al. (2020), who assert that innovation-driven strategies expand the scope and effectiveness of sustainability audits. H_2 hypothesises that IAE positively impacts SA practices. The data strongly support this claim, with a significant total effect (TE = 0.412, t = 4.221, $p < 0.01$). This reinforces the critical role of skilled and independent internal auditors in enhancing transparency and accountability in ESG reporting (Mulyani et al., 2019; Schneider, 2003). H_3 suggests that ASP has no significant influence on SA practices. The regression results indicate a nonsignificant effect (TE = −0.155, t = 1.465, p = 0.144), which does not support H_3. This outcome echoes Ridley et al. (2011) and Mulyani et al. (2019), who argue that standardised frameworks alone are insufficient without proactive organisational commitment and stakeholder engagement. H_4 indicates that the interaction between SI and IAE has a positive influence on SA practices. The results show a significant interaction effect (TE = 0.087, $p < 0.05$), supporting H_4. This suggests that the combined effect of innovation and effective internal auditing amplifies sustainability outcomes. H_5 provides that the interaction between ASP and SI moderates the relationship between IAE and SA practices. The findings support this hypothesis, with a significant interaction effect (TE = 0.082, $p < 0.05$). This indicates that the synergy between ASP and SI enhances the impact of IAE on SA. H_6 states that the interaction between ASP and IAE has a positive influence on SA practices. The results show a significant interaction effect (TE = 0.075, $p < 0.05$), supporting H_6. This highlights the importance of aligning audit standards with effective internal audit practices to drive sustainability outcomes. The R^2 value of 0.498 suggests that the predictors explain nearly half of the variance in SA practices, with Q^2 accounting for 0.510, indicating moderate predictive relevance (Hair et al., 2020). Cohen's f^2 values further confirm the relatively small effect sizes of the relationships, underscoring the need for additional factors to fully explain sustainability auditing practices.

Table 7. Summary of a structural model.

Hypothesis	TE	*t*-Value	*p*-Values	f^2	CI		Decision Rule	Rankings
					Lower Bound	Upper Bound		
H_1. SI → SA	0.309	3.665	0.003 ***	0.032	0.112	0.452	Supported	2
H_2. IAE → SA	0.412	4.221	0.000 ***	0.078	0.211	0.469	Supported	1
H_3. ASP → SA	−0.155	1.465	0.144	0.009	−0.314	0.027	Not Supported	3
H_4. SI x IAE → SA	0.087	2.112	0.035 *	0.015	0.021	0.153	Supported	4
H_5. ASP x SI → SA	0.082	2.045	0.041 *	0.014	0.018	0.146	Supported	5
H_6. ASP x IAE → SA	0.075	1.987	0.047 *	0.013	0.015	0.135	Supported	6
Endogenous Variable	R^2	Adjusted R^2		Q^2 predict		RMSE	MAE	
SA	0.498	0.501		0.510		0.631	0.443	

Notes: | 0 | Total effect (TE), 7 |O/7|; Variance inflation factor (VIF); Confidence interval (CI), Q^2 prediction, root mean squared error (RMSE), and mean absolute error (MAE) depict coefficients, standard deviation, *t*-statistics, predictive relevance, and root mean squared error. SA: Sustainability audits; SI: Sustainability innovation; IAS: Internal audit effectiveness; ASP: Audit standards and principles. * $p < 0.05$, *** $p < 0.1$. Source(s): Authors' own calculations.

Table 8 provides a deeper examination of the regression results, focusing on the impacts of IAE, SI, and ASP on specific ESG dimensions—ENI, SOI, and GOI. IAE consistently demonstrates a significant positive effect across all three dimensions (ENI: β = 0.293, p = 0.001; SOI: β = 0.376, $p < 0.001$; GOI: β = 0.305, p = 0.001), reinforcing its foundational role in advancing comprehensive sustainability audits (Institute of Internal Auditors,

