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The Influence of Environmental Management Systems, Eco-Efficiency, and Media Exposure on Carbon Emission Disclosure: Evidence from Indonesian Energy Companies

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Abstract

Carbon emission disclosure (CED) has become increasingly important as stakeholders demand greater corporate transparency regarding climate-related environmental impacts. However, prior studies examining the determinants of CED have reported inconsistent findings, particularly regarding the roles of environmental management systems, eco-efficiency, and media exposure. This study aims to examine the influence of Environmental Management Systems (EMS), Eco-Efficiency, and Media Exposure on carbon emission disclosure among energy sector companies listed on the Indonesia Stock Exchange during 2021–2024. A quantitative approach was employed using panel data regression analysis. The sample consisted of 25 energy companies (100 firm-year observations) selected through purposive sampling. Data were analyzed using the Fixed Effect Model in EViews 12. The findings indicate that Environmental Management Systems significantly enhance carbon emissions disclosure, suggesting that implementing structured environmental management practices encourages greater transparency in carbon reporting. In contrast, Eco-Efficiency and Media Exposure do not significantly influence carbon emission disclosure. These findings enrich the carbon emission disclosure literature by providing evidence from the Indonesian energy sector and demonstrating that formal environmental management systems play a more prominent role in encouraging disclosure than operational eco-efficiency or external media pressure. The results also provide practical insights for managers and policymakers to strengthen corporate environmental reporting practices and support climate accountability.

JEL Classification: M41, Q54, Q56

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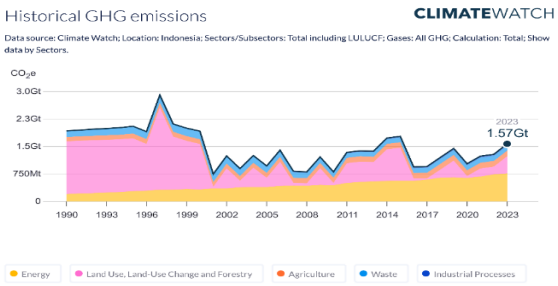
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Introduction

Global temperature changes occurring today result from the increasing greenhouse effect in the atmosphere, driven by human activities, especially the use of fossil fuels as a primary energy source (Gillett et al., 2021; Soedar, 2021). The extensive use of fossil fuels has significantly increased atmospheric carbon dioxide (CO_2) concentrations, contributing to global warming and climate change (Fresilia, 2024). Fossil fuels are even recorded as the main source of human-caused greenhouse gas emissions worldwide, reducing their use a top priority in global climate policy (Lazarus & Van Asselt, 2018). Therefore, reducing carbon emissions and improving corporate transparency regarding environmental impacts have become important priorities in global climate mitigation efforts (Nunes, 2023).

In Indonesia, carbon emissions are also increasing. The National Development Planning Agency (PPN/Bappenas), a division of the National Development Planning Ministry, said that the energy industry has been the largest source of carbon emissions since 2022, followed by the transportation sector, which accounts for 50.6% of emissions. Total emissions from these sectors have the potential to reach 1 Giga Ton CO_2eq in 2022. Furthermore, Indonesia is projected to experience an increase in carbon emissions of up to 59%, or equivalent to 1.4 Giga Ton CO_2eq, by 2030 (Low Carbon Development Indonesia, 2024).

Figure 1.1 Global Temperature Increase



Historical GHG emissions - Climate Watch (2026)

Based on data from Climate Watch, greenhouse gas emissions in Indonesia fluctuated over the period 1990–2023, reaching approximately 1.57 Gt CO_2e in 2023. Of this total, the energy sector was the largest contributor at around 650 Mt CO_2e, followed by the land use and forestry sector at approximately 500 Mt CO_2e. Meanwhile, the agriculture sector contributed around 150 Mt CO_2e, the waste sector approximately 130 Mt CO_2e, and the industrial processes sector around 30 Mt CO_2e. These data indicate that in Indonesia, the energy sector is the primary source of greenhouse gas emissions, generating far more than any other sector.

The energy sector's significant contribution highlights the importance of carbon emissions disclosure (CED) as a mechanism for companies to communicate their environmental commitments to stakeholders. Carbon emission disclosure enables companies to demonstrate accountability, respond to increasing public and regulatory pressure, and maintain organizational legitimacy (Ding et al., 2022; Hapsari & Hardiyanti, 2024). This issue is particularly relevant in Indonesia's energy sector, where operational activities remain closely tied to the use of coal, oil, and gas, while voluntary corporate initiatives and stakeholder pressures continue to influence carbon emissions disclosure practices (Lestari et al., 2025; Mahendra et al., 2025). Previous studies have identified several factors influencing carbon emission disclosure, including environmental management systems, eco-efficiency, and media exposure. However, empirical findings regarding these relationships remain inconsistent. These inconsistencies indicate that the determinants of carbon emission disclosure are not yet fully understood, particularly in high-emission industries such as the energy sector in developing countries.

