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The Effect of Institutional Ownership and Sustainability Committees on Carbon Emission Disclosure with the Proportion of Female Directors as a Moderating Variable

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Abstract: This study examines the effects of institutional ownership and sustainability committees on carbon emission disclosure, with female director representation as a moderating variable, in energy and manufacturing companies listed on the Indonesia Stock Exchange (IDX) from 2021 to 2024. Motivated by low carbon emission disclosure in Indonesia, this study draws on Stakeholder Theory and Legitimacy Theory. Using purposive sampling, 40 companies were selected, yielding 160 observations. Data were analyzed using panel data regression and Moderated Regression Analysis (MRA) with the Random Effects Model (REM) and clustered-robust standard errors to address heteroskedasticity and autocorrelation. The results indicate that institutional ownership and sustainability committees positively and significantly affect carbon emission disclosure. However, female director representation does not moderate either relationship. These findings suggest that numerical female representation alone may be insufficient to strengthen corporate governance in promoting carbon transparency, particularly when substantive influence in strategic decision-making is not captured by the measurement. This study contributes to carbon accounting literature by highlighting the importance of institutional ownership and sustainability committees in enhancing carbon emission disclosure. The findings offer insights for companies, investors, and regulators seeking to strengthen sustainability governance and improve corporate environmental transparency.

Keywords: institutional ownership, sustainability committee, proportion of female directors, carbon emission disclosure, corporate governance.

INTRODUCTION

Climate change has become an increasingly critical global issue because of its extensive impacts on the environment, economy, and human well-being. One of the primary drivers of climate change is global warming caused by the accumulation of greenhouse gases, particularly carbon dioxide generated from fossil fuel consumption, deforestation, and land-use change (Nunes, 2023; Yoro & Daramola, 2020). The Intergovernmental Panel on Climate Change reported that the global average surface temperature has increased by approximately 1.1°C due to human activities (WRI Indonesia, 2023). In 2024, the global mean surface temperature

reached 1.55°C above the pre-industrial level, making it the warmest year in 175 years of observational records and exceeding the 1.5°C threshold established under the Paris Agreement (WMO, 2025). This condition has increased pressure on corporations to demonstrate greater environmental accountability and transparency, particularly through carbon emission disclosure.

Indonesia faces substantial challenges in controlling greenhouse gas emissions. In 2023, Indonesia generated approximately 704.4 million tonnes of carbon dioxide equivalent, making it the sixth-largest carbon-emitting country globally (Energy Institute, 2024). National data also show an increasing trend in greenhouse gas emissions, reaching 1,008,178 gigagrams of carbon dioxide equivalent in 2022 (BPS, 2024). In response, the Indonesian government has strengthened its climate-related policies through Presidential Regulation Number 98 of 2021 concerning the Implementation of Carbon Economic Value and Financial Services Authority Regulation Number 51 of 2017 concerning Sustainable Finance. Financial Services Authority Circular Letter Number 16 of 2021 further requires public companies to disclose environmental performance, including emissions from scope 1, scope 2, and scope 3. Nevertheless, carbon emission disclosure in Indonesia remains largely voluntary (Setiawan et al., 2025; Wahyuningrum et al., 2024). Consequently, disclosure levels remain relatively low, reaching only 47.4% in the energy sector and 22.5% in the manufacturing sector (Candra & Lindrianasari, 2024; Yauri & Widianingsih, 2023).

The importance of carbon emission disclosure is particularly relevant to energy and manufacturing companies because their operational activities contribute substantially to national emissions. Indonesia's First Biennial Transparency Report indicates that the energy sector contributed 53.42% of national emissions in 2022, while energy industries, manufacturing, and transportation accounted for 92.11% of emissions from fuel combustion activities (KLHK, 2024). Corporate environmental impacts are also reflected in cases such as gas flaring at PT Medco E&P Indonesia, which caused air pollution and mass poisoning in East Aceh Rizkyana et al. (2024), as well as the environmental impacts associated with plastic production and waste from major manufacturing companies (Break Free From Plastic, 2024). These conditions increase pressure on companies to measure, manage, and communicate their environmental impacts through carbon accounting and carbon emission disclosure. From the perspective of stakeholder theory, companies are expected to consider the interests and expectations of parties affected by their operations (Tingbani et al., 2020). Meanwhile, legitimacy theory suggests that environmental disclosure enables companies to demonstrate conformity with prevailing social values and maintain social acceptance (Alipour et al., 2019; Kurniawan et al., 2019).

