

BOARD CHARACTERISTICS AND CARBON EMISSIONS: THE ROLE OF CSR COMMITTEE

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Abstract: *The urgent worldwide issue of climate change brought on by rising greenhouse gas emissions is the main subject of this study. It also evaluated the possible moderating effect of the CSR Committee as well as the impact of board characteristics like size, tenure, and gender diversity on carbon emissions. 285 observations from 57 ASEAN-based energy companies made up the dataset. These were recorded between 2020 and 2024 and approximated using panel data regression. The findings demonstrated that while board size and tenure did not exhibit statistical significance, board gender diversity had a significant and favorable impact on carbon emissions. Additionally, the association between board size and gender diversity and carbon emissions was marginally reduced by the CSR Committee, which also lessened the impact of board tenure. This demonstrated that rather than significant environmental accountability, internal governance mechanisms in ASEAN energy corporations relied on symbolic pleasure. To guarantee that CSR committees have supervisory authority in advancing decarbonization efforts, regulators and policymakers in the ASEAN region must enforce more stringent, required requirements.*

Keywords: Board Characteristics, Carbon Emissions, CSR Committee, Energy Sector.

INTRODUCTION

In light of rising greenhouse gas emissions, the issue of climate change has become a top global priority. This phenomenon has been observed in terms of surface temperature, which has risen by 1.1 °C compared to pre-industrial levels ([Intergovernmental Panel on Climate Change 2023](#)). Furthermore, the increase in temperature tend to continue because an average global CO₂ of 36.3 Gigatons was recorded in 2024 ([Deng et al. 2025](#); [Friedlingstein et al. 2023](#)). This issue,

which was labeled by the United Nations (UN) as a "Code Red for Humanity," demanded economic policy support in line with environmental regulations to achieve the SDG-13 (Climate Action) targets and the Paris Agreement ([Kartal et al. 2025](#); [SDGs Center 2024](#); [Young 2023](#)). As a result, companies adjusted respective internal governance structures to promote tangible greenhouse gas reductions. This led to shift in focus from reporting to operational decarbonization, particularly in the energy sector, which has a

significant environmental impact ([Dridi et al. 2026](#)).

Based on this perspective, the ASEAN region requires special attention because the projected increase in the energy demand by 2050 significantly depends on fossil fuels, particularly coal, among massive industrialization and urbanization ([ASEAN Centre for Energy 2022](#); [International Energy Agency 2022](#)). The significant dependence caused the energy sector to promptly adjust its operational strategies. However, the effectiveness of the adjustment was greatly dictated by corporate governance quality, with leadership perceived as the core driver of the environmental commitment of a company ([Albitar et al. 2023](#); [Gardazi et al. 2020](#); [Husted and Sousa-Filho 2019](#)).

Previous research has produced mixed findings on whether Board Characteristics affect Carbon Emission Performance. These mixed findings primarily stems from the differences in institutional contexts, specifically between developed markets and developing regions, where socio-cultural dynamics, regulatory stringency, and stakeholder pressures diverge significantly. The article addresses this empirical gap by introducing the CSR Committee as a moderating variable, with the aim of determining whether a committee focused on sustainable development can minimize these discrepancies and effectively guide the board of directors' decisions in favor of initiatives aimed at reducing carbon emissions. Furthermore, the ASEAN energy sector provides an appropriate and critical context for filling this gap. Rapid economic development has positioned ASEAN among the world's leading growth regions. Nevertheless, its energy sector continues to depend relies heavily on fossil fuels and massive capital investment, creating significant barriers to the low-carbon transition. Consequently, these firms face immense global and local pressure to implement decarbonization, making the region a perfect testing ground to evaluate how corporate governance structures actually

translate into hard environmental outcomes like carbon emissions reduction under tight institutional constraints. Regarding Board Size, some studies found that a large board supports Carbon Emission Performance through a diversity of expertise ([Liao et al. 2015](#)), yet other studies stated that it actually creates a free-rider problem and hinders the decision-making process ([Muktadir-Al-Mukit and Bhaiyat 2024](#)). Regarding the Board Tenure variable, a long tenure can support a deep understanding of long-term environmental issues ([Gallego-Álvarez and Rodriguez-Dominguez 2023](#)), but it also risks making the board tend to be rigid in maintaining old business models that produce high emissions ([Gavana et al. 2024](#)). Furthermore, previous research has shown that increasing the number of women on the board of directors can improve a company's performance in terms of carbon emissions ([Rjiba and Thavaharan 2022](#)), but in the reality of emerging markets, the pressure of a predominantly masculine corporate culture can make female board members focus more on proving short-term financial performance, thereby ignoring environmental aspects ([Abdelkader et al. 2024](#)).

Following the description above, the CSR Committee in the governance structure ensure that the decarbonization agenda is implemented in operational activities ([Hussain et al. 2018](#)). Previous studies reported that this committee improved emission reduction performance in certain cases ([Derchi et al. 2021](#); [Michelon and Parbonetti 2012](#)). The effectiveness hindered if the formation satisfied formalities (symbolic management) without strong supervisory authority ([Lajmi and Nekhili 2020](#); [Velte and Stawinoga 2020](#)). Moreover, a symbolic committee may fail to translate board decisions into actual emission cuts, whereas a substantive committee is expected to strengthen the board's capacity to reduce the firm's absolute carbon output.

Based on existing research gaps and inconsistent findings in previous literature, this research reevaluates how Carbon Emission

Performance with firm-level absolute Scope 1 and Scope 2 Carbon Emissions serving as the measurement indicator is influenced by three important Board Characteristics: Board Size, Board Tenure, and Board Gender Diversity. Additionally, this study incorporates the CSR Committee into the model as a moderator to examine whether its presence strengthens the effect of Board Characteristics on Carbon Emission Performance.

