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Research Article

Do Environmental Management Systems, Environmental Performance, and Firm Size Influence Greenhouse Gas Emission Disclosures?

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Abstract

This study aims to investigate whether the variables related to environmental management systems, environmental performance, and company size impact the reporting of greenhouse gas emissions. This research adopts a quantitative approach, utilizing secondary data from annual and sustainability reports selected through purposive sampling. Information was gathered from official company websites and the Indonesian Stock Exchange (BEI). The study encompasses 68 samples from an unbalanced panel data set of 28 companies from 2019 to 2021. The analytical methodology employed in this research involves panel data regression analysis. The results indicate that environmental management system variables and company size do not significantly influence greenhouse gas emission disclosures. However, it was observed that company size does have a notable positive effect on reporting greenhouse gas emissions. These findings offer valuable insights for governments and other institutions aiming to enhance environmental policies and foster improved greenhouse gas emission transparency within the industrial sector.

Keywords: Environmental Management System, Environmental Performance, Company Size, Disclosure of Greenhouse Gas Emissions

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1. Introduction

Currently, attention worldwide is focused on environmental problems such as global warming, one of which is that Indonesia is facing the highest risk of global warming (Febriani & Davianti, 2018). Global warming is the phenomenon of increasing global average temperatures continuously every year as a result of the greenhouse effect caused by increased emissions of gases such as nitrous oxide (N2O), carbon dioxide (CO2), chlorofluorocarbons (CFC), sulfur dioxide (SO2) and methane (CH4), this gas is known as greenhouse gas (GHG) emissions which are released into the atmosphere and cause the earth's temperature to increase (Suriandjo, 2020).
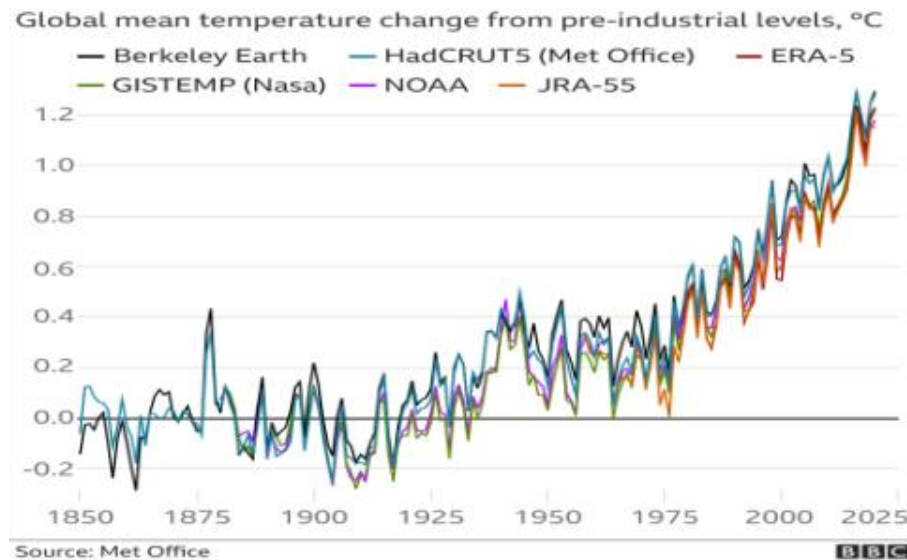
Figure 1. Global Temperature Changes

Figure 1. explains that the earth's global temperature continues to increase every year. Human activities produce excessive amounts of greenhouse gas (GHG) emissions into the atmosphere, which is the cause of increasing global warming. The National Aeronautics and Space Administration (NASA) revealed that the earth's surface temperature increased by 0.85°C in 2021. In the last ten years, the earth's surface temperature increased to 1.02°C in 2016 and 2020 (Rizaty, 2022). According to Pusparisa (2021), Indonesia is among the ten countries producing the most greenhouse gas emissions globally, reaching 965.3 M_tCO_{2e} or 2% of world emissions.