One mechanism that may encourage greater carbon emission disclosure is institutional ownership. Institutional investors possess substantial financial resources, voting rights, and monitoring capabilities, allowing them to influence managerial decisions and corporate policies (Hikal et al., 2025; Yahaya, 2025). Their increasing attention to environmental, social, and governance issues has also strengthened pressure on companies to improve environmental transparency. For example, BlackRock requires portfolio companies to disclose and manage climate-related risks, while First Sentier Investors divested from PT Astra International Tbk after considering the company's carbon footprint and involvement in coal-mining activities (Bose et al., 2024; Munger, 2022). These examples demonstrate that institutional investors can act not only as capital providers but also as external monitoring mechanisms that pressure companies to respond to stakeholder expectations and maintain legitimacy. Institutional investors can encourage carbon emission disclosure by demanding greater transparency and accountability regarding companies' environmental impacts. Accordingly, higher institutional ownership may strengthen pressure on companies to disclose carbon-related information in response to stakeholder expectations (Adam et al., 2024; Bedi & Singh, 2024).

However, empirical findings regarding institutional ownership and carbon emission disclosure remain inconsistent. Abdelrahman Adam Abdalla et al. (2024), Adam et al. (2024), and Bedi & Singh (2024) found that institutional ownership has a positive and significant effect on carbon emission disclosure, indicating that institutional investors may encourage greater environmental transparency. Conversely, Nguyen et al. (2024), Oyerogba et al. (2025), and Wahyuningrum et al. (2024) reported a negative relationship, while Darlis et al. (2020) and Wahyuningrum et al. (2023) no significant effect. These conflicting findings indicate that institutional ownership alone may not sufficiently explain differences in carbon emission disclosure and suggest the need to examine other governance mechanisms and contextual factors.

In addition to external monitoring, sustainability committees represent an internal governance mechanism that may strengthen corporate environmental transparency. A sustainability committee can provide specialized oversight of environmental issues, coordinate sustainability strategies, and monitor corporate environmental performance. Such a mechanism is consistent with stakeholder theory, as it provides a formal structure for incorporating stakeholder interests into corporate decision-making, and with legitimacy theory, as it signals the company's commitment to socially accepted environmental expectations (Driss et al., 2024). Previous studies have shown that companies with sustainability committees are more likely to disclose carbon emissions and demonstrate stronger environmental performance (Biswas et al., 2018; Córdova Román et al., 2021). Nevertheless, sustainability committees remain relatively uncommon among Indonesian companies. Budianto et al. (2025) found that only 34.8% of energy companies had sustainability committees, while Fransisca et al. (2024) reported that only 9.33% of energy and manufacturing companies had established such committees. Moreover, empirical findings remain inconsistent, with several studies reporting a positive effect (Córdova Román et al., 2021; Fransisca et al., 2024; Sulistiyanti & Setiawan, 2025; Toukabri & Mohamed Youssef, 2023), while others found no significant relationship (Amira et al., 2024; Chakraborty & Dey, 2024; Tingbani et al., 2020).

The inconsistent findings concerning institutional ownership and sustainability committees indicate that other corporate characteristics may determine the effectiveness of these governance mechanisms. In this context, the proportion of female directors may serve as an important moderating factor. Female directors are generally associated with greater sensitivity to social and environmental issues, as well as stronger concern regarding reputational and legal risks (Gonenc & Krasnikova, 2022; Hartanto et al., 2021). Female representation may therefore increase board responsiveness to stakeholder demands and strengthen corporate efforts to maintain legitimacy through environmental transparency (Akhter et al., 2023; Zampone et al., 2024). Empirical evidence also suggests that female directors can encourage environmental investment and voluntary carbon emission disclosure (Gonenc & Krasnikova, 2022; Kim, 2022). Furthermore, Budanti et al. (2025) found that female representation strengthens the relationship between institutional ownership and carbon emission disclosure. However, other studies have found no significant effect of female directors on carbon emission disclosure (Khairunnisa et al., 2024; Yesa & Iqbal, 2026). These inconsistent findings suggest that female representation may not automatically translate into greater environmental transparency, particularly when female directors have limited influence over strategic decision-making.

