

The Influence of Energy Consumption on Company's Carbon Emissions; Is GCG Capable of Reducing The Carbon Emissions, Research on State-Owned Enterprises in Indonesia

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ABSTRACT: *The escalating global temperature resulting from climate change demands urgent attention. Carbon gas pollution, a leading contributor to climate change, induces a greenhouse gas effect. This study aims to assess the influence of Energy Consumption on Carbon Emissions generated by companies. Additionally, it explores the relationships between Carbon Emissions and other variables, including Good Corporate Governance (GCG) practices, Profitability, Size, and Debt Ratios of companies, utilizing an analytical framework model for regression analysis. The research relies on data extracted from annual and sustainability reports of 31 State-Owned Enterprises (BUMN) in Indonesia spanning the years 2018 to 2022. The findings underscore that GCG Practices, Debt Ratios, Size, and Energy Consumption exert a direct impact on environmental performance. In contrast, Profitability does not demonstrate a direct influence on the magnitude of Carbon Emissions produced. The empirical evidence indicates uncertainty in the results when compared with other studies examining factors influencing company performance.*

KEYWORDS: carbon emissions, energy consumption, profitability, size, leverage, GCG.

INTRODUCTION

Climate change is increasingly apparent as the Earth's temperature rises, culminating in its highest point during the 2011-2020 period. This phenomenon is leading to more severe storms, prolonged droughts, elevated sea levels, the extinction of species on

both land and sea, and a heightened risk of poverty and health-related challenges. The primary driver behind these changes is the widespread use of fossil fuels, including oil, coal, and gas. Fossil fuel consumption is responsible for 75% of global greenhouse gas emissions and 90% of carbon dioxide emissions (*Causes and Effects of Climate Change | United Nations, 2023*).

In commitment to the United Nations (UN) goals for environmental preservation, Indonesia, along with other nations, has pledged to take action against climate change. Indonesia has set targets to reduce Greenhouse Gas (GHG) emissions by 29% and achieve peak emissions in 2030 (*Causes and Effects of Climate Change | United Nations, 2023*). Additionally, the country aims to attain Net Zero Emissions by 2060 (*G20 Indonesia 2022 | Net Zero Carbon 2060, 2022*).

Research on industrial pollution underscores its adverse effects on human health, correlating significantly with increased mortality rates. Therefore, it is imperative to raise awareness about the crucial balance between environmental preservation and the demands of industrial production activities (Rahman et al., 2021).

Industrial pollution is an inevitable byproduct of business operations, and the environmental impact of these activities can be assessed through various indicators. Energy consumption, representing the amount of energy resources utilized by a company for production, is a key input. Studies conducted by (Mesagan & Chidi, 2020) reveal a direct relationship between increased energy consumption and higher carbon pollution. Furthermore, capital investment in energy intensity is shown to have a positive and significant impact on carbon emissions. Notably, research suggests that strategic capital investments can enhance energy efficiency, ultimately leading to a reduction in carbon emissions.

Jiménez and Lorente (2001) emphasized in their literature review that assessing environmental performance should extend beyond environmental factors alone. They argued that various operational aspects (Cost, Time, Quality, and Service) are interconnected and can influence each other. Therefore, effective environmental management in a company is the result of a complex interaction between environmental practices, human resources, and other operational capabilities.

Building on this perspective, the author of this study incorporates multiple measurement variables to explore their relationships with Environmental Performance. Profitability, Corporate Governance (GCG), Company Size, and Leverage are among the variables considered. The research scope is specifically tailored to companies falling within certain groups, chosen based on ownership characteristics, with a focus on State-Owned Enterprises (BUMN).

A study by (Wang et al., 2022) delves into the environmental performance of state-owned enterprises in China. The research indicates that these enterprises exhibit superior environmental performance concerning regulated pollutants in alignment with government targets. Interestingly, their performance is comparable to that of private companies for unregulated pollutants, implying that BUMN entities are more responsive to and responsible for meeting regulatory requirements. The study further suggests that privatization may lead to a deterioration in the environmental performance of state-owned enterprises.