2012). SI also significantly enhances all ESG dimensions (ENI: $\beta = 0.215$, $p = 0.007$; SOI: $\beta = 0.283$, $p = 0.002$; GOI: $\beta = 0.179$, $p = 0.013$), corroborating the notion that innovation facilitates broader and more effective sustainability practices (DeSimone et al., 2021; Simoni et al., 2020). However, ASP fails to show significant effects across all dimensions (ENI: $\beta = -0.046$, $p = 0.489$; SOI: $\beta = -0.117$, $p = 0.104$; GOI: $\beta = -0.089$, $p = 0.182$), further validating the earlier finding that standardised audit principles alone do not drive ESG integration (Mulyani et al., 2019; Ridley et al., 2011). Control variables, such as LEV, exhibit a positive and significant effect on environmental indicators (β = 0.059, p = 0.018), indicating that higher debt ratios may pressure firms to adopt more rigorous ESG practices to satisfy creditor demands (Y. Zhang et al., 2020). FSIZE also shows significant positive relationships with environmental and governance indicators, suggesting that larger organisations have more resources to implement comprehensive sustainability audits (Karikari et al., 2022).

Table 8. Regression results of internal audit effectiveness, sustainable innovation, and audit standards and principles.

Variable	Environmental Indicators	Social Indicators	Governance Indicators
Constant	1.322 (0.276) *** $p = 0.000$	0.968 (0.242) *** $p = 0.000$	1.146 (0.281) *** $p = 0.000$
IAE	0.293 (0.082) *** $p = 0.001$	0.376 (0.095) *** $p = 0.000$	0.305 (0.091) *** $p = 0.001$
SI	0.215 (0.076) ** $p = 0.007$	0.283 (0.086) *** $p = 0.002$	0.179 (0.079) ** $p = 0.013$
ASP	−0.046 (0.067) $p = 0.489$	−0.117 (0.071) $p = 0.104$	−0.089 (0.067) $p = 0.182$
Control variables			
FAGE	0.038 (0.029) $p = 0.194$	0.066 (0.033) ** $p = 0.043$	0.049 (0.031) * $p = 0.086$
FSIZE	0.121 (0.053) ** $p = 0.021$	0.109 (0.057) * $p = 0.063$	0.133 (0.056) ** $p = 0.015$
ATYPE	−0.077 (0.046) $p = 0.102$	−0.052 (0.051) $p = 0.302$	−0.044 (0.045) $p = 0.329$
LEV	0.059 (0.025) ** $p = 0.018$	0.031 (0.027) $p = 0.246$	0.028 (0.026) $p = 0.280$
Model summary			
Model F	34.122 ***	29.544 ***	31.097 ***
R^2	0.416	0.389	0.402
Adjusted R^2	0.404	0.374	0.388
F Change	5.088 **	4.665 **	4.907 **
R^2 change	0.041	0.029	0.036
Durbin–Watson	1.932	1.977	1.912

Note(s): SA: Sustainability audits; SI: Sustainability innovation; IAS: Internal audit effectiveness; ASP: Audit standards and principles; FSIZE: Firm size; ATYPE: Auditor type; LEV: Leverage. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.1$. Source(s): Authors' own calculations.

4.5. Robustness Check Results

The robust checks, summarised in Table 9, confirm the stability and reliability of the regression model, as the key variable coefficients (IAE, SI, ASP) and their interactions remain consistent across alternative specifications, with only minor variations in magnitude and significance levels. Diagnostic tests indicate no severe multicollinearity or heteroscedasticity, reinforcing the validity of the findings. Specifically, the coefficients for IAE (ranging from 0.248 to 0.261) and SI (ranging from 0.229 to 0.241) remain statistically significant and stable across different model specifications, aligning with prior research by DeSimone et al. (2021) and Schneider (2003). The exclusion of outliers slightly increases the magnitude of the coefficients for IAE (0.261) and SI (0.241), suggesting that extreme observations may attenuate the estimated effects. This finding is consistent with Hair et al. (2020), who advocate for the removal of outliers to improve model accuracy. Applying robust standard errors to address potential heteroscedasticity does not alter the significance or direction of the coefficients, as confirmed by the Breusch-Pagan test results ($p > 0.05$), aligning with Wooldridge (2019), who recommends robust standard errors to account for concerns related to heteroscedasticity. Additionally, VIF values remain below the accepted threshold of five

across all models, indicating the absence of severe multicollinearity, which aligns with Hair et al. (2020), who consider VIF values below five acceptable for regression analysis.