The relevance of female directors is also supported by Sustainable Development Goal 5, particularly Target 5.5, which emphasizes women's participation and leadership in decision-making (United Nations, 2020). However, female representation on corporate boards in Indonesia remains relatively low. A 2021 survey by the Indonesia Business Coalition for Women Empowerment reported that female representation among corporate executives generally ranged from 0% to 10%, while 50% of energy companies had no female directors. This condition raises an important question regarding whether female representation is

sufficient to strengthen the effectiveness of corporate governance mechanisms in promoting environmental transparency. Therefore, examining female directors as a moderating variable is particularly relevant in the Indonesian context, where corporate carbon emission disclosure remains largely voluntary and governance mechanisms are still developing.

The research gap addressed in this study lies in the limited integration of external and internal governance mechanisms with board gender diversity in explaining carbon emission disclosure. Previous studies have generally examined institutional ownership or sustainability mechanisms separately, while research that simultaneously considers sustainability committees and the moderating role of female directors remains limited, particularly among energy and manufacturing companies in Indonesia (Ali et al., 2024; Majid et al., 2023; Rini, 2024). In addition, much of the existing evidence originates from developed countries with more established regulatory and capital market environments, which may limit its applicability to emerging markets such as Indonesia (Hazwani Hassan et al., 2021). Accordingly, this study offers a distinctive contribution by integrating institutional ownership as an external governance mechanism and sustainability committees as an internal governance mechanism while examining whether female board representation strengthens their respective effects on carbon emission disclosure. This integrated perspective provides a more comprehensive understanding of how governance mechanisms and gender diversity interact to promote environmental transparency in a developing-market context.

Based on these considerations, this study aims to examine the effect of institutional ownership and sustainability committees on carbon emission disclosure and to determine whether the proportion of female directors moderates these relationships in energy and manufacturing companies listed on the Indonesia Stock Exchange during 2021–2024. Specifically, this study addresses four research questions: (1) Does institutional ownership affect carbon emission disclosure? (2) Does the sustainability committee affect carbon emission disclosure? (3) Does the proportion of female directors moderate the effect of institutional ownership on carbon emission disclosure? and (4) Does the proportion of female directors moderate the effect of the sustainability committee on carbon emission disclosure? The answers to these questions are expected to contribute to the literature on carbon accounting and provide practical insights for companies, investors, and regulators in strengthening corporate governance and environmental transparency.

Stakeholder theory serves as the grand theory underlying this study. The theory explains that companies are not solely responsible to shareholders but also to various stakeholders whose interests are affected by corporate activities (Tingbani et al., 2020). Therefore, companies are expected to respond to stakeholder demands by providing relevant and transparent information regarding their social and environmental impacts. Legitimacy theory complements this perspective by explaining that companies seek to maintain social acceptance by aligning their activities with prevailing societal values, norms, and expectations. Environmental disclosure, including carbon emission disclosure, can therefore function as a corporate strategy to demonstrate accountability, respond to stakeholder expectations, and maintain legitimacy (Akhter et al., 2023; Werastuti, 2026). These theoretical perspectives provide the basis for examining how corporate governance mechanisms influence carbon emission disclosure.

Institutional ownership is expected to increase carbon emission disclosure because institutional investors have substantial resources and monitoring capabilities that enable them to influence managerial decisions. Institutional investors are also increasingly concerned with environmental, social, and governance issues and long-term corporate value (Bedi & Singh, 2024; Hikal et al., 2025). From the stakeholder perspective, their monitoring pressure encourages companies to respond to environmental information demands, while from the legitimacy perspective, greater transparency can help companies maintain their social acceptance. Empirical evidence supporting this argument is provided by Abdelrahman Adam Abdalla et al. (2024), Adam et al. (2024), and Bedi & Singh (2024) who found a positive

relationship between institutional ownership and carbon emission disclosure. Accordingly, the first hypothesis is formulated as follows:

H1: Institutional ownership has a significant positive effect on carbon emission disclosure.

Sustainability committees are expected to strengthen carbon emission disclosure by providing specialized oversight of corporate sustainability practices. The existence of such committees enables companies to formulate sustainability strategies, monitor environmental performance, and improve the transparency of environmental information (Driss et al., 2024). In accordance with stakeholder theory, sustainability committees provide a formal mechanism for responding to stakeholder concerns, while legitimacy theory suggests that their presence demonstrates the company's commitment to environmental responsibility and social expectations. Previous studies have found that sustainability committees positively influence carbon emission disclosure (Córdova Román et al., 2021; Fransisca et al., 2024; Sulistiyanti & Setiawan, 2025; Toukabri & Mohamed Youssef, 2023). Therefore, the second hypothesis is formulated as follows:

H2: Sustainability committees have a significant positive effect on carbon emission disclosure.