Due to these problems, Indonesia is committed to reducing greenhouse gas emissions. One form of the Indonesian Government's commitment is that the government ratifies the Paris Agreement, a global agreement to reduce emissions by 2030 (Anggela, 2022). Commitment to reduce greenhouse gas emissions by 29 to 41 percent by 2030 compared to the GHG Emissions Baseline. To strengthen national, regional, and community resilience to climate change, protection programs against various types of climate change must also be increased to advance the goal of national contribution and management of greenhouse gas (GHG) emissions in social development. Indonesia has also issued Presidential Regulation No. 98 of 2021 concerning the Economic Value of Carbon.

Quoted by Anwar (2020), there are cases related to environmental pollution caused by chemical waste in Indonesia. Air pollution reduces air quality, which is dangerous for health and the environment. Those producing greenhouse gas emissions that have the greatest opportunity are companies engaged in industrial activities, so companies should report information related to financial activities to face the risks of climate change and global warming caused by the company's activities. The obligation is in the form of disclosing greenhouse gas emissions (Deantari et al., 2019).

In business entities, environmental management systems can enable companies to disclose more information about CO2 emissions and influence other broader environmental disclosure practices (Setiadi, 2021). If a company wants optimal environmental performance, the company must be able to control environmental pollution caused by the company's activities by creating a management system. Based on Setiawan & Iswati (2019), the environmental management system does not affect emissions disclosure. Meanwhile, Kristianto & Lasdi (2022) stated that the environmental management system positively affects the disclosure of greenhouse gas emissions.

Environmental performance can be a benchmark for a company's environmental responsibility. Proactive companies will strive to regulate and minimize the effects of climate change by implementing environmental management strategies and policies to control emissions and

developing special programs so that the benefits of greening become popular among the public (Purnayudha & Hadiprajitno, 2022). Research results by Setiadi (2021) suggest that environmental performance negatively affects emissions disclosure. Meanwhile, according to Purnayudha & Hadiprajitno (2022), environmental performance positively affects the disclosure of greenhouse gas emissions.

Companies that have a large scale show a variety of activities (Maqfirah & Fahrianta, 2022). Where large companies are more visible to society than small companies, large-scale companies experience greater pressure and demands from society (Deantari et al., 2019). Based on Septriyawati & Anisah (2019) stated that company size does not affect emissions disclosure. Meanwhile, Deantari et al. (2019) stated that company size positively affects the disclosure of greenhouse gas emissions.

This research is a replication of research by Kristianto & Lasdi (2022). There are differences between this research and previous research, namely that this research uses the basic materials and industrial sectors, uses stakeholder theory, uses a research period from 2019-2021, and uses the Eviews data analysis method. This research does not include the gender diversity variable because it does not influence on increasing disclosure of greenhouse gas emissions. The female board does not excuse companies to communicate their ideas more innovatively. Whether the number of female and male directors in the company is large or small is not a big problem in decision making Kristianto & Lasdi (2022). The findings from this research can guide governments and other institutions in developing more effective environmental policies and improving the spread of greenhouse gas emissions at the industrial level.

2. Literature Review and Hypothesis

The theories used in this research are stakeholder theory and legitimacy theory. The term stakeholder describes the relationship of a group or person identified as having the ability to influence or be influenced by organizational goals (Freeman & Reed, 1983). Strong stakeholder relationships are based on the trust of this stakeholder group, which is an important perspective for companies when choosing whether to make disclosures or not in additional reports (Putra & Susila, 2020). Legitimacy theory, according to Dowling & Pfeffer (1975), is that companies try to build and adapt social values and business processes to be accepted and recognized by society. This study is done by adapting the company's values and standards.