Table 9. Robustness check results.

Variable	Baseline Model	Alternative Measures	Excluding Outliers	Robust Standard Errors
IAE	0.254 (0.056) ***	0.248 (0.058) ***	0.261 (0.055) ***	0.254 (0.059) ***
SI	0.234 (0.049) ***	0.229 (0.051) ***	0.241 (0.048) ***	0.234 (0.052) ***
ASP	0.109 (0.066) *	0.105 (0.068) *	0.113 (0.065) *	0.109 (0.069) *
IAE x SI	0.075 (0.041) *	0.072 (0.043) *	0.078 (0.040) *	0.075 (0.044) *
IAE x ASP	0.070 (0.039) *	0.067 (0.041) *	0.073 (0.038) *	0.070 (0.042) *
Control variables				
FAGE	0.048 (0.028)	0.045 (0.029)	0.051 (0.027)	0.048 (0.030)
FSIZE	0.122 (0.052) *	0.118 (0.054) *	0.126 (0.051) *	0.122 (0.055) *
ATYPE	−0.073 (0.043) *	−0.070 (0.045) *	−0.076 (0.042) *	−0.073 (0.046) *
LEV	0.036 (0.024)	0.033 (0.025)	0.039 (0.023)	0.036 (0.026)
Diagnostic tests				
Breusch-Pagan Test (p-value)	–	0.124	0.132	0.128
VIF (Max)	1.460	1.472	1.451	1.460
R^2	0.482	0.475	0.489	0.482
Adjusted R^2	0.465	0.458	0.472	0.465

Notes: SA: Sustainability audits; SI: Sustainable innovation; IAE: Internal audit effectiveness; ASP: Audit standards and principles; FSIZE: Firm size; ATYPE: Auditor type; LEV: Leverage. * $p < 0.05$, *** $p < 0.1$. Source: Authors' own calculations.

5. Discussion

The findings of this study provide valuable insights into the factors influencing SA practices, particularly the roles of IAE, SI, and ASP. The results align with and extend prior research, offering a nuanced understanding of how these elements influence organisational sustainability outcomes. The study confirms that IAE significantly enhances SA practices, accounting for 25.6% of the variance in Model 1 ($R^2 = 0.256$, $p < 0.01$). This finding highlights the crucial role of competent and independent internal auditors in fostering transparency and accountability in ESG reporting (Institute of Internal Auditors, 2012; Schneider, 2003). The consistent positive impact of IAE across all ESG dimensions—environmental (ENI), social (SOI), and governance (GOI)—further validates its foundational importance in driving comprehensive sustainability practices (Table 8). These results align with Mulyani et al. (2019), who emphasise that effective internal audits are essential for integrating ESG considerations into organisational frameworks. The introduction of SI in Model 2 significantly increases the explanatory power of the regression model ($R^2 = 0.399$, $p < 0.01$), highlighting its pivotal role in enhancing SA outcomes. The positive correlation between SI and SA ($\beta = 0.279$, $p < 0.01$) suggests that innovation-driven strategies enable organisations to address complex sustainability challenges more effectively (DeSimone et al., 2021; Simoni et al., 2020). This is further supported by the strong association between R&D investments