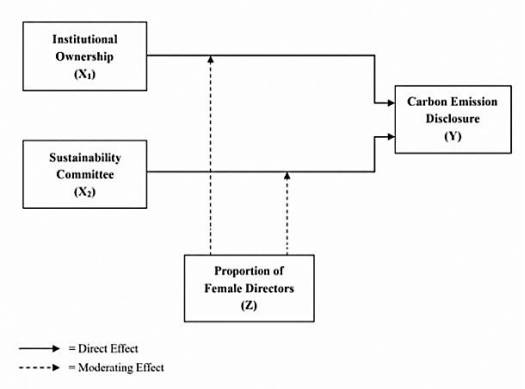
The proportion of female directors is expected to strengthen the influence of institutional ownership on carbon emission disclosure. Female directors may broaden board perspectives and increase sensitivity to social and environmental issues, thereby improving the board's responsiveness to stakeholder demands (Gonenc & Krasnikova, 2022; He et al., 2021). From a legitimacy perspective, female representation can also signal the company's responsiveness to evolving social expectations regarding responsible and inclusive governance (Zampone et al., 2024). When institutional investors exert pressure for greater environmental transparency, the presence of female directors may enhance the board's ability to translate such pressure into environmental disclosure practices. Budanti et al. (2025) provide empirical support by demonstrating that female representation strengthens the relationship between institutional ownership and carbon emission disclosure. Therefore, the third hypothesis is proposed:

H3: The proportion of female directors strengthens the positive effect of institutional ownership on carbon emission disclosure.

The proportion of female directors may also strengthen the influence of sustainability committees on carbon emission disclosure. Female directors may contribute different perspectives to board deliberations and increase attention to environmental and social concerns, potentially enhancing the effectiveness of sustainability-oriented governance mechanisms. In the context of legitimacy theory, female representation may further strengthen the company's efforts to demonstrate conformity with social expectations regarding environmental responsibility and inclusive governance (Akhter et al., 2023; Zampone et al., 2024). Thus, the presence of female directors is expected to enhance the ability of sustainability committees to translate sustainability oversight into more transparent carbon emission disclosure. Based on this reasoning, the fourth hypothesis is formulated as follows:

H4: The proportion of female directors strengthens the positive effect of sustainability committees on carbon emission disclosure.

Based on the theoretical arguments and the proposed hypotheses, this study conceptualizes institutional ownership and sustainability committees as independent variables that influence carbon emission disclosure, while the proportion of female directors is positioned as a moderating variable that strengthens the relationships between the two governance mechanisms and carbon emission disclosure. The conceptual framework is presented in Figure 1. Conceptual Framework



Source: Authors (2026)

Figure 1. Conceptual Framework

METHODS

This study employs a quantitative research approach using secondary data and a deductive design. The research examines energy and manufacturing companies listed on the Indonesia Stock Exchange during 2021–2024. Secondary data were obtained from annual reports and sustainability reports published on the official website of the Indonesia Stock Exchange and the respective company websites. The population consisted of 240 companies that were consistently listed during the observation period. Samples were selected using purposive sampling based on three criteria: companies that published sustainability reports and disclosed carbon emission information based on the Global Reporting Initiative 305 standard, provided institutional ownership information, and had at least one female director during the observation period. Based on these criteria, 40 companies were selected, resulting in 160 firm-year observations.

The dependent variable is carbon emission disclosure, measured using a disclosure index based on the Global Reporting Initiative 305 standard. Each disclosure item is scored one if disclosed and zero otherwise, with a maximum score of 37. Institutional ownership is measured as the proportion of shares held by institutional investors to total outstanding shares, while the sustainability committee is measured using a dummy variable, with one indicating the existence of a sustainability committee and zero otherwise. The moderating variable, the proportion of female directors, is measured as the number of female directors divided by the total number of directors.

