



## **Green Accounting, Carbon Emission Disclosure, Sustainable Development: The Moderating Role of Environmental Management System**

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**Abstract.** *This study examines the effect of Green Accounting and Carbon Emission Disclosure on Sustainable Development, with the Environmental Management System as a moderating variable, in infrastructure sector companies listed on the Indonesia Stock Exchange. The study uses secondary data and is analyzed using multiple linear regression. The results show that Green Accounting and Carbon Emission Disclosure have a positive effect on Sustainable Development. However, the Environmental Management System does not moderate the relationship between Green Accounting and Sustainable Development, nor between Carbon Emission Disclosure and Sustainable Development.*

**Abstrak.** Penelitian ini menguji pengaruh *Green Accounting* dan *Carbon Emission Disclosure* terhadap *Pembangunan Berkelanjutan*, dengan *Sistem Manajemen Lingkungan* sebagai variabel moderasi, pada perusahaan sektor infrastruktur yang terdaftar di Bursa Efek Indonesia. Penelitian ini menggunakan data sekunder dan dianalisis dengan regresi linier berganda. Hasil penelitian menunjukkan bahwa *Green Accounting* dan *Carbon Emission Disclosure* berpengaruh positif terhadap *Pembangunan Berkelanjutan*. Namun, *Sistem Manajemen Lingkungan* tidak memoderasi hubungan antara *Green Accounting* maupun *Carbon Emission Disclosure* dengan *Pembangunan Berkelanjutan*.

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#### **Keywords:**

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## Introduction

The development of a country cannot be separated from the pivotal role of the infrastructure sector, which drives connectivity, economic productivity, and the achievement of the Sustainable Development Goals (SDGs). Reliable and high-quality infrastructure not only strengthens interregional connectivity but also expands public access to basic services such as clean water, electricity, and safe transportation. Within the framework of SDG 9, infrastructure development plays a crucial role in promoting industry, innovation, and sustainable growth. The United Nations Development Programme (UNDP) highlights that investment in sustainable infrastructure can reduce socioeconomic inequality and mitigate the impacts of climate change. In Indonesia, the government prioritizes infrastructure development as a key driver of economic growth and regional equity. According to Statistics Indonesia (BPS, 2024), the construction sector contributed 9.86 percent to the national GDP in the third quarter of 2023, making it the fifth-largest contributor.

However, the growing intensity of development activities often exerts pressure on the environment. The excessive exploitation of natural resources for infrastructure projects has become a major cause of environmental degradation. For instance, the National Strategic Project under President Joko Widodo's administration—such as the Yogyakarta–Bawen Toll Road construction—has led to severe environmental impacts due to the use of illegal materials sourced from the geological heritage areas of Sleman. Land-use conversion for infrastructure has also reduced biodiversity, lowered water absorption capacity, and worsened air quality through increased greenhouse gas emissions.

Global awareness of sustainability issues has encouraged various stakeholders, including business organizations, to balance economic growth with environmental preservation. The World Meteorological Organization (2024) reported that 2023 was the hottest year on record, with global average temperatures rising 1.45°C above pre-industrial levels. This condition is largely driven by carbon emissions from fossil fuel combustion and cement production, reflecting the limited adoption of renewable energy sources by corporations.

In response, many organizations have begun integrating sustainability principles into their business strategies through the implementation of Environmental, Social, and Governance (ESG) practices. This commitment underscores the critical role of the private sector in mitigating climate crises and achieving the SDGs. One strategic approach is the adoption of green accounting, which recognizes and reports environmental costs in financial statements (Nurfaidah et al., 2024; Endiana et al., 2020). According to Lako (2018) and Gine (2021), green accounting serves to measure, record, and disclose environmental information transparently as a form of organizational accountability to stakeholders. Several studies (Giang et al., 2021; Somantri et al., 2023; Dura & Suharsono, 2022; Muniroh et al., 2023; Dhar et al., 2022a; Ahmed, 2023) have shown that the implementation of green accounting positively contributes to sustainable development.

Furthermore, carbon emission disclosure is an essential component in supporting SDG 13, which addresses climate change. Greenhouse gas (GHG) emissions, primarily resulting from fossil fuel combustion, are major contributors to global warming (Hapsoro & Ambarwati, 2018; Bae Choi et al., 2013). In accordance with PSAK No. 1 paragraph 9 and Presidential Regulations No. 61 and 71 of 2011, companies in Indonesia are encouraged to report carbon emissions as part of their transparency and commitment to the National Action Plan for Greenhouse Gas Emission Reduction (RAN-GRK). Empirical findings, however, remain mixed. For example, Fathia & Sulfitri, (2023) found a positive relationship between carbon

emission disclosure and sustainability reporting, while Anggita & Nugroho (2022) and Angelia & Lastanti, (2024) reported the opposite.

