

Research Article

Environmental Management Systems, Firm Size, and Corporate Governance as Determinants of Carbon Emission Disclosure

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Abstract

This study examines the effects of Environmental Management System (EMS), firm size, institutional ownership, and the audit committee on carbon emission disclosure among energy sector companies listed on the Indonesia Stock Exchange during 2021–2024. Using a quantitative associative approach, secondary data from 33 firms selected through purposive sampling are analyzed, yielding 132 firm-year observations. Carbon emission disclosure is measured using a disclosure index; EMS is proxied by ISO 14001 certification; firm size by the natural logarithm of total assets; institutional ownership by the proportion of institutional shareholding; and the audit committee by the frequency of audit committee meetings. Panel data regression is conducted using EViews, with the fixed-effects model chosen based on model selection tests. The results indicate that EMS has a significant positive effect on carbon emission disclosure, suggesting greater transparency among firms with structured environmental management systems. Firm size also positively influences disclosure, reflecting higher public visibility and accountability. Institutional ownership significantly enhances disclosure through effective monitoring, while audit committee activity strengthens disclosure practices via improved oversight and governance. Overall, the findings highlight the importance of environmental management and corporate governance in improving sustainability reporting and supporting Indonesia's transition toward a low-carbon economy.

Keywords: Environmental Management System, Firm Size, Institutional Ownership, Audit Committee, Carbon Emission Disclosure

JEL Classification: Q56, M14, L25

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1. Introduction

Climate change and global warming have become global issues with widespread impacts on human health, agriculture, forests, infrastructure, energy systems, and social life (Ainurrohmah & Sudarti, 2022; Malihah, 2022). One of the main drivers of this phenomenon is the increasing volume of carbon emissions generated from fossil fuel combustion, which accelerates the accumulation of greenhouse gases in the atmosphere (Florenca & Handoko, 2021; Zaemi & Rohmana, 2021).

As an archipelagic country located between two continents and two oceans, Indonesia is highly vulnerable to climate-related risks due to strong interactions between atmospheric and oceanic systems (BMKG, 2024). Empirical evidence from EDGAR (2024) places Indonesia as the seventh-largest carbon emitter globally and the largest in ASEAN, with the energy sector contributing approximately 701.4 million tons of CO₂ emissions, ranking sixth worldwide. These environmental pressures have translated into tangible socio-economic consequences, particularly in major urban areas such as DKI Jakarta, where rising pollution levels are associated with increasing cases of acute respiratory infections (Firdaus et al., 2024).

Indonesia's commitment to climate mitigation is reflected in its ratification of the Kyoto Protocol through Law No. 17 of 2004, which reinforces corporate responsibility in managing and reporting environmental impacts (Rusdi & Helmayunita, 2023). In this context, Carbon Emission Disclosure (CED) emerges as a critical component of Corporate Social Responsibility (CSR) reporting, serving not only as an accountability mechanism to stakeholders but also as a strategic communication tool to maintain corporate legitimacy (Wirawan & Setijaningsih, 2022). From the perspective of legitimacy theory, companies disclose carbon-related information to align their operations with societal expectations and regulatory pressures, thereby securing continued access to economic resources and public trust (Dani & Harto, 2022).

Beyond legitimacy considerations, CED also holds increasing relevance for capital markets. Transparent carbon disclosure provides investors with material information regarding environmental risk exposure, regulatory compliance costs, and long-term sustainability performance, all of which influence firm valuation and investment decisions. In emerging markets such as Indonesia, where carbon disclosure remains voluntary, limited transparency can exacerbate information asymmetry between management and investors, potentially increasing perceived risk and capital costs (Syabilla et al., 2021). Consequently, firms with more comprehensive carbon disclosures are better positioned to attract institutional investors who increasingly integrate environmental, social, and governance (ESG) considerations into portfolio allocation.