Data were collected using documentation and analyzed using panel data regression with Moderated Regression Analysis (MRA) to examine the direct effects of institutional ownership and sustainability committees on carbon emission disclosure and the moderating role of female directors. This method enables the study to assess both the direct effects of institutional ownership and sustainability committees on carbon emission disclosure and the moderating effects of the proportion of female directors on these relationships (Dharmawan et al., 2025). The analysis includes interaction terms between female directors and each independent variable to test the moderating hypotheses. The appropriate panel data model was determined through model selection tests, resulting in the Random Effect Model. To obtain more reliable statistical inference, the regression analysis employed clustered-robust standard errors to account for potential heteroskedasticity and within-cluster correlation in the panel data. This approach provides more robust standard errors and significance tests in the presence of violations of the classical regression assumptions.

RESULTS AND DISCUSSION

The study examines the effects of institutional ownership and sustainability committees on carbon emission disclosure, as well as the moderating role of the proportion of female directors. The sample consists of 40 energy and manufacturing companies listed on the Indonesia Stock Exchange during 2021–2024, resulting in 160 firm-year observations. The

analysis was conducted using panel data regression with the Random Effect Model (REM) and clustered-robust standard errors. The descriptive statistics and hypothesis testing results are presented in Tables 1 and 2.

Table 1. Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Carbon Emission Disclosure (CED, index 0–1)	0.2335	0.1394	0.03	0.62
Institutional Ownership (IO, %)	74.0016	18.3221	3.34	99.69
Sustainability Committee (SC, dummy 0–1)	0.2625	0.4414	0	1
Female Directors (FD, %)	26.4674	13.3773	6.70	66.70

Source: Processed data (2026)

The descriptive statistics indicate that the average carbon emission disclosure (CED) is 0.2335, meaning that the sampled companies disclose approximately 23.35% of the carbon emission disclosure index, equivalent to about 8 of the 37 items. The disclosure level is therefore relatively low, with values ranging from 0.03 to 0.62. This indicates that substantial differences remain in the extent of carbon-related information disclosed by energy and manufacturing companies. Institutional ownership has a relatively high mean of 74.0016%, indicating that institutional investors hold a substantial proportion of shares in the sampled companies. Meanwhile, only 26.25% of the observations have a sustainability committee, as indicated by the mean value of 0.2625. The proportion of female directors averages 26.47%, with 65.6% of observations having female directors representing less than 30% of the board. These characteristics indicate that institutional ownership is relatively dominant, whereas formal sustainability governance and female representation remain comparatively limited.

Before conducting the hypothesis testing, several classical assumption tests were performed to assess the suitability of the regression model. The multicollinearity test indicated that all Variance Inflation Factor (VIF) values were below the commonly accepted threshold of 10, suggesting that multicollinearity was not present in the model. However, the white test indicated the presence of heteroskedasticity, with a probability value of 0.0006, while the wooldridge test for panel data indicated the presence of autocorrelation, with a probability value of 0.0013. Therefore, to address these violations and obtain more reliable statistical inference, the regression analysis was estimated using the Random Effects Model (REM) with clustered-robust standard errors. This approach allows the standard errors to account for within panel dependence and heteroskedasticity, thereby improving the reliability of the hypothesis testing.

Table 2. Regression and Moderation Results

Variable	Coefficient	Probability	Decision	Decision
Institutional Ownership (IO)	0.0021072	0.001	H1 Supported	Institutional Ownership (IO)
Sustainability Committee (SC)	0.1440855	0.000	H2 Supported	Sustainability Committee (SC)
IO × Female Directors (FD)	-0.0000132	0.787	H3 Not Supported	IO × Female Directors (FD)
SC × Female Directors (FD)	-0.0016469	0.217	H4 Not Supported	SC × Female Directors (FD)
Overall R^2 - Moderation Model	0.2582			Overall R^2 – Moderation Model

Source: Processed data (2026)

The regression results show that institutional ownership has a positive and significant effect on carbon emission disclosure, with a coefficient of 0.0021072 and a probability value

of 0.001. Therefore, H1 is supported. The average institutional ownership of 74.00% suggests that institutional investors hold a substantial position in the ownership structure of the sampled companies, potentially enabling them to exert monitoring pressure on management to improve environmental transparency.