Environmental management systems provide a framework for businesses to maintain the environment and respond to changing environmental circumstances to balance social needs. Based on stakeholder theory, stakeholders monitor all company activities, including environmental issues. Companies are encouraged to make disclosures. Meanwhile, according to legitimacy theory, companies that follow the ISO 14001 standard indicate that they have a superior management system and have adapted their business to applicable rules and norms. The existence of an internal environmental management system in the company will allow the company to disclose information related to greenhouse gas emissions in additional reports. In line with research by Prafitri & Zulaikha (2016), Deantari et al. (2019), and Kristianto & Lasdi (2022) revealed that the environmental management system has a positive effect on the disclosure of greenhouse gas emissions. The first hypothesis of this research is:

H_1: The environmental management system has a positive effect on the disclosure of greenhouse gas emissions

Environmental performance is a company's achievement in controlling environmental issues related to the impact of the company's operational activities (Purnayudha & Hadiprajitno, 2022). Based on stakeholder theory, optimal environmental performance is used as a form of company communication with stakeholders to increase the company's reputation in the eyes of external parties. Meanwhile, according to legitimacy theory, companies with high levels of propriety will dare to disclose because this can grow the company's image in society. Companies with the best environmental performance will differentiate themselves by making disclosures as a form of what the company does to overcome existing environmental problems. In line with research by Prafitri

& Zulaikha (2016), Deantari et al. (2019), and Kristianto & Lasdi (2022) revealed that environmental performance has a positive effect on the disclosure of greenhouse gas emissions. The second hypothesis of this research is:

H₂: Environmental performance has a positive effect on the disclosure of greenhouse gas emissions

The general public better knows large companies, so the public pays attention to large-scale companies (Gunawan & Meiranto, 2020). Based on stakeholder theory, companies will be more transparent in carrying out their activities to maintain the reputation and trust of stakeholders that they are responsible for the impact of the emissions they produce. Meanwhile, according to legitimacy theory, large companies receive much attention from the public because the activities they carry out are greater. Large companies will experience more pressure and demands from society because their operations are more visible to the public than small companies. In order to gain legitimacy from the public, companies must disclose greenhouse gas emissions. In line with research by Maqfirah & Fahrianta (2020) and Setiadi (2021) revealed that company size has a positive effect on emissions disclosure. The third hypothesis of this research is:

H₃: Company size has a positive effect on disclosure of greenhouse gas emissions

3. Data and Method

The method used in this research is quantitative research. The quantitative method is an information-based research methodology that combines statistics in numbers as a calculation tool to draw conclusions from the problems studied (Sugiyono, 2018). This research uses a causality design to see the possibility of a cause-and-effect relationship between variables.

Population and Sample

This study focuses on companies in the basic materials and industrial sectors listed on the Indonesia Stock Exchange (BEI) from 2019 to 2021. The sampling method employed is purposive sampling, which involves selecting samples based on specific criteria. These criteria include: (1) Companies consecutively listed on the IDX in the basic materials and industrial sectors from 2019 to 2021. (2) Companies that consistently release annual reports from December 31 for 2019 to 2021. (3) Companies that publish sustainability reports as of December 31 for 2019, 2020, or 2021. (4) Companies included in the PROPER program administered by the Ministry of Environment and Forestry of the Republic of Indonesia for 2019 to 2021.

Data Collection Methods

This study relies on secondary data collected through the technique of documentation. Documentation involves the research, observation, and utilization of secondary information sourced from the Indonesia Stock Exchange (BEI) official website at www.idx.co.id. Therefore, the secondary data for this research comprises annual reports and sustainability reports obtained by visiting company websites.