Previous empirical studies examining the determinants of CED have produced mixed results, indicating the need for further investigation, particularly within high-emission industries. Environmental Management Systems (EMS), especially those certified under ISO 14001, are theorized to enhance carbon disclosure by institutionalizing environmental monitoring, measurement, and reporting processes. Similarly, firm size reflects visibility and political cost pressures, which incentivize larger firms to disclose more extensive environmental information. Corporate governance mechanisms, such as institutional ownership and audit committees, function as internal monitoring tools that can mitigate managerial opportunism and encourage more transparent sustainability reporting.

Given the strategic importance of the energy sector as Indonesia's largest source of carbon emissions and its exposure to emerging carbon taxation under the 2021 HPP Law, examining CED determinants within this sector is particularly relevant. This study therefore re-examines the influence of EMS, firm size, institutional ownership, and audit committees on carbon emission disclosure in energy sector companies during the 2021–2024 period, contributing to the literature by integrating legitimacy theory and capital market perspectives within a high-emission regulatory context.

2. Literature Review and Hypothesis

Stakeholder Theory

Stakeholder theory explains that companies cannot separate themselves from the social environment. Companies are required to be responsible not only for profit and shareholder interests, but also for the community, customers, suppliers, and the environment, as part of their activities, as defined by stakeholder theory (Saputri & Fidiana, 2023). Climate change issues demand that companies be more environmentally responsible. Disclosure of carbon emissions in sustainability reports demonstrates a company's concern for environmental impacts, allows stakeholders to assess and monitor its performance, and increases trust in the company (Setiadi & Nurwati, 2022).

Carbon Emission Disclosure

Carbon emissions are exhaust gases resulting from the combustion of carbon-containing fuels (Claudia & Halik, 2024). Continuous increases in carbon emissions cause global warming and ecosystem damage (Kurnia et al., 2021). This situation encourages companies to take responsibility for their emissions by disclosing them in sustainability reports. This disclosure reflects the company's environmental performance and efforts to reduce its carbon footprint, such as energy efficiency and the use of environmentally friendly energy (Pitrakkos & Maroun, 2020; Oktariyani, 2024). However, in Indonesia, disclosure of carbon emissions remains voluntary, leading to only a small number of companies reporting them (Syabilla et al., 2021; Sari & Nisa, 2020).

Environmental Management System

An environmental management system (EMS) is a systematic approach to managing a company's environmental impacts. The international standard ISO 14001:2015 serves as the primary reference for planning and implementing environmental protection (Utomo et al., 2021). ISO 14001 helps companies manage and reduce their environmental impacts through structured policies, procedures, and assigned responsibilities. Its goal is to support environmental protection and pollution prevention while balancing economic needs. ISO 14001 certification is awarded by external auditors to companies that meet the standard, signaling a company's commitment to regulatory compliance and continuous improvement in environmental performance (Riaz et al., 2022; Di Giacomo et al., 2017).

Firm Size

Firm size Corporate size is a company's scale as measured by total assets, sales, or market capitalization (Septriyawati & Anisah, 2019). The greater the total assets, the larger the company. Larger companies tend to make more voluntary disclosures, including those related to carbon emissions, because they face greater pressure from stakeholders to demonstrate concern for environmental issues (Nastiti & Hardiningsih, 2022).

Institutional Ownership

Institutional ownership is the percentage of shares held by institutions, which can be used to monitor and control a company's performance. A high level of institutional ownership leads to greater oversight by institutional investors, thereby preventing misconduct by company management. High institutional ownership encourages companies to disclose all activities, including environmental disclosure (Putri, 2017).

Audit Committee

Found that the number of meetings is one indicator of the audit committee's prominence and primary strengths. The number of meetings is intended to audit reports and oversee the company's corporate governance activities. The higher the quality of the audit committee, the easier it is for the company to convey information as stakeholders expect.