This study draws its empirical evidence from energy companies operating in ASEAN over the 2020–2024 observation period. This context is particularly relevant because ASEAN continues to experience rapid growth in energy demand driven by industrialization and urbanization ([International Energy Agency 2022; Kartal et al. 2025](#)), while its energy supply remains heavily dependent on fossil fuels, especially coal ([ASEAN Centre for Energy 2022; International Energy Agency 2022](#)). As a result, greater expectations are being placed on energy companies to adopt stronger governance mechanisms and pursue meaningful reductions in carbon emissions to advance decarbonization initiatives ([Dridi et al. 2026](#)). The transition is further complicated by the energy sector's dependence on capital-intensive operations and long-lived assets, which create substantial barriers to implementing major operational changes and decarbonization strategies. These characteristics make board oversight particularly important because decisions related to investment, operational transformation, and environmental strategy are largely determined at the board level. The 2020–2024 period also provides a unique phase marked by the COVID-19 pandemic and the following economic recovery, during which companies were challenged to achieve business recovery alongside stronger commitments to sustainability. By doing so, the research primarily offers empirical evidence on how corporate governance practices help firms advance operational decarbonization amidst intense energy transition demands in a market

dominated by fossil fuels, specifically through examining the moderating capacity of the CSR Committee.

Upper Echelons Theory

Based on the Upper Echelons Theory, this research posits that the experiences and distinctive traits of a company's leadership team play a major role in its operational strategy ([Hambrick and Mason 1984](#)). These characteristics encompass values, backgrounds, experiences, and personal perspectives in interpreting organizational situations. Through this approach, decisions are not solely based on rational calculations or economic factors, but rather on the subjective interpretations of executives who hold the strategic authority to determine policy directions. Therefore, top management is expected to thoroughly understand the constantly changing dynamics of the business environment to promote corporate sustainability over time ([Hambrick and Mason 1984](#)).

From an environmental management perspective, strategic decisions regarding carbon emission reduction are influenced by internal and external factors interpreted by top executives ([Di Vaio et al. 2024](#)). These factors do not only relate to compliance with regulatory demands, but also reflect the firm's philosophical view toward environmental responsibility ([Bui and De Villiers 2017](#)). Through these strategic decisions, stakeholders can evaluate the extent to which board decisions reflect actual corporate efforts to mitigate negative impacts on Carbon Emission Performance ([Ganda and Milondzo 2018](#)).

Furthermore, corporate strategic responses to various external pressures are demonstrated through carbon emission reduction efforts. Upper Echelons Theory explains that such mitigation decisions are determined by how top management characteristics understand and respond to the situations confronting the corporation ([Zhou et al. 2025](#)). Emission reduction efforts represent

not only a concrete contribution to global decarbonization targets, but also a part of the firm's long-term strategy to maintain ecosystem balance while ensuring future business viability ([Zhou et al. 2025](#)).

Within this conceptual framework, Board Size, Board Tenure, and Board Gender Diversity represent important indicators of the upper echelon's collective cognitive capacity, experience, and values. According to Upper Echelons Theory, differences in these board characteristics influence how corporate leaders interpret and respond to carbon-related risks and decarbonization challenges. Specifically, Board Size influences the range of viewpoints represented in strategic discussions and the level of coordination required among directors, Board Tenure reflects the stability or adaptability of strategic experience over time, and Board Gender Diversity introduces different ethical perspectives and sustainability values into board discussions. Overall, Upper Echelons Theory provides a behavioral explanation for how board experience and diversity influence strategic decisions related to corporate carbon emission reduction.

Board Size

The size of the board of directors is intended to reflect the breadth of a company's combined resources and expertise ([Al-Faryan 2021](#)). A larger number of board members provides broader access to expertise, experiences, and strategic networks to process various information, help companies face business uncertainties, and support long-term corporate sustainability ([Khatib and Nour 2021](#)). Corporate governance systems are commonly organized under either a one-tier or a two-tier board structure ([Schumann et al. 2024](#)). A unitary or one-tier board framework, which consolidates management and oversight duties into a single entity, is widely embraced by the majority of ASEAN countries, such as Malaysia, Thailand, Singapore, the Philippines, and Vietnam. Conversely, Indonesia adheres to a

two-tier mechanism by separating executive responsibilities, which are handled by the Board of Directors (BOD), from oversight activities, which are supervised by the Board of Commissioners (BOC) ([Khan et al. 2020](#)). Regardless of these structural differences, the absolute size of the board remains a critical determinant of governance capacity in both systems. A larger board size also incorporates a wider diversity of backgrounds and alternative viewpoints to reduce the dominance of any single faction and foster comprehensive strategic debates ([Grove et al. 2021](#)). Furthermore, a larger headcount supports a clearer division of labor to make the strategic decision-making process more focused and help the firm face complex risks and conditions ([Al-Faryan 2021](#); [Zaid et al. 2020](#)).

Although environmental decisions often require timely responses, carbon reduction in the energy sector involves capital-intensive investments, regulatory uncertainty, and long project lifecycles. As a result, these decisions require careful evaluation rather than quick action alone. A larger board may support carbon reduction by drawing on the complementary knowledge and viewpoints of its members when evaluating long-term investment and environmental strategies. This broader discussion can enhance the board's strategic judgment and help firms implement carbon reduction initiatives more effectively.

Board Tenure

According to [Aslam et al. \(2026\)](#), the length of a board member's term is determined based on the average length of time each member serves on a company's board of directors. This tenure reflects the level of experience and understanding that board members possess in executing their supervisory functions. The formulation of sustainability initiatives and the oversight of corporate environmental practices depend heavily on the board, which holds a vital responsibility in driving Carbon Emission Performance ([Peng et al.](#)

[2021](#)). However, an excessively long tenure potentially reduces supervisory effectiveness due to a tendency toward rigidity in strategic decision-making. Extended service periods can narrow perspectives, making directors less responsive to emerging environmental demands and weakening the quality of oversight in driving carbon reduction efforts ([Aslam et al. 2026](#); [Graf-Vlachy et al. 2020](#)). In contrast, while a longer board tenure can provide valuable experience in dealing with complex issues ([Paolone et al. 2023](#)), this study argues that, in the energy sector, the risk of strategic rigidity is more likely to outweigh these benefits. As a result, longer board tenure is expected to increase carbon emissions due to less effective environmental oversight.