Operational Variables

Disclosure of Greenhouse Gas Emissions (DGGE)

Disclosure of greenhouse gas emissions is a company that is seriously committed to reducing the impact of greenhouse gas emissions on the surrounding environment (Kristianto & Lasdi, 2022). This disclosure is proxied by measuring using the index Choi et al. (2013). The index developed will get a score of 1 if the company discloses items in a certain way, while it will get a score of 0 if certain items are not disclosed. Here is the formula:

$$\text{DGGE} = \frac{\sum di}{(M)} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \tag{1}$$

Information:
DGGE = disclosure of greenhouse gas emissions
$\sum di$ = the sum of all scores disclosed by the company
M = maximum number of items disclosed (18 items)

Environmental Management System (EMS)
An environmental management system is the entire framework of an organization's management structure that estimates the current and long-term environmental effects of an organization's activities, goods, and services (Rachman et al., 2019). The environmental management system is proxied by taking measurements, namely, if companies that are ISO 14001 certified get a score of 1, while companies without ISO 14001 certification get a score of 0.

Environmental Performance (EP)
Environmental performance is environmental governance by companies to participate in, protect, and protect the environment (Dewayani & Ratnadi, 2021). The proxy used for environmental performance variables is the PROPER rating published by the Ministry of the Environment (Deantari et al., 2019).

Table 1. PROPER Rating

Color	Description	Value
Black	Very Bad	1
Red	Bad	2
Blue	Good	3
Green	Very Good	4
Gold	Excellent	5

Company Size (CS)
Company size is a scale that shows the size of the business entity seen by the business in terms of the number of assets (Setiadi, 2021). The proxy used for this variable is the natural logarithm proxy of total assets (Ln Asset). Here is the formula:

$$\text{Company Size} = \text{Ln (Total Assets)} \quad\text{..} \quad (2)$$

4. Results

Descriptive statistics
This study employed descriptive statistics to calculate the smallest value, largest value, average, and standard deviation.

Table 2. Descriptive Statistical Test Results

	DGGE	EMS	EP	CS
Mean	0.464870	0.911765	3.176471	29.36902
Maximum	0.777780	1.000000	5.000000	32.48394
Minimum	0.055560	0.000000	1.000000	23.40192
Std. Dev.	0.198786	0.285746	0.689823	2.200074
Observations	68	68	68	68

Source: Data processed (2023)

Table 2 provides descriptive statistics for the Disclosure of Greenhouse Gas Emissions (DGGE) variable. It shows a range from a minimum value of 0.055560 to a maximum value of 0.777780, with a mean of 0.464870 and a standard deviation of 0.198786. For Environmental Management System (EMS), the values range from a minimum of 0.000000 to a maximum of 1.000000, with a mean of 0.911765 and a standard deviation of 0.285746. As for Environmental Performance (EP), the values range from a minimum of 1.000000 to a maximum of 5.000000, with a mean of 3.176471 and a standard deviation of 0.689823. Regarding Company Size (CS), the minimum value is 23.40192, and the maximum is 32.48394, with a mean of 29.36902 and a standard deviation of 2.200074.

Selection of Panel Data Regression Model
Test Chow
The Chow test is employed to ascertain whether the optimal panel data regression model should be a common effect or fixed effect model. The decision criterion is based on the probability value: if it is less than 0.05, the fixed effect model is selected; conversely, if it is greater than 0.05, the common effect model is chosen.

Table 3. Chow Test Results

Effects Test	Statistic	d.f.	Prob.
Cross-section F	2.280974	(27,37)	0.0101
Cross-section Chi-square	66.640969	27	0.0000

Source: Data processed (2023)

Table 3 displays the outcomes of the Chow test, specifically focusing on the probability value. The calculated cross-section chi-square is 0.0000. Given that this value is less than 0.05, as per the Chow test, the preferred model is determined to be the fixed effect model.

Hausman test
The Hausman test is conducted to identify the most suitable panel data regression model, whether it should be a fixed effect or random effect model. The decision criterion is based on the probability value: if it is less than 0.05, the fixed effect model is chosen; conversely, if it is greater than 0.05, the random effect model is selected.

Table 4. Hausman Test Results

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	6.407476	3	0.0934

Source: Data processed (2023)

As indicated in Table 4, the probability value is presented. The resulting chi-square statistic is 0.0934, which exceeds the threshold of 0.05. Therefore, according to the Hausman test, the most suitable model is the random effect model. Subsequently, the random effect model is further assessed against the common effect model using the Lagrange multiplier test.

The Lagrange multiplier test
The Lagrange multiplier test is employed to identify the optimal panel data regression model, whether it should be a random effect or a common effect model. The decision criterion is based on the probability value: if it is less than 0.05, the random effect model is selected; conversely, if it is greater than 0.05, the common effect model is chosen.

Table 5. Lagrange Multiplier Test Results

|	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	4.160131	13.56721	17.72734
	(0.0414)	(0.0002)	(0.0000)

Source: Data processed (2023)

According to the findings in Table 5, the Lagrange multiplier test demonstrates a Breusch-Pagan probability value of 0.0000. Given that this value is less than 0.05, as per the Lagrange multiplier test, the preferred model is determined to be the random effect model.

Classic Assumption Test
Normality test
The normality test aims to determine whether the confounding or residual variables in the

regression model are normally distributed (Ghozali & Ratmono, 2017). In this study, you can use Jarque-Bera with a sig value to detect normality. 0.05. If the probability value is > 0.05, it is considered normally distributed.
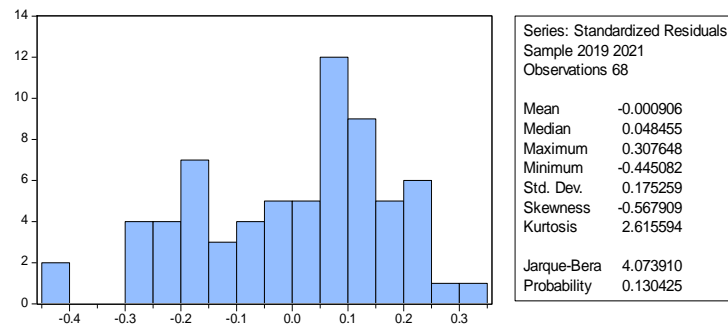
Source: Data processed (2023)

Figure 2. Normality Test Results

Multicollinearity Test
The multicollinearity test is to see whether, in the regression model, there is a relationship between the independent variables (Ghozali & Ratmono, 2017). Multicollinearity can be detected using the Variance Inflation Factor (VIF), where if the VIF is less than 10, the data does not have multicollinearity.

Table 6. Multicollinearity Test Results

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	0.084942	181.9848	NA
EMS	0.006276	12.25880	1.081659
EP	0.001152	26.06124	1.157233
CS	0.000112	208.9068	1.148734

Source: Data processed (2023)

Based on table 6 shows that everything is fine in this research because the centered VIF value of all independent variables is less than 10.

Heteroscedasticity Test
The heteroscedasticity test aims to ascertain if there is a variation in the residual variance across different observations within the regression model. To identify the presence or absence of heteroscedasticity using the White test, one examines the Chi-Square probability. If the Chi-Square probability is greater than 0.05, it indicates the absence of heteroscedasticity.

Table 7. Heteroscedasticity Test Results

F-statistic	0.397183	Prob. F(8,59)	0.9177
Obs*R-squared	3.475015	Prob. Chi-Square(8)	0.9011
Scaled explained SS	8.112415	Prob. Chi-Square(8)	0.4226

Source: Data processed (2023)

Table 7 displays the outcome of the heteroscedasticity test using the White test. The Obs*R-squared value is 3.475015, and the Prob. Chi-Square (8) is 0.9011. This indicates that 0.9011 exceeds the threshold of 0.05. Therefore, based on this research, there is no presence of heteroscedasticity.

Autocorrelation Test
The autocorrelation test checks whether there is a relationship between disturbances in period t and period t-1 (previously) in the regression model (Ghozali & Ratmono, 2017). Detecting autocorrelation in this study used the Durbin-Watson test.

Table 8. Autocorrelation Test Results

Durbin-Watson stat
1.519814

Source: Data processed (2023)

Based on Table 8 above, the results of the autocorrelation test on the Durbin Waston (D-W) value are 1.519814, where -2 < 1.519814 < 2, so that the conclusion in this study is that there is no autocorrelation either positively or negatively.

Panel Data Regression Analysis

Table 9. Results of Panel Data Regression Analysis

Variable	Coefficient
C	-0.443375
EMS	0.130262
EP	0.078990
CS	0.018369

Source: Data processed (2023)

The results of the regression equation are as shown in table 9 in the coefficient section, the results are as follows:

$$DGGE = -0.443375 + 0.130262\ EMS + 0.078990\ EP + 0.018369\ CS + e \ldots\ldots\ldots\ldots\ (3)$$

In the equation above, the constant value is -0.443375. It can be interpreted that if the EMS, EP, and CS values are zero, then the DGGE value will be minus 0.443375. The regression coefficient for EMS is 0.130262. This implies that a 1% increase in EMS would lead to a corresponding increase of 0.130262 in DGGE, assuming all other independent variables remain constant. For EP, with a regression coefficient of 0.078990, a 1% increase in EP would result in a 0.078990 increase in DGGE, provided that all other independent variables remain unchanged. As for CS, the regression coefficient is 0.018369, indicating that a 1-unit increase in CS would lead to a 0.018369 increase in DGGE, assuming all other independent variables are held constant.

Coefficient of Determination Test (R^2)
According to Ghozali & Ratmono (2017), the coefficient of determination test determines how much the independent variable can describe the dependent variable.

Table 10. Coefficient of Determination Results (R^2)

Adjusted R-squared
0.142166

Source: Data processed (2023)

Table 10 presents the Adjusted R Square value as 0.142166 or 14.22%. This result means that the independent variable in this study influences only 14.22%, while 85.78% is explained by other variables not included.

F test
The F test aims to prove that the independent variables in the model together influence the dependent variable (Ghozali & Ratmono, 2017).

Table 11. F Test Results

F-statistic	Prob(F-statistic)
4.701242	0.004988

Source: Data processed (2023)

Table 11 shows that the prob f-statistic value is 0.004988 < 0.05, and the f-statistic is 4.701242 > f-table 2.75. In conclusion, the independent variables in this study are appropriate for the disclosure of greenhouse gas emissions variables. The regression model in this research can be used.

T-test
The t-test aims to show how much influence one independent variable has on the dependent variable by assuming the other independent variables are constant (Ghozali & Ratmono, 2017).

Table 12. T-test results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.443375	0.371006	-1.195062	0.2365
SML	0.130262	0.089098	1.462005	0.1486
KL	0.078990	0.034424	2.294641	0.0250
UKP	0.018369	0.013313	1.379721	0.1725

Source: Data processed (2023)

The obtained t value of 1.462005 is less than the critical t value of 1.99773, and the probability value of 0.1486 exceeds 0.05. Consequently, the alternative hypothesis (Ha) is rejected, and the null hypothesis (Ho) is accepted. This result indicates that the environmental management system (EMS) variable does not significantly influence the disclosure of greenhouse gas emissions. Therefore, the first hypothesis is not supported by the findings.

On the other hand, with a t value of 2.294641, which surpasses the critical t value of 1.99773, and a probability value of 0.0250, which is less than 0.05, the null hypothesis (Ho) is rejected, and the alternative hypothesis (Ha) is accepted. This finding suggests that the environmental performance variable (EP) indeed impacts the disclosure of greenhouse gas emissions. As a result, the second hypothesis is confirmed.

Furthermore, the t value of 1.379721 falls short of the critical t value of 1.99773, and the probability value of 0.1725 exceeds 0.05. Therefore, the alternative hypothesis (Ha) is rejected, and the null hypothesis (Ho) is accepted. This result implies that the company size variable (CS) does not significantly influence the disclosure of greenhouse gas emissions. Consequently, the third hypothesis is not supported by the results.

5. Discussion
In this study, the environmental management system was not proven to influence the disclosure of greenhouse gas emissions. This research's results align with research by Setiawan & Iswati (2019) and Maqfirah & Fahrianta (2020). The management system in this research uses the ISO 14001 proxy. As quoted by the Indonesia Environment & Energy Center, ISO 14001 is conformance, not performance, where ISO 14001 certificates can be given to companies that have a negative contribution to the environment but are committed to continuous improvements. The company with ISO 14001 does not mean that the company's environment is good. It is also said that ISO 14001 does not require management to disclose emissions; this ISO standard is still voluntary. So, an ISO 14001 certificate cannot be used as a reference for a company will disclose emissions produced (Maqfirah & Fahrianta, 2022).

In the second hypothesis of this research, environmental performance has a significant positive effect on the disclosure of greenhouse gas emissions. The results of this research are in line with research by Deantari et al., (2019), Kristianto & Lasdi (2022), and Purnayudha & Hadiprajitno, (2022). Environmental performance is one of the benchmarks in assessing a company's responsibility to the environment. One form of participation is by following the PROPER level. The higher the PROPER level in a company, such as green or gold, will influence the disclosure of greenhouse gas emissions because the company has tried to minimize the emissions released from its business activities. So companies are quick in disclosing environmental issues and want to gain

a positive view and be able to improve the company's image or gain legitimacy from the public.

Company size does not significantly affect the disclosure of greenhouse gas emissions. This research's results align with research by Septriyawati Anisah (2019) and Nastiti & Hardiningsih (2022). Company size is measured using Ln (total assets). The large scale of a company does not mean that its financial performance management could be better. In contrast, large companies do not necessarily get maximum profits because large companies use greater operational costs. The firm size does not influence the disclosure of greenhouse gas emissions because large companies still believe that disclosure could be more effective and do not think it will negatively impact the future (Cahya, 2016). Companies also think that making disclosures will increase the company's burden because there is no awareness from company interns. In Perpes number 61 of 2011, it is also not stated that only large companies must disclose emissions where it is hoped that all large and small companies will participate in the emission reduction target (Septriyawati & Anisah, 2019).

6. Conclusion

Based on the conducted tests, it was found that only one variable, environmental performance, has a significant impact on the disclosure of greenhouse gas emissions. On the other hand, both the environmental management system and company size were found to have no significant influence on this disclosure. It is important to note that this research has some limitations. The sample size was restricted to only 28 companies within the selected sector, and the Adjusted R Squared value was relatively low at 14.22%. Given these limitations, it is recommended for future research to diversify the sectors included in the study to encompass a broader range of samples. Additionally, incorporating additional independent variables not utilized in this research may provide further insights.

In terms of managerial implications, companies are advised to place a heightened emphasis on environmental management. This involves developing and implementing policies and practices that actively contribute to reducing greenhouse gas emissions. Additionally, managers must maintain consistent monitoring of environmental performance. This practice enables a thorough assessment of how operational activities impact the environment and allows for necessary improvements. Furthermore, meticulous attention to detail in disclosing greenhouse gas emissions is paramount. Providing accurate and transparent information fosters trust among stakeholders and ensures compliance with regulatory standards.

Recommendations

Suggestions for Further Research on Environmental Management Systems: Focus research on specific elements of environmental management systems, such as policies, procedures, and practices that influence greenhouse gas emissions. An in-depth analysis of the components of this system can provide richer insights and conduct case studies in specific industries to understand how the factors in the study influence the spread of greenhouse gas emissions. Each industry may have unique dynamics in terms of environmental management practices.

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Ethics declarations

Availability of data and materials

Data sharing does not apply to this article as no new data were created or analyzed in this study.

Competing interests

The authors reported no potential competing interest.