Research Framework

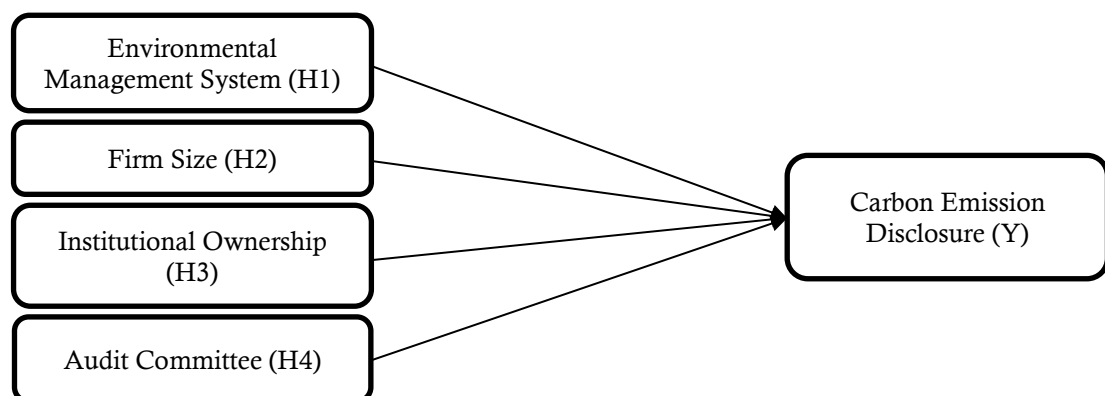


Figure 1. Research Framework

Research Hypothesis

Environmental Management System influences Carbon Emission Disclosure

Companies that hold ISO 14001 certification have complied with internationally recognized environmental management standards, indicating the existence of structured procedures for monitoring, controlling, and reporting environmental impacts. Within the legitimacy theory framework, firms adopt Environmental Management Systems (EMS) to demonstrate conformity with societal expectations and regulatory requirements, thereby reducing legal risk and enhancing business competitiveness. An EMS represents a concrete manifestation of corporate environmental responsibility and provides an internal mechanism for systematically measuring and disclosing carbon emissions (Jannah & Narsa, 2021).

Empirical studies document a positive relationship between EMS implementation and carbon emission disclosure. Research by Rohmah and Nazir (2022) and Jannah and Narsa (2021) shows that companies with ISO 14001 certification tend to disclose carbon-related information more extensively. Similar findings are reported by Dewi and Kurniawan (2020), Puteri and Inawati (2023), and Suherman and Kurniawati (2023). However, contrary evidence from Linda and Shanti (2022) suggests that some ISO 14001-certified firms may perceive their emissions as immaterial and therefore refrain from disclosure. Despite these mixed findings, EMS is theoretically expected to enhance transparency through standardized environmental reporting mechanisms. Therefore, the first hypothesis is formulated as follows:

H1: The environmental management system has a positive effect on carbon emission disclosure.

Firm Size Affects Carbon Emission Disclosure

Firm size reflects the scale of a company's operations and resources, which influences its visibility and exposure to public scrutiny. Larger firms tend to face greater stakeholder pressure from regulators, investors, and the general public, motivating them to disclose more comprehensive environmental information to maintain legitimacy and reputation. In addition, larger firms generally possess greater financial and human resources, enabling them to prepare detailed sustainability reports and participate in international reporting frameworks such as the Global Reporting Initiative (GRI).

Empirical evidence supports this argument. Firmansyah et al. (2021) and Kiliç and Kuzey (2019) find that firm size positively affects carbon emission disclosure, as larger firms are more compliant and transparent in their reporting practices. Conversely, Rosa et al. (2024) report no significant effect, attributing the result to the voluntary nature of carbon disclosure in Indonesia. Despite these inconsistencies, legitimacy theory predicts that firm size increases disclosure incentives due to heightened public exposure. Accordingly, the second hypothesis is proposed:

H2: Firm Size Has a Positive Effect on Carbon Emission Disclosure.

Institutional Ownership Influences Carbon Emission Disclosure

Institutional ownership represents the proportion of shares held by institutional investors such as banks, pension funds, and investment companies. High institutional ownership strengthens monitoring mechanisms and limits managerial opportunism, thereby encouraging greater transparency. From a stakeholder theory perspective, institutional investors demand higher-quality disclosure to assess environmental risks and long-term sustainability performance.