Board Gender Diversity

Following ([Barroso et al. 2024](#)), the inclusion of women in leadership roles at the highest levels of a company is reflected in gender diversity on the board of directors. ([Mellyanawati and Kurniasih 2025](#)) note that including women on boards is a key factor that drives corporate sustainability. Integrating women into the board introduces varied viewpoints into strategic choices, specifically regarding ethical standards and social responsibility. Furthermore, the inherent positive traits of female leaders, including stronger moral development, greater moral sensitivity, and more prudent risk-taking tendencies, are considered essential for minimizing risks and reducing the potential for fraud in corporate reporting ([Daryatno and Santioso 2021](#)). However, in developing countries, female board members often face immense pressure to establish managerial legitimacy amidst a predominantly masculine corporate culture ([Abdelkader et al. 2024](#)). As a result, female directors may feel pressured to support short-term corporate decisions that produce quick and visible results to demonstrate their capability ([Abdelkader et al. 2024](#)). This does not mean that women naturally prefer short-term

decisions. Instead, it reflects their effort to overcome negative stereotypes, demonstrate their competence, and gain acceptance from shareholders and other board members. As noted by ([Gupta et al. 2026](#)), female leaders often face intense scrutiny, which compels them to be overly prepared and to manage their duties very carefully in order to counter potential biases. In high-carbon sectors, such as the energy sector, prioritizing short-term financial considerations over long-term sustainability initiatives can inadvertently lead to an increase in carbon emissions. Consequently, because of the institutional pressure to conform to masculine organizational norms, the board's response to environmental issues becomes less than optimal, heavily limiting their strategic capacity to drive carbon emission reduction ([Abdelkader et al. 2024](#)). ([Aprilia et al. 2026](#)) further show that greater female representation in leadership roles introduces complex dynamics when navigating these corporate governance pressures.

CSR Committee

The CSR Committee oversees the integration of environmental considerations into core corporate strategies ([Driss et al. 2024](#)). The existence of this committee is reinforced by its members' specific expertise in understanding various environmental risks ([Aslam et al. 2026](#)). An effective CSR Committee promotes transparency in emissions disclosure and ensures corporate activities strictly align with established carbon reduction targets ([Driss et al. 2024](#)). Ultimately, a firm's capacity to deliver high-quality environmental reports and achieve top-tier sustainability benchmarks is closely anchored to the presence of such a committee ([Driss et al. 2024](#)). An excellent CSR Committee assists the board in processing and managing information regarding carbon emissions more effectively. Additionally, this committee strengthens the firm's capacity to respond to external sustainability pressures to leave the

company better prepared to face continuously evolving environmental demands.

Board Size, Carbon Emissions, and CSR Committee

Board Size is represented by the total number of individuals serving as board directors. A larger board generally combines directors with diverse backgrounds, complementary skills, and broad professional networks, thereby strengthening the resources available for strategic decision making. As a result, boards with more members are better able to address complex environmental issues ([Nguyen and Thanh 2022](#); [Nguyen and Nguyen 2023](#)). Within this framework, a larger board reflects a higher collective cognitive capacity to identify sustainability trends and respond to ecological issues comprehensively ([Lippi and Galavotti 2024](#)). However, empirical literature on the impact of Board Size on Carbon Emission Performance has produced mixed findings. While researchers such as [Endrikat et al. \(2021\)](#) and [Sekarlangit and Wardhani \(2021\)](#) argue that a broader pool of institutional resources within larger boards contributes to improved environmental performance, other studies such as those by [Disli et al. \(2022\)](#) and [Nuhu and Alam \(2024\)](#) find that smaller boards are more effective due to simpler coordination and faster strategic decision-making. Furthermore, evidence from [Liu et al. \(2024\)](#) suggests that the effect of board size on environmental performance can also be statistically nonsignificant.

Given the mixed results of previous research, the current study draws on the Upper Echelons Theory, which posits that increasing the size of a board of directors promotes diversity in the skills and experiences represented, thereby improving the quality of strategic judgment. From a carbon management perspective, a larger board can provide better oversight and support more effective carbon reduction efforts. As such, large boards of directors are expected to play a role in reducing

Carbon Emissions. In addition to the direct influence of the board's size, a CSR Committee also plays a crucial role in developing companies' carbon emission reduction strategies. On one hand, establishing a CSR Committee is found to optimize a firm's disclosure benchmarks, ecological outcomes, openness, and innovative capacities ([Cosma et al. 2022](#); [Driss et al. 2024](#); [Javeed et al. 2022](#)), alongside bridging Board Characteristics with strategic sustainability frameworks ([Qaderi et al. 2022](#)). However, other studies indicate that these committees often play a purely symbolic role and have little real influence on actual decision-making processes ([Tingbani et al. 2020](#)). Although Board Size and CSR Committee are related to Carbon Emissions, their interaction shows a different role where a large Board Size provides diverse resources but is not always effective without a clear direction. In this case, a CSR Committee functions to direct the board's focus on sustainability issues, including Carbon Emission reduction, making the environmental oversight and policy formulation more structured to reinforce the firm's effectiveness in reducing Carbon Emissions. Accordingly, the following hypotheses are put forward for empirical testing:

H_{1a}: Board Size has a negative effect on Carbon Emissions.

H_{1b}: CSR Committee strengthens the negative effect of Board Size on Carbon Emissions.

Board Tenure, Carbon Emissions, and CSR Committee

Drawing on ([Aslam et al. 2026](#)), Board Tenure reflects the average duration of board members' service in carrying out their responsibilities within an organization. Because Board Characteristics significantly influence corporate strategic outcomes, the duration of a director's tenure shapes how corporate situations are perceived and influences subsequent policy directions ([Peng et al. 2021](#)). Furthermore, a longer tenure reflected deeper