Empirically, high-quality climate risk disclosure has been shown to reduce carbon emissions, particularly when supported by strong governance, although inconsistent reporting standards and the risk of

greenwashing remain important limitations in practice (Wang et al., 2024; Zhang, 2024; Nyakuwanika & Panicker, 2025). One event that highlighted the environmental impact of energy sector activities was the flood disaster that struck South Kalimantan in early 2021. The flood caused widespread damage and affected hundreds of thousands of people in the region. Several parties argued that environmental degradation and land conversion resulting from the exploitation of natural resources, including coal mining, may have exacerbated the disaster. One company that came under scrutiny in this issue was PT Adaro Energy Indonesia Tbk, which through its subsidiaries holds extensive coal mining concession areas in South Kalimantan and Central Kalimantan (Kontan, 2021).

Environmental Management System (EMS) is one of the mechanisms that encourage companies to improve environmental transparency. By implementing ISO 14001, companies are expected to manage environmental impacts, improve resource efficiency, reduce emissions, and increase stakeholder confidence (Fauzi et al., 2025). Previous studies by Armono and Santosa (2024); Dewi and Dewi (2024) found that the implementation of ISO 14001 positively influences carbon emissions disclosure. However, other studies by Annisa and Ersyafdi (2025); Iratiwi and Sulfitri (2023) reported insignificant relationships between EMS and carbon emission disclosure. These inconsistent results suggest that the effectiveness of EMS in encouraging disclosure may depend on differences in industry characteristics, regulatory pressures, and corporate environmental commitment. Furthermore, evidence focusing specifically on Indonesia's energy sector remains limited.

Besides Environmental Management Systems, Eco-Efficiency is also considered an important factor influencing carbon emission disclosure. Eco-Efficiency reflects a company's ability to generate economic value while minimizing environmental impacts, particularly carbon emissions and resource consumption (Munawaroh et al., 2018). Unlike conventional environmental performance measurements that often rely on qualitative assessments, such as environmental ratings, Eco-Efficiency provides a quantitative approach by assessing the relationship between economic output and environmental impact. In this study, Eco-Efficiency is measured as the ratio of revenue to total CO_2 emissions, where a higher value indicates that a company can generate greater economic value with relatively lower emissions.

Previous studies examining the relationship between Eco-Efficiency and carbon emissions disclosure have yielded mixed results. found that Eco-Efficiency is associated with greater carbon emission disclosure, indicating that companies with higher efficiency in managing environmental impacts tend to provide more transparent environmental information. However, differences in measurement approaches, company characteristics, and disclosure practices may contribute to inconsistent findings. Therefore, further investigation is needed to examine whether Eco-Efficiency influences carbon emission disclosure, particularly in Indonesian energy sector companies (Sari et al., 2024).

Most previous studies have measured environmental performance using qualitative proxies, particularly the Indonesian corporate performance rating program (PROPER) to evaluate corporate environmental performance (Munif & Nikmah, 2025). However, qualitative ratings simultaneously create economic value while minimizing environmental impacts. Therefore, this study employs Eco-efficiency as a quantitative proxy for environmental performance, providing a more comprehensive assessment of firms' environmental performance in relation to carbon emission disclosure.

Media exposure also plays an important role in encouraging corporate environmental transparency. Companies receiving greater public and media attention are expected to disclose more environmental information to maintain reputation and stakeholder trust (Yasa & Purnawati, 2024). However, previous studies examining media exposure have produced mixed results Aryni et al. (2021) found that media exposure positively influences carbon emission disclosure, while other studies by Berliana and Putri (2024) while other studies such as Fazrin et al., (2025); Musyifa and Risa (2025) found insignificant relationships. These differences may arise from variations in media exposure measurement, sample characteristics, and industrial contexts. Therefore, further evidence is needed to clarify the role of media exposure in promoting carbon emission disclosure, particularly in Indonesia's energy sector.

The inconsistent findings from previous studies indicate several research gaps. First, although environmental management systems, environmental performance, and media exposure have been widely examined, previous studies have not provided consistent evidence regarding their influence on carbon emission disclosure. Second, previous research has predominantly relied on qualitative measures of environmental performance, limiting its ability to capture corporate efficiency in reducing emissions. Third, studies that simultaneously examine internal factors (environmental management systems and eco-efficiency) and external pressures (media exposure) within Indonesia's energy sector remain limited.