and SI ($r = 0.548$, $p < 0.05$), indicating that organisations prioritising innovation are better equipped to implement eco-friendly and socially responsible initiatives (Table 5). While ASP contributes to SA practices, its impact is relatively limited compared to IAE and SI. The inclusion of ASP in Model 3 results in a modest increase in R^2 (0.416), with a coefficient of $\beta = 0.124$ ($p < 0.05$). This suggests that adherence to standardised frameworks alone cannot significantly improve sustainability auditing (Ridley et al., 2011; Mulyani et al., 2019). The nonsignificant effect of ASP on specific ESG dimensions (Table 8) further reinforces the notion that standardised principles must be complemented by proactive organisational commitment and stakeholder engagement to achieve meaningful outcomes. The study reveals significant interaction effects between IAE, SI, and ASP, highlighting the synergistic role of these factors in enhancing SA practices. The interaction term IAE $\times$ SI ($\beta = 0.087$, $p < 0.05$) demonstrates that innovation amplifies the impact of effective internal audits on sustainability outcomes (Karikari et al., 2022). Similarly, the interaction term IAE $\times$ ASP ($\beta = 0.075$, $p < 0.05$) indicates that aligning audit standards with internal audit effectiveness further strengthens sustainability practices (Table 6). These findings suggest that organisations should adopt a holistic approach, integrating innovation, internal audit effectiveness, and standardised frameworks to maximise sustainability outcomes. The inclusion of control variables in Model 6 ($R^2 = 0.482$) highlights the influence of organisational characteristics on SA practices. FSIZE and ATYPE significantly contribute to the variance in SA practices, with larger firms demonstrating greater capacity to implement comprehensive sustainability audits (Karikari et al., 2022). Conversely, FAGE and LEV show no significant impact, suggesting that organisational maturity and debt levels have a minimal direct influence on sustainability practices (Table 6). The robustness checks confirm the regression model's stability and reliability, with key variable coefficients (IAE, SI, ASP) remaining consistent across alternative specifications (Table 9). Diagnostic tests indicate no severe multicollinearity or heteroscedasticity, reinforcing the validity of the findings (Hair et al., 2020; Wooldridge, 2019). The exclusion of outliers and the application of robust standard errors further validate the model's accuracy, ensuring that extreme observations or concerns related to heteroscedasticity do not unduly influence the results.

6. Conclusions and Implications

The results of this study provide important insights into the relationship between internal audit effectiveness, sustainable innovation, and sustainability auditing in Libya's public sector. The findings highlight that IAE fosters sustainability governance, ensuring greater transparency, accountability, and ESG compliance. Furthermore, sustainable innovation enhances the outcomes of sustainability auditing, reinforcing the need for organisations to adopt innovation-driven strategies in their audit functions. While audit standards and principles provide a structural foundation for sustainability auditing, their impact remains limited unless accompanied by active organisational commitment and implementation strategies. From a theoretical perspective, this study contributes to stakeholder and agency theories by demonstrating how internal audit effectiveness and sustainable innovation influence sustainability auditing practices. The stakeholder theory suggests that organisations must balance the interests of multiple stakeholders, ensuring ESG compliance while maintaining institutional legitimacy. This study extends the existing literature by illustrating how internal audit functions serve as a mechanism for embedding sustainability considerations into decision-making processes, thereby addressing gaps in prior research on public sector governance. Agency theory further underscores how internal audits mitigate agency conflicts, reducing information asymmetry in public sector governance. By linking sustainable innovation to internal audit practices, the study highlights the evolving

role of auditors as strategic partners in sustainable governance, offering a novel perspective that bridges corporate governance and sustainability auditing research.

The study's findings also have significant policy and practical implications. To enhance the efficiency of sustainability auditing, regulatory bodies should mandate sustainability-focused audit disclosures, requiring public institutions to integrate ESG metrics into their audit reports and align with global sustainability standards. Additionally, audit frameworks should be revised to incorporate AI-driven audit technologies and blockchain-enabled transparency mechanisms, improving real-time ESG performance tracking and fraud detection. Public sector governance can benefit from automated risk assessment tools that enhance the accuracy and reliability of sustainability audits, reducing reporting biases and inconsistencies (Cho et al., 2022; Karikari et al., 2022). Policymakers should encourage the development of sector-specific ESG reporting regulations, ensuring that sustainability auditing frameworks align with the unique risks and compliance requirements of different industries. Furthermore, internal audit capacity building is essential for institutionalising sustainability governance. Government agencies should establish mandatory professional training programs and certification standards for sustainability auditors, equipping them with the expertise necessary for ESG reporting, climate risk assessments, and regulatory compliance. Strengthening these competencies will enhance audit quality and ensure that sustainability audits are not mere compliance exercises but are integral to long-term governance strategies that prioritise environmental, social, and economic stability. The findings suggest that organisations that effectively combine IAE and SI achieve superior ESG performance, which strengthens public trust, institutional resilience, and long-term sustainability compliance.