experience and understanding of corporate conditions. This is in relation to the direction of decisions regarding environmental practices and carbon emission reduction. The evidence obtained showed that a longer board tenure improved Carbon Emission Performance, particularly in promoting sustainable practices and carbon reduction ([Gallego-Álvarez and Rodriguez-Dominguez 2023](#); [Paolone et al. 2023](#)). Similarly, boards with longer tenures showed greater transparency in emissions reporting well as actively engaged in corporate social responsibility ([Nguyen and Nguyen 2023](#); [Peng et al. 2021](#)). While longer tenure may provide valuable experience, rigidity may become a more prominent concern in the ASEAN energy sector, where firms face increasing pressure to respond to climate-related challenges. In industries facing complex environmental challenges, such as the ASEAN energy sector, long-tenured directors may become increasingly comfortable with established business practices and strategic approaches. Over time, this tendency can create rigidity in decision-making and make boards less responsive to emerging climate-related risks. As a result, companies may continue relying on traditional strategies that are closely linked to fossil fuel use, while oversight of environmental issues becomes less effective. This condition can ultimately contribute to higher carbon emissions ([Aslam et al. 2026](#)). Establishing a CSR committee is essential to resolving this issue. An effective CSR Committee can encourage long-tenured boards to evaluate corporate policies through more technical, independent, and climate-focused oversight ([Gull et al. 2023](#)). In this role, the CSR Committee acts as a strategic mechanism that helps keep the company focused on sustainability objectives while promoting transparency ([Cosma et al. 2022](#)). By providing specialized expertise and increasing the focus on environmental issues, the CSR committee has the ability to reduce the dominant influence of directors who have served for an extended

period, thereby mitigating the positive impact of directors' tenure on carbon emissions ([Gull et al. 2023](#)). Based on these arguments, this study advances the following hypotheses:

H_{2a}: Board Tenure has a positive effect on Carbon Emissions.

H_{2b}: CSR Committee weakens the positive effect of Board Tenure on Carbon Emissions.

Board Gender Diversity, Carbon Emissions, and CSR Committee

The assessment of gender diversity on the board of directors is based on the representation of women on the board. According to the Upper Echelons Theory, greater representation of women on the board should introduce diverse perspectives, particularly with regard to a greater awareness of environmental issues. However, their influence on strategic decisions depends on the organizational and institutional context. In developing countries, especially in the energy sector, female directors often face strong pressure to gain acceptance in a board environment that is still dominated by men ([Abdelkader et al. 2024](#); [Aprilia et al. 2026](#)). In addition, the scarcity of female representation in corporate governance may reinforce perceptions that women directors serve mainly symbolic purposes rather than having equal influence in strategic decisions ([Ahmad et al. 2018](#)). The Tokenism Theory suggests that insufficient female representation may weaken the effectiveness of female board directors participate effectively in strategic decision-making, including the formulation of environmental policies ([Gantjowati et al. 2026](#)). This situation may encourage female directors to follow existing board norms, resulting in support for corporate strategies that focus on immediate financial targets while giving less attention to broader environmental objectives. In the ASEAN energy sector, short-term financial performance is still closely linked to fossil-fuel production and the expansion of carbon-intensive operations.

Therefore, when female directors conform to these dominant business priorities, they may also support strategic decisions that maintain or expand carbon-intensive activities, which can ultimately lead to higher corporate carbon emissions.

To reduce this problem, the presence of an effective CSR Committee becomes important. A dedicated CSR Committee provides more structured oversight, reliable sustainability information, and technical support that enables female directors to participate more actively in environmental decision-making ([Abu Alia et al. 2024](#); [Qaderi et al. 2022](#)). By strengthening sustainability policies and reporting practices, the CSR Committee creates greater opportunities for female directors to express their views and contribute to climate-related decisions ([Driss et al. 2024](#)). Therefore, the CSR Committee is expected to limit the negative implications of tokenism while modifying the influence of Board Gender Diversity on Carbon Emissions. Following the theoretical discussion above, this research develops the hypotheses outlined below:

H_{3a}: Board Gender Diversity has a positive effect on Carbon Emissions.

H_{3b}: CSR Committee weakens the positive effect of Board Gender Diversity on Carbon Emissions.

METHOD

The present study employs a quantitative approach to examine the variables

under investigation. Based on the predefined purposive sampling criteria and data availability, the final sample comprised 57 energy corporations operating across the ASEAN region. The analysis covered a five-year period, from 2020 to 2024, thereby enabling the creation of a balanced sample comprising 285 company-year observations. Table 1 presents the sample selection process based on the predetermined criteria and data availability, resulting in the final sample of 57 energy corporations and 285 company-year observations. The financial, governance, and environmental data essential to the empirical analysis were meticulously collected from the Refinitiv Eikon data platform to ensure their comparability and reliability.

The intentional focus on energy corporations within this sampling framework is justified by multiple strategic and environmental rationales. Primarily, this specific sector exerts a profound ecological footprint as a direct consequence of its extensive dependency on natural resources and fossil fuels. Subsequently, the industry demands substantial long-term capital investments, rendering its asset and operational structures relatively inflexible to immediate strategic shifts. As a result, energy enterprises operate under intense global and domestic stakeholder scrutiny to mitigate carbon outputs, enhance environmental disclosures, and advance decarbonization pathways.

Table 1. Sample Selection Criteria

No	Sample Selection Criteria	Total
1.	Energy sector firms in the ASEAN region consistently listed in the Refinitiv Eikon database during the 2020–2024 period.	233
2.	Firms with incomplete data for the research variables in the Refinitiv Eikon database during the 2020–2024 period.	(176)
Total Firms		57
Total Observations		285

Concurrently, to ensure measurement consistency across the ASEAN sample, specific data aggregation rules were applied to account for institutional variations in corporate board structures. The measurement of Board Size (BSIZE) follows the corporate governance structure adopted in each country. For Malaysia, Singapore, Thailand, the Philippines, and Vietnam, which implement a single-tier board system, the size of the board of directors (BSIZE) is calculated based on the total number of directors present at board meetings. However, Indonesia uses a two-tier governance structure, so the size of the board of directors (BSIZE) is determined by adding the number of members on the BOD to the number of members on the BOC. As noted by [\(Ararat et al. 2021\)](#), differences between single-tier and two-tier governance systems create challenges for corporate governance research. Therefore, combining both boards allows the Indonesian two-tier structure to be more comparable with the broader responsibilities typically carried out by a single-tier board. The final sample distribution across the ASEAN countries is presented in Table 2, providing an overview of the number and proportion of sampled energy corporations from each country.