Based on these gaps, this study examines the effects of environmental management systems, eco-efficiency-based environmental performance, and media exposure on carbon emissions disclosure among energy sector companies listed on the Indonesia Stock Exchange during 2021–2024. This study differs from previous research in several aspects. First, it integrates three important determinants of carbon emission disclosure into a single research framework, providing a more comprehensive understanding of corporate environmental transparency. Second, this study applies an eco-efficiency approach as an alternative measurement of environmental performance, providing a quantitative assessment of companies' ability to generate economic value while reducing carbon emissions. Third, this study focuses specifically on Indonesian energy sector companies, which represent the largest contributor to national greenhouse gas emissions.

Based on legitimacy theory by Suchman (1995), this study contributes by explaining how companies respond to stakeholder expectations through carbon emission disclosure as a strategy to maintain social acceptance. Internal factors, such as environmental management systems and environmental efficiency, and external factors, such as media exposure, represent different pressures that may influence corporate disclosure decisions. Therefore, this research provides empirical evidence on the determinants of carbon emissions disclosure and offers practical implications for companies and policymakers to strengthen environmental transparency and accountability.

This study presents up-to-date empirical data on the variables influencing carbon emission disclosure among energy sector companies listed on the Indonesia Stock Exchange between 2021 and 2024. By offering a unique perspective on assessing environmental performance and understanding corporate environmental disclosure practices in a developing country, our findings are expected to enrich future research. From a practical standpoint, this study can help companies recognize the importance of implementing environmental management systems, improving emission efficiency, and strengthening environmental communication strategies to enhance stakeholder trust and transparency. Regulators and policymakers can also use these findings to develop rules that encourage more comprehensive carbon emissions disclosure practices, particularly for companies with high emissions. Given the challenges posed by global climate change, this research is expected to help enhance corporate accountability and foster a transition toward more sustainable business practices.

Literature Review

Legitimacy Theory

According to legitimacy theory, companies seek to gain and maintain social acceptance by ensuring that their activities are consistent with prevailing norms and values (Suchman, 1995). Companies operate under a social contract with society, meaning they are responsible not only for achieving economic objectives but also for managing the social and environmental impacts of their activities. When a gap occurs between corporate activities and societal expectations, companies tend to implement strategies to restore or maintain legitimacy, one of which is through increased disclosure of social and environmental information (Sukmawati, 2023).

In the environmental context, legitimacy is associated with companies' ability to demonstrate responsibility for their environmental impacts and to respond to stakeholder expectations. Carbon emissions disclosure is

one form of environmental communication through which companies provide information about their environmental performance, demonstrate accountability, reduce information asymmetry, and maintain stakeholder trust.

Furthermore, companies operating in environmentally sensitive industries face greater pressure to align their activities with societal expectations. Through environmental management practices, efficiency improvements, and transparent environmental disclosure, companies seek to demonstrate that their operations align with sustainable business principles. Therefore, legitimacy theory provides an appropriate foundation for explaining corporate decisions to disclose carbon emissions information as a strategy for maintaining social acceptance and stakeholder confidence (Ding et al., 2022; Kusumajaya & Budiasih, 2024).

The Effect of Environmental Management System on Carbon Emission Disclosure

One of the company's initiatives to address environmental issues is an EMS with ISO 14001 certification, which reduces emissions from its operations (Limang et al., 2024). Based on Legitimacy Theory, the implementation of EMS demonstrates a business's dedication to environmental management, boosting credibility and trust from society and stakeholders (Fauzi et al., 2025).

Companies that implement EMS tend to share environmental data, such as carbon emissions, more transparently. Previous empirical studies provide evidence supporting this relationship. Armono and Santosa (2024) found that companies implementing Environmental Management Systems disclose carbon emission information more extensively because EMS strengthens environmental accountability and improves the quality of environmental reporting. Similarly, Dewi and Dewi (2024) found that the use of EMS significantly increases carbon emissions disclosure among energy companies in Indonesia, indicating that businesses with well-organized environmental management are more committed to open environmental reporting.

Demonstrated that companies certified with It is more likely that ISO 14001 will include comprehensive data on carbon emissions, reflecting their commitment to environmental sustainability and stakeholder accountability. also emphasized that the implementation of EMS enhances corporate environmental responsibility, encouraging companies to communicate their environmental performance more openly through carbon emission disclosure. These results indicate that, to fulfill stakeholder expectations and preserve organizational legitimacy, businesses with established environmental management systems tend to disclose carbon emissions statistics more openly. Consequently, the following theory is put forth (Limang et al., 2024).

