

Driving Sustainable Transparency: How Environmental Management Accounting and Green Innovation Shape Carbon Emission Disclosure through Financial Performance

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Abstract

Global warming is the most pressing major environmental issue today, due to its far-reaching and ongoing impact on life on Earth. This study aims to determine the influence of green innovation and *environmental management accounting* on carbon emission disclosure, with financial performance as a mediating variable. The research method is quantitative, utilizing the assistance of the *EViews* application. The research sample consists of manufacturing companies listed on the *Indonesian stock exchange* from 2019 to 2023. The results show that the green innovation variable has a positive and significant effect on carbon emission disclosure. *Environmental management accounting* has a negative and significant effect on carbon emission disclosure. Financial performance does not affect carbon emission disclosure. *Environmental management accounting* also has a negative and significant effect on financial performance. Additionally, green innovation on carbon emission disclosure through financial performance has no effect, and *environmental management accounting* on carbon emission disclosure with financial performance as a mediator also has no effect.

Kata Kunci: Green Innovation, Environmental Management Accounting, Financial Performance dan Carbon Emission Disclosure.

INTRODUCTION

Carbon emission disclosure refers to the reporting of generated carbon emissions and the company's efforts to reduce them, which is prepared based on the standards of the *Global Reporting Initiative* and the *Carbon Disclosure Project* (Pitrakkos & Maroun, 2019). The government has established several regulations related to carbon emission reduction, namely Presidential Regulation No. 98 of 2021 on the Implementation of *Carbon Economic Value* and Control of Greenhouse Gas Emissions, Presidential Regulation No. 14 of 2024 on the Implementation of *Carbon Capture and Storage* Activities, and Law No. 16 of 2016 on the Ratification of the Paris Agreement on Climate Change. Mediana (2021) states that carbon emission reduction regulations aim to achieve net zero emissions by 2060.

Global warming is the main environmental issue today. Dharma et al. (2024) state that global warming is closely related to carbon emissions—the higher the carbon emissions from industrial activities, the faster global warming occurs. Carbon emissions have also become a trend with the growth of the industrial world, as more companies are realizing the importance of managing their

emissions. In addition, stakeholder pressure is encouraging companies to implement environmentally friendly business practices (Loru, 2023). The increasing attention to carbon emission issues emphasizes the importance of this discussion for the sustainability of future businesses (Trimuliani & Febrianto, 2023).

Márquez et al. (2022) state that carbon emission disclosure raises social questions about its truthfulness. This situation occurs due to greenwashing practices by companies, which involve building an environmentally friendly image without actual supporting actions. As a result, stakeholders are increasingly skeptical of the sustainability reports and annual reports published by companies. This situation highlights the importance of discussing carbon emissions, as transparency in disclosure can benefit companies by reducing demand caused by greenhouse gas emissions, mitigating reputational risks, and preventing potential legal proceedings (Loru, 2023).

Research on carbon emission disclosure has been widely conducted and generally shows significant results, including the influence of green innovation and *environmental management accounting*. However, previous studies have not discussed the mechanism of the influence of green innovation and *environmental management accounting* on carbon emission disclosure. Therefore, the researcher adds financial performance as a mediating variable to fill the gap in prior studies.

Chen et al. (2006) reveal that corporate green innovation consists of green process innovation and green product innovation, which aim to reduce negative environmental impacts and enhance corporate competitive advantage. Zhang et al. (2019) argue that sustainability issues are a top priority today, making the push for green growth increasingly urgent. The study by Maharani & Dewi (2024) shows that green innovation positively affects carbon emission disclosure. Sari et al. (2024) also reveal that green innovation has a positive influence on carbon emission disclosure.

Sari et al. (2021) state that companies' activities need to consider their environmental impact and associated costs; therefore, companies must have *Environmental Management Accounting* (EMA), which serves as a cost measurement tool to address environmental and financial issues. Qian et al. (2018) and Nkundabanyanga et al. (2021) argue that *environmental management accounting* positively affects carbon emission disclosure.

Maysaroh & Murwaningsari (2023) define financial performance as a measure of the extent to which a company can achieve its targeted profits. Alfriansyah & Darmawati (2024) reveal that financially successful companies are more likely to implement environmentally friendly policies. The better the company's financial condition, the greater the chance to protect the environment. Al-Mari & Mardini (2024) state that financial performance positively affects carbon emission disclosure.

Manufacturing companies produce carbon emissions from hazardous and toxic waste (B3). Furthermore, manufacturing companies were the largest waste producers in 2021. The novelty of this research lies in the inclusion of financial performance as a mediating variable because previous studies generally only analyzed the effect of green innovation and *environmental management accounting* on carbon emission disclosure without considering financial performance as a mediator. In fact, financial performance is an important factor that drives companies to disclose carbon emissions, as high financial performance encourages companies to improve both disclosure and carbon emission performance in the future (Al-Mari & Mardini, 2024).

The hypotheses used were:

- 1) H1: Green Innovation has a positive and significant effect on Carbon Emission Disclosure.

- 2) H2: Environmental Management Accounting has a positive and significant effect on Carbon Emission Disclosure.
- 3) H3: Financial Performance has a positive and significant effect on Carbon Emission Disclosure.
- 4) H4: Green Innovation has a positive and significant effect on Financial Performance.
- 5) H5: Environmental Management Accounting has a positive and significant effect on Financial Performance.
- 6) H6: Green Innovation has a positive and significant effect on Carbon Emission Disclosure through Financial Performance.
- 7) H7: Environmental Management Accounting has a positive and significant effect on Carbon Emission Disclosure through Financial Performance.

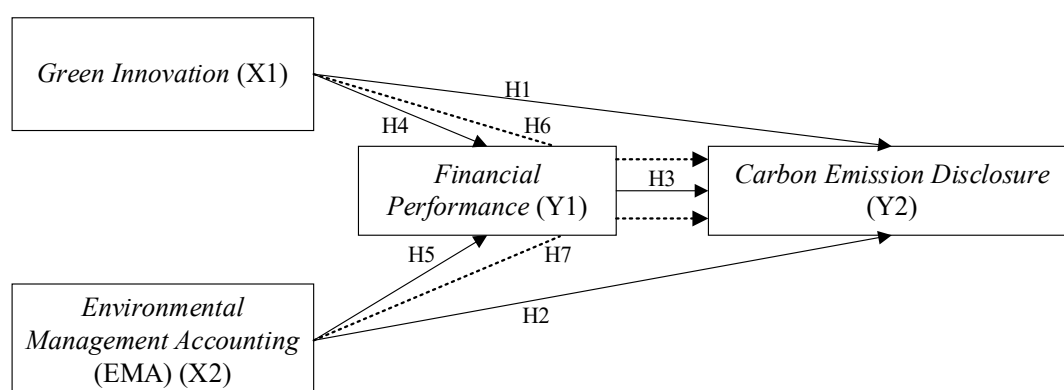


Figure 1. Hypotheses

RESEARCH METHODS

The method used in this study was quantitative, with an explanatory research design. Data were collected from the sustainability reports and annual reports of manufacturing companies listed on the Indonesia Stock Exchange for the years 2019–2023. The data were analyzed using panel data regression with EViews (Econometric Views) software version 13. Ismanto and Pebruary (2021) identified common effect, fixed effect, and random effect models as suitable for estimating panel data parameters. Because this study involved a mediating variable, a Sobel test was conducted to analyze the indirect effects of the independent variables on the dependent variable.

Carbon emission disclosure was measured using the disclosure index developed by Choi et al. (2013), which includes categories such as climate change, greenhouse gas emissions, energy consumption, reduction of greenhouse gases and related costs, and carbon emission accountability. Each disclosed item was assigned a score of 1, and nondisclosed items a score of 0.

Financial performance was measured using Return on Assets (ROA), based on the financial statements of the manufacturing companies. According to Winarno (2019), ROA is an appropriate indicator of financial performance. A company with an ROA above the industry average (>5%) is considered good, while an ROA greater than 20% is regarded as excellent (Birken, 2021).

RESULT AND DISCUSSION

Descriptive Statistics

Table 1. Descriptive Statistics

Description	Green Innovation (X1)	Environmental Management Accounting (X2)	Financial Performance (Y1)	Carbon Emission Disclosure (Y2)
Mean	0.266936	3.426127	-2.836631	0.318497
Median	0.250000	2.370000	-2.813411	0.330000
Maximum	0.630000	20.74000	-0.051293	0.940000
Minimum	0.060000	0.410000	-4.605170	0.060000
Std. Dev.	0.115035	3.648124	0.930926	0.191281

Model Selection

Chow Test for Equation I

Table 2. Chow Test for Equation I

Description	Probability Value
Cross section F	0,0000
Cross section Chi square	0,0000
$Y1 = \alpha + \beta_1 X_1 + \beta_2 X_2$ Description: Y1: Financial Performance X1: Green Innovation X2: Environmental Management Accounting	

Chow Test for Equation II

Table 3. Chow Test for Equation II

Description	Probability Value
Cross section F	0,0000
Cross section Chi square	0,0000
$Y2 = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 Y_1 + \varepsilon$ Description: Y1: Financial Performance Y2: Carbon Emission Disclosure X1: Green Innovation X2: Environmental Management Accounting	

Hausman Test for Equation I

Table 4. Hausman Test for Equation I

Description	Probability Value
Cross section random	0,1778
$Y1 = \alpha + \beta_1 X_1 + \beta_2 X_2$ Description: Y1: Financial Performance X1: Green Innovation X2: Environmental Management Accounting	

Hausman Test for Equation II

Table 5. Hausman Test for Equation II

Description	Probability Value
Cross section F	0,0069

$$Y2 = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 Y_1 + \varepsilon$$

Description:

Y1: *Financial Performance*

Y2: *Carbon Emission Disclosure*

X1: *Green Innovation*

X2: *Environmental Management Accounting*

Based on the Chow test and Hausman test conducted on Equations I and II, it can be concluded that for Equation I, the appropriate model to use is the random effect model. This is because the random nature of the sample data is more dominant than the fixed effects. Meanwhile, for Equation II, the results indicate that the fixed effects are more dominant than the random effects, making the fixed effect model a more suitable choice. Therefore, the use of the selected models is expected to produce more accurate and relevant estimations in analyzing the relationships among the variables studied.

Hypothesis Testing

T-Test for Equation I

Table 6. T-Test for Equation I

Variable	Direction		Probability Value
	Coefficient Value	Symbol	
<i>Green Innovation</i>	0,864272	+	0,1587
<i>Environmental Management Accounting</i>	0,058315	-	0,0390

$$Y1 = \alpha + \beta_1 X_1 + \beta_2 X_2$$

Description:

Y1: *Financial Performance*

X1: *Green Innovation*

X2: *Environmental Management Accounting*

T-Test for Equation II

Table 7. T-Test for Equation II

Variable	Direction		Probability Value
	Coefficient Value	Symbol	
<i>Green Innovation</i>	1,026034	+	0,0000
<i>Environmental Management Accounting</i>	0,024323	-	0,0028
<i>Financial Performance</i>	0,023024	+	0,0994

$$Y2 = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 Y_1 + \varepsilon$$

Description:

Y1: *Financial Performance*

Y2: *Carbon Emission Disclosure*

X1: *Green Innovation*

X2: *Environmental Management Accounting*

Sobel Test

Green Innovation (X1) on Carbon Emission Disclosure (Y2) toward Financial Performance (Y1)

$$t = \frac{ab}{\sqrt{(b^2 SEa^2) + (a^2 SEb^2)}}$$

$$t = \frac{0,86 \times 0,02}{\sqrt{(0,02^2 \times 0,61^2) + (0,86^2 \times 0,01^2)}}$$

$$t = \frac{0,02}{\sqrt{(0,00 \times 0,37) + (0,74 \times 0,00)}}$$

$$t = \frac{0,02}{\sqrt{0,00 + 0,00}}$$

$$t = \frac{0,02}{\sqrt{0,00}}$$

$$t = \frac{0,02}{0,02} = 1,07$$

The results of the Sobel test for the first path coefficient show that the t-statistic value is $1.07 < 1.97308$ (t-table), meaning that the variable green innovation on carbon emission disclosure through financial performance has a positive but not significant effect.

Environmental Management Accounting (X1) on Carbon Emission Disclosure (Y2) toward Financial Performance (Y1)

$$t = \frac{ab}{\sqrt{(b^2 SEa^2) + (a^2 SEb^2)}}$$

$$t = \frac{-0,06 \times 0,02}{\sqrt{(0,02^2 \times 0,03^2) + (-0,06^2 \times 0,01^2)}}$$

$$t = \frac{0,00}{\sqrt{(0,00 \times 0,00) + (0,00 \times 0,00)}}$$

$$t = \frac{0,00}{\sqrt{0,00 + 0,00}}$$

$$t = \frac{0,00}{\sqrt{0,00}}$$

$$t = \frac{0,00}{0,00} = -1,30$$

The results of the Sobel test for the second path coefficient show that the t-statistic value is $-1.30 < 1.97308$ (t-table), meaning that the variable environmental management accounting on carbon emission disclosure through financial performance has a negative but not significant effect.

The Effect of Green Innovation on Carbon Emission Disclosure

The hypothesis testing shows that the green innovation variable has a positive and significant effect on carbon emission disclosure, as indicated by the positive correlation coefficient and a probability value of $0.0000 < 0.05$.

This finding supports legitimacy theory, which explains that companies implement green innovation to gain legitimacy, allowing them to continue operating without public pressure. The results of green innovation practices are disclosed in the sustainability report, which includes green innovation activities (Sari & Handayani, 2020). This finding is also consistent with stakeholder theory, which states that companies conduct business not only for their own interests but also for the interests of stakeholders (Yuliana & Wedari, 2023).

The studies by Maharani & Dewi (2024) and Xu et al. (2021) found that green innovation has a positive and significant effect on carbon emission disclosure. This is in line with the findings of this research, which also shows that green innovation has a positive and significant effect on carbon emission disclosure. Therefore, hypothesis 1 in this research is proven.

The Effect of Environmental Management Accounting on Carbon Emission Disclosure

The findings regarding environmental management accounting and carbon emission disclosure reveal a negative coefficient and a probability value of $0.0028 < 0.05$.

Companies implement EMA internally to achieve cost efficiency in energy use, which is part of the CED items. However, efficient EMA implementation does not encourage companies to disclose emissions data comprehensively, due to concerns about negative public perception. Companies disclose carbon emissions mainly based on POJK No.51/POJK.03/2017, which mandates disclosure related to energy and greenhouse gas emissions, while other forms of carbon emission disclosure, such as climate change and carbon emission accountability, are still rarely reported because they are not mandatory and remain voluntary. This is supported by data showing that the average carbon emission disclosure rate is only 31%.

Companies with good EMA have more accurate and detailed emissions data, which reveals high emission levels they must report. However, high transparency is often seen as a reputational risk, making companies cautious about disclosing carbon emissions information. This is consistent with Kazemi et al. (2025), who state that reputational risk can influence environmental disclosure.

These findings do not align with legitimacy theory, which suggests that environmental management accounting encourages companies to disclose carbon emissions to gain social legitimacy. Companies that already implement EMA and do not feel their social legitimacy is threatened or pressured by the public tend to disclose only the mandatory emission data (Bahriansyah & Ginting, 2022). This result also contradicts stakeholder theory, which explains that companies have an obligation to meet stakeholders' needs, including carbon emission disclosure. In this context, EMA implementation should push companies to be more transparent (Qian et al., 2018; Meutia et al., 2019). Based on the hypothesis testing, hypothesis 2 in this research is not proven. However, this finding is supported by Qian et al. (2018), who state that EMA significantly affects carbon emission disclosure.

The Effect of Financial Performance on Carbon Emission Disclosure

The findings regarding the effect of financial performance on carbon emission disclosure show a positive coefficient and a probability value of $0.0994 > 0.05$.

This reflects that carbon emission disclosure is not yet a priority for companies, especially since the reporting is still voluntary. The OJK Regulation No.51/POJK.03/2017 only requires minimal carbon emission disclosure, covering information about energy usage, greenhouse gas emissions, and reduction efforts. As a result, many companies only meet the minimum requirements without expanding the scope of disclosure. This is supported by data showing the average carbon emission disclosure rate is only 31% of the 100% ideal disclosure items.

The hypothesis testing results are not consistent with legitimacy theory, which suggests that financial performance should encourage companies to disclose carbon emissions to gain legitimacy. Meanwhile, stakeholder theory states that carbon emission disclosure is a communication tool for companies to show stakeholders that they are not only profit-oriented but also environmentally responsible (Guterman, 2023). Based on these findings, it is concluded that hypothesis 3 in this research is not proven. This finding aligns with Dharma et al. (2024), who state that financial performance does not affect carbon emission disclosure.

The Effect of Green Innovation on Financial Performance

The regression test results show a positive coefficient and a probability value of 0.1587, which is > 0.05 . This indicates that the green innovation variable has a positive but not significant effect on financial performance.

The findings suggest that the implementation of green innovation among manufacturing companies listed on the Indonesia Stock Exchange is still not optimal. This is supported by research data showing that

the average implementation rate of green innovation is only 27% of green innovation activities disclosed, both from processes and products.

This finding does not align with legitimacy theory, which states that to promote corporate sustainability, it is essential to gain social approval through actions consistent with societal values and norms (Santo & Hivianto, 2023). It is also inconsistent with stakeholder theory, which explains that green innovation should serve as a corporate strategy to enhance financial performance as expected by stakeholders. However, due to the low implementation, these expectations are not being met. Based on hypothesis testing, it is concluded that hypothesis 4 is not proven. This result is supported by Chandra & Sumani (2023) and Wati & Latifah (2024), who also found that green innovation does not affect financial performance.

The Effect of Environmental Management Accounting on Financial Performance

The hypothesis testing shows a negative coefficient and a probability value of 0.0390, which is < 0.05 . Thus, environmental management accounting has a negative and significant effect on financial performance. In other words, the greater the implementation of EMA, the more financial performance decreases.

This result does not align with legitimacy theory, which suggests that companies implementing environmental practices gain legitimacy that improves financial performance (Chen & Roberts, 2010; Santo & Hivianto, 2023). However, this study shows that optimal EMA implementation reduces financial performance due to the significant upfront investment required, which directly impacts profitability. Moreover, this finding contradicts stakeholder theory, which states that EMA can bridge environmental and economic interests to meet stakeholder needs (Wahyuni et al., 2024). In fact, this research shows that high EMA implementation reduces financial performance and fails to meet stakeholder expectations as stated in the theory. Based on these findings, hypothesis 5 is not proven. This result aligns with Rachman et al. (2024) and Maysaroh & Murwaningsari (2023), who found that EMA significantly affects financial performance.

The Effect of Green Innovation on Carbon Emission Disclosure with Financial Performance as a Mediating Variable

The Sobel test shows that the t-statistic is $1.07 < 1.97308$ (t-table), which means that green innovation affects carbon emission disclosure through financial performance positively but not significantly. This indicates that while green innovation can improve carbon emission disclosure, financial performance cannot act as a mediator or supporting factor for this influence.

This result does not support legitimacy theory, which suggests that companies disclose carbon emissions to gain legitimacy. If legitimacy theory held true, companies implementing green innovation with strong financial performance should be encouraged to disclose carbon emissions. However, this finding indicates that good financial performance does not mediate the relationship between green innovation and carbon emission disclosure (Xie et al., 2019; Ladista et al., 2023; Yuliana & Wedari, 2023). This finding also contradicts stakeholder theory, which emphasizes that companies have a responsibility to meet stakeholders' interests. According to this theory, companies with strong financial performance should be more transparent in disclosing carbon emissions, especially if they are committed to green innovation (Guttermann, 2023; Yuliana & Wedari, 2023; Maharani & Dewi, 2024). Based on these findings, hypothesis 6 is not proven.

The Effect of Environmental Management Accounting on Carbon Emission Disclosure with Financial Performance as a Mediating Variable

The Sobel test for environmental management accounting on carbon emission disclosure through financial performance shows that the t-statistic is $-1.30 < 1.97308$ (t-table), which means that EMA affects carbon emission disclosure through financial performance negatively and not significantly. This indicates that financial performance does not mediate the relationship between EMA and carbon emission disclosure.

This result is inconsistent with legitimacy theory, which suggests that companies will increase environmental information, including carbon emissions, to gain or maintain legitimacy. The inconsistency arises due to the lack of social pressure or regulations requiring comprehensive carbon emission disclosure, leading companies to feel no need to improve such disclosure (Nkundabanyanga et al., 2021). This finding also fails to confirm stakeholder theory, which states that financial performance can serve as a means for companies to gain the trust of internal and external stakeholders. In this context, companies should not only pursue economic goals but also meet environmental responsibilities. However, in this study, financial performance does not mediate the influence of EMA on carbon emission disclosure because companies are satisfied with minimal carbon emission disclosure as a form of accountability to stakeholders (Kelvin et al., 2017; Bibi & Narsa, 2022).

CONCLUSION

This study found that green innovation positively and significantly influenced carbon emission disclosure, whereas environmental management accounting had a negative and significant effect on disclosure. Financial performance showed a positive but insignificant effect on carbon emission disclosure, with green innovation also having a positive yet insignificant impact on financial performance. Conversely, environmental management accounting negatively and significantly affected financial performance. The mediating role of financial performance revealed that the indirect effect of green innovation on carbon emission disclosure was positive but insignificant, while the indirect effect of environmental management accounting was negative and insignificant. Based on these results, companies are encouraged to continuously enhance green innovation by adopting environmentally friendly technologies and process improvements to foster more transparent carbon emission disclosures. Additionally, strengthening environmental management accounting with a strategic focus beyond cost control can add value to both environmental and financial outcomes. Future research should explore other variables such as corporate governance or environmental strategy that might significantly influence carbon emission disclosure.

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