Statistical Test

Employing panel data regression analysis processed through the EViews statistical software, the investigation rigorously evaluated how Board Characteristics influence Carbon Emission Performance and examined whether the CSR Committee moderates this

relationship. To ensure the robustness of the statistical models and minimize bias associated with unobserved variables, this study incorporates a number of control variables. First, firm size, measured by the natural logarithm of total assets, is considered, given that large firms often have more abundant organizational resources and face higher expectations from stakeholders regarding environmental performance [\(Abu Alia et al. 2024; Hassanein et al. 2024; Zaid et al. 2020\)](#). Second, to account for differences in firms' short-term financial capacity, liquidity is taken into consideration, as measured by the current ratio. Companies with greater liquidity are better able to meet their current obligations while maintaining the financial flexibility needed to support investments requiring significant capital [\(Al-Mari and Mardini 2024; Khatib and Nour 2021\)](#). Third, indebtedness, measured by the debt-to-equity ratio, is taken into account to reflect disparities in firms' financing structures [\(García-Sánchez et al. 2019; Hassanein et al. 2024; Qaderi et al. 2022\)](#). Fourth, profitability, that is, return on equity (ROE) is used as a control variable, since firms with more favorable financial results tend to be better equipped to undertake environmental initiatives and comply with carbon regulations [\(Gavana et al. 2024; Paolone et al. 2023\)](#). Fifth, gross domestic product (GDP) growth is considered a control variable at the national level to account for macroeconomic conditions that may affect firms' operations and their environmental performance [\(Park et al. 2019\)](#).

Table 2. Sample Distribution by Country

No	Country	Number of Companies	Percentage (%)
1.	Thailand	22	38,60
2.	Malaysia	20	35,09
3.	Indonesia	10	17,54
4.	Singapore	4	7,01
5.	Philippines	1	1,76
Total Companies		57	100

The most appropriate panel regression model was determined using the Chow, Hausman, and Lagrange Multiplier (LM) tests to evaluate the suitability of the CEM, FEM, and REM. Furthermore, statistical validity and Best Linear Unbiased Estimator (BLUE) properties were verified through classical assumption diagnostics, including Jarque-Bera (normality), Variance Inflation Factor (multicollinearity), Durbin-Watson (serial correlation), and Breusch Pagan-Godfrey (heteroscedasticity) tests. Empirical results were evaluated using the adjusted R^2 , F-test for simultaneous significance, and t-test for hypothesis verification. Finally, both direct and interaction effects were operationalized and compared through four distinct, incremental regression models.

$$\text{LN_EMISSIONS} = \alpha + \beta_1 \text{BSIZE} + \beta_2 \text{BTEN} + \beta_3 \text{BGEN} + \beta_4 \text{LN_ASSET} + \beta_5 \text{CR} + \beta_6 \text{DER} + \beta_7 \text{ROE} + \beta_8 \text{GDP} + \varepsilon_1 \quad (1)$$

$$\text{LN_EMISSIONS} = \alpha + \beta_1 \text{BSIZE} + \beta_2 \text{CSRCOM} + \beta_3 (\text{BSIZE} * \text{CSRCOM}) + \beta_4 \text{LN_ASSET} + \beta_5 \text{CR} + \beta_6 \text{DER} + \beta_7 \text{ROE} + \beta_8 \text{GDP} + \varepsilon_2 \quad (2)$$

$$\text{LN_EMISSIONS} = \alpha + \beta_1 \text{BTEN} + \beta_2 \text{CSRCOM} + \beta_3 (\text{BTEN} * \text{CSRCOM}) + \beta_4 \text{LN_ASSET} + \beta_5 \text{CR} + \beta_6 \text{DER} + \beta_7 \text{ROE} + \beta_8 \text{GDP} + \varepsilon_3 \quad (3)$$

$$\text{LN_EMISSIONS} = \alpha + \beta_1 \text{BGEN} + \beta_2 \text{CSRCOM} + \beta_3 (\text{BGEN} * \text{CSRCOM}) + \beta_4 \text{LN_ASSET} + \beta_5 \text{CR} + \beta_6 \text{DER} + \beta_7 \text{ROE} + \beta_8 \text{GDP} + \varepsilon_4 \quad (4)$$

Figure 1 illustrates the research framework of Board Characteristics, Carbon Emissions, and the CSR Committee, with the definitions and measurements of the variables presented in Table 3.