While there is existing research on the individual relationships between Energy Consumption, Profitability, Size, Debt Ratios, and Corporate Governance with corporate environmental performance, the simultaneous examination of these variables on similar company characteristics, especially in the context of Indonesia, remains unexplored. This research aims to fill this gap by addressing the following questions.

- a. How does energy consumption influence a company's Carbon Emissions?
- b. How does profitability influence a company's Carbon Emissions?
- c. How does the size of a company influence its Carbon Emissions?
- d. How does the value of debt ratio influence a company's Carbon Emissions?
- e. How does corporate governance influence a company's Carbon Emissions?

LITERATURE AND THEORETICAL FRAMEWORK

Energy Consumption on Carbon Emissions

The utilization of energy in business operations inevitably leads to pollution (Le et al., 2017). It is established that the higher the energy intensity a company exhibits, the more significant its contribution to environmental degradation. To address this issue, businesses can implement two key policies aimed at managing and reducing energy intensity, thus mitigating pollution impacts on the environment (Sun et al., 2019). These policies encompass a comprehensive approach involving an increase in the use of renewable energy through energy conservation and efficiency measures, as well as the adoption of a mixed approach involving both renewable and non-renewable energy sources.

Research by Hu and Kao (2007) intensity can be achieved by substituting energy use with labor. This approach proves to be more effective than solely pursuing targets related to energy use efficiency.

Profitability

The theoretical framework underlying this study is grounded in the Environmental Kuznets Curve (EKC) concept, which posits that the relationship between an economic indicator and an environmental indicator takes the shape of an inverted U curve when measured against pollution and income growth on the same axis (*Environmental Kuznets Curve - an Overview | ScienceDirect Topics*, 2018). The

curve illustrates the dynamic relationship between economic development and environmental quality over the course of progress. Essentially, during the early stages of development, pollution tends to increase. However, at a certain inflection point, often referred to as the turning point, as the economy advances further, pollution starts to decline. According to Kuznets' Theory, Environmental Performance can be gauged by assessing the Carbon Emissions produced by a company.

In parallel, Financial Performance is evaluated through the use of Return on Assets (ROE), a key performance indicator (KPI) in financial analysis. ROE is a metric that calculates the income generated from the investment in capital or assets. It provides investors with insights into how efficiently a company transforms investments into net profit. A higher ROE indicates greater efficiency in utilizing assets. The calculation of ROE is as follows:

$$\text{ROE} = \frac{\text{Profit of the Year}}{\text{Average total equity}} \times 100 \% \quad (1)$$

Good Corporate Governance within the Perspectives of the Agency Theory and Stakeholders

In Agency Theory, proposed by Jensen and Meckling, (1976), the agency relationship is elucidated as the dynamic between the owner (principal) and the agent (manager), particularly in the context of conferring decision-making authority within a company. This theory posits that a conflict of interest is inherent in an agency relationship, as the owner seeks to enhance corporate profitability and dividends, while the agent, or manager, is driven to maximize personal interests. Profit Management in the presentation of financial reports is one way through which managers may act to serve their personal interests.

Recognizing that the activities of a company are intertwined with its surrounding stakeholders, Stakeholder Theory, as introduced by Freeman in 1984, asserts that the primary purpose of a company is to fulfill the desires of its stakeholders. The stronger the influence of stakeholders, the greater the adaptability efforts required by the company. From the perspective of this research, stakeholders are considered to be the environment in which the company operates.

In tandem with these theories, companies require a governance system that can steer the organization in alignment with its initial goals. The Cadbury Committee (Mahrani & Soewarno, 2018), asserted in 1992 that good corporate governance entails a set of principles governing relationships among shareholders, managers, creditors, government entities, employees, and other internal and external stakeholders concerning their respective rights and obligations. Corporate governance emerges from the company's commitment to assuring owners that invested funds have been utilized efficiently and appropriately.

Theories on the Impact of Asset Markets on Social Stakeholders

The theory put forth by (Jensen, 1988) posits that alterations in a company's structure resulting from the divestiture and acquisition of assets can yield both positive and negative consequences for different stakeholders. According to this theory, the decision to enhance company valuation through asset acquisition can positively impact the company's environmental performance targets (Berchicci et al., 2017). This positive impact is contingent on the implementation of an effective strategy for the judicious utilization of assets, thereby achieving the anticipated environmental performance. Conversely, when a company undergoes asset sales, strategic considerations become crucial to maintaining the targeted environmental performance. It becomes imperative for the company to devise a strategy that aligns with the existing asset conditions while still achieving the desired environmental performance targets.