This finding can be explained by Stakeholder Theory, which views institutional investors as influential stakeholders because of their economic power, voting rights, and monitoring capabilities (Hikal et al., 2025; Yahaya, 2025). Institutional investors may encourage companies to disclose carbon-related information through shareholder engagement, dialogue with management, and strategic pressure to integrate sustainability into corporate policies (Cohen et al., 2023; Hikal et al., 2025). In certain circumstances, investors may also withdraw their investments when companies fail to meet their sustainability expectations, as illustrated by First Sentier Investors' divestment from PT Astra International Tbk amid concerns about its carbon footprint and coal-mining involvement (Munger, 2022).

From the perspective of Legitimacy Theory, carbon emission disclosure enables companies to demonstrate environmental accountability and maintain social acceptance. Institutional investors can reinforce this incentive by demanding greater transparency regarding corporate environmental impacts (Bedi & Singh, 2024; Yahaya, 2025). Nevertheless, the positive effect of institutional ownership does not imply that overall disclosure levels are high. The average carbon emission disclosure score is only 23.35% of the 37 indicators based on GRI 305, suggesting that companies disclose only part of the information covered by these indicator of the information covered by these indicators. This condition may reflect the relatively voluntary nature of carbon emission reporting in Indonesia (Harits & Mutasowifin, 2024; Sulistiyanti & Setiawan, 2025; Wahyuningrum et al., 2025). Thus, institutional ownership is associated with greater carbon transparency, although the overall level of disclosure remains limited. This finding is consistent with Abdelrahman Adam Abdalla et al. (2024) and Adam et al. (2024), who found a positive and significant relationship between institutional ownership and carbon emission disclosure.

The sustainability committee also has a positive and significant effect on carbon emission disclosure. The coefficient of 0.1440855 with a probability value of 0.000 indicates that companies with a sustainability committee tend to have higher levels of carbon emission disclosure than companies without such a committee. Thus, H2 is supported. The descriptive results show that only 26.25% of the observations have a sustainability committee, indicating that this governance mechanism is not yet widely adopted among the sampled companies. Nevertheless, its significant coefficient demonstrates that the existence of a formal sustainability governance structure is associated with greater carbon transparency.

The positive effect of sustainability committees can be explained by their formal role in overseeing sustainability strategies, environmental risks, and related disclosure practices. In the stakeholder perspective, sustainability committees provide an internal governance mechanism through which companies can respond to increasing demands from investors, regulators, communities, and other stakeholders for environmental transparency. From the legitimacy perspective, the establishment of such committees signals organizational commitment to sustainability and can support the company's efforts to maintain social legitimacy. This finding is consistent with Córdova Román et al. (2021), Driss et al. (2024), and Sulistiyanti & Setiawan (2025), who find that sustainability or environmental committees are positively associated with carbon or environmental disclosure.

The proportion of female directors does not significantly moderate the relationship between institutional ownership and carbon emission disclosure, as indicated by the interaction coefficient of −0.0000132 and a probability value of 0.787. Therefore, H3 is not supported. This finding suggests that female representation does not significantly strengthen or weaken the association between institutional ownership and carbon emission disclosure.

Theoretically, female directors may contribute greater sensitivity to social and environmental issues, potentially strengthening corporate responses to stakeholder demands (Gonenc & Krasnikova, 2022). However, institutional investors may exert more direct influence through their economic power, voting rights, shareholder engagement, and monitoring activities (Hikal et al., 2025; Yahaya, 2025). Consequently, female representation may not provide an additional influence strong enough to alter the relationship between institutional ownership and carbon emission disclosure.

One possible explanation is the relatively limited representation of women on corporate boards. The average proportion of female directors is 26.47%, while 65.6% of the observations have female representation below 30%. From the perspective of Critical Mass Theory and tokenism, limited representation may constrain women's ability to influence board discussions, build consensus, and shape strategic decisions (De Masi et al., 2021; Kanter, 1977). Moreover, female representation does not necessarily reflect substantive authority in corporate decision-making. Accordingly, the presence of female directors may not automatically translate into stronger environmental disclosure practices. This finding differs from Budanti et al. (2025) and Ma'wa & Setiawan (2025) but is consistent with Khairunnisa et al. (2024) and Yesa & Iqbal (2026) who found that female representation did not significantly influence carbon emission disclosure.

The proportion of female directors does not significantly moderate the relationship between sustainability committees and carbon emission disclosure. The interaction coefficient is −0.0016469, with a probability value of 0.217. Therefore, H4 is not supported. This result indicates that the positive association between sustainability committees and carbon emission disclosure does not significantly depend on the proportion of female directors.