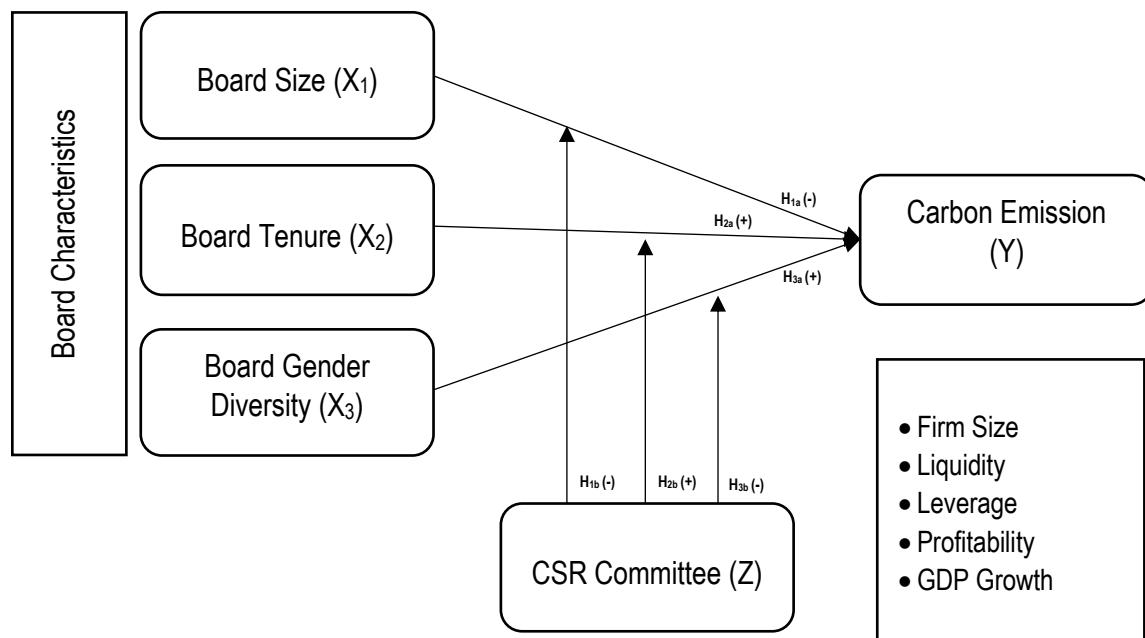


Figure 1. Research Framework

Table 3. Definition, Measurement, and Source Variables

Variable	Symbol	Measurement
Carbon Emissions	LN_EMISSIONS	Natural logarithmic transformation of total CO ₂ -equivalent emissions from Scope 1 and Scope 2 sources (Oyewo 2023 ; Gaganis et al. 2023).
Board Size	BSIZE	The annual count of individuals occupying board director positions (Al-Faryan 2021 ; Khatib and Nour 2021 ; Nguyen and Nguyen 2023).
Board Tenure	BTEN	The mean tenure of directors serving on the board. (Gallego-Álvarez and Rodriguez-Dominguez 2023 ; Paolone et al. 2023 ; Peng et al. 2021).
Board Gender Diversity	BGEN	Proportion of women among the total members of the board (Abdelkader et al. 2024 ; Dridi et al. 2026 ; Wang et al. 2023).
CSR Committee	CSRCOM	Operationalized as a binary indicator, assigning a value of one to firms with an established CSR Committee and zero to firms without one (Aslam et al. 2026 ; Jarboui et al. 2023).
Firm Size	LN_ASSET	Natural logarithmic transformation of total asset (Abu Alia et al. 2024 ; Hassanein et al. 2024 ; Zaid et al. 2020).
Liquidity	CR	Comparing cash holdings, including cash equivalents, with current liabilities. (Al-Mari and Mardini 2024 ; Khatib and Nour 2021).
Leverage	DER	The ratio of total liabilities to shareholders' equity (García-Sánchez et al. 2019 ; Hassanein et al. 2024 ; Qaderi et al. 2022).
Profitability	ROE	Relating net income to shareholders' equity (Gavana et al. 2024 ; Paolone et al. 2023).
GDP Growth	GDP	The yearly GDP growth rate based on constant local currency values (Park et al. 2019).

RESULTS

The central tendency measures for all investigated variables based on 285 observations are presented in Table 4. The log-transformed Carbon Emissions (LN_EMISSIONS) exhibit an average value of 12.07, representing the log-scale baseline carbon footprint generated by the sampled energy corporations during the observation period. With a mean value of 9.09, Board Size (BSIZE) implying that the typical energy firm in the sample is governed by a board comprising

approximately 9 to 10 members. The relatively large board composition suggests the availability of sufficient governance resources to oversee complex organizational activities. Board Tenure (BTEN) records a mean tenure of 6.77 years, typically remain in their positions for approximately 6.77 years, reflecting a stable boardroom dynamic with a high accumulation of institutional experience. With an average proportion of 0.18, Board Gender Diversity (BGEN) indicates that female directors make up around 18% of total board membership among

the sampled energy firms. This relatively small proportion reflects the continued underrepresentation of women on corporate boards across the ASEAN region. The CSR Committee (CSRCOM) institutionalization exhibits a mean value of 0.73, implying that approximately 73.68% of the total observations have established a dedicated sustainability committee within their governance structures, while the remaining 26.32% have not. Meanwhile, Liquidity (CR), Leverage (DER), Profitability (ROE), and GDP Growth (GPD) average 0.64, 0.66, 0.14, and 2.23 respectively.

Model Estimation Test Results

The summary of the model specification tests carried out across all empirical frameworks is shown in Table 5. Considering the statistical diagnostics produced mixed results between the FEM and REM across the specifications, this study consistently used REM as the definitive estimation approach for all four frameworks to maintain optimal estimation efficiency. In line with the study by [\(Gujarati and Porter 2009\)](#), this methodological preference is heavily justified by

the static nature of the primary independent variables, which showed low within-variation over the observation period. FEM estimation was highly inefficient under the diverse conditions, due to near-collinearity with unobserved corporate-specific individual effects. The forceful use of the FEM approach under the numerous conditions triggered severe model overfitting, which artificially inflated the Adjusted R^2 values and undermined the predictive validity of the model.

Regression Results

Table 6 presents the results of the panel data regression analysis of Board Characteristics, Carbon Emissions, and the CSR Committee. Based on the regression outputs, Model 1 showed simultaneous significance, represented by an F-value of 3.497 ($p = 0.000$). An R^2 value of 0.133 suggested that the combination of independent variables accounts for roughly 13% of the variance observed in corporate carbon emissions. Meanwhile, the remaining proportion was driven by factors not incorporated in the model framework.

Table 4. Descriptive Statistic

Variable	Mean	Std. Dev	Min	Max
LN_EMISSIONS	12.0740	2.9058	5.0713	17.6046
LN_SCOPE1	11.8677	3.0296	4.5643	17.5010
LN_SCOPE2	9.2100	2.6663	2.5416	14.1425
BSIZE	9.0982	3.4042	3.0000	18.0000
BTEN	6.7745	3.7514	1.7570	18.9200
BGEN	0.1838	0.1422	0.0000	0.6162
CSRCOM	0.7368	0.4411	0.0000	1.0000
LN_ASSET	30.0140	3.8961	20.2851	34.7784
CR	0.6398	0.5454	0.0181	2.5650
DER	0.6688	0.5117	0.0207	1.9936
ROE	0.1406	0.2007	-0.3646	0.9423
GDP	2.2390	4.1878	-9.5200	10.1400

Source: Data processed via Eviews

Table 5. Model Estimation Test Results

Model	Chow Test	Hausman Test	LM Test	Selected Model	Employed Model
1	0.	0.1997	0.	REM	REM
2	0.	0.0031	0.	FEM	REM
3	0.	0.0040	0.	FEM	REM
4	0.	0.0020	0.	FEM	REM

Source: Data processed via Eviews

On a partial basis, Board Size (BSIZE) showed a positive coefficient which lacked a statistically significant influence on Carbon Emissions. The empirical evidence indicates that Board Size, by itself, does not exert a direct influence on corporate Carbon Emissions. The Upper Echelons Theory posited that larger boards have greater resources and more diverse perspectives to address environmental issues ([Al-Faryan 2021](#); [Grove et al. 2021](#)), a larger board does not necessarily lead to better climate-related decisions. In the sampled energy firms, larger boards create structural challenges, including more complex decision-making processes, slower communication, and weaker strategic coordination. These conditions make it more difficult for directors to work effectively and may increase free-rider behavior. Upper Echelons Theory helps explain these findings by indicating that the strategic value of a larger board can diminish when coordination among board members becomes more challenging. Although a larger board is assumed to bring broader knowledge and perspectives, these advantages may not be fully realized because the decision-making process becomes less efficient, particularly in the ASEAN energy sector. As a result, adding more directors does not necessarily improve strategic oversight or strengthen the board's ability to support carbon reduction initiatives. This finding is consistent with ([Muktadir-Al-Mukit and Bhaiyat 2024](#); [Liu et al. 2024](#)), who also found that increasing board size does not improve Carbon Emission Performance because of these operational challenges. Therefore, Hypothesis 1a is rejected.