Prior studies by Pratiwi (2017), Halimah and Yanto (2018), and Amaliyah and Solikhah (2019) provide evidence that institutional ownership positively influences carbon emission disclosure. However, finds no significant relationship, suggesting that institutional investors may prioritize financial performance over environmental transparency. Nevertheless, given the increasing integration of ESG considerations into institutional investment decisions, a positive relationship is expected. Thus, the following hypothesis is formulated:

H3: Institutional Ownership Has a Positive Influence on Carbon Emission Disclosure.

Audit Committee Influence on Carbon Emission Disclosure

The audit committee serves as an internal governance mechanism, overseeing management performance and ensuring the credibility of corporate reporting. The effectiveness of the audit committee is commonly reflected in the frequency of its meetings, which signals the intensity of oversight and monitoring activities. According to stakeholder theory, an active audit committee enhances accountability and promotes transparency, including in environmental and sustainability disclosures.

Empirical studies indicate that more frequent audit committee meetings improve disclosure quality and reduce information asymmetry. Conversely, weak or passive audit committees may undermine governance effectiveness (Simamora, 2021). Based on these arguments, the fourth hypothesis is proposed:

H4: The audit committee has a positive effect on carbon emission disclosure.

3. Data and Method

Research Strategy

This study uses a quantitative, causal approach to examine the influence of environmental management systems, firm size, institutional ownership, and audit committees on carbon emission disclosure. The data used are secondary, in the form of financial, annual, and sustainability reports of energy sector companies listed on the Indonesia Stock Exchange (IDX) for the 2021–2024 period, obtained from the official IDX websites and the relevant companies. The quantitative approach was chosen because the data used are numerical and aim to test hypotheses statistically (Sugiyono, 2018).

Population and Sample

The population is always larger than the sample size. The population used in this study was energy sector companies listed on the Indonesia Stock Exchange (IDX) between 2021 and 2024. Using a purposive sampling technique based on the aforementioned criteria, 33 energy sector companies were selected, with observations spanning 2021-2024 (4 years). Therefore, the total sample size is 132 companies.

Method of collecting data

The data used in this study are secondary, in the form of financial, annual, or sustainability reports, disclosed by companies. Data sources on firm size and environmental management systems were obtained from the financial reports, annual reports, and sustainability reports of the relevant companies, which can be accessed at <https://www.idx.co.id/id> or on each company's website. Meanwhile, data on institutional ownership and audit committee size were obtained from annual reports. The period used in this study was 2021 to 2024.

4. Results

Classical Assumptions

Normality Test

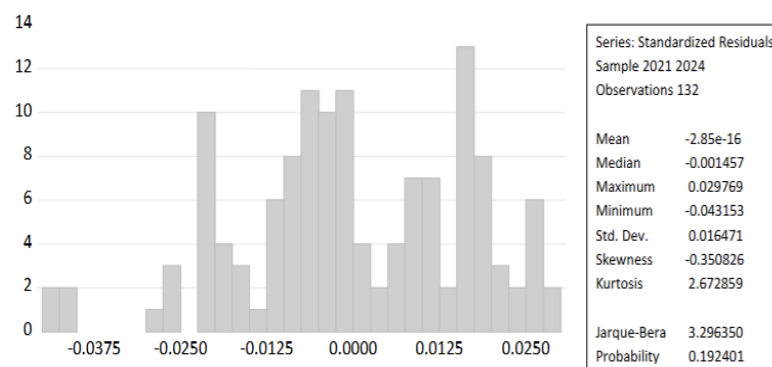


Figure 2. Normality Test Results

Based on the image above, the results of the normality test using the Jarque-Bera method yielded a p-value of 0.192401, which is greater than 0.05. Because the Jarque-Bera probability value is $> \alpha = 5\%$, the data are normally distributed.