Although female directors are theoretically associated with greater sensitivity to social and environmental issues, such characteristics may not translate into greater influence without sufficient representation and decision-making authority (Gonenc & Krasnikova, 2022). In this study, the average proportion of female directors is 26.47%, and 65.6% of the observations have female representation below 30%. According to Critical Mass Theory, limited representation may constrain women's ability to influence discussions, build consensus, and shape strategic corporate decisions (De Masi et al., 2021). Furthermore, the presence of female directors does not necessarily indicate that they occupy strategic positions with direct authority over sustainability policies.

These conditions suggest that the effectiveness of sustainability committees may depend more on their formal responsibilities and authority in overseeing sustainability strategies and environmental disclosure than on the numerical representation of female directors. In other words, female directors' sensitivity to sustainability issues may be insufficient to strengthen the committee's influence when their structural position and decision-making authority remain limited. This finding differs from Gonenc & Krasnikova (2022) and Ma'wa & Setiawan (2025), but is consistent with Khairunnisa et al. (2024) and Yesa & Iqbal (2026), who found no significant effect of female representation on carbon emission disclosure.

Overall, the moderation model has an R^2 of 0.2582, indicating that the variables included in the model explain 25.82% of the variation in carbon emission disclosure. The findings demonstrate that institutional ownership and sustainability committees have positive and significant effects on carbon emission disclosure, whereas the proportion of female directors does not significantly moderate either relationship.

The novelty of this study lies in integrating institutional ownership as an external governance mechanism and sustainability committees as an internal governance mechanism while examining female board representation as a moderating factor in Indonesian energy and manufacturing companies. The results suggest that institutional monitoring and formal sustainability oversight are associated with greater carbon transparency, whereas female representation alone does not provide a significant additional moderating effect. This study

extends the carbon accounting literature by highlighting the importance of governance mechanisms and the distinction between numerical gender representation and substantive influence in corporate decision-making.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study concludes that institutional ownership and sustainability committees have positive and significant effects on carbon emission disclosure among energy and manufacturing companies listed on the Indonesia Stock Exchange during 2021–2024. However, the proportion of female directors does not significantly moderate either relationship. These findings suggest that institutional monitoring and formal sustainability oversight are associated with greater carbon transparency, whereas female board representation alone does not provide a significant additional moderating effect. Although institutional ownership is relatively high, the average carbon emission disclosure score remains low at 23.35% of the 37 GRI 305 indicators, indicating that opportunities to improve environmental transparency remain substantial. The findings contribute to the carbon accounting literature by highlighting the importance of effective governance mechanisms and the distinction between numerical gender representation and substantive influence in corporate decision-making.

Limitations

This study has several limitations. First, the sample is limited to energy and manufacturing companies listed on the Indonesia Stock Exchange during 2021–2024, which may limit the generalizability of the findings to other sectors and countries. Second, the model examines institutional ownership, sustainability committees, and female director representation, while other potential determinants of carbon emission disclosure are not included. Third, female director representation is measured numerically and does not capture directors' strategic positions, decision-making authority, or involvement in sustainability governance. In addition, the relatively limited variation in female representation should be considered when interpreting the insignificant moderation results. Future research could address these limitations by expanding the sample and observation period, incorporating additional variables, and examining the substantive roles and authority of female directors in corporate sustainability governance.

Recommendations

Based on the findings, companies are encouraged to improve the completeness and consistency of carbon emission disclosure in accordance with GRI 305 and strengthen the role of sustainability committees in overseeing environmental strategies and reporting practices. Companies that have not established sustainability committees may consider adopting them as part of good corporate governance. Furthermore, female representation should be accompanied by meaningful participation and adequate authority in strategic sustainability-related decisions rather than being assessed solely by the number of female directors.

Investors are encouraged to use their monitoring and engagement capabilities to promote greater corporate environmental transparency. Regulators may also consider strengthening carbon reporting guidance to improve the consistency, comparability, and accountability of corporate disclosures. Future researchers are encouraged to examine additional determinants of carbon emission disclosure and use more comprehensive measures of female directors' roles, such as strategic positions, sustainability expertise, and participation in sustainability committees. Further research could also assess sustainability committee characteristics, including committee size, meeting frequency, independence, and members' expertise, to provide deeper insights into the effectiveness of sustainability governance.

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