The length of the term of office for members of the board of directors (BTEN) showed a positive correlation but did not play a statistically significant role in carbon emissions. This substantiated that the longevity of service offered by directors within a company does not meaningfully alter corporate carbon strategies. According to the Upper Echelons Theory, tenure shaped the strategic experience and managerial character behind policy preferences ([Gallego-Álvarez and Rodríguez-Domínguez 2023](#)). Empirical evidence further showed that prolonged tenure tended to diminish cognitive flexibility, entrapping the board within legacy paradigms and ensuring it was less responsive to evolving climate demands. Senior directors adopted existing, carbon-heavy business models rather than pioneering eco-innovations ([Gavana et al. 2024](#)). Excessive tenure also degraded independent monitoring capabilities and restricted fresh perspectives toward environmental risks ([Aslam et al. 2026](#)). This favored institutional stability over active emission reduction, therefore Hypothesis 2a was rejected.

A higher percentage of women on boards of directors was associated with higher carbon emissions among the emerging-market companies in the sample, suggesting a positive and statistically significant link between gender diversity on boards (BGEN) and Carbon Emissions. This observation can be explained by top-level theory, which highlights that the demographic characteristics of executives influence strategic decisions and, by extension, organizational performance ([Wang et al. 2023](#)). However, unlike in developed nations, female board members in developing markets

frequently face intense pressure to secure professional legitimacy within heavily masculine corporate cultures. This institutional friction pressures them to over-index on short-term financial expansion and immediate profitability to prove their competence, overshadowing long-term environmental targets ([Abdelkader et al.](#)

[2024](#)). Additionally, due to tokenism and the lack of a critical mass, female directors lack the structural voting power to enforce stringent green policies, forcing them to conform to the carbon-intensive growth agendas of the male majority ([Ahmad et al. 2018](#); [Yarram and Adapa 2021](#)). Thus, Hypothesis 3a was accepted.

Table 6. Panel Data Regression Analysis Results

Variable	Model 1	Model 2	Model 3	Model 4
BSIZE	0.0257 (0.0429)	0.0426 (0.0516)		
BTEN	-0.0025 (0.0263)		0.0651** (0.0354)	
BGEN	2.0290*** (0.5813)			2.4195*** (0.7525)
CSRCOM		0.1687 (0.3850)	0.7086** (0.2890)	0.2463 (0.2101)
BSIZE_M		0.0025 (0.0437)		
BTEN_M			-0.0728** (0.0353)	
BGEN_M				-0.7830 (0.8141)
LN_ASSET	0.0762 (0.3636)	0.08921 (0.0761)	0.0882 (0.2373)	0.0904 (0.2302)
CR	0.4854*** (0.0011)	0.5317*** (0.0005)	0.5349*** (0.0004)	0.5024*** (0.0007)
DER	-0.2866** (0.1110)	-0.3111*** (0.1137)	-0.2962*** (0.1129)	-0.2926*** (0.1116)
ROE	-0.6031* (0.3354)	-0.6284* (0.3437)	-0.5100 (0.3435)	-0.5824* (0.3330)
GDP	0.0196 (0.02727)	0.0196 (0.0281)	0.0232 (0.0279)	0.0163 (0.0272)
R ²	0.133	0.097	0.107	0.130
Adjusted R ²	0.095	0.057	0.068	0.092
F-Value	3.497***	2.441***	2.731***	3.412***

Standard errors are presented in parentheses; ***p < 0.01, **p < 0.05, dan *p < 0.10.

Source: Data processed via Eviews

The interaction variable (BSIZE_M) fails to exhibit statistical significance. This demonstrates that the presence of a CSR Committee (CSRCOM) is unable to channel large-scale boardroom capacity into concrete carbon reduction efforts. This lack of interaction stems from internal governance friction. Because larger boards already suffer from bureaucratic complexity and free-riding behaviors, the CSR Committee lacks the institutional leverage required to realign the unwieldy board's strategic focus toward green initiatives. Instead of optimizing environmental governance, the committee simply adds another administrative layer without delivering material impact. This confirms the assertions of [\(Tingbani et al. 2020\)](#) that CSR Committees in emerging markets frequently serve a purely symbolic function to satisfy regulatory compliance rather than exercising real strategic influence. Thus, Hypothesis 1b was rejected.

The results of the moderation analysis show a statistically significant negative interaction (BTEN_M). Thus, the CSR Committee reduces the correlation between a longer tenure on the board of directors and higher carbon emissions. This result highlights the critical monitoring and corrective function of the CSR Committee. While long-tenured boards inherently default to operational rigidity and maintain legacy, carbon-heavy business models [\(Gavana et al. 2024\)](#), a dedicated CSR Committee disrupts this inertia. By introducing structured reporting data and specialized environmental oversight, the committee forces entrenched directors to confront climate risks and integrate sustainability metrics into corporate policies [\(Cosma et al. 2022\)](#). This specialized oversight counterbalances senior board stagnation, successfully steering the firm toward actionable carbon-reduction strategies, consistent with [\(Gull et al. 2023\)](#). Thus, Hypothesis 2b was accepted.