Autocorrelation Test

Table 1. Autocorrelation Test Results

Effects Specification			
Cross-section fixed (dummy variable)			
R-Squared	0.994340	Mean dependendt var	0.725602
Adjusted R-Squared	0.992196	S.D. dependendt var	0.130648
S.E. of regression	0.011542	Akaike info criterion	-5.854004
Sum squared resid	0.012655	Schwarz criterion	-5.045946
Log likelihood	423.3643	Hannan-Quinn criter	-5.525646
F-statistic	463.6195	Durbin-Watson stat	1.670295
Prob(F-statistic)	0.000000		

Source: Processed Data (2025)

Based on Table 1 above, the Durbin-Watson (DW) value of 1.670295 indicates no indication of autocorrelation in the regression model. In DW interpretation, the value is between -2 and +2.

Multicollinearity Test

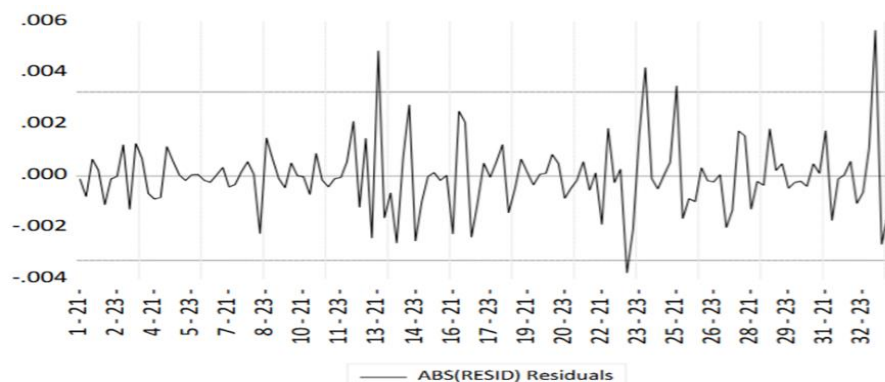
Table 2. Multicollinearity Test Results

	X1	X2	X3	X4
X1	1.000000	0.074672	-0.056354	-.052486
X2	0.074672	1.000000	0.315484	0.142919
X3	-0.056354	0.315484	1.000000	0.104104
X4	-0.052486	0.142919	0.104104	1.000000

Source: Processed Data (2025)

Based on Table 2 above, there is no strong indication of multicollinearity among the independent variables in the model. This indicates that each independent variable is relatively independent and does not have a strong linear relationship with the others, making it suitable for simultaneous inclusion in the regression analysis on Carbon Emission Disclosure (Y).

Heteroscedasticity Test



Source: Processed Data (2025)

From the residual graph, it can be seen that the data is stationary, indicating equal residual variances. Therefore, there is no heteroscedasticity in this model.

Panel Data Regression Estimation Method Common Effect Model

Table 3. Panel Data Regression Results with the Common Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.858633	0.030819	-60.30889	0.0000
X1	0.020592	0.001515	13.59018	0.0000
X2	0.081084	0.001053	76.99642	0.0000
X3	0.000153	5.96E-05	2.573850	0.0112
X4	0.020832	0.000998	20.87902	0.0000

Source: Processed Data (2025)

The Panel Least Squares estimation results show that Environmental Management System, Firm Size, institutional ownership, and the audit committee have a positive and significant effect on Carbon Emission Disclosure at the 5% significance level. Firm Size has the most considerable influence, followed by EMS, the audit committee, and institutional ownership. This confirms that the larger the company, the better the implementation of the environmental management system, and the more effective internal oversight and institutional investors, the higher the level of transparency in carbon emission disclosure.

Fixed Effect Model (FEM)

Table 4. Panel Data Regression Results with Fixed Effect Model (FEM)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.674629	0.100304	-16.69552	0.0000
X1	0.019067	0.001281	14.87862	0.0000
X2	0.074237	0.003392	21.88699	0.0000
X3	0.001229	0.000320	3.839829	0.0002
X4	0.017899	0.001511	11.84792	0.0000

Source: Processed Data (2025)

The Fixed Effect Model (FEM) estimation results show that all independent variables have a positive and significant effect on Carbon Emission Disclosure at the 1% significance level. Firm size has the most significant influence, followed by the Environmental Management System, the audit committee, and institutional ownership. This indicates that the larger the company, the better its environmental management system and the more effective its governance mechanisms, the higher the level of transparency in carbon emission disclosure. These findings emphasize the importance of internal factors and corporate governance in promoting environmental accountability.

Random Effect Model (REM)

Table 5. Panel Data Regression Results with the Common Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.858633	0.030819	-60.30889	0.0000
X1	0.020592	0.001515	13.59018	0.0000
X2	0.081084	0.001053	76.99642	0.0000
X3	0.000153	5.96E-05	2.573850	0.0112
X4	0.020832	0.000998	20.87902	0.0000

Source: Processed Data (2025)

Panel Least Squares estimation results show that Environmental Management System, Firm Size, institutional ownership, and audit committee have a positive and significant effect on Carbon Emission Disclosure at the 5% significance level. Firm Size has the most significant influence, indicating that larger companies disclose more extensive carbon emissions.

Panel Data Regression Model Selection Test Chow Test

Table 6. Results Chow Test

Effects Test	Statistics	d.f.	Prob.
Cross-section F	5.055667	(32,95)	0.0000
Cross-section Chi-square	131.253945	32	0.0000

Based on Table 6 above, the chi-square cross-section probability value is 0.000. Because the chi-square cross-section probability value is $< \alpha = 5\%$, the Fixed Effect Model is selected for use.

Hausman test

Table 7. Hausman Test Results

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	16.740587	4	0.0022

Based on Table 7 above, the Hausman test yielded a random-effects probability value of 0.0022. Because the random cross-section probability value is $< \alpha = 5\%$, the model selected for use is the Fixed Effect Model.

Hypothesis Testing

Table 8. Hypothesis Testing

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.674629	0.100304	-16.69552	0.0000
X1	0.019067	0.001281	14.87862	0.0000
X2	0.074237	0.003392	21.88699	0.0000
X3	0.001229	0.000320	3.839829	0.0002
X4	0.017899	0.001511	11.84972	0.0000
Effects Specification				
Cross-section Fixed Effects (dummy variables)				
R-squared	0.994340	Mean dependent var		0.725602
Adjusted R-squared	0.992196	S.D. dependent var		0.130648
S.E. of regression	0.011542	Akeiko info criterion		-5.854004
Sum squared resid	0.012655	Schwarz criterion		-5.045946
Log likelihood	423.3643	Hannan-Quin criter.		-5.525646
F- statistic	463.6195	Durbin-Watson stat		1.670295
Prob(F- statistic)	0.000000			

The test results in Table 8 above show that the Environmental Management System, Firm Size, institutional ownership, and audit committee have a significant effect on Carbon Emission Disclosure ($p < 0.05$; t-count > 1.979), so that all hypotheses are accepted.

5. Discussion

The Impact of Environmental Management Systems on Carbon Emission Disclosure

Based on Table 8, the Environmental Management System (EMS) has a positive and significant influence on Carbon Emission Disclosure. This means that the first hypothesis stating that the

Environmental Management System has a positive effect on Carbon Emission Disclosure is accepted, meaning that the better a company's Environmental Management System (as measured by ISO 14001), the higher its carbon emission disclosure. The very high t-statistic indicates that implementing a structured environmental management system is a strong predictor of transparency in a company's disclosure of its carbon emissions.

The results of this study align with those of Rohmah & Nazir (2022); Jannah & Narsa (2021); Dewi & Kurniawan (2020); Puteri & Inawati (2023); and Suherman & Kurniawati (2023), who stated that a sound environmental management system can increase public trust and open access to more investment opportunities. Contrary to Linda & Shanti's (2022) findings, companies that have obtained ISO 14001 certification are not yet motivated to disclose carbon emissions in their sustainability reports because they believe their emissions are below the threshold.

The Effect of Firm Size on Carbon Emission Disclosure

Based on Table 8, this has a positive and significant effect on carbon emission disclosure. The very high t-statistic provides robust evidence that company size is a major driver of carbon emission disclosure. These results support the second hypothesis, which posits that company size has a positive effect on carbon emission disclosure. This means that the larger a company, the higher its level of carbon emission disclosure.