The role of Environmental Management Systems (EMS) is also significant in strengthening the linkages between green accounting, carbon emission disclosure, and sustainable development. An effective EMS can enhance the positive effects of green accounting practices on an organization's sustainability performance.

Based on this discussion, there remains a research gap regarding the consistent relationship among green accounting, carbon emission disclosure, and environmental management systems in promoting sustainable development, particularly within the infrastructure sector, which has high environmental impacts. Therefore, the objective of this study is to analyze the effect of carbon emission disclosure on corporate sustainability performance, with environmental management systems as a moderating variable, in infrastructure sector organizations listed on the Indonesia Stock Exchange during the 2019–2023 period.

## Research Method

The researcher employs a quantitative research approach. The data are obtained from the annual reports of infrastructure sector companies in Indonesia for the 2019–2023 period. This timeframe was chosen to ensure the use of the most recent data, thereby increasing the relevance and accuracy of the research results. The sampling technique used is purposive sampling, considering the availability of data that meet the research requirements.

The research variables are measured using a ratio scale, with environmental costs representing green accounting, the CED ratio representing carbon emission disclosure, and the sustainable development ratio representing sustainability performance. The environmental management system is measured using a dummy variable, assigned a value of 1 for companies with ISO 14001 certification and 0 for those without. The dependent variable in this study is sustainable development (SD), while the independent variables are green accounting ( $X_1$ ) and carbon emission disclosure ( $X_2$ ). The multiple linear regression model used is as follows:

$$SD = \alpha + \beta_1GA + \beta_2CED + e$$

To examine the moderating effect, Moderated Regression Analysis (MRA) is applied with the following model:

$$SD = \alpha + \beta_1GA + \beta_2CED + \beta_3GAEMS + \beta_4CEDEMS + e$$

Notes:

SD = sustainable development,

GA = green accounting,

CED = carbon emission disclosure, and

EMS = environmental management system.

## Result and Discussion

To provide an initial overview of the research data, descriptive statistical analysis was conducted. The results, including the minimum, maximum, mean, and standard deviation values, are presented in Table 1.

Table 1. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
SD	50	.18	.94	.4803	.16306
GA	50	-.09	19.45	1.7452	4.61453
CED	50	.00	.83	.5665	.19282
EMS	50	.00	1.00	.9400	.23990
Valid N (listwise)	50				

Source : Data Processed by Researchers, (2024)

Table 1 presents the descriptive statistics of the study variables, namely Sustainable Development (SD), Green Accounting (GA), Carbon Emission Disclosure (CED), and Environmental Management System (EMS). The SD variable has a mean of 0.4803 with a standard deviation of 0.16306, indicating consistent data. GA shows a wide range and high standard deviation, reflecting variation in green accounting practices. CED has a mean of 0.5665, suggesting moderate disclosure levels, while EMS has a mean of 0.9400, indicating that most companies have implemented environmental management systems. Overall, the results show that companies generally demonstrate a commitment to sustainability, although variations remain in green accounting and carbon emission disclosure.

Prior to implementing regression and MRA on the proposed hypothetical model, this study assessed a classical assumption test. The classical assumption test consists of four tests, namely the normality, multicollinearity, autocorrelation, and heteroscedasticity. The normality test uses Kolmogorov Smirnov. The results of the normality test show that the residual of the research model had a significance level greater than 0.05, confirming that the residual are normally distributed and meet the normality assumption. The multicollinearity test looks at the VIF value, and the tolerance value for each variable and model tested. A model is considered free from multicollinearity if the tolerance value exceeds 0.10 and a VIF value below 10. The results showed that the regression model is free from multicollinearity, with a tolerance value above 0.1, and VIF value is below 10 for each variable of the proposed model. This Durbin-Watson approach was used to test for autocorrelation, with the model considered free from autocorrelation if the significant absolute residual value exceeds 0.05. Heteroscedasticity was assessed using the Glejser test which checks for discrepancies in observation residuals. The results indicated that none of the independent variables significantly affected the absolute residual value of the dependent variable, confirming that the research model is free from heteroscedasticity issues.