Capital Structure and Company Value

The theory on capital structure finds its roots in the propositions asserting that, fundamentally, the capital structure of a company does not impact its overall value (Modigliani & Miller, 1958). However, (Vernimmen et al., 2022) challenge this notion in their book "Corporate Finance," demonstrating that the optimal mix of debt and equity is influenced by numerous factors that entail both costs and benefits. The capital structure essentially determines the composition of a company's assets and the proportion of these assets financed by liabilities and equity. High Gearing occurs when liabilities outweigh equity, whereas Low Gearing is characterized by equity exceeding liabilities.

The magnitude of a company's debt plays a pivotal role in assessing its financial health. Companies with debt surpassing their assets may encounter challenges in meeting their financial obligations, posing a risk to their overall financial condition. A commonly used indicator for measuring debt is the Solvency Ratio, which evaluates how well a company's assets can cover its debts, often expressed as the Debt to Asset Ratio (DAR). The calculation for DAR is as follows:

$$\text{DAR} = \frac{\text{Total Debt}}{\text{Total Asset}} \times 100 \% \quad (2)$$

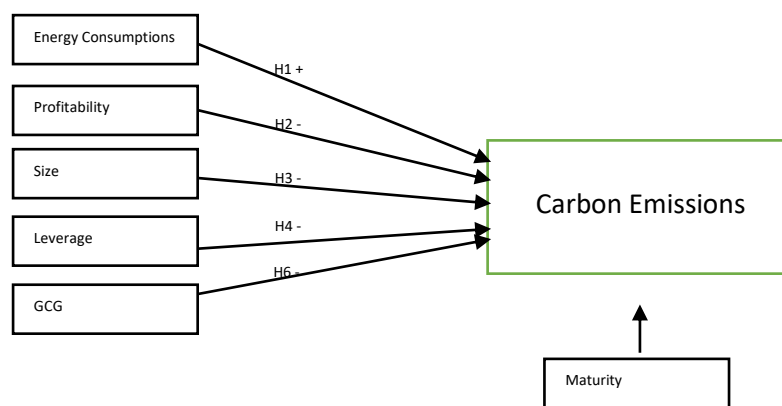
Conceptual Framework

The conceptual framework serves as a visual representation of the anticipated associations among variables. This elucidation delineates the pertinent components within the research, illustrating how they collectively contribute to a unified conclusion (Sekaran and Bougie, 2016).

Building upon the theoretical foundation and formulation of the research problem, seven variables have been identified: independent variables (Profitability, GCG, Company Size, Leverage, Energy), a dependent variable (Carbon Emissions), and a

control variable (Maturity). It is hypothesized that the independent variables will exert a direct and statistically significant influence on the dependent variable.

The subsequent model is a product of this research, designed to assess the interplay between individual variables:



a. Company’s energy consumption on environmental performance

Previous studies have established a correlation between rising energy consumption within companies and an escalation in pollution, leading to environmental degradation. Khan *et al.*, (2022) conducted research spanning 21 APEC member countries during the period of 1990-2016. Their findings indicate a positive relationship between energy intensity, development, and economic growth with the carbon ecological footprint. However, under non-linear conditions, only development and economic growth were observed to decrease carbon emissions, thereby enhancing environmental quality. This aligns with the conclusions drawn by Mesagan and Chidi (2020) in their research encompassing three African countries over the period 1981-2017. Their study affirms that an increase in energy consumption contributes to elevated carbon pollution, while capital investment also exhibits a positive and significant impact on carbon emissions.

In regards to the results of the aforementioned research, the first hypothesis of this research was formulated as follows.

H₁ = Energy Consumption positively affects the Carbon Emissions

b. Profitability affects the Environmental Performance

Drawing from the Environmental Kuznets Curve Theory (EKC), this research explores two possible scenarios regarding the relationship between financial

performance and environmental impact—a positive relationship and a negative relationship.