The results of this study align with those of Chariri et al. (2023), and Armono et al. (2024), who found that larger companies are better able to disclose carbon emissions comprehensively to build their reputations. These findings also support those of Setiadi & Nurwati (2022), who found that carbon emission disclosure increases stakeholder trust and global competitiveness. However, these results differ from those of Sari & Pratama (2023), who found an insignificant relationship between company size and environmental disclosure because EMS practices are sometimes symbolic.

The Influence of Institutional Ownership on Carbon Emission Disclosure

Table 8 shows that institutional ownership has a positive and significant effect on carbon emission disclosure. These results provide strong evidence that the third hypothesis, which states that institutional ownership has a positive effect on carbon emission disclosure, is accepted. This means that the higher the proportion of shares owned by institutional investors, the greater the level of carbon-emission disclosure a company provides.

The results of this study align with those of Chariri et al. (2023) and Armono et al. (2024), who stated that institutional ownership encourages sustainable disclosure practices. Smith & Johnson (2022) also found that companies with high institutional ownership tend to disclose more extensive and high-quality environmental information. However, this finding contradicts Chen et al. (2015), who stated that institutional investors tend to be passive and do not pressure management to disclose, primarily because not all investors are oriented towards long-term sustainability.

The Influence of the Audit Committee on Carbon Emission Disclosure

Based on Table 8, these results provide strong evidence that the fourth hypothesis, which states that the audit committee has a positive effect on carbon emission disclosure, is accepted. This means that the more meetings the audit committee holds, the more comprehensive the company's carbon emissions disclosure is. The strength of the relationship, as indicated by the t-statistic, suggests that the existence and effectiveness of the audit committee are powerful predictors of transparency in corporate carbon emission disclosure.

The results of this study align with those of Armono et al. (2024) and Chariri et al. (2023), who stated that an independent and competent audit committee improves carbon emissions disclosure. Smith & Johnson (2022) also confirmed that audit committee effectiveness influences disclosure quality through the use of external assurance and reporting standards. However, these findings differ from those of Chen et al. (2022), who found a negative relationship in developing countries due to weak governance and a lack of environmental expertise within audit committees.

6. Conclusion

This study finds that Environmental Management System, firm size, institutional ownership, and audit committee are positively and significantly associated with carbon emission disclosure. Firms with stronger environmental management practices, larger operational scale, higher institutional ownership, and more active audit committees tend to disclose carbon-related information more transparently. These findings are consistent with legitimacy, stakeholder, and agency theories, which emphasize governance and accountability in disclosure practices. However, as carbon emission disclosure in Indonesia is largely voluntary and based on reported information, the results should be interpreted with caution due to potential disclosure bias, measurement limitations, and omitted variables. Future studies are encouraged to incorporate additional determinants and alternative disclosure measures.

Managerial Implications

Companies need to strengthen environmental governance practices and internal oversight mechanisms to enhance transparency in carbon emissions disclosure. Management is expected to prioritize implementing effective environmental management systems, strengthen audit committees' roles, and encourage institutional investors' involvement in oversight of sustainability policies. For regulators and policymakers, these findings can serve as a basis for formulating stricter carbon disclosure guidelines to support corporate accountability and sustainability in Indonesia.

Recommendation

Companies should target ISO 14001 certification within 2–3 years, ensure audit committee meetings on sustainability are held at least quarterly, and promote active institutional investor engagement through ESG-based monitoring and voting policies. Regulators are encouraged to implement mandatory carbon emission disclosure for high-emission sectors, starting with standardized guidelines and a phased timeline toward full compliance within 3–5 years, supported by appropriate incentives.

Limitations and avenues for future research

Based on these limitations, further research is recommended to expand the study to other industrial sectors beyond energy to make the results more representative of the overall market. Furthermore, the observation period could be extended to provide a more comprehensive picture of the long-term dynamics and trends in the variables under study.

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