H1: *Environmental Management System has a positive effect on carbon emission disclosure.*

The Effect of Eco-Efficiency on Carbon Emission Disclosure

Based on Legitimacy Theory, companies with higher eco-efficiency are expected to disclose environmental information more extensively to demonstrate their commitment to sustainable business practices and maintain social legitimacy. Eco-efficiency reflects a company's ability to generate economic value while reducing environmental impacts, particularly carbon emissions and resource consumption. Through carbon emission disclosure, companies communicate their efforts in managing environmental impacts, improving transparency, and fulfilling stakeholder expectations (Sari et al., 2024).

Previous empirical studies support the relationship between eco-efficiency and carbon emission disclosure. Munawaroh et al. (2018) explained that eco-efficiency refers to companies' ability to achieve economic performance while minimizing environmental impacts, thereby indicating greater environmental responsibility. Furthermore, Sari et al. (2024) found that eco-efficiency is associated with carbon emission disclosure, suggesting that companies with higher eco-efficiency tend to provide greater environmental transparency. Similarly, Oktaviani et al. (2025) showed that eco-efficiency plays an important role in encouraging companies to communicate their environmental achievements through carbon-related disclosures. These findings indicate that companies with higher eco-efficiency have greater incentives to disclose carbon emissions as a strategy to reduce the legitimacy gap, strengthen stakeholder trust, and maintain corporate reputation.

Therefore, the following hypothesis is proposed:
H2: *Eco-Efficiency has a positive effect on carbon emissions disclosure.*

The Effect of Media Exposure on Carbon Emission Disclosure
Based on Legitimacy Theory, media exposure increases public attention to corporate activities, thereby encouraging companies to report environmental facts more openly. A company is more motivated to make disclosures when it attracts greater public attention to its carbon emissions information, thereby maintaining its reputation and gaining legitimacy in society (Loru, 2023; Wahyuningrum et al., 2024). Companies that receive greater media attention are more likely to experience external pressure from stakeholders, such as the public, regulators, and investors, to demonstrate their environmental responsibility through adequate carbon emission disclosure.

Therefore, Companies may be encouraged to give more detailed environmental information via media attention as a strategy to reduce legitimacy gaps and strengthen stakeholder trust. Previous research has shown that Businesses that receive a lot of media attention are more likely to disclose their carbon emissions and tend to provide broader carbon emission disclosures (Yasa & Purnawati, 2024; Aryni et al., 2021; Sukmawati, 2023). This indicates that media coverage can serve as an external monitoring tool, motivating organizations to improve transparency in their environmental performance and carbon emissions. Based on these theoretical arguments and empirical findings, companies with higher media exposure are expected to implement stricter procedures for carbon emission disclosure. Therefore, the following theory is proposed:
H3: *Media Exposure has a positive effect on carbon emission disclosure.*