Despite these contributions, the study has certain limitations. The cross-sectional design limits the ability to track long-term changes in sustainability auditing practices. Future research should employ longitudinal studies to examine how evolving audit mechanisms influence sustainability governance over time, capturing dynamic shifts in regulatory compliance and organisational strategies. Additionally, while the study focuses on Libya's public sector, its findings may not be generalisable to other governance contexts. Expanding the research scope to include cross-country comparative analyses would provide deeper insights into how sustainability auditing frameworks vary across developed and developing economies, considering differences in regulatory enforcement, institutional capacity, and stakeholder expectations. Another critical avenue for future research involves examining the role of emerging technologies—particularly AI, blockchain, and big data analytics—in sustainability auditing. Exploring how automation enhances audit accuracy, reduces reporting biases, and improves regulatory compliance could offer valuable insights into modernising sustainability governance. Additionally, investigating the interaction between auditor independence and sustainable innovation would provide a deeper understanding of ethical challenges in ESG auditing, addressing concerns related to conflicts of interest, assurance reliability, and regulatory inconsistencies. Finally, research on the role of industry-specific sustainability regulations—such as sectoral ESG reporting requirements—could further refine an understanding of how sustainability auditing frameworks can be effectively tailored to different institutional contexts.

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Institutional Review Board Statement: This is a non-interventional survey-based research study conducted among professionals in financial and governmental institutions in Libya. According to local guidelines (National Guidelines for Non-Interventional Research), this type of study does not require formal approval from an ethics committee: "Survey-based studies without collection of sensitive or identifying personal data are exempt from ethics committee approval," from the National

Guidelines for Non-Interventional Research, Libyan Ministry of Health, Tripoli, Libya, 2021. For your reference, please see the following link: https://moh.gov.ly/?AspxAutoDetectCookieSupport=1 (accessed on 12 August 2024).

Informed Consent Statement: Informed consent was obtained from all participants before the survey. They were assured of anonymity, briefed on the research purpose and data usage, and informed that participation was both voluntary and confidential.

Data Availability Statement: All data generated or analysed during this study are included in this published article.

Conflicts of Interest: The author declares that the research was conducted without commercial or financial relationships that could create a conflict of interest.

Appendix A Questionnaire

Sustainable innovation's role in enhancing public finance governance through internal audit and sustainability auditing: Libya's public sector.

Dear Participant,

Thank you for taking the time to participate in this important study. Your input is invaluable in helping us understand the role of internal audit effectiveness (IAE) and sustainable innovation (SI) in enhancing sustainability auditing (SA) practices within public sector organisations in Libya. Your responses will contribute to advancing knowledge in this field and support efforts to improve sustainable practices in the public sector.

Instructions:

1. Please read each statement carefully and indicate your level of agreement by selecting the response that best aligns with your opinion.
2. Use the following scale to respond:
    - ○ 1: Strongly Disagree
    - ○ 2: Disagree
    - ○ 3: Somewhat Disagree
    - ○ 4: Neutral
    - ○ 5: Somewhat Agree
    - ○ 6: Agree
    - ○ 7: Strongly Agree
3. Answer all questions honestly and to the best of your ability.
4. The questionnaire should take approximately 10–15 min to complete.

Confidentiality:

All responses will be treated with the utmost confidentiality. Your data will be used solely for academic and research purposes, and no identifying information will be shared or published.

Thank you for your cooperation and valuable contribution to this research.

Table A1. Demographic information.

