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ENVIRONMENTAL PERFORMANCE, CARBON PERFORMANCE, AND GREEN INNOVATION: IMPACT ON CARBON EMISSION DISCLOSURE

Khalisah Oktavia[1], Husnah Nur Laela Ermaya[2]*
[1]khalisahoktavia@gmail.com, [2]husnah_ermaya@upnvj.ac.id
[1,2]Universitas Pembangunan Nasional "Veteran" Jakarta, Indonesia
*corresponding author

Abstract

This study was designed to empirically test the influence of environmental performance, carbon performance, and green innovation on carbon emission disclosure with profitability and firm age as control variables. The research was conducted on companies in the basic materials sector listed on the Indonesia Stock Exchange during the 2022-2024 period with a total sample of 96 observations from 32 companies. This study used a quantitative approach with multiple linear regression analysis using STATA v.17 software. This study found that environmental performance and green innovation have a positive effect on carbon emission disclosure, but carbon performance has no effect on carbon emission disclosure. In addition, the control variables show that profitability has no effect on carbon emission disclosure, while firm age has a positive effect.

Keywords: Carbon Emission Disclosure; Environmental Performance; Carbon Performance; Green Innovation.

Abstrak

Penelitian ini dilakukan betujuan menguji secara empiris pengaruh environmental performance, carbon performance, dan green innovation terhadap carbon emission disclosure dengan variabel kontrol profitability dan firm age. Penelitian dilakukan pada perusahaan sektor basic materials yang terdaftar di Bursa Efek Indonesia periode 2022-2024 dengan total sampel observasi sejumlah 96 dari 32 perusahaan. Penelitian ini menggunakan pendekatan kuantitatif dengan metode analisis regresi linier berganda dengan bantuan software STATA v.17. Penelitian ini memberikan hasil berupa environmental performance dan green innovation berpengaruh positif terhadap carbon emission disclosure, tetapi carbon performance tidak berpengaruh terhadap carbon emission disclosure. Selain itu, variabel kontrol profitability tidak berpengaruh terhadap carbon emission disclosure, sedangkan firm age berpengaruh positif.

Kata Kunci: *Carbon Emission Disclosure; Environmental Performance; Carbon Performance; Green Innovation.*

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INTRODUCTION

Climate change is an urgent issue that poses significant threats to the sustainability of both human life and the environment. At present, regulators and stakeholders increasingly demand the disclosure of non-financial information within the business sector as a demonstration of commitment to addressing climate-related challenges. Such disclosures encompass internal reporting, integrated reporting, sustainability accounting practices, as well as carbon emissions reporting (Mardini & Lahyani, 2024). This is attributable to the fact that industrial and commercial activities, whether directly or indirectly, generate carbon emissions that serve as primary contributors to global warming and climate change, thereby adversely affecting ecosystems and human life (Muarif, 2024). In the context of sustainability accounting and Environmental, Social, and Governance (ESG) reporting, carbon emission disclosure serves as an important mechanism for enhancing transparency, accountability, and the quality of information available to investors and stakeholders regarding corporate environmental performance and climate-related risks.

Regulations concerning carbon emissions as a global environmental issue were formally established through the adoption of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 (Ayuningsih et al., 2023). As a manifestation of its commitment to addressing the consequences of climate change, Indonesia has also participated by signing the UNFCCC in 1992 and ratifying both the Kyoto Protocol and the Paris Agreement as part of its mitigation and adaptation efforts. Furthermore, Presidential Regulation No. 98 of 2021 requires business entities to conduct and report greenhouse gas emission inventories, while Financial Services Authority Regulation (POJK) No. 51/POJK.03/2017 obliges listed companies and financial institutions to prepare sustainability reports annually. In this context, carbon emissions reporting constitutes a component of Corporate Social Responsibility (CSR) disclosure within sustainability reporting.

Despite the proliferation of regulations requiring companies to disclose carbon emissions, in practice, a considerable number of firms both publicly listed and privately held, at the global level as well as in Indonesia have yet to report or publicly disclose information related to their carbon emissions (Doloksaribu et al., 2024). The Global Reporting Initiative (GRI), through its report Climate Reporting in ASEAN: State of Corporate Practice, indicates that the level of climate-related reporting among Indonesian companies stands at only 44%. This condition is particularly concerning when associated with the increasing trend of carbon emissions at both global and national levels in recent years. According to the Intergovernmental Panel on Climate Change (IPCC), the rise in greenhouse gas emissions since the mid-20th century is projected to drive an increase in global temperatures of up to 1.5°C between 2030 and 2050 compared to the pre-industrial period of 1850–1900, which refers to the era prior to the onset of the Industrial Revolution. Meanwhile, a report from International Energy Agency (2025) reported that global CO_2 emissions increased by 0.8%, reaching 37.8 gigatons (Gt) in 2024, thereby setting a new record high.

At the national level, Indonesia ranked as the seventh-largest contributor to global carbon dioxide emissions as of 2022. The manufacturing industry remains

one of the largest contributors to greenhouse gas emissions, with the basic materials sector playing a substantial role in emission generation (Badan Pusat Statistik, 2025). Furthermore, Indonesia's decarbonization agenda increasingly prioritizes hard-to-abate industries such as cement, steel, and petrochemicals because these sectors are considered strategic industries with high emission intensity and significant transition risks.

In the latest case, PT Gunung Raja Paksi Tbk, a steel company, has reportedly generated emissions containing hazardous substances such as nitrogen dioxide (NO_2), sulfur compounds, and PM 2.5, which have caused respiratory problems among surrounding communities. Despite public protests and complaints submitted to relevant authorities, both the company and the government have yet to demonstrate significant corrective actions or transparent accountability regarding these environmental impacts (Maulana, 2025). In other case, PT Pindo Deli 3 operational activities were stopped by the Ministry of Environment and Forestry (KLHK) because did not comply the technical provisions regarding fly ash and bottom ash (FABA) dumping activities (Dwi, 2023). The low level of carbon emission disclosure in the basic materials sector indicates that many companies still provide limited transparency regarding their environmental impacts, emission reduction targets, and mitigation strategies. This lack of disclosure may reduce the relevance and reliability of sustainability information needed by investors and stakeholders in assessing corporate environmental risks and long-term sustainability performance. Therefore, identifying factors that influence corporate carbon emission disclosure becomes increasingly important, particularly in industries with substantial environmental impacts.

Environmental performance is widely considered one of the key determinants of carbon emission disclosure (Meiryani et al., 2023). In the research conducted by Budianto et al. (2025) and Priliana & Ermaya (2023) reveals that environmental performance has a positive effect on carbon emission disclosure. Meanwhile, a study conducted by Wiguna et al. (2025), Faisal & Pratama (2024) and Rahman & Mujiyati (2024) reports that there is no significant effect of environmental performance on carbon emission disclosure.

In addition to environmental performance, the level of a company's carbon emission intensity also plays an important role in carbon emission disclosure. Mardini & Lahyani (2024), Putri & Arieftiara (2023), Ladista et al. (2023) and Bui et al. (2020) provides evidence that carbon performance has an effect on carbon emission disclosure, indicating that companies with strong carbon performance are able to deliver more comprehensive carbon emission disclosures. However, these findings are inconsistent with those reported by Wiguna et al. (2025), Rahman & Mujiyati (2024), Priliana & Ermaya (2023), and Ratmono et al. (2021) which states that the level of a company's carbon emissions does not influence its decision to disclose carbon emissions.

Furthermore, carbon emission disclosure is also commonly influenced by a company's internal strategies, one of which is green innovation. Companies that develop green innovations are more likely to communicate such achievements through carbon emission disclosure as evidence of their credibility, capability, and commitment to sustainability (Jia & Takeuchi, 2023). Study by Sari et al. (2024) and García-Sánchez et al. (2021) states that green innovation has an effect on carbon

emission disclosure, while a study conducted by Ladista et al. (2023) and Jia & Takeuchi (2023) shows the opposite results.

Although prior studies have examined factors affecting carbon emission disclosure, several research gaps remain. Previous findings regarding the effects of environmental performance, carbon performance, and green innovation remain inconsistent. In addition, studies focusing specifically on high-emission industries, particularly the basic materials sector in Indonesia, are still limited, despite the sector's strategic role in national decarbonization efforts. Furthermore, most prior studies measured carbon emission disclosure using the framework developed by Choi et al. (2013), while the the Global Reporting Initiative (GRI) Standard 305 as a emissions disclosure measurements remains relatively limited, despite its broader recognition as a comprehensive disclosure standard.

This research extends the study conducted by Rahman & Mujiyati (2024) by employing GRI Standard 305 as different measurements of carbon emission disclosure. Also, carbon performance is measured by comparing the carbon performance of the current year with that of the preceding year. In addition, this research introduces a novel contribution by incorporating green innovation as a variable, considering its theoretical relevance and alignment with carbon emission disclosure, as well as the limited number of studies in Indonesia addressing this topic. From an empirical perspective, this research examines companies in the basic materials sector listed on the Indonesia Stock Exchange (IDX), as this sector comprises industries such as cement, ammonia, iron, and steel, which have significantly contributed to the increase in emissions in recent years (Lu et al., 2024). Companies within the basic materials sector are the primary contributors to carbon emissions and remain a central target of national decarbonization programs. The sector is also part of the manufacturing industry, which as reported by Badan Pusat Statistik (2025) is identified as the largest contributor to emissions in Indonesia,

Based on these considerations, this research aims to empirically examine: (1) the effect of environmental performance on carbon emission disclosure; (2) the effect of carbon performance on carbon emission disclosure; and (3) the effect of green innovation on carbon emission disclosure in basic materials companies listed on the Indonesia Stock Exchange. Through this investigation, the study is expected to provide insights for regulators, investors, and corporate management regarding the determinants of carbon emission disclosure and the importance of improving transparency in high-emission industries.

LITERATURE REVIEW

Legitimacy Theory

Legitimacy theory explains that organizations seek to establish alignment between the social values associated with, or implied by, their activities and the norms of acceptable behavior within the broader social system in which they operate (Dowling & Pfeffer, 1975). Environmental disclosure serves as one of the means through which organizations seek to obtain legitimacy (Berthelot & Robert, 2011). In the context of environmental issues, corporate legitimacy is closely related to how companies respond to increasing public concern regarding climate change,

environmental degradation, and greenhouse gas emissions. Companies that are perceived as contributing negatively to environmental sustainability may experience legitimacy pressure from society, regulators, investors, and other stakeholders.

Carbon emission disclosure becomes one of the strategic mechanisms used by companies to maintain and strengthen legitimacy. Through such disclosure, companies communicate their environmental responsibilities, environmental management efforts, and commitments to reducing carbon emissions. The disclosure therefore functions not only as a reporting activity but also as a tool to demonstrate that the company's operations remain consistent with societal expectations regarding environmental sustainability.

Legitimacy theory is relevant in explaining the relationship between environmental performance, carbon performance, and carbon emission disclosure. Companies with strong environmental performance are more likely to disclose carbon emission information because such disclosure reinforces public perception that the company has fulfilled its environmental responsibilities (Budianto et al., 2025). Meanwhile, legitimacy theory explains the relationship between carbon performance and the level of disclosure that should be undertaken as a form of corporate responsibility to the public (Ratmono et al., 2021).

Stakeholder Theory

Stakeholder theory is a concept that refers to the need for organizations to manage relationships with various stakeholder groups. Stakeholders are defined as any group or individual that can affect or be affected by the objectives of the organization, and each of these groups plays a significant role in the success of business enterprises in the contemporary environment (Freeman, 1984). Stakeholders such as governments, investors, customers, communities, environmental organizations, and the media increasingly demand transparency regarding corporate environmental impacts, particularly those related to carbon emissions and climate change. In response to these pressures, companies are encouraged to provide environmental information to the company's stakeholders (Syafik et al., 2025). Carbon emission disclosure therefore represents a form of corporate accountability to stakeholders by providing transparency regarding emission levels, environmental risks, and mitigation efforts undertaken by the company. In this context, disclosure is considered essential to fulfill standards and responsibilities by providing relevant information.

Increasing demands from various stakeholders that emphasize the importance of environmental sustainability encourage companies to take initiatives in developing sustainable innovations aimed at reducing negative environmental impacts through environmentally friendly approaches, including production processes, product design, and the use of clean technologies (García-Sánchez et al., 2021). Consequently, carbon emission disclosure becomes an important communication medium to demonstrate that the company is responding to stakeholder expectations concerning environmental responsibility and sustainable business practices.

Signaling Theory

Signaling theory was first introduced by Spence (1973) in his article entitled "Job Market Signaling." This theory explains that companies possessing superior

information tend to communicate such information to external parties in order to reduce information asymmetry. In the context of greenhouse gas emissions disclosure, the adoption of renewable energy, and waste management practices, companies that engage in such activities aim to minimize information asymmetry between the firm and its stakeholders. (Emmanuel et al., 2024). Bui et al. (2020) states companies that improve their environmental performance have incentives to provide greater disclosure in order to highlight their efforts. Since information regarding actual performance cannot be directly observed by external parties, firms tend to convey positive signals to stakeholders through the disclosures they make (Datt et al., 2019).

Signaling theory is particularly relevant in explaining the role of green innovation in encouraging carbon emission disclosure. Green innovation reflects the company's capability to develop environmentally friendly products, processes, and technologies that support sustainability objectives. The innovation becomes a positive signal indicating that the company possesses long-term strategic commitment, operational capability, and environmental awareness. Consequently, companies engaging in green innovation are more likely to disclose carbon emission information to strengthen stakeholder confidence regarding the credibility and sustainability quality of the company.

Carbon Emission Disclosure

Carbon emission disclosure is defined as a form of environmental reporting that contains information related to the measurement, recognition, and presentation of carbon emissions (Ladista et al., 2023). Carbon emission disclosure is part of Corporate Social Responsibility (CSR) reporting, which is presented in both annual reports and sustainability reports, providing information on the total carbon emissions generated by a company as well as how the company manages and mitigates the impacts arising from those emissions.

Carbon emission disclosure enables companies to communicate their environmental accountability and demonstrate responsiveness to stakeholder demands for greater environmental transparency. In addition, disclosure practices may help companies strengthen legitimacy, improve corporate reputation, and reduce information asymmetry between management and stakeholders. Accordingly, carbon emission disclosure is not merely a compliance mechanism but also a strategic communication tool reflecting the company's environmental commitment.

Environmental Performance

Environmental performance is a concept that reflects the impact a company has on the natural environment and its efforts to reduce the negative effects it generates (Dragomir, 2018). Good environmental performance indicates that the company is capable of implementing environmental management practices effectively and fulfilling its environmental responsibilities.

Companies with strong environmental performance tend to disclose environmental information more extensively because such disclosure supports the company's efforts to maintain legitimacy and demonstrate accountability to stakeholders. Moreover, companies that successfully manage environmental issues are more confident in communicating their environmental achievements publicly through carbon emission disclosure.

Carbon Performance

As cited from Velte et al. (2020) in the study by Priliana & Ermaya (2023), carbon performance refers to managerial activities related to carbon emissions, particularly concerning the quantification of greenhouse gas (GHG) emissions that have the potential to drive climate change, as well as the various actions undertaken by companies to reduce these emission levels. The management and measurement of carbon emissions are therefore essential for companies as part of their environmental responsibility and business sustainability. Failure to fulfill such responsibilities may lead the public to perceive that management lacks awareness or concern regarding climate change issues, and may also indicate the absence of a clear strategy to mitigate carbon-related risks and reduce emission levels (Luo et al., 2012). From the perspective of legitimacy theory, under such conditions, companies may become reluctant to disclose carbon emission information comprehensively due to concerns that the disclosed information could attract negative public attention, damage corporate reputation, or increase stakeholder pressure.

Green Innovation

Green innovation is defined as hardware or software innovation related to green products or processes, including technological innovations associated with energy efficiency, pollution prevention, waste recycling, green product design, and corporate environmental management (Chen et al., 2006). The presence of green innovation within a company indicates effort to meet stakeholder demands related to climate change issues. More importantly, green innovation can simultaneously enhance the company's productivity (Xu et al., 2021). Other reasons that encourage companies to adopt green innovation include reducing environmental risks and impacts, improving resource efficiency, enhancing reputation, responding to market pressures, increasing supplier engagement, alleviating social pressures, and gaining a competitive advantage (García-Sánchez et al., 2021).

From the perspective of signaling theory, green innovation acts as a positive signal indicating that the company possesses strong environmental capability, long-term orientation, and commitment to sustainable business practices. Through carbon emission disclosure, companies communicate these innovations to stakeholders in order to strengthen corporate reputation, enhance stakeholder trust, and differentiate themselves from competitors with weaker environmental initiatives.

Environmental Performance on Carbon Emission Disclosure

Environmental performance reflects a company's response to environmental conditions (Solikhah et al., 2021). To ensure the continuity of its business operations in a sustainable manner, a company must assume responsibility for its surrounding environment. Strong environmental performance can foster a company's awareness to provide assurance to the public that it has contributed to mitigating climate change impacts and minimizing global warming (Hidayat et al., 2022). Environmental performance has strong relevance to legitimacy theory, which emphasizes that companies must align with societal norms, values, and expectations, as society grants a form of social license for companies to operate. Such legitimacy can only be maintained if companies demonstrate behavior that is consistent with public standards and expectations.

The findings of studies by Jannah & Narsa (2021), Hidayat et al. (2022), Priliana & Ermaya (2023), Meiryani et al. (2023), Maryono & Ermawati (2024), and Budianto et al. (2025) indicating that environmental performance has a positive effect on carbon emission disclosure, further strengthening this argument; thus, the following hypothesis can be formulated:
H1: Environmental performance has a positive effect on carbon emission disclosure

Carbon Performance on Carbon Emission Disclosure

Activities related to carbon emission management and calculation need to be carried out by companies as part of their environmental responsibility and business sustainability. A high level of carbon emissions indicates poor carbon performance, as it reflects inefficient use of resources (Putri & Arieftiara, 2023). Thus, it can be stated that a positive value of carbon emission intensity indicates poor performance, which in turn reduces a company's willingness to engage in carbon emission disclosure. Conversely, a negative value of carbon emission intensity reflects strong performance, thereby increasing a company's willingness to disclose carbon emissions.

From the perspective of legitimacy theory, poor carbon performance may increase legitimacy pressure from stakeholders because high emission levels are considered inconsistent with societal expectations concerning environmental sustainability. Under these circumstances, companies may limit carbon emission disclosure to avoid negative stakeholder reactions, reputational damage, or increased public scrutiny regarding environmental impacts. This is consistent with the findings of Bui et al. (2020) and Putri & Arieftiara (2023) which state that carbon performance has a negative effect on carbon emission disclosure. Based on this explanation, the proposed hypothesis is as follows:
H2: Carbon performance has a negative effect on carbon emission disclosure

Green Innovation on Carbon Emission Disclosure

As evidence of a company's credibility, capability, and sustainability commitment through innovations aimed at reducing carbon emissions, firms will communicate the success of their innovations through carbon emission disclosure (Jia & Takeuchi, 2023). Therefore, companies that engage in green innovation tend to become more confident in disclosing carbon emissions. This is consistent with stakeholder theory, which states that firms or entities have an obligation to maintain relationships and meet the needs of owners, government, local communities, shareholders, customers, suppliers, competitors, employees, the media, and other interest groups. Furthermore, signaling theory explains that green innovation serves as a positive signal regarding the company's environmental capability, credibility, and long-term sustainability orientation. Through carbon emission disclosure, companies communicate the success of their green innovations to reduce information asymmetry and strengthen stakeholder confidence regarding corporate environmental quality.

This statement is consistent with the findings of Sari et al. (2024) and Maharani & Dewi (2024) which examined the effect of green innovation on carbon emission disclosure and found a positive relationship. Accordingly, the higher the level of green innovation implemented by a company, the greater the incentive to

disclose carbon emissions transparently. Based on this explanation, the following hypothesis can be formulated:
H3: Green innovation has a positive effect on carbon emission disclosure

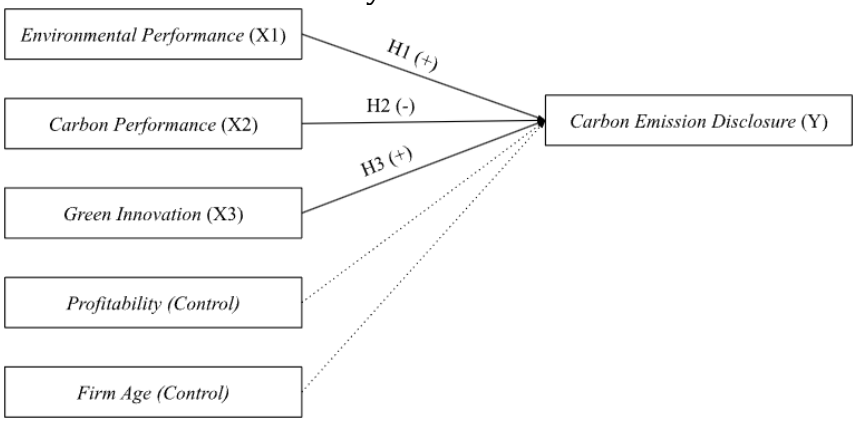
Control Variable

1. Profitability

   A company's ability to generate profit or earnings is referred to as profitability (Aryni et al, 2021). Profitable companies tend to disclose more environmental information to maintain their reputation, strengthen stakeholder confidence, and signal that the company is capable of achieving both economic performance and environmental responsibility simultaneously
2. Firm Age

   Firm age refers to a measure used to determine whether a company is newly established or has been in operation for a long period (Jannah & Narsa, 2021). In the context of carbon emission disclosure, older firms are more likely to disclose environmental information extensively because higher public visibility and greater pressure to maintain legitimacy and corporate reputation.

The research model in this study is as follows:



Source: Processed by the author (2025)

RESEARCH METHODOLOGY

In this study, hypothesis testing is conducted using multiple linear regression analysis. The purpose of this analysis is to measure the strength of the relationships among the variables under study as well as to determine the direction of the effect between the independent variables and the dependent variable. This study uses data comprising several variables, including the dependent variable, namely carbon emission disclosure, and the independent variables, namely environmental performance, carbon performance, and green innovation. In addition, there are control variables, namely profitability and firm age. Accordingly, the regression model applied in the hypothesis testing of this study is presented as follows:

$$CEDit = \alpha + \beta 1ENVit - \beta 2CEIit + \beta 3GIit + \beta 4\,PROit + \beta 5\,AGEit + eit$$

Notes:
CED : Carbon Emission Disclosure
α : Constant
β : Regression coefficient
i : Entity
t : Period
ENV : Environmental Performance
CEI : Carbon Performance
GI : Green Innovation
PRO : Profitability
AGE : Firm Age
e : Error

Table 1. Operational Definitions and Measurement of Variables

Variable	Indicator	Formula
Carbon Emission Disclosure (Y)	A form of environmental reporting that encompasses information pertaining to the measurement, recognition, and disclosure of carbon emissions. (Ladista et al., 2023). This measurement was also chosen because companies in Indonesia follow GRI criteria in terms of environmental disclosure, particularly carbon emissions (Yuliana & Wedari, 2023).	$CED = \frac{The\ total\ score\ disclosed\ by\ the\ company}{Total\ maximum\ score\ (7\ item)}$ Item Disclosure: - 305-1 Direct greenhouse gas (GHG) emissions (Scope 1) - 305-2 Indirect greenhouse gas (GHG) emissions from energy consumption (Scope 2) - 305-3 Other indirect greenhouse gas (GHG) emissions (Scope 3) - 305-4 Greenhouse gas (GHG) emission intensity - 305-5 Efforts to reduce greenhouse gas (GHG) emissions - 305-6 Ozone-depleting substances (ODS) emissions - 305-7 Nitrogen oxides (NOx), sulfur oxides (SOx), and other significant air pollutant emissions
Environmental Performance (X1)	A term related to how well an organization or company manages environmental aspects associated with its activities, products, services, and their impacts on the environment (Hidayat et al., 2022). The reason for using PROPER is because this program was developed by the Ministry of Environment since 1995 as an external assessment mechanism aimed at stimulating companies to be more responsible in	PROPER Ranking

	environmental management (Hidayat et al., 2022). PROPER not only evaluates management systems, but also the actual performance of companies in the field as stated in the Regulation of the Minister of Environment/Environmental Management Agency of the Republic of Indonesia Number 7 of 2025.	
Carbon Performance (X2)	Managerial activities focused on carbon emissions, particularly regarding the quantification of greenhouse gas (GHG) emissions that may contribute to climate change, as well as the actions taken by companies to reduce these emission levels (Priliana & Ermaya, 2023). This measurement proxy was chosen because it indicates management's ability to manage and optimize all the resources available in the company (Luo & Tang, 2014). On the other hand, the comparison between the research year and the previous year can provide a more comprehensive picture of the development and consistency of the company's performance in managing carbon emissions over time.	$CEI = \frac{Total\ carbon\ emission\ t\ year}{Total\ sales\ t\ year} - \frac{Total\ carbon\ emission\ t-1\ year}{Total\ sales\ t-1\ year}$
Green Innovation (X3)	Green innovation refers to innovation undertaken by a company to create competitive advantages while simultaneously	$GI = \frac{Total\ Green\ Innovation}{Total\ Maximum\ Item}$ (8) Indikator: Green Process Innovation - PROC1. The company has the goal of reducing the consumption of resources

	reducing environmental damage, thereby generating economic benefits (Sari et al., 2024). Measurement of the green innovation variable in this study adopts the indicators of (Xie et al., 2019) by conducting content analysis in the company's annual report or sustainability report, as the indicators employed were developed based on theoretical and empirical considerations derived from previous studies on green innovation. These indicators represent the two primary dimensions of green innovation widely recognized in the international literature, namely green product innovation and green process innovation. Furthermore, these indicators have been extensively utilized in prior studies in Indonesia, thereby supporting their relevance and suitability for measuring environmentally friendly innovations implemented by companies.	and energy used and also increasing the efficiency of resources and energy. - PROC2. The company uses recycled materials, recycling techniques, and environmentally friendly technology. - PROC3. The company conducts environmental campaigns. - PROC4. The company uses equipment to manage pollution. - PROC5. The company adopts projects and technology in the context of pollution control. Green Product Innovation - PROD1. The company makes changes to product design by avoiding pollutant or toxic compounds. - PROD2. The company improves and designs existing or new products using environmentally friendly packaging. - PROD3. The company makes product design modifications in order to improve energy efficiency during its use..
Profitability (Control Variable)	The profitability measurement in this study uses the return on assets (ROA) ratio, as it reflects management's ability to manage and optimize all available company resources. This measure is considered a more reliable indicator of profitability, as other measures such as revenue growth or return	$ROA = \frac{\text{Net Profit After Tax}}{\text{Total Asset}}$ -

	on investment are more susceptible to short-term managerial actions. Therefore, return on assets is regarded as providing a more stable and representative picture of a company's profitability (Wang & Ahmad, 2024).	
Firm Age (Control Variable)	Firm age is measured by calculating the difference between the year of the study and the year in which the company was first established, as applied in the study by Jannah & Narsa (2021). This measure is chosen because a longer-established company better reflects business continuity (going concern).	$Firm\ Age = Year\ of\ the\ study - Year\ of\ company\ establishment$

Source: Processed by the author (2025)

Table 2. Research Sample

Information	Amount
Basic materials sector companies listed on the Indonesia Stock Exchange (IDX) during the 2022–2024 period.	285
Basic materials sector companies that published annual reports and/or sustainability reports consistently during the 2022–2024 period.	-42
Basic materials sector companies participating in the PROPER organized by the Ministry of Environment and Forestry during the 2022–2024 period.	-138
Basic materials sector companies that possess complete and valid data relevant to the variables required for this study during the 2022–2024 period.	-9
Total Sample	**96**

Source: Processed by the author (2025)

In this study, companies within the basic materials sector listed on the Indonesia Stock Exchange (IDX) during the 2022–2024 period were selected as the population. This selection is predicated on the fact that the sector comprises the iron, steel, and cement industries, which have contributed to a significant increase in emissions over recent years and have been designated as primary targets for Indonesia's decarbonization initiatives (Lu et al., 2024). Furthermore, these sectors constitute a

segment of the manufacturing industry, which according to Badan Pusat Statistik (2025) is represents the primary contributor to emissions in Indonesia. Since the Carbon Performance (CEI) variable was calculated as the difference between carbon emission intensity in year t and year t−1, only companies with complete prior-year emission data were included in the sample. However, all sampled firms had available t−1 data, allowing all observations to be retained in the analysis without reducing the effective number of observations.

RESULT AND DISCUSSIONS

Based on the data processing conducted, the presented information encompasses the minimum and maximum values, the mean, and the standard deviation for each variable, as detailed in the table below:

Table 3. Descriptive Statistics

No	Variable	Mean	Std. Dev	Min	Max
1	CED	0.6815	0.2508	0.1429	1
2	ENV	3.1557	0.6291	2	5
3	CEI	9.32×10^{-9}	8.57×10^{-8}	-1.83×10^{-7}	5.96×10^{-7}
4	GI	0.6640	0.1476	0.375	1
5	PRO	0.03	0.0643	-0.1555	0.2656
6	AGE	41.625	14.0497	11	73

Source: Processed by the author (2025)

Based on the data for each variable presented in Table 3 above, the mean value for carbon emission disclosure is 0.6815396 (68.15%). This indicates that the carbon emission disclosure practices of the companies are relatively commendable, although they have not yet reached the optimal level, which typically involves approximately 4 to 5 disclosure items. The standard deviation is 0.2508606, which is lower than the mean value. The minimum and maximum values are recorded at 0.1429 (14.29%) and 1.0000 (100%), respectively. Furthermore, the environmental performance variable shows a mean value of 3.155728 (Rank 3), with a standard deviation of 0.6291766, which is also lower than the mean. The minimum value for this variable is 2, while the maximum value is 5. Regarding carbon performance, the mean value is 0.00000000932, with a standard deviation of 0.0000000857; notably, this standard deviation is higher than the mean. The minimum and maximum values for carbon performance are -0.000000183 and 0.000000596, respectively. For the green innovation variable, the mean value is 0.6640625, with a standard deviation of 0.1476933, indicating lower dispersion relative to the mean. The minimum and maximum values are 0.375 and 1.000, respectively. Additionally, the profitability control variable has a mean of 0.03 (3%), with a standard deviation of 0.0643323, which exceeds the mean value. The minimum and maximum profitability values are -0.1555 (-15.55%) and 0.2656 (26.56%). Finally, the firm age control variable has a mean of 42.15625 years, with a standard deviation lower than the mean at 14.40346. The minimum age recorded is 11 years, while the maximum is 73 years.

In this study, the Random Effect Model (REM) was selected as the most

appropriate model based on the results of the Chow, Lagrange Multiplier (LM), and Hausman tests. Furthermore, the model has been confirmed to be free from issues regarding normality, multicollinearity, heteroscedasticity, and autocorrelation. The results of the coefficient of determination (R-squared) indicate that the independent variables: environmental performance, carbon performance, and green innovation, along with the control variables of profitability and firm age, account for 35.30% (0.3530) of the variance in the dependent variable, carbon emission disclosure. The remaining 64.70% is attributed to other variables or factors beyond the scope of this research. This level of explanatory power is relatively common in social science and sustainability disclosure research, where corporate disclosure practices are influenced by complex organizational and institutional factors. Previous studies by Priliana & Ermaya (2023), Putri & Arieftiara (2023), and Wiguna et al. (2025) on carbon and environmental disclosure have also reported moderate R^2 values.

Table 4. Regression Analysis Results

Variable Independent	Coefficient	z	Prob > |z|	Sig (one-tailed)
ENV	0.0926	2.38	0.017	0.008
CEI	126646.4	0.52	0.602	0.301
GI	0.2994	1.87	0.061	0.030
PRO	-0.3170	-1.21	0.226	0.113
AGE	0.0078	3.09	0.002	0.001
cons	-0.1279	-0.83	0.407	0.203

Source: Processed by the author (2025)

Based on the table above, the results indicate that environmental performance positively influences carbon emission disclosure. A higher level of environmental performance within a company correlates with a more extensive degree of carbon emission disclosure. This finding is consistent with both legitimacy theory and stakeholder theory. In the context of basic materials companies in Indonesia, this finding reflects the increasing pressure faced by firms operating in environmentally sensitive industries. The basic materials sector is closely associated with intensive natural resource utilization, high energy consumption, and substantial carbon emissions. Consequently, companies with good environmental performance are encouraged to communicate their environmental responsibility more openly to maintain legitimacy and strengthen public trust. This study reinforces previous research conducted by Jannah & Narsa (2021), Hidayat et al. (2022), Priliana & Ermaya (2023), Meiryani et al. (2023), Maryono & Ermawati (2024), and Budianto et al. (2025), which similarly demonstrated that environmental performance positively influences carbon emission disclosure.

Furthermore, carbon performance through the CEI coefficient appears numerically large. This is attributable to the very small magnitude of the CEI variable itself, which is measured in values around 10^{-8}. To preserve the original measurement scale and avoid altering the underlying data structure, the variable was retained in its original form. Accordingly, the coefficient should be interpreted relative to small incremental changes in CEI rather than as a one-unit increase. In

addition, the results indicate that carbon performance does not appear to influence carbon emission disclosure.

This finding is inconsistent with legitimacy theory and indicates that companies with lower emission intensity are not necessarily more transparent in disclosing carbon-related information. Companies within the basic materials sector are the primary contributors to carbon emissions and remain a central target of national decarbonization programs. Regardless of whether their carbon performance is favorable or unfavorable, these companies are inherently aware of their significant role in carbon emissions. Conversely, companies are fundamentally driven by profit maximization. Efforts to mitigate carbon emissions and conduct comprehensive disclosures incur substantial costs, such as investments in renewable energy, the adoption of emission-reduction technologies, carbon inventory processes, and external verification by independent parties for reporting purposes. Consequently, firms meticulously weigh these expenditures when deciding to undertake disclosure. The results of this study align with prior research by Ratmono et al. (2021), Priliana & Ermaya (2023), Yuliana & Wedar (2023), Iratiwi & Sulfitri (2023), Rahman & Mujiyati (2024), and Wiguna et al. (2025), providing empirical evidence that carbon performance has no significant impact on carbon emission disclosure.

Furthermore, the results of green innovation variables indicate that green innovation has a significant positive effect on carbon emission disclosure. This finding aligns with both stakeholder theory and signaling theory. Companies seek to fulfill the informational requirements of stakeholders as expectations for sustainable business practices continue to increase. Consequently, firms that implement green innovation are more motivated to disclose their carbon emissions as a means of conveying positive signals and communicating the success of their innovations. This serves as empirical evidence of the company's reliability, capability, and commitment to sustainability. The result also indicates that sustainability-oriented innovation increasingly functions as both an operational and reputational asset. In industries with high environmental exposure such as basic materials, green innovation can help companies reduce environmental risks while simultaneously improving stakeholder perceptions. The finding of this research is consistent with research by García-Sánchez et al. (2021), Maharani & Dewi (2024), and Sari et al. (2024), which demonstrates that green innovation positively influences carbon emission disclosure.

Regarding the control variables, profitability has no significant influence on carbon emission disclosure. This finding suggests that financially stronger companies are not automatically more committed to transparent carbon disclosure. In Indonesian companies, carbon disclosure may still be viewed as a strategic or compliance-related activity rather than a direct consequence of financial capability. Companies may prioritize profitability for operational expansion and business continuity instead of allocating resources toward extensive sustainability disclosure initiatives. On the other hand, firm age positively influences carbon emission disclosure. Older companies tend to provide broader disclosure because they generally have greater experience in responding to stakeholder expectations, regulatory developments, and sustainability-related pressures. Long-established firms are also better reflects business continuity (going concern) and therefore

place greater emphasis on maintaining corporate legitimacy and reputation through transparent reporting practices.

Overall, the findings of this study provide important implications for both companies and regulators. For companies, the results indicate that environmental performance and green innovation have become increasingly important drivers of sustainability communication and corporate legitimacy. For regulators, these findings highlight the importance of developing more comprehensive sustainability reporting frameworks and carbon disclosure standards, particularly for carbon-intensive industries such as basic materials.

CONCLUSION

Based on the test results, this study concludes that environmental performance has a significant positive effect on carbon emission disclosure. This finding indicates that companies with better environmental performance tend to provide more extensive carbon emission disclosures. In addition, green innovation is also found to have a significant positive influence on carbon emission disclosure, implying that companies with stronger commitments to environmentally friendly innovation are more likely to disclose carbon emission information more comprehensively. On the other hand, carbon performance does not have a significant effect on carbon emission disclosure, suggesting that the level of a company's carbon performance does not necessarily determine the extent of its carbon emission disclosure practices.

During the research process, several limitations were identified and should be considered in future studies. One of the primary limitations relates to the sampling criteria applied in this study, which resulted in a relatively limited final sample size due to the exclusion of many companies that did not meet the required criteria, particularly regarding the availability and completeness of sustainability reporting data. Consequently, the findings of this research may not fully represent all sectors or industries. Future research is therefore recommended to utilize broader datasets with larger sample sizes and to include companies from various industrial sectors in order to obtain more comprehensive and generalizable results. In addition, future studies may conduct cross-country comparisons to examine how different regulatory environments and corporate cultures influence carbon emission disclosure practices. Researchers are also encouraged to explore additional variables that may affect carbon emission disclosure, such as green strategy, financial distress, environmental governance, or institutional ownership. Furthermore, future studies could incorporate moderating variables to provide deeper insights into the relationship between carbon performance and carbon emission disclosure. The use of alternative measurement proxies for carbon emission disclosure, such as the disclosure indicators established by the Carbon Disclosure Project (CDP), is also recommended to enrich future analyses.

This study also provides several practical implications. Companies are encouraged to continuously improve their environmental performance and strengthen green innovation initiatives in both operational processes and product development, as these factors have been proven to support more comprehensive carbon emission disclosure practices. For the Otoritas Jasa Keuangan (OJK), the

findings of this study may serve as a reference for strengthening regulations related to sustainability reporting, particularly those concerning mandatory and standardized carbon emission disclosures in accordance with the GRI 305 standards. Furthermore, for the Ministry of Environment and Forestry, this research is expected to encourage greater participation of public companies in the PROPER program, considering that environmental performance measured through PROPER has been shown to significantly enhance carbon emission disclosure.

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