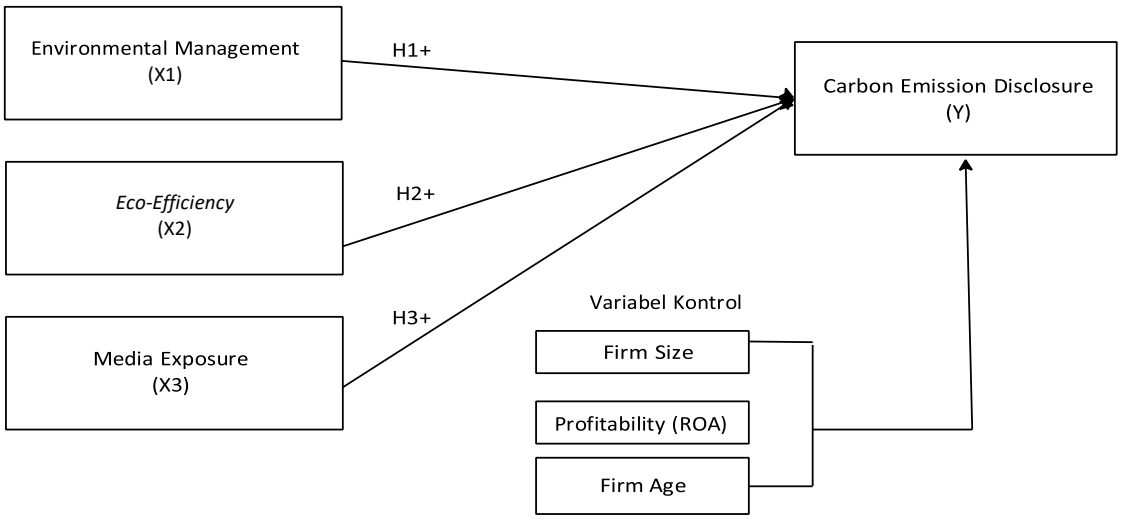


Figure 2. Conceptual Framework

Method

Based on secondary data collected from the sustainability and annual reports of energy sector corporations listed on the Stock Exchange of Indonesia between 2021 and 2024, this study uses a quantitative methodology. Sampling with a purpose was used to select the research sample based on specific, advance-specified criteria. Data were gathered by looking at information in corporate reports using documentation methods. The study used panel data regression to examine how the Environmental Management System impacts carbon emissions disclosure, eco-efficiency, and media coverage. The analysis also took into account other factors such as the company's size, profitability, and length of operation. Data processing was done with EViews 12.

The sample selection process began with 92 energy-sector companies listed on the Indonesia Stock Exchange (IDX) during the 2021–2024 period. Companies that did not consistently publish annual financial reports throughout the observation period were excluded, resulting in the removal of 32 companies. Subsequently, 24 companies were excluded because they did not consistently publish sustainability reports during 2021–2024. Furthermore, 11 companies were excluded for not disclosing information in accordance with GRI Standard 305 (Emissions). After applying all sampling criteria, 25 companies met the research requirements and were selected as the final sample. With a four-year observation period (2021–2024), the study obtained 100 firm-year observations (25 companies × 4 years) for further analysis.

Table 1: Operational Definition of Variables

Variable	Definition	Indicator	Scale
Carbon Emission Disclosure (Y)	Carbon Emission Disclosure (CED) is a report on carbon emissions and corporate efforts in addressing climate change (Yuliana & Wedari, 2023)	1. GRI 305-1: Direct Emissions of Greenhouse Gases (Scope 1) 2. GRI 305-2: GHG Emissions from Indirect Energy (Scope 2) 3. GRI 305-3: Scope 3: Other Indirect GHG Emissions 4. GRI 305-4: Intensity of GHG Emissions 5. GRI 305-5: GHG Emissions Reduction 6. GRI 305-6: Ozone-Depleting Substance (ODS) Emissions 7. GRI 305-7: Sulphur Oxides (SOx), Nitrogen Oxides (NOx), and Other Important Air Emissions	Ratio
Environmental Management System (X1)	EMS is a system for managing the environmental impact of organizational activities	The A dummy variable is used to measure the variable, with a score of 0 for businesses without ISO 14001 certification and a score of one for without ISO 14001 certification.	Nominal
Eco-Efficiency (X2)	Eco-efficiency reflects a company's ability to generate economic value while minimizing carbon emissions. In this study, eco-efficiency is measured by the ratio of revenue to total CO_2 emissions, where a higher value indicates greater efficiency in creating value with lower environmental impacts (Munawaroh et al., 2018)		Rasio
Media Exposure (X3)	Media exposure is the level of media coverage regarding corporate environmental activities that encourages transparency in carbon emission disclosure (Fitriyani & Sulfitri, 2025)	Dummy Variable AR = 1 SR = 1 Website =1 Koran 1 ME=	Ratio
Firm Size	Company size indicates how large a company is, measured by its total assets (Ramadhan & Riwayadi, 2025)	*Firm Size = Ln Total Asset*	Ratio
Profitability	Profitability indicates how well A business can use all of its assets to produce net profit (Setiawan et al., 2026)		Ratio
Firm Age	Firm Age indicates the company's degree of maturity and experience in disclosing information (Munif & Nikmah, 2025)	Research sample year – year of company establishment	Ratio

Data processing, analysis, and hypothesis testing were carried out using EViews) version 12 software. The analytical methods employed include descriptive statistics and panel data regression (Panel Least Squares). The panel data model is determined using the Chow test and Hausman test, as well as the coefficient of determination, t-test, and F-test. were used to assess hypotheses. (R-squared).

$$Y = \alpha + \beta 1\text{EMS} + \beta 2\text{EE} + \beta 3\text{ME} + \beta 4\text{SIZE} + \beta 5\text{PROF} + \beta 6\text{AGE} + \varepsilon$$

Where: Y stands for Disclosure of Carbon Emissions, Environmental Management System (EMS), Eco-efficiency (EE), ME for Media Exposure, SIZE for Firm Size, PROF for Profitability, and AGE for Firm Age.

Result and Discussion

Table 2: Descriptive Statistics

Variables	Mean	Median	Min	Max	Std.Dev
CED	0.601	0.714	0.000	1.000	0.317
EMS	0.760	1.000	0.000	1.000	0.429
EE	1254.617	565.358	0.062	8167.499	1771.865
ME	0.618	0.500	0.500	1.000	0.140
SIZE	19.910	19.888	13.107	29.016	3.125
ROA	186.064	7.762	-24.650	17245.400	1723.233
AGE	30.500	29.000	12.000	55.000	11.826

The descriptive statistics indicate considerable variation in Carbon Emission Disclosure among companies, suggesting that the level of transparency in reporting carbon emissions remains inconsistent across the sample. Most companies have implemented an Environmental Management System (EMS), although some have not yet adopted one, reflecting differences in environmental management practices. Eco-efficiency also varies substantially among companies, indicating differences in their ability to generate economic value while minimizing carbon emissions. In this study, eco-efficiency is measured by the ratio of revenue to total CO_2 emissions, where a higher value indicates greater efficiency in creating economic value with lower environmental impacts. Meanwhile, Media Exposure is relatively homogeneous, suggesting that companies generally receive comparable levels of public attention across media channels.

Regarding the control variables, firm size varies across the sample, indicating that the study includes companies with different operational scales. Profitability shows substantial variation due to extreme values, reflecting differences in financial performance among companies. Firm age also differs considerably, representing both relatively young and well-established firms. Overall, these findings indicate that the sampled companies exhibit diverse environmental, financial, and organizational characteristics, providing sufficient variation to support further regression analysis examining factors influencing carbon emission disclosure.

Table 3 Model Selection Test

Variabel	CEM	FEM	REM
C	0.124	0.000	0.033
EMS	0.832	0.024	0.055
EE	0.113	0.944	0.626
ME	0.211	0.919	0.157
SIZE	0.006	0.704	0.008
ROA	0.056	0.971	0.166
AGE	0.012	0.000	0.003
Test	Cross-section	d.f	Prob
Chow Test (Cross-section F)	9.398	(24.69)	0.000
Chow Test (Cross-section Chi-square)	145.136	24	0.000
Hausman Test (Cross-section Random)	50.307	6	0.000

The Chow test is used because the Fixed Effect Model (FEM) is better suited for use than the Common Effect Model (CEM). This test is carried out by comparing the F and Chi-square test statistics against a significance level of 0.05. As presented in Table 4, the Chow test produced a Cross-section F statistic of 9.398179 with a probability value of 0.0000, while the Cross-section Chi-square statistic was 145.136364 with a probability value of 0.0000. Since both probability values are below 0.05, the Fixed Effect Model (FEM) is preferred over the Common Effect Model (CEM).

Furthermore, to confirm the superiority of FEM, an additional Hausman test was performed over REM (the Random Effect Model). The findings show a probability of 0.0000 and a Chi-square value of 50.307158, both of which are below the significance level of 0.05. These results confirm that the Fixed Effect Model was chosen as the primary estimation model for subsequent research, as it is the most suitable specification for this investigation.

Table 4 Matrix Correlation

Correlation	EMS	EE	ME	SIZE	ROA	AGE
EMS	1.000					
EE	0.138	1.000				
ME	-0.115	-0.160	1.000			
SIZE	0.252	0.259	-0.086	1.000		
ROA	0.056	0.179	-0.086	-0.175	1.000	
AGE	-0.198	-0.317	0.060	-0.361	-0.126	1.000

Based on the correlation test results, the relationships between the research variables indicate a relatively low level of correlation. This indicates that there is no significant correlation among the independent variables, so multicollinearity is unlikely. The EMS, EE, and ME variables exhibit weak correlations with the other variables; consequently, each variable can more independently explain its impact on carbon emission disclosure.

Furthermore, control variables such as SIZE, ROA, and AGE show weak correlations with the independent variables and with one another. Thus, the correlation test results indicate that the study model does not exhibit multicollinearity, thereby ruling out the possibility that multicollinearity affects the variables used for further in-depth analysis within the regression model.

Table 5 Panel Data Regression

	Moderation			
Variable	Coefficient	Std. Error	t-Stat.	Probability
C	-2.952	0.497	-5.942	0.000
EMS	0.121	0.053	2.302	0.024
EE	1.02E-06	1.45E-05	0.071	0.944
ME	0.032	0.312	0.101	0.920
SIZE	-0.006	0.015	-0.381	0.705
ROA	4.75E-07	1.31E-05	0.036	0.971
AGE	0.117	0.016	7.215	0.000
R Square	0.802	0.802	0.802	0.802
Adjusted R Square	0.716	0.716	0.716	0.716
F-Statistic	9.312	9.312	9.312	9.312
Prob (F-Statistic)	0.0000	0.0000	0.0000	0.0000
Notes: significant at 1%	Notes: significant at 1%	Notes: significant at 1%	Notes: significant at 1%	Notes: significant at 1%

The Effect of Environmental Management System on Carbon Emission Disclosure

The results presented in Table 5 indicate that the Environmental Management System (EMS) has a significant positive effect on Carbon Emission Disclosure (CED), with a coefficient value of 0.121169 and a probability value of 0.0244 ($p < 0.05$). Therefore, H1, which states that Environmental Management Systems positively affect Carbon Emission Disclosure, is supported.

This finding indicates that companies implementing environmental management systems tend to provide more extensive carbon emission disclosures. The implementation of EMS, particularly ISO 14001 certification, provides companies with structured procedures for identifying, monitoring, and controlling environmental impacts, including greenhouse gas emissions. These systematic environmental practices enable companies to develop better environmental information management systems that support more transparent carbon emissions reporting.

This result is consistent with Legitimacy Theory, which explains that companies undertake environmental initiatives to align their activities with societal expectations and maintain social acceptance. The adoption of EMS represents a formal commitment to environmental responsibility, allowing companies to demonstrate accountability and reduce the legitimacy gap through greater transparency in carbon emission disclosure. By disclosing carbon-related information, companies can communicate their environmental efforts and strengthen stakeholder trust. This finding is consistent with previous studies by Bui et al. (2020); Toukabri and Youssef (2022), which found that stronger environmental governance mechanisms contribute to higher levels of environmental disclosure.

The Effect of Eco-efficiency on Carbon Emission Disclosure

The results indicate that Eco-efficiency (EE) has no significant effect on Carbon Emission Disclosure (CED), with a coefficient of 1.02E-06 and a probability value of 0.9440 ($p > 0.05$). Therefore, H2, which proposes that Eco-efficiency positively affects Carbon Emission Disclosure, is not supported.

This finding suggests that companies with higher eco-efficiency do not necessarily provide more extensive carbon emission disclosure. Companies may prioritize improving operational efficiency and reducing emissions without increasing the level of environmental information disclosed to stakeholders. Conversely, companies with lower eco-efficiency may still disclose carbon emission information due to regulatory requirements, stakeholder pressure, or efforts to maintain corporate legitimacy.

Based on Legitimacy Theory, companies disclose environmental information as a strategy to gain and maintain stakeholder trust. However, this study indicates that eco-efficiency alone is insufficient to encourage broader disclosure of carbon emissions. Other factors, such as disclosure policies, regulatory pressures, and corporate transparency strategies, may influence carbon emission disclosure.

This result is consistent with studies showing that efficiency-related environmental practices do not always lead to greater environmental disclosure. Differences in measurement methods, industry characteristics, and corporate disclosure strategies may explain the insignificant relationship between Eco-efficiency and Carbon Emission Disclosure (Afrilianita & Mardjono, 2026; Yuliandhari et al., 2023).

The Effect of Media Exposure on Carbon Emission Disclosure

The results presented in Table 5 indicate that Media Exposure (ME) has no significant effect on Carbon Emission Disclosure (CED), with a coefficient value of 0.031647 and a probability value of 0.9195 ($p > 0.05$). Therefore, H3, which posits that Media Exposure positively affects Carbon Emission Disclosure, is not supported. This finding suggests that media attention does not significantly influence companies' decisions to disclose carbon emission information. Although media exposure can increase public awareness and create external pressure on companies, media attention alone may not be sufficient to encourage companies to enhance environmental transparency.

Companies may consider other factors, such as internal environmental policies, regulatory requirements, and corporate reporting strategies, to be more relevant drivers of carbon emissions disclosure. From the

perspective of Legitimacy Theory, media exposure is expected to act as an external pressure mechanism that encourages companies to align their activities with societal expectations and maintain legitimacy. However, the insignificant result indicates that media visibility has not become a dominant factor influencing carbon emission disclosure among Indonesian energy sector companies. This finding may indicate that companies place greater emphasis on internal environmental management practices and formal reporting mechanisms rather than relying solely on external media pressure to demonstrate environmental accountability.