The investigation of financial performance and environmental performance as variables within the EKC has been a subject of extensive research. Mesagan et al. (2022) examined 36 companies in Africa over the period 1990-2020, employing financial performance as an independent variable and environmental performance as a dependent variable. The results indicate a positive impact of company performance on environmental performance, albeit not statistically significant.

In contrast, (Nakao et al., 2007) utilized Return on Assets (RoA) and Return on Equity (RoE) indicators as measures of company profitability in their study on 300 companies in Japan during the period 1999-2003. This research suggests a positive relationship between environmental performance and financial performance, a trend observed not only in well-performing companies but across the entire spectrum of companies.

Building upon these studies, the hypothesis was formulated as follows:

H₂: RoE negatively affects the resulting Carbon Emissions
c. Company size in affecting environmental performance

The foundational theory underpinning this research is centered on the repercussions of asset market dynamics and their implications for stakeholders. Notably, alterations in the composition of assets, particularly those with direct implications for the value of investments linked to environmental sustainability programs, warrant specific attention.

In accordance with this theory, a study conducted by (Berchicci et al., 2017) on 3130 companies in the USA concluded that the decision to enhance company valuation through asset acquisition can positively impact the company's environmental performance targets. This positive effect is contingent upon the adoption of a strategy that effectively utilizes the acquired assets to attain the envisaged environmental performance.

Concurrently, research by Woo *et al.*, (2014) on 1,656 companies in South Korea during the 2007-2009 period demonstrated that asset value serves as a positive moderator in the relationship between environmental innovation and company environmental performance.

The third hypothesis for this research was proposed as follows::

H₃ = Size negatively affect the resulting Carbon Emissions
d. The Debt Ratio of the company affects environmental performance

A company's financial performance is inherently tied to its capacity to leverage existing assets for profit generation. According to capital structure theory, the valuation of the same set of assets can yield different outcomes depending on whether the proportion of liabilities or equity is higher or lower.

In line with this theory, research conducted by Cariola *et al.* (2020) on 12,615 companies across 26 European countries during the 2003-2005 period posits that an increase in debt financing tends to diminish a company's environmental performance. However, this negative relationship transforms into a positive one when moderated by a robust commitment to environmental control at the country level.

Conversely, findings from research by Fernández-Cuesta *et al.*, (2019) involving 428 companies in 16 European countries over the period 2005-2015 suggest that the reduction of carbon emissions has a positive impact on corporate financing from debt in European companies.

Building upon these studies, the hypothesis for this research can be summarized as follows:

- H₄ = The Debt Ratio has a negative impact on the produced Carbon Emissions
- e. Corporate Governance influences Environmental Performance

In response to the risk of agency problems, as posited by Agency Theory, and recognizing the company's obligation to safeguard stakeholders, as emphasized by Stakeholder Theory, it becomes imperative for companies to establish effective control systems to align with the company's objectives.

Specifically, in the context of Good Corporate Governance (GCG) research, prior investigations have explored the relationship between GCG and sustainable company performance utilizing the Triple Bottom Line (TBL) approach. (Tjahjadi *et al.*, 2021). conducted research on 117 Indonesian companies over the 2013-2017 period. Among the four GCG indicators (Number and Education of Commissioners, and Number and Education of Management Directors) and three Sustainable performance indicators (Economic, Social, Environment), the study proposed four hypotheses regarding the influence of GCG on environmental performance. The results indicated that two hypotheses had no significant effect, while the other two hypotheses exhibited a significant negative impact.

Conversely, 83 companies in Indonesia spanning the period 2001-2019 suggests a positive relationship between corporate governance and resultant company performance (Satrio, 2022). However, Cong and Freedman (2011) (2011) on 50 highly pollutant companies in the USA during 2003-2005 found no relationship

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between GCG and the company's environmental performance. Instead, GCG was positively associated with the disclosure of pollution information.

Based on these insights, the fifth hypothesis of this research was determined as follows.

H₅ = GCG negatively affects the resulting Carbon Emissions.

METHODOLOGY

Using Stata software program, this research regarded secondary data sources, specifically in the form of annual reports and sustainability reports obtained from various BUMNs (State-Owned Enterprises) in Indonesia. