

The Influence of Board Characteristics on Carbon Emission Disclosure in Indonesia and Malaysia

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ABSTRACT

The primary objective of this research is to investigate the extent to which specific attributes of the board of directors affect Carbon Emission Disclosure (CED) practices within energy firms across Indonesia and Malaysia. The research population comprises all energy companies listed on the Indonesia Stock Exchange and Bursa Malaysia during the period 2022–2024. Using a purposive sampling method, the samples were selected based on specific criteria, primarily the accessibility of sustainability and annual reports and the completeness of the data required for the analysis, resulting in 119 firm-year observations. This study adopts a quantitative approach and employs multiple linear regression to analyze the effects of foreign board members, female board members, board expertise, and board educational background on CED. Data analysis was conducted using SPSS version 24, preceded by descriptive statistics and classical assumption tests. The results indicate that board characteristics jointly have a significant effect on Carbon Emission Disclosure. To some extent, female board members, board expertise, and board educational background have a positive and significant influence on the depth and measurability of carbon emission disclosure. In contrast, the presence of foreign board members shows a positive but insignificant effect on CED. These findings imply that variations in Carbon Emission Disclosure are more strongly driven by board attributes closely related to monitoring capacity and internal reporting processes. This study concludes that strengthening internal board characteristics is crucial for enhancing the quality of Carbon Emission Disclosure in energy-sector companies in Indonesia and Malaysia.

Keywords: Board Expertise, Board Educational, Female Board, Foreign Board, Sustainability Reporting

INTRODUCTION

Currently, global warming represents a critical environmental challenge attracting worldwide attention. The escalation in global temperatures is caused by two main factors, namely natural factors and human activities, although the most significant cause stems from human activities. In particular, human activities have led to the accumulation of greenhouse gases such as carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) in the atmosphere, mainly through industrial, transportation, and energy-related activities. Extreme weather changes caused by humans are altering rainfall patterns, raising sea levels, and triggering extreme storms (Shivanna, 2022) Among the various types of greenhouse gases, carbon dioxide is the primary contributor because it has the largest volume in the total emissions produced by human activities. High carbon emissions accelerate the greenhouse effect, which ultimately causes global warming and climate change. Specifically, carbon emissions are the leading cause of global warming and climate change (Saadah et al., 2024).

The rise in global temperatures and climate change caused by carbon emissions directly affects human life Febriani Irma & Gusmira (2024) Climate change worsens air quality, prolongs dry seasons, and increases the frequency of natural disasters. Air pollution from industrial and transportation activities can be considered a consequence of extreme climate conditions. Exposure

to air pollution has been shown to increase the risk of respiratory and cardiovascular diseases, as well as premature death (Manisalidis et al., 2020). These impacts show that climate change is not only an environmental issue but also a global threat to human health and welfare. Mitigation and transparency regarding carbon emissions are important for maintaining environmental balance and human life. Shivanna (2022) also said in his study that the current generation is the last generation that can take effective mitigation measures to minimize the impact of global warming today.

One effective mitigation approach is to emphasize the demand for transparency on emission footprints through carbon emission disclosure (CED) for large carbon emitters. CED is defined as the reporting of greenhouse gas emissions in both qualitative and quantitative terms, typically measured in CO₂ or CO₂ equivalents, accompanied by measurement methodologies, Scope 1–3 emissions, governance, and the role of the board, as well as reduction targets and achievements (Bae et al., 2014). CED can serve as a mechanism for public accountability and as a climate risk management tool to prepare companies for the transition to a low-carbon economy. With these characteristics, CED is not merely a reporting obligation, but a policy tool for business actors to guide their strategies in facing global warming in the medium to long term. The urgency of this practice is also growing at the regional level, particularly in ASEAN.

The ASEAN region is vulnerable to climate risks, such as rising sea levels and extreme weather (Babu et al., 2024). Many of its economies also remain dependent on high-emission sectors, making corporate emissions information increasingly material (Mansour et al., 2025). CED practices in ASEAN are not yet uniform and in many cases are still voluntary (Al-Okaily et al., 2023). In 2021, only about 30% of issuers in ASEAN-6 (Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam) reported carbon emissions, while >90% in the European Union did so, indicating a transparency gap (Mansour et al., 2025). These findings highlight the need for a stronger regulatory framework in the region.

ASEAN countries such as Indonesia and Malaysia have begun to make sustainability reporting a formal obligation. In Indonesia, the Financial Services Authority (OJK) issued POJK No. 51/POJK.03/2017 on the Implementation of Sustainable Finance, which requires issuers and public companies to prepare and submit sustainability reports annually along with their annual reports. The regulation also provides a basis for supervision, sets minimum reporting requirements (covering environmental aspects, including emissions), and stipulates sanctions for non-compliance. Malaysia is moving in a similar direction through Bursa Malaysia. Bursa Malaysia amended its Listing Requirements so that issuers on the Main Market are required to include a "Sustainability Statement" in their annual reports starting for the financial year ending after December 31, 2016. This policy was then reinforced with sustainability reporting guidelines and gradual steps to align disclosures with global standards such as TCFD and, more recently, IFRS S1 and S2 as a framework for sustainability and climate-related disclosures (Envirosec, 2022).

Specifically, Indonesia and Malaysia were chosen as research subjects because both countries require public companies to submit sustainability reports as part of their annual reporting to capital market authorities, which includes disclosure of environmental issues such as carbon emissions and climate change. However, even though sustainability reporting has become a formal obligation, carbon emission disclosure practices at the company level still vary in depth, completeness, and measurability. This condition is essential because Indonesia and Malaysia both depend on the fossil fuel energy sector and are among the most significant contributors to greenhouse gas emissions in the ASEAN region (ACE, 2024). Carbon emissions transparency is not only a reputational aspect, but also a material economic and governance issue.

The energy sector is one of the most significant contributors to greenhouse gas emissions globally (Bappenas, 2025). The International Energy Agency (IEA) reports that the burning of fossil fuels for electricity, industry, and transportation accounts for more than three-quarters of total global greenhouse gas emissions, meaning that the operational decisions of energy companies contribute directly to the rate of global warming. This pattern is also evident in Southeast Asian developing countries. In Indonesia, emissions from the energy sector are estimated to reach around 600 million tons of CO₂ in 2021, making the energy sector one of the largest contributors to emissions at the national level and placing Indonesia among the world's largest energy emitters (IEA, 2022). According to NRES (2024) a similar situation exists in Malaysia, where the national

greenhouse gas inventory shows that the energy sector accounts for approximately 78% of total national emissions, making it the dominant contributor to the country's emissions. This situation creates double pressure on energy companies, environmental pressure due to their high carbon footprint, and institutional pressure due to increasing demands for transparency.

The energy sector is not only the sector that generates a large proportion of carbon emissions in both countries, but also the industry that is subject to the highest expectations of transparency through CED. However, even though a sustainability reporting framework has been institutionalized, the quality and depth of CED vary due to differences in measurement capacity, referenced standards, and reporting governance between companies (Du et al., 2025). This raises empirical questions, such as what internal factors make some companies more willing and able to disclose their emissions in detail than others. These conditions then open up space to assess the factors that can determine carbon emissions disclosure in a company.

The decision to disclose carbon emissions (CED) is a strategic decision, not merely administrative compliance, as it involves choices regarding the level of depth, breadth, reporting standards, and assurance taken by the company. In Upper Echelons Theory (UET), the characteristics of decision-makers at the top level (the board) shape how companies assess risk, respond to stakeholder pressure, and ultimately determine the transparency of their CED (Hambrick & Mason, 1984). In practice, companies may withhold some elements of CED (e.g., external assurance) due to cost trade-offs, data system readiness, or risk exposure considerations. This study focuses on four attributes of foreign citizenship boards (global investor/standard exposure), female boards (social-environmental sensitivity and oversight orientation), expertise (technical-financial capabilities to assess climate risk and measurement quality), and education (policy/reporting literacy).

Foreign boards are believed to influence how companies perceive issues due to their different cultures and ways of thinking compared to those in Indonesia. According to previous research by Priliana & Ermaya (2023) foreign boards do not significantly affect carbon emissions disclosure. However, other studies, such as those by Fadhila & Wijayanti (2022) and Jannah (2020) state that foreign boards have a significant effect on carbon emission disclosure. This shows that there is still an inconsistency in the foreign board variable in influencing carbon emission disclosure. A company's sensitivity to environmental issues can arise from various factors, one of which is having a female board member. Several previous studies have shown that the influence of female boards on carbon emission disclosure has a positive and significant effect, such as (Al-Qahtani & Elgharbawy, 2020), (Bui et al., 2020) and (Kim, 2022). However, based on Fadhila & Wijayanti (2022), female boards do not significantly influence carbon emission disclosure. This inconsistency is the background for selecting the female board variable for research. With expertise certification in the environmental field, top boards can be expected to issue high-quality carbon emission disclosures in accordance with regulations. Previous research Abbasi et al. (2024) states that the expertise of these boards does not significantly affect Carbon Emission Disclosure, whereas Chariri et al. (2018) found the opposite result. Namely, that a person's educational background plays a major role in how they view an issue, especially one related to the environment. However, there remains an inconsistency in the research results regarding whether the board's education has a significant effect. Al-Qahtani & Elgharbawy (2020) and Syafik et al. (2025) found that the education of the board has a significant effect on Carbon Emission Disclosure, but Armono & Santosa (2024) said the opposite.

There are differences with many CED studies in Indonesia, which are generally single-country, focus on the non-energy sector, and are from the pre-2021 period (e.g., Chariri et al., 2018; Putri et al., 2022). This study offers several key updates. First, the cross-country sample of Indonesia–Malaysia in the energy sector, a high-emission-intensity sector with strong expectations for transparency (Mansour et al., 2025). Second, this study explicitly uses Upper Echelons Theory to view CED as a strategic decision at the top level of the organization (Hambrick & Mason, 1984) and simultaneously tests four characteristics of the board, namely nationality, gender, expertise (board expertise), and education, which in previous studies were generally tested separately (Al-Qahtani & Elgharbawy, 2020; Bui et al., 2020; Kim, 2022) Third, the current observation period, 2022–2024, was chosen to ensure the findings reflect post-COVID-19 dynamics and capture

updates in sustainability reporting practices.

The purpose of this study is to examine and verify the influence of board characteristics on carbon-emission disclosure among energy-sector companies in Indonesia and Malaysia for the period 2022–2024. Specifically, it aims to: 1. Test the influence of board citizenship on carbon emission disclosure. 2. Test or verify the influence of female board members on carbon emission disclosure. 3. Test or verify the influence of the board on carbon emission disclosure. 4. Test or verify the influence of board education on carbon emission disclosure.

LITERATURE REVIEW

Upper Echelons Theory

According to Upper Echelons Theory (UET), the strategic directions taken by an organization are a manifestation of the cognitive backgrounds, values, and experiences held by its top executives (Hambrick & Mason, 1984). Individual characteristics of the board/top management are often overlooked, with many studies emphasizing group, company, or country factors (Velte, 2019). Meanwhile, carbon emission disclosure is a strategic decision (depth, standards, *assurance*), so it is reasonable that those at the top influence the company's transparency. Empirical evidence supports the role of the board in GHG climate disclosure (Al-Qahtani & Elgharbawy, 2020). Therefore, this study, based on UET, focuses on four board attributes as potential determinants of CED: nationality (exposure to global standards), gender (social-environmental sensitivity/monitoring), expertise (measurement and *oversight* capabilities), and education (policy/reporting literacy).

Carbon Emission Disclosure

Carbon emission disclosure (CED) is a company's disclosure of greenhouse gas emissions arising from its activities, generally including emission levels and/or intensity, primary sources, and policies, targets, and reduction strategies, presented in an annual report or sustainability report (Hilmi et al., 2020). The aim is accountability and transparency for external parties (investors, regulators, and the public). The depth of CED is crucial because it forms the basis for assessing a company's mitigation efforts and climate risk management performance (Nur et al., 2021). Because CED is a strategic decision, the board's characteristics are likely to influence how transparent and measurable the information disclosed is.

Foreign Boards

Within the framework of Upper Echelons Theory, the knowledge and professional experience accumulated by the top management board form the basis for how they understand information, assess risks, and choose strategies (Hambrick & Mason, 1984). The presence of foreign board members can expand this cognitive capital through exposure to international climate reporting standards, cross-jurisdictional experience with strict regulatory regimes, and interaction with global investors. This combination of backgrounds and experiences enhances the board's ability to interpret emissions metrics, identify transition and litigation risks, and determine material information. Foreign boards tend to encourage adequate quantification, time- and intensity-based target setting, and independent assurance, while strengthening oversight of data collection systems to reduce information asymmetry (Liu, 2024). Evidence regarding the diversity of board members' backgrounds also shows a tendency toward increased voluntary emissions disclosure, in line with the argument that knowledge and networks strengthen transparency (Barg et al., 2024)

Thus, the existence of foreign boards is expected to make companies more willing and able to disclose carbon emissions more fully and accurately, not merely for compliance but also as a risk management strategy, and to send a signal of credibility to the market. Hypothesis: *H1 — The existence of foreign boards has a positive effect on Carbon Emission Disclosure in Indonesia and Malaysia*

Female Boards

Gender differences in an environment can change the way the group views its surroundings. In practice, women's boards are able to provide various perspectives to shape a flexible

organizational culture when making corporate management decisions (Kim, 2022). The presence of female board members is generally associated with greater sensitivity to socio-environmental issues, stricter monitoring, and a preference for risk control. These characteristics increase demand for adequate emissions disclosure, including greater transparency and more detailed data. This is in line with the Upper Echelons Theory, where all company practices depend on the top board. This can reduce information asymmetry and increase the depth of corporate emissions disclosure. Previous studies have shown that the presence of female board members can significantly improve emissions/climate disclosure practices (Liao et al., 2015).

Thus, the presence of female board members is expected to make companies more willing and able to disclose carbon emissions more fully and accurately, not only for compliance but also as a risk management strategy and to strengthen the credibility of the information. Hypothesis: *H2 — The presence of female board members has a positive effect on Carbon Emission Disclosure in Indonesia and Malaysia*

Board Expertise

Board expertise related to financial reporting, accounting, risk management, and environmental and sustainability issues provides a foundation of competence that enables them to understand the dynamics of carbon emissions in greater depth. Boards with strong professional backgrounds can accurately, transparently, and measurably interpret all aspects of sustainability reports. This technical ability makes boards more critical in demanding data quality, overseeing the reporting process, and ensuring that the information presented by companies meets transparency and accountability standards. With this capacity, boards not only increase the depth of disclosure but also encourage companies to present more comprehensive, consistent, and verifiable emissions information. Empirical findings reinforce this argument, as companies with more competent boards have been shown to demonstrate stronger and more informative climate disclosure (Chariri et al., 2018).

Thus, board expertise is expected to make companies more willing and able to disclose carbon emissions more completely and measurably, not merely for compliance, but as part of risk management and accountability to stakeholders. Hypothesis: *H3 — Board expertise has a positive effect on Carbon Emission Disclosure in Indonesia and Malaysia*

Board Education

In line with Upper Echelons Theory, board members' education expands their intellectual capacity and analytical rigor, thereby improving their ability to absorb technical information and assess the reasonableness of companies' emission data (Cohen & Levinthal, 1990). A higher or more relevant educational background, especially in accounting, management, environmental engineering, or sustainability, makes the board better able to direct the quality of reporting by encouraging explanations of methods, presentation, and disclosure of risks and mitigation plans in line with the latest climate reporting guidelines, such as TCFD. Strong education also contributes to increased report credibility because boards tend to emphasize the need for independent assurance of emissions data to enhance information reliability (Simnett, Vanstraelen, & Chua, 2009). Consistent with this mechanism, several empirical studies show that board education is positively associated with the breadth and quality of emissions disclosures, although the results are not always significant when education is defined differently, such as based on level rather than field of study (Al-Qahtani & Elgharbawy, 2020; Syafik et al., 2025; (Armono & Santosa, 2024).

In summary, education increases the board's ability to direct the quality of information, making companies more willing and able to disclose CED completely and measurably. Hypothesis: *H4 — Board education has a positive effect on carbon emissions disclosure in Indonesia and Malaysia.*

CONCEPTUAL FRAMEWORK

The conceptual framework of this study was developed to describe the causal relationship between board characteristics, as independent variables, and Carbon Emission Disclosure (CED), as the dependent variable. This framework explains how each board characteristic, including the

presence of foreign board members, female board members, board expertise, and board educational background, directly affects the level of corporate carbon-emission disclosure.

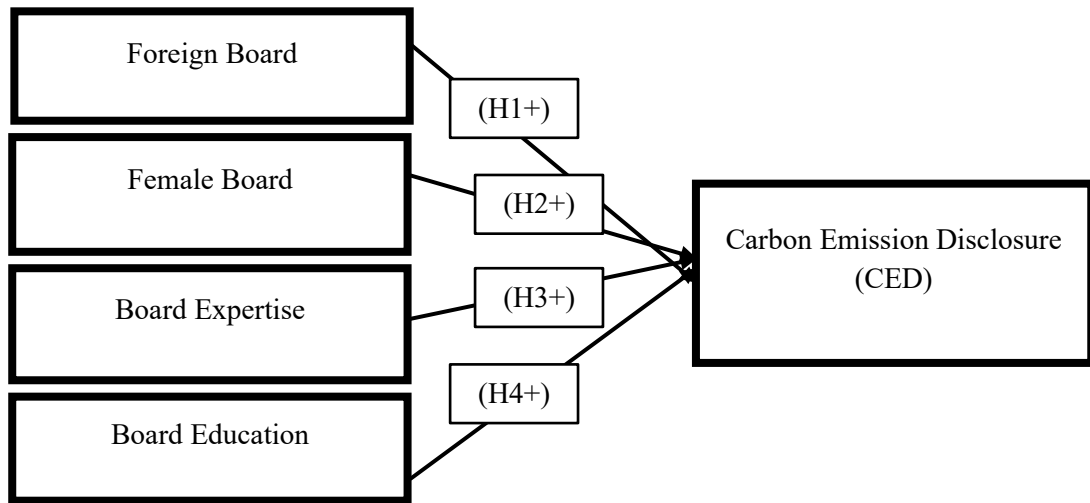


Figure 1. Conceptual Framework
Source: Author's elaboration (2025)

METHOD

Companies listed on both the Indonesia Stock Exchange (IDX) and Bursa Malaysia constitute the population for this research. To determine the sample, this study used purposive sampling guided by specific inclusion criteria. The following sampling criteria were used to sort the population data in this study. Companies listed in the Energy Sector of the Indonesia Stock Exchange (IDX) and Bursa Malaysia for the years 2022-2024. Energy sector companies that disclose annual and sustainability reports for 2022-2024 on the IDX and Bursa Malaysia. Companies that did not incur losses in 2022-2024. Companies that are in the primary sector category on the IDX and Bursa Malaysia.

Table 1. Sample Selection Criteria

No	Selection Description	Number
	Companies listed in the Energy Sector of the Indonesia Stock Exchange and the Malaysian Stock Exchange in 2022-2024.	107
2	Companies not included in the primary sector categories of the IDX and Bursa Malaysia.	(67)
3	Companies that incurred losses in 2022-2024.	(11)
4	Selected companies in the sample	41
5	Data studied (41 x 3)	123
6	Outlier data	(4)
7	Total research sample	119

Source: Data processed by the author (2025)

This study uses secondary quantitative data on all energy-sector issuers in Indonesia (IDX) and Malaysia (Bursa Malaysia) for 2022–2024. Research data and information were taken from annual reports and/or sustainability reports published by companies, covering the governance/profile section and the environment/climate section. Annual reports and sustainability reports were obtained through the official websites of the stock exchanges (idx.co.id, bursamalaysia.com) and the official websites of each company. The following model represents the multiple linear regression equation used for analysis:

$$CED = \alpha + \text{Foreign_Board} + \text{Gender_Board} + \text{Expertise_Board} + \text{Educational_Board} + \varepsilon$$

CED = Carbon Emission Disclosure

Foreign_Board = proportion of foreign nationals on the board

Gender_Board = proportion of women on the board

Expertise_Board = expertise of the board

Educational_Board = educational level

ε = error term

The data analysis technique used in this study was SPSS version 24. The initial stage involved descriptive statistics to summarize the data characteristics, followed by testing the classical assumptions in the regression model, such as multicollinearity (VIF and Tolerance indicators) and heteroscedasticity. Hypothesis testing was performed using multiple linear regression with t-tests for partial effects, an F-test for simultaneous effects/model feasibility, and the coefficient of determination (Adjusted R²) to assess the model's explanatory power. The significance decision was set at $\alpha = 5\%$, with interpretation based on the sign of the coefficient and the p-value of each variable.

Definition and Measurement of Operational Variables

Carbon Emission Disclosure

Carbon Emission Disclosure (CED) refers to corporate disclosure related to greenhouse gas emissions, including policies, targets, emission reduction strategies, and carbon emission reporting governance presented in annual or sustainability reports (Choi & Lee, 2013). In this study, CED is measured using an 18-item checklist developed by Choi (2013) that captures the breadth and depth of a company's carbon emission disclosure. The measurements are grouped into five main classifications: disclosure of climate change risks and opportunities, greenhouse gas emissions accounting, energy use accounting, greenhouse gas emission reduction efforts and related costs, and carbon emissions accountability and governance. These five classifications are used to assess the extent to which companies not only disclose the existence of carbon emissions narratively but also present measurable, structured, and accountable information, thereby reflecting the comprehensive quality of carbon emissions disclosure. The formula used in this CED measurement is:

$$CED = \sum \text{disc} / M$$

Explanation:

CED: Carbon Emission Disclosure

Sigma(di): Total score for one overall disclosure item

M: Total maximum disclosure items (18 items).

Foreign Board

A foreign board refers to the presence of board members whose nationality differs from that of the country where the company is listed on the stock exchange. Diversity of nationality on the board is seen as broadening knowledge and perspectives on governance, thereby encouraging stronger emissions disclosure practices. The foreign board is measured by the percentage of foreign directors in the total number of directors (Priliana & Ermaya, 2023)

$$FOREIGN = \frac{\text{Number of Foreign Board}}{\text{Total Number of Directors}}$$

Female Board

The presence of female board members refers to the gender composition of board membership and is seen as expanding oversight capacity and sensitivity to environmental and social issues, thereby encouraging stronger emissions disclosure practices (Kim, 2022). The

operationalization of the female board presence variable is by dividing the total number of female directors by the total number of directors (Saadah et al., 2024).

$$GENDER = \frac{\text{Number of Female Board}}{\text{Total Number of Directors}}$$

Board Expertise

Board expertise refers to the substantive competence of board members relevant to directing the quality of emissions reporting, particularly the technical ability to assess figures, calculation methods, and related risks, which in governance research is associated with stronger climate disclosure (Liao et al., 2015). This board expertise variable is measured using a dummy variable indicating whether the board is certified in environmental expertise, carbon emissions, and GHG (Homroy & Slechten, 2019).

Board Education

Board education refers to the highest level of education attained by board members that is relevant to their capacity to oversee and direct the quality of reporting. Higher education is generally associated with the ability to absorb and evaluate complex information and direct the quality of disclosure (Cohen & Levinthal, 1990). In some empirical findings, it is positively related to the breadth/quality of emissions disclosure (Al-Qahtani & Elgharbawy, 2020). According to Wahyuningrum et al. (2025), the operationalization of Board Education is to assign a score of 1 for boards with Diploma/D3 education, 2 for S1/D4 education, 3 for Master's/S2 education, and 4 for S3/Doctoral education. This study also uses the same method, namely, assigning scores based on the level of education pursued by each board.

$$EDUCATION = \frac{\text{Total Board Education Score}}{\text{Total Number of Directors}}$$

RESULTS

Table 2. Results of Descriptive Statistical Tests

	N	Minimum	Maximum	Mean	Std. Deviation
Foreign_Board	119	0	0.9091	0.113348	0.192313
Gender_Board	119	0	0.5556	0.16925	0.1379741
Expertise Board	119	0	1	0.294118	0.4575717
Educational_Board	119	1.9	3.2	2.520812	0.2613472
Ced	119	0.1111	0.9444	0.666667	0.2399911
Valid N (listwise)	119	119	119	119	119

Source: Data processed by the author (2025)

Table 1 presents a statistical summary of all research variables based on 119 observations of energy-sector companies in Indonesia and Malaysia for the period 2022–2024. The carbon emission disclosure (CED) index is measured by assigning a score of 1 to each disclosure, with a maximum score of 18. CED has an average value of 0.667 with a minimum of 0.111 and a maximum of 0.944. This value indicates that the research sample of energy-sector companies in Indonesia and Malaysia disclosed only around 67% of the CED out of 100%. This shows that the sample companies have not met the perfect criteria of the CDP standards proposed in the study (Bae et al., 2014).

The proportion of foreign board members is 0.113, which means that, on average, only about 11.3% of board seats in the energy sector in Indonesia and Malaysia are held by non-domestic citizens. However, with a maximum value of 0.91, this indicates that some companies have 91% of their board seats filled by non-domestic citizens. The proportion of female board members is 0.169, indicating that women's representation remains relatively limited, with several observations having no female representation at all. The board expertise variable is coded as a dummy and has an average value of 0.294, which can be interpreted as 29.4% of observations having at least one

board member with expertise in the environment/sustainability/energy according to the research criteria. Meanwhile, board education is measured as the average level score (1= \leq D3; 2=S1; 3=S2; 4=S3), showing an average of 2.521 (sd 0.261; min 1.9; max 3.2), which indicates that the composition of board education is generally in the range of S1–S2.

Overall, this descriptive overview indicates a moderate-high level of CED, accompanied by inter-company variations in board composition (nationality and gender) and the availability of environmental competencies at the board level. These preliminary findings serve as a basis for testing classical assumptions and hypotheses in the next section.

Table 3. Multicollinearity Test Results

	Collinearity Statistics	
	Tolerance	VIF
Foreign_Board	0.915	1.093
Gender Board	0.951	1.051
Expertise Board	0.783	1.277
Educational Board	0.797	1.254

Source: Data processed by the author (2025)

Multicollinearity was assessed using the Variance Inflation Factor (VIF) and Tolerance statistics in the multiple regression model. Theoretically, high correlations between independent variables will inflate the variance of the estimator, rendering the t-test inefficient. The criteria used were VIF < 10 and Tolerance > 0.10 as the safety limit. The SPSS output shows that all independent variables have VIFs in the range of \pm 1.05–1.28 and Tolerances in the range of \pm 0.78–0.95; this range is well below the problem threshold, so the model does not indicate disruptive multicollinearity. Thus, each coefficient can be interpreted without concern for excessive overlap of information among the explanatory variables.

Table 4. Heteroscedasticity Test Results

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
	0.257	0.122		2.111	0.037
Foreign_Board	-0.073	0.061	-0.109	-1.197	0.234
Gender_Board	-0.201	0.083	-0.218	-2.430	0.066
Expertise_Board	-0.087	0.028	-0.313	-3.173	0.940
Educational_Board	-0.004	0.048	-0.009	-0.092	0.927

a. Dependent Variable: Abs_RES

Source: Data processed by the author (2025)

The heteroscedasticity test using the Glejser method was conducted by regressing the absolute residual value (Abs_RES) against all independent variables. Based on the table, the significance values of each variable show that Foreign_Board has a Sig. Value of 0.234, Gender_Board has a Sig. Value of 0.066, Expertise_Board has a Sig. Value of 0.940, and Educational_Board has a Sig. Value of 0.927. All significance values for the independent variables are greater than 0.05, so it can be concluded that there is no evidence of heteroscedasticity in the regression model (the residuals are homoscedastic). Thus, the regression model meets the classical assumption of heteroscedasticity and is suitable for proceeding to the hypothesis testing stage.

In panel data-based studies with an adequate number of observations, the primary focus of classical assumption testing is directed at potential multicollinearity and heteroscedasticity. Econometric literature states that the advantages of panel data and large sample sizes make OLS inferences reliable even if the residual distribution is not exactly normal (Gujarati, 2003). In line

with this, the normality of residuals is mainly an issue in small samples; when $n \geq 100$, the distribution of errors tends to be close to normal, so that normality tests are not decisive for the validity of t-tests and F-tests (Kasim et al., 2021). Based on these references, the testing strategy in this study is adequate to ensure the feasibility of the regression model used.

Table 5. Hypothesis Test Results

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.054	0.225		0.242	0.809
Foreign_Board	0.087	0.112	0.070	0.777	0.439
Gender_Board	0.393	0.153	0.226	2.574	0.011
Expertise_Board	0.122	0.051	0.233	2.409	0.018
Education Board	0.198	0.088	0.216	2.250	0.026

a. Dependent Variable: Ced

Source: Data processed by the author (2025)

$$Y = 0.054 + 0.087X_1 + 0.393X_2 + 0.122X_3 + 0.198X_4 + e$$

Based on *the Model Summary*, the model correlation value (R) is 0.403, with R Square = 0.162 and Adjusted R Square = 0.133. This means that the four board characteristic variables together explain only 16.2% of the CED variation in the combined Indonesia-Malaysia sample, while factors outside the model influence the remaining variation. The simultaneous test (ANOVA) results show a significant model with $F = 5.529$ and $\text{Sig.} = 0.000 (< 0.05)$. This indicates that the board variables collectively influence CED in the combined sample.

The variable of foreign board presence shows a coefficient of $B = 0.087$, with $t = 0.777$ and $\text{Sig.} = 0.439 (> 0.05)$. This means that the effect of foreign boards on CED in the combined sample is positive but not significant, so H1 is rejected. The female board presence variable has a coefficient of $B = 0.393$, with $t = 2.574$ and $\text{Sig.} = 0.011 (< 0.05)$. This indicates a positive and significant effect, so H2 is accepted. Meanwhile, the board expertise variable has a coefficient of $B = 0.122$, with $t = 2.409$ and $\text{Sig.} = 0.018 (< 0.05)$. This indicates a positive and significant effect, so H3 is accepted. The education variable has a coefficient $B = 0.198$, with $t = 2.250$ and $\text{Sig.} = 0.026 (< 0.05)$. This indicates a positive and significant effect, so H4 is accepted.

Table 6. Summary of Hypothesis Decisions

Variable	Coefficient	t	Conclusion
Foreign_Board	0.087	0.777	H1 Rejected
Gender_Board	0.393	2,574	H2 Accepted
Expertise_Board	0.122	2,409	H3 Accepted
Educational Board	0.198	2.250	H4 Accepted

Source: Data processed by the author (2025)

DISCUSSION

The Effect of Foreign Board Members on Carbon Emission Disclosure

The regression results in this study show that the variable foreign board membership has a positive but insignificant coefficient, consistent with research by (Priliana & Ermaya, 2023) and (Armono & Santosa, 2024) This indicates that variations in the proportion of foreign directors do not yet explain the differences in the level of carbon emission disclosure between energy companies

in Indonesia and Malaysia. This finding can be explained by the limited substantive role of foreign directors in the company's decision-making structure. In the research sample, the proportion of foreign directors is relatively small and often not in a dominant position, so their contribution to corporate strategic policies, including decisions related to Carbon Emission Disclosure, is limited. Under these conditions, the influence of foreign directors tends to be normative and not directly involved in the technical and operational mechanisms that determine the level and depth of carbon emission disclosure.

Furthermore, even though companies have board members of foreign nationality, decisions regarding carbon emission disclosure are still influenced by a range of other complex factors. The decision-making process in the board of directors is the result of collective considerations involving managerial interests, internal company policies, and applicable regulatory and institutional pressures (Saptono, 2014). Therefore, the existence of a foreign board does not automatically guarantee an increase in the level of Carbon Emission Disclosure, because the influence of individuals on the board is often limited by the company's governance structure and decision-making mechanisms.

Finally, differences between companies in CED in the Indonesian-Malaysian energy sector are more closely aligned with attributes related to the reporting process. The presence of environmental expertise on the board (Chariri et al., 2018), literacy and educational attainment (Syafik et al., 2025), can drive demand for quantification, assurance, and quality in CED more than simply national diversity. Therefore, although foreign boards have the potential to bring global-standard perspectives, their effects are mitigated by institutional realities and operational limitations, so that, empirically, they do not emerge as significant determinants of CED in this sample.

The Influence of Women on Boards on Carbon Emission Disclosure

The results of this study indicate that the presence of women on boards has a positive and significant effect on Carbon Emission Disclosure (CED) in energy companies in Indonesia and Malaysia. These findings are consistent with Kim (2022) and Upper Echelons Theory, which found that the presence of women on boards is associated with higher levels of carbon emission disclosure, as well as Hollindale et al. (2019), which showed that the presence of women on boards plays a role in increasing the transparency of environmental disclosure. The significance of these results indicates that the gender composition of boards is a relevant governance mechanism for explaining variations in CED quality across companies, particularly in sectors with high environmental risk exposure.

Substantively, the influence of women on boards on CED works through strengthening oversight and procedural discipline, rather than through increased technical expertise. Governance literature shows that the presence of women on boards is associated with stronger monitoring intensity, higher meeting attendance rates, and more consistent enforcement of governance compliance (Saadah et al., 2024). This mechanism is reflected in the push to make reporting processes orderly, documented, and consistent across periods. The measurability of CED does not stop at policy narratives but meets the governance and reporting accountability requirements as demanded in environmental reporting practices.

These significant findings are relevant in the context of Indonesia and Malaysia, where sustainability reporting has become a formal obligation, so that differences in CED quality are determined more by the effectiveness of internal oversight than by technical capabilities alone. Wahyuningtyas & Susesti (2023) show that the structure of boards and committees in this region functions as an institutional channel that converts board characteristics, including female board members, into more accountable reporting practices. Thus, although the level of female representation on boards is still relatively limited, any meaningful increase can strengthen governance oversight mechanisms and ultimately improve the quality of Carbon Emission Disclosure in energy companies in Indonesia and Malaysia.

The Influence of Board Expertise on Carbon Emission Disclosure (CED)

This study found that board expertise in the fields of energy/emissions/sustainability can

significantly and positively influence CED, in line with *Upper Echelons Theory*. The presence of at least one board member with environmental/sustainability/energy expertise is associated with higher CED levels than in companies without such experts. Substantively, this effect makes sense because the content of CED is technical; companies must compile energy/electricity/fuel data and, where possible, provide third-party assurance. Board members who understand technical aspects tend to demand quantification, assess the reasonableness of figures, and direct the setting of realistic targets. This decision-making process directly increases the depth of CED (Zahri et al., 2023).

Indonesian and Malaysian regulations that have implemented sustainability reporting requirements show that differences between companies usually lie in the depth of reporting rather than in whether a report exists. Research by Mutia & Selatan (2025) also shows that, despite the issuance of regulations on sustainability reporting obligations through POJK 51/POJK.03/2017, the quality of sustainability reporting in Indonesia remains highly variable. Many energy issuers face data capacity limitations (facility mapping, supplier emission factors, system integration), and the presence of experts on the board usually forces management to build a more organized recording system, which in turn expands *the capacity to disclose*. The characteristics of the energy sector in both operating markets, which are technical, have high emission intensity, and face high expectations from regulators/capital markets, make substantive competence more relevant. That is why, at present, issuers with environmental/energy experts on their boards tend to exceed the minimum threshold. That is why, at present, issuers with environmental or energy experts on their boards tend to exceed the minimum disclosure threshold, as research findings indicate that boards with strong competencies and structures are better able to promote high-quality emissions reporting, rather than merely fulfilling formal obligations (Chariri et al., 2018).

The Influence of Board Educational Background on Carbon Emission Disclosure

In line with the research Al-Qahtani & Elgharbawy (2020), the regression results show that the educational background of the board has a positive and significant effect on CED. The positive coefficient indicates that an increase in the average level of education of board members is associated with an increase in the depth and measurability of carbon emission disclosure in energy sector companies in Indonesia and Malaysia. These findings indicate that board education is a relevant attribute in explaining variations in CED quality between companies, even after controlling for other board characteristics.

The influence of board education aligns with the Upper Echelons Theory, which posits that higher education levels increase cognitive capacity and the quality of board assessment in corporate decision-making. Boards with higher education levels tend to be more selective and critical in assessing the validity of the information presented, including demanding clarity of definitions, consistency of reporting logic, and relevance of the emission indicators disclosed (Armono & Santosa, 2024). This ability is reflected in the demand for verifiable and meaningful information, not just the fulfillment of general narratives, thereby encouraging companies to present more structured and measurable disclosures.

In Indonesia and Malaysia, where sustainability reporting has become a formal obligation, differences in CED quality are more determined by how companies interpret and execute these obligations (Dewi & Rahaditama, 2024). board education strengthens strategic oversight capacity to filter information that is material and relevant to stakeholders, thereby encouraging companies to move beyond symbolic reporting toward more informative disclosures. Therefore, the significant findings in this study confirm that board education is not merely a demographic attribute but an essential factor that shapes the quality of carbon emissions disclosure decisions in energy companies in both countries.

CONCLUSION

This study aims to analyze the role of board characteristics in the disclosure of carbon emissions (CED) among energy-sector companies in Indonesia and Malaysia. Empirical evidence demonstrates that, collectively, the characteristics of the board significantly influence CED. Partially, the presence of female board members, board expertise, and board educational background have been shown to have a positive and significant effect on the depth and

measurability of carbon emission disclosure. These findings indicate that the quality of CED is more determined by board attributes directly related to oversight capacity, technical competence, and strategic judgment quality, as explained by the Upper Echelons Theory framework. Conversely, the presence of foreign board members shows a positive but insignificant effect, indicating that board nationality is not yet a significant determinant of carbon emission disclosure quality when more substantive board characteristics are functioning effectively. Thus, this study concludes that strengthening internal board characteristics, particularly in education, expertise, and the presence of female board members, is a key factor in improving the quality of Carbon Emission Disclosure in energy-sector companies in Indonesia and Malaysia.

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