The evaluation of the moderation analysis reveals that the positive impact of board gender diversity on Carbon Emissions shows no

significant change in companies that have a CSR committee, indicating that this committee does not significantly alter this relationship. These findings imply that the Committee has not been effective in modifying the environmental outcomes associated with greater female representation on corporate boards within the sampled energy firms. This finding differs from the dominant evidence from developed countries, which generally suggests that female leadership contributes to lower carbon emissions [\(Wang et al. 2023; Toukabri and Jilani 2023\)](#). This is more consistent with data from emerging markets, where structural conditions and the broader context frequently limit the effectiveness of corporate governance mechanisms [\(Abdelkader et al. 2024; Tingbani et al. 2020\)](#). This finding can be explained by using Institutional Theory and Tokenism Theory. From the perspective of Institutional Theory, companies in the ASEAN energy sector operate under institutional pressures that place greater emphasis on financial performance, Energy security, and regulatory compliance than on environmental objectives. As a result, board members, including female directors, may have limited opportunities to prioritize carbon reduction when these objectives conflict with business interests. At the same time, Tokenism Theory suggests that because female directors still represent a relatively small proportion of board members, they may lack the critical mass needed to influence strategic decisions and are more likely to adapt to the dominant board culture and existing organizational priorities. Under these conditions, the CSR Committee may function primarily as a formal governance mechanism established to meet sustainability and regulatory expectations rather than as a strategic body with sufficient influence over corporate decision-making. Thus, the committee cannot strengthen the power of female board members or effectively translate the sustainable development goals established by the board of directors into operational actions to reduce carbon emissions. Consequently, there is no

evidence to suggest that the CSR Committee alters the relationship between gender diversity on the board and Carbon Emissions. It is therefore not possible to confirm Hypothesis 3b.

Additional Test

To check structural stability, Table 7 presents an additional test by partitioning the dataset into the COVID-19 pandemic (2020–2022) and recovery (2023–2024) periods. During the crisis period, Board Tenure (BTEN) which was insignificant in the main model exhibits a positive and statistically significant impact on Carbon Emissions ($p = 0.0496$). This demonstrates that under high economic uncertainty, long-tenured boards prioritize immediate corporate survival and adopt a more conservative decision-making approach. To maintain operational efficiency, firms cut discretionary spending and postpone capital-intensive investments in green innovations or eco-friendly technologies ([Hermundsdottir and Aspelund 2022](#)). Consequently, carbon emissions remained elevated during the pandemic years as survival overrode environmental goals.

Conversely, a different dynamic emerges during the recovery period, where the interaction between Board Size and the CSR Committee (BSIZE_M) yields a positive and highly significant effect on Carbon Emissions ($p = 0.0006$). As market conditions stabilized, energy corporations shifted their focus toward

aggressive operational expansion to recover business performance. While larger boards pushed for higher production volumes, the oversight from the CSR Committee was insufficient to restrain the resulting environmental impact. This limitation occurs because, during the pandemic, the strategic focus of CSR committees in developing nations heavily shifted from environmental protection to urgent social and health issues ([Umar et al. 2023](#)). Because corporate attention toward environmental matters fluctuates based on economic shocks ([Cardillo et al. 2023](#)), the post-pandemic ramp-up in energy production inevitably drove up total carbon outputs

CONCLUSION

This study focused on the influence of board characteristics to understand corporate carbon emissions, while examining whether the involvement of the CSR committee alters these relationships. Of all the board characteristics studied, only gender diversity on the board shows a positive and statistically significant correlation with carbon emissions. However, neither the size of the board nor the experience of its members has a direct impact. Furthermore, the results regarding the moderating effect show that the Corporate Social Responsibility committee mitigates the impact of board members' experience on carbon emissions but does not alter the relationships associated with board size or gender diversity on the board.

Table 7. Additional Test Result

Variable	Crisis Period (2020-2022)	Recovery Period (2023-2024)
BSIZE	0.0429 (0.0568)	0.0517 (0.0475)
BTEN	0.0955** (0.0483)	0.0220 (0.0317)
BGEN	0.7057 (0.9275)	0.0175 (0.6014)
BSIZE_M	0.1265* (0.0729)	0.5080*** (0.1443)
BTEN_M	-0.0502 (0.0511)	-0.2288** (0.1096)
BGEN_M	-0.5003 (1.3537)	-1.8480 (3.3726)

Standard errors are presented in parentheses; *** $p < 0.01$, ** $p < 0.05$, dan * $p < 0.10$.

Source: Data processed via Eviews

Furthermore, the additional temporal analysis reveals that corporate governance strategies toward environmental preservation undergo drastic transformations when transitioning between economic shocks and recovery periods, where long tenure drives emissions during crises, and larger boards accelerate emissions post-pandemic.

These findings have major theoretical and practical implications for business leaders, institutional investors, and decision-makers striving to address the challenges related to carbon emissions in developing markets. Theoretically, this research enriches the body of literature on corporate governance by examining the complexities of tokenism and pressures related to legitimacy. It also highlights how the representation of women when hindered by a male-dominated corporate culture impacts short-term structural economic gains that, without any intention to cause harm, contribute to increased emissions. Practically, corporate managers must empower CSR Committees with robust strategic authority rather than treating them as tokenistic formalities. For shareholders, board diversity and committee presence should not be viewed merely as a compliance checklist, instead, investors must evaluate the actual operational effectiveness and green commitment history of these bodies before making investment decisions. Consequently, policymakers and regulators are advised to formulate binding Key Performance Indicator (KPI) standards related to the energy transition and establish strict oversight guidelines for green investments, especially during periods of economic recovery.

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Despite these insights, several limitations of this paper must be highlighted to guide future empirical extensions. First, due to the severe lack of uniform reporting standards and pervasive data inconsistencies surrounding supply chain disclosures in ASEAN markets, Scope 3 emissions were excluded, leaving the analysis reliant strictly on Scope 1 and Scope 2 metrics. Second, the CSR Committee in this study is measured in a limited manner through a binary dummy variable representing committee presence, which may not capture the nuanced quality of corporate oversight.

To mitigate these limitations, future studies should broaden their scope of analysis by more accurately incorporating Scope 3 emissions, as reporting frameworks continue to improve in developing regions. Furthermore, it is strongly recommended that future researchers use more comprehensive governance quality indicators to measure the actual effectiveness of environmental policies. These indicators should include the frequency of CSR committee meetings, the proportion of corporate budgets allocated to low-carbon technologies, and the specific environmental or scientific expertise possessed by board members.

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