This result differs from previous studies by Hapsari and Hardiyanti (2024); Shao et al. (2025), which found that media attention positively influences carbon emission disclosure. The differences in findings may be attributed to variations in research periods, industry characteristics, institutional environments, and the measurement approaches used to assess media exposure.

Table 6: Robustness Check

Variable	Coefficient	Std. Error	t-Stat.	Probability
C	-1.819	0.501	-3.629	0.001
EMS	-0.075	0.053	-1.420	0.160
EE	5.24E-06	1.46E-05	0.359	0.720
ME	-0.079	0.315	-0.251	0.803
SIZE	-0.006	0.015	-0.429	0.669
ROA	6.03E-06	1.32E-05	0.458	0.649
AGE	0.087	0.016	5.314	0.000
R Square	0.769	0.769	0.769	0.769
Adjusted R Square	0.669	0.669	0.669	0.669
F-Statistic	7.673	7.673	7.673	7.673
Prob (F-Statistic)	0.000	0.000	0.000	0.000
Notes: significant at 1%	Notes: significant at 1%	Notes: significant at 1%	Notes: significant at 1%	Notes: significant at 1%

To examine the robustness of the main findings, an additional analysis was conducted using an alternative measure of the dependent variable. In the main model, Carbon Emission Disclosure (CED) was measured using the GRI 305 (Emissions) indicators, which specifically assess carbon emission reporting. For the robustness test, CED was alternatively measured using the GRI 300 (Environmental Standards), which captures a broader range of corporate environmental disclosure practices. The estimation was performed using the same Fixed Effect Model (FEM) to ensure comparability between the two specifications.

The robustness results are presented in Table 6. Overall, the model explains 76.94% of the variation in the dependent variable, as measured by the GRI 300 framework, indicating adequate explanatory power. The model also explains 76.94% of the variation in environmental disclosure ($R^2 = 0.769389$). Compared with the main results, Eco-Efficiency and Media Exposure remain statistically insignificant, suggesting that these findings are robust to an alternative measurement of the dependent variable. However, Environmental Management System (EMS), which was significant when carbon emission disclosure was measured using GRI 305, becomes statistically insignificant when the broader GRI 300 framework is applied. This finding suggests that EMS has a stronger influence on carbon emission-specific disclosure than on general environmental disclosure. In other words, companies implementing environmental management systems appear to be more committed to reporting emission-related information rather than environmental information in general.

Overall, the robustness test indicates that the main conclusions regarding Eco-Efficiency and Media Exposure remain stable. At the same time, the influence of Environmental Management System depends on how environmental disclosure is measured.

Conclusions and Recommendations

This study examines the determinants of carbon emission disclosure among energy sector companies listed on the Indonesia Stock Exchange during 2021–2024, focusing on Environmental Management Systems (EMS), Eco-Efficiency, and Media Exposure. The findings indicate that Environmental Management Systems have a significant positive effect on carbon emission disclosure, while Eco-Efficiency and Media Exposure do not significantly influence disclosure practices. These findings suggest that companies with structured environmental management mechanisms are more likely to enhance carbon transparency, as EMS provides a formal framework for monitoring, managing, and communicating environmental responsibilities.

Theoretically, this study contributes to the carbon emission disclosure literature by extending the application of Legitimacy Theory. The findings demonstrate that companies primarily rely on internal environmental management structures to maintain legitimacy and respond to stakeholder expectations, rather than on operational eco-efficiency achievements or external media attention alone. This indicates that formal environmental governance mechanisms play an important role in shaping corporate environmental disclosure behavior, particularly among Indonesian energy companies.

From a practical perspective, the findings highlight the importance of companies strengthening environmental management systems as part of their sustainability strategies and carbon reporting practices. For policymakers and regulators, encouraging the implementation of structured environmental management practices may support greater transparency and accountability in corporate climate reporting. Meanwhile, the insignificant effects of Eco-Efficiency and Media Exposure suggest that improvements in environmental efficiency and external visibility alone may not automatically translate into broader carbon emission disclosure, emphasizing the need for stronger reporting frameworks and institutional encouragement.

This study also provides empirical evidence from the Indonesian energy sector, a carbon-intensive industry that faces increasing pressure to improve environmental accountability. However, several limitations should be acknowledged. Carbon emissions disclosure is measured by the extent of disclosure rather than disclosure quality. In contrast, EMS is measured with a dummy variable that may not fully capture differences in implementation effectiveness. Future research may employ more comprehensive measurement approaches, extend the observation period, examine other industrial sectors, and incorporate additional theoretical perspectives to provide a deeper understanding of the factors influencing carbon emission disclosure.

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