Category	Criteria	Response
Gender	Male	[ ]
	Female	[ ]
	I prefer not to say	[ ]
Job Title	Chairman of Board	[ ]
	Chief Executive Officer (CEO)	[ ]
	Manager Head of Department	[ ]
	Financial Manager	[ ]
	Internal Auditor	[ ]
	External Auditor	[ ]
	Accountant	[ ]
	Other (Please specify): _____	[ ]
Educational Qualification	Diploma	[ ]
	Graduate Degree (Bachelor's)	[ ]
	Post-Graduate Degree (Master's/PhD)	[ ]
	Professional Qualification (e.g., CPA, CIA)	[ ]
	Other (Please specify): _____	[ ]
Work Experience (Years)	1 to 5 years	[ ]
	6 to 10 years	[ ]
	11 to 15 years	[ ]
	Above 15 years	[ ]

Table A2. Sustainability auditing (SA) practices questions.

Item	Statement	1	2	3	4	5	6	7
SA1	The organisation conducts systematic sustainability audits to evaluate its environmental performance.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
SA2	Sustainability audits identify and address gaps in social responsibility practices.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
SA3	Insights from sustainability audits are integrated into organisational strategic and operational plans.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
SA4	Sustainability audits ensure compliance with applicable environmental and social regulations.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
SA5	The organisation's sustainability audit processes are transparent and accessible to stakeholders.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
SA6	Audit recommendations contribute to measurable improvements in the organisation's environmental footprint.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
SA7	Actionable steps based on audit findings are consistently implemented to promote sustainability goals.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Table A3. Internal audit effectiveness (IAE) questions.

Item	Statement	1	2	3	4	5	6	7
IAE1	The internal audit function operates independently and transparently, free from external influence.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
IAE2	Auditors possess the specialised knowledge and skills necessary to address sustainability-related risks.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
IAE3	The audit team is equipped with adequate resources, including personnel and technology.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
IAE4	Audit reports are delivered promptly and provide actionable insights that support decision-making.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
IAE5	Management effectively implements the recommendations provided in internal audit reports.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
IAE6	The internal audit function actively mitigates risks and ensures compliance with sustainability policies.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
IAE7	Continuous improvements in audit processes align with the organisation's long-term sustainability goals.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Table A4. Sustainable innovation (SI) questions.

Item	Statement	1	2	3	4	5	6	7
SI1	The organisation fosters a culture of innovation to address sustainability challenges.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
SI2	Sustainable innovation is explicitly integrated into the organisation's strategic objectives.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
SI3	R&D investments specifically target the development of sustainable practices and technologies.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
SI4	Employees are actively encouraged and rewarded for contributing innovative sustainability solutions.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
SI5	The organisation's sustainability initiatives lead to quantifiable improvements in ESG metrics.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
SI6	Collaborative partnerships with external stakeholders promote innovative sustainability projects.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Table A5. Audit standards and principles (ASP) questions.

Item	Statement	1	2	3	4	5	6	7
ASP1	The audit standards and principles are comprehensive, addressing all critical aspects of ESG practices.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
ASP2	Regular updates to audit standards ensure alignment with global best practices and regulations.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
ASP3	The organisation's audit framework integrates sustainability objectives into core auditing principles.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
ASP4	Comprehensive training equips auditors with knowledge of updated standards and emerging ESG trends.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
ASP5	Adherence to defined audit principles enhances the efficiency and credibility of audit practices.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Table A6. Control variables (CV) questions.

Item	Statement	1	2	3	4	5	6	7
CV1	The institution has been in operation for over 10 years.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CV2	The institution is classified as a large organisation (e.g., based on assets).	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CV3	The institution primarily relies on internal audit services.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CV4	The institution has a high level of debt relative to equity.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CV5	The institution has a dedicated sustainability department or team.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CV6	The institution's annual revenue exceeds $10 million.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CV7	The institution operates in multiple geographic regions.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CV8	The institution has a formal policy for environmental and social governance.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CV9	The institution's audit committee meets at least quarterly.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
CV10	The institution has received external awards or recognition for sustainability efforts.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Table A7. Additional comments.

Section F: Additional Comments
Please provide any additional comments or insights related to your organisation's internal audit effectiveness, sustainable innovation, and sustainability auditing practices. Include observations, challenges, or opportunities not captured in the questionnaire. Open Text Area: _____ _____ _____

Thank you for your participation!

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