Table 2. Hypothesis Equation 1

		<b>Coefficients<sup>a</sup></b>				
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	.179	.055		3.278	.002
	GA	.009	.004	.249	2.515	.015
	CED	.540	.080	.667	6.733	<.001

a. Dependent Variable: SD

Source : Data Processed by Researchers, (2024)

Based on the partial test results, Equation 1 indicates the following: Green Accounting (X1) has a t-value of 2.515, which is greater than the t-table value of 2.011, with a significance value of 0.015, which is less than 0.05. Therefore, the null hypothesis (Ho) is rejected, and the hypothesis (Ha) is accepted, meaning that Green Accounting (X1) affects Sustainable Development (Y). This confirms the hypothesis that "Green Accounting has an effect on Sustainable Development." For Carbon Emission Disclosure (X2), the calculated t-value is 6.733, which is greater than 2.011, with a significance value of 0.001, also less than 0.05. Thus, (Ho) is rejected, and (Ha) is accepted, indicating that Carbon Emission Disclosure (X2) influences Sustainable Development. This supports the hypothesis that "Carbon Emission Disclosure affects Sustainable Development."

Table 3. Hypothesis Equation 2

Model		Coefficients <sup>a</sup>		T	Sig.	
		Unstandardized Coefficients	Standardized Coefficients			
		B	Std. Error	Beta		
1	(Constant)	.170	.105		1.614	.114
	GA	.009	.004	.256	2.489	.017
	CED	.542	.085	.669	6.377	<.001
	ECO	.037	.092	.053	.399	.692
	GA*EMS	.002	.004	.067	.653	.517
	CED*EMS	-.069	.095	-.097	-.728	.471

a. Dependent Variable: SD

Source : Data Processed by Researchers, (2024)

The partial test results for Equation 2 reveal the following: Green Accounting (X1) has a t-value of 2.489, which is greater than the t-table value of 2.015, with a significance level of 0.017, which is less than 0.05. Therefore, (Ho) is rejected, and (Ha) is accepted, indicating that Green Accounting (X1) affects Sustainable Development (Y). This supports the hypothesis that "Green Accounting affects Sustainable Development." For Carbon Emission Disclosure (X2), the calculated t-value is 6.377, exceeding the t-table value of 2.015, with a significance value of 0.001, which is below 0.05. Thus, (Ho) is rejected, and (Ha) is accepted, confirming that Carbon Emission Disclosure (X2) impacts Sustainable Development, supporting the hypothesis that "Carbon Emission Disclosure affects Sustainable Development."

However, the Environmental Management System (Z) has a t-value of 0.399, which is less than 2.015, and a significance value of 0.692, greater than 0.05. As a result, (Ho) is accepted, and (Ha) is rejected, indicating that the Environmental Management System (Z) does not influence Sustainable Development. Additionally, the t-value for the interaction between Green Accounting and the Environmental Management System is 0.653, less than the t-table value of 2.015, with a significance value of 0.517, which is greater than 0.05. Therefore, Ho is accepted, and Ha is rejected, indicating that the Environmental Management System does not moderate the effect of Green Accounting on Sustainable Development (Y). This leads to the conclusion that the hypothesis stating "Environmental Management System moderates the effect of Green Accounting on Sustainable Development" is rejected.

Similarly, the t-value for the interaction between Carbon Emission Disclosure and the Environmental Management System is -0.728, which is less than the t-table value of 2.015, with a significance value of 0.471, which is greater than 0.05. Thus, (Ho) is accepted, and (Ha) is rejected, indicating that the Environmental Management System does not moderate the effect of Carbon Emission Disclosure on Sustainable Development (Y). Consequently, the hypothesis stating "Environmental Management System moderates the effect of Carbon Emission Disclosure on Sustainable Development" is also rejected.

### **Green Accounting affects Sustainable Development**

The results of this research indicate that green accounting affects sustainable development. This is based on the significant value owned by green accounting, which is  $0.015 < 0.05$  and the t-count value of  $2.515 > t\text{-table } 2.011$ . So it can be said that H1 is accepted. Green accounting refers to the environmental costs that companies incur for their business practices. Green accounting is a way for businesses to support sustainable development by incurring environmental costs in all aspects of the environment. The trend of green accounting value of infrastructure companies fluctuates and tends to increase. If the value of green accounting increases, it shows

that the company maximizes the environmental costs incurred in the company's sustainability report. The company's commitment to green accounting can provide a sense of security for the parties involved in its business operations. Companies involved in green accounting practices will attract a positive image of the community because they care about environmental issues. The company's green accounting practice initiative is seen by investors as a sign that the company has complied with its commitment to support sustainable development. This is what causes a positive response from investors.

The company's commitment to green accounting can provide a sense of security for the parties involved in its business operations. Companies involved in green accounting practices will attract a positive public image because they care about environmental issues. Green accounting practice initiatives carried out by companies are viewed by investors as a sign that the company has complied with its commitment to supporting sustainable development. This is what causes a positive response from investors.

A global study by (Dhar et al., 2022) shows that for companies that significantly pollute the environment, the implementation of green accounting supported by high-quality social responsibility reporting can substantially promote sustainable development. In addition, a study by (Gola et al., 2022) in India shows that green accounting has begun to be applied in corporate reporting, but it is not yet evenly distributed and has not become mandatory. Significant disclosures are seen in sectors that have a major impact on the environment.

However, green accounting practices carried out by companies must be well designed because the environmental costs incurred are certainly commensurate with the environmental problems that occur due to the company's operations. In addition, companies must carry out green accounting practices with clear objectives, so that this practice is not carried out solely for branding to improve the company's image. The application of green accounting practices in sustainability reports must also follow the rules commonly used by many companies, although there are no regulations that specifically regulate green accounting practices, it is not appropriate for companies to apply green accounting carelessly.

### **Carbon Emission Disclosure affects Sustainable Development**

The research findings indicate that carbon emission disclosure affects sustainable development. This conclusion is supported by the significant value for green accounting, which is 0.001, less than 0.05, and a t-count value of 6.733, greater than the t-table value of 2.011. Therefore, hypothesis H2 is accepted. Carbon emission disclosure, a voluntary practice by companies to report their carbon emissions, serves as a method for businesses to contribute to sustainable development. The trend of carbon emission disclosure among infrastructure companies continues to rise. An increase in a company's carbon emission disclosure reflects its commitment to sustainability, enhancing the company's sustainability report. This commitment provides reassurance to stakeholders involved in the company's operations. Companies that engage in green accounting practices are likely to build a positive reputation for being environmentally conscious. Investors view carbon emissions disclosure as a sign that the company is adhering to its commitment to support sustainable development, leading to a positive response from the investment community.

At the global level, research by (Ding et al., 2022) in Australia shows that companies with high carbon emissions appear to carry out their corporate accountability by increasing climate-related disclosures, which is consistent with legitimizing their potentially unethical actions and submitting to stakeholder and community pressure. In addition, according to a study by (Liu et al., 2023) in the

United Kingdom, companies with high emissions tend to increase carbon disclosure in an effort to maintain legitimacy and protect company value.

However, disclosing carbon emissions is not enough if the company does not provide solutions to reduce carbon emissions because in addition to disclosing carbon emissions, companies must take immediate action to reduce these emissions. Monitoring carbon emissions can identify areas where operational efficiency can be improved and emissions reduced, thus encouraging companies to innovate and develop new technologies that are more environmentally friendly. Disclosing carbon emissions in sustainability reports must also follow the rules commonly used by many companies, although there are no regulations governing the disclosure of carbon emissions specifically, it is not appropriate for companies to disclose carbon emissions carelessly. The test results show new research results that carbon emission disclosure affects sustainable development. Research conducted (Fathia & Sulfitri, 2023) shows that the increase or decrease in the sustainability of the company is influenced by this variable.

### **Environmental Management System in Moderating the Relationship Green Accounting and Sustainable Development**

The research results indicate that the environmental management system does not moderate the relationship between green accounting and sustainable development. This conclusion is based on the significant value of 0.517, which is greater than 0.05, and a t-count value of 0.653, which is less than the t-table value of 2.011. Therefore, hypothesis H3, which suggests that the environmental management system moderates the effect of green accounting on sustainable development, is rejected. The relationship between green accounting and sustainable development is complex and influenced by other factors that may moderate it, such as organizational culture, stakeholder pressure, and external environmental conditions because companies that implement environmental management standards and have ISO 14001 certification do not adequately reflect the company's contribution to sustainable development efforts.

Although ISO 14001:2015 is designed to help companies manage their environmental impacts systematically, the results of research by (Bravi et al., 2020) on ISO 14001 certified companies in Italy show that the main benefits of implementing this system are more operational, such as risk prevention, improved management of environmental activities, and setting energy and waste reduction targets. However, significant obstacles also arise, such as increased bureaucracy, complexity of procedures, and difficulties in fostering environmental awareness among employees.

This strengthens the finding that ownership of EMS certification (such as ISO 14001) does not necessarily moderate the relationship between green accounting and sustainable development. This certification reflects more administrative compliance than strategic commitment to sustainability. In other words, without the comprehensive and consistent application of sustainability principles in business strategy and organizational culture, the existence of an environmental management system is not enough to strengthen the positive impact of green accounting on sustainable development goals. Thus, both the empirical findings in your research and the results of the Italian study indicate that the effectiveness of an EMS depends largely on substantial implementation, not just the formality of certification. The comprehensive integration of sustainability values into business operations and strategies remains a more decisive key factor in driving sustainable development.

The impact of green accounting on sustainable development is multifaceted and shaped by a diverse range of factors, extending beyond economic and ecological efficiency. This is exemplified by the fact that companies implementing environmental

management standards and obtaining ISO 14001 certifications do not inherently reflect their contributions to sustainable development endeavors.

An Environmental Management System is a structured framework that combines policies, procedures, and processes to train personnel, monitor environmental performance, summarize data, and report results to interested parties inside and outside the company. The implementation of Environmental Management Standards, ISO 14001 certification that a company has will not necessarily be able to increase sustainable development. Although this is contrary to initial expectations, an environmental management system that focuses on reducing environmental impacts can increase the effectiveness of green accounting in encouraging sustainable development. The test results reveal the environmental management system cannot moderate the influence of the relationship between green accounting and sustainable development.

### **Environmental Management System in Moderating the Relationship Carbon Emission Disclosure and Sustainable Development**

The research findings indicate that the environmental management system does not moderate the relationship between carbon emission disclosure and sustainable development. This conclusion is supported by a significant value of 0.471, which is greater than 0.05, and a t-count value of -0.728, which is less than the t-table value of 2.011. As a result, hypothesis H4, which posits that the environmental management system moderates the effect of carbon emission disclosure on sustainable development, is rejected.

A study conducted in a multinational context by (Margaret et al., 2024) assessed the impact of ISO 14001 after the Paris Agreement. The study found that although ISO 14001 has the potential to increase a company's market value, its effectiveness is highly dependent on external institutional pressures, such as strict environmental regulations or a country's commitment to international climate agreements. This indicates that the existence of EMS certification alone is not enough to produce a real impact on sustainability, including in terms of moderation of carbon emission disclosure.

Thus, the results of this study emphasize that EMS is contextual and does not have a universal moderating effect. In the context of companies in developing countries or sectors that have not yet faced strict regulatory pressures, environmental certification tends to be a mere symbol of administrative compliance, rather than a strategic tool to drive real sustainability practices. This also shows that disclosure of carbon emissions that have an impact on sustainable development requires more than just a management system; it requires real management commitment, an organizational culture that supports sustainability, and incentives and pressure from external stakeholders. These findings provide important implications for policy makers and regulators that the effectiveness of EMS as a tool to strengthen sustainability practices needs to be reviewed. Certifications such as ISO 14001 need to be strengthened in substance, not just procedurally, in order to be able to produce real impact on the environmental and economic sustainability of companies.

The study concludes that the environmental management system cannot be used as a benchmark for assessing how carbon emission disclosure by companies affects sustainable development. An Environmental Management System, which includes policies, procedures, and processes for training personnel, monitoring environmental performance, summarizing data, and reporting results, does not necessarily enhance sustainable development when based on the ISO 14001 standard. The test results reveal that the environmental management system fails to moderate the impact of carbon emission disclosure on sustainable development.

## Conclusion and Suggestion

This study examines the impact of green accounting and carbon emission disclosure on sustainable development, with environmental management systems as a moderating variable, focusing on infrastructure companies listed on the Indonesia Stock Exchange from 2019 to 2023. The findings reveal that both green accounting and carbon emission disclosure significantly affect sustainable development. This indicates that effective implementation of green accounting and transparency in carbon emission disclosure can enhance a company's sustainable development performance. However, the environmental management system, measured by ISO 14000 certification, does not moderate the relationship between green accounting and sustainable development, nor between carbon emission disclosure and sustainable development. In other words, the presence or absence of an environmental management system certification does not influence the effectiveness of green accounting or carbon emission disclosure in promoting sustainable development. The implications of these findings suggest that companies, particularly in the infrastructure sector, should focus on improving green accounting practices and carbon emission disclosure to advance sustainable development. Investors are also advised to consider a company's commitment to these aspects as key indicators of its contribution to sustainable development. The study is limited by its small sample size and the consideration of only two independent variables. Future research should include additional independent and moderating variables to offer a more thorough analysis of the factors influencing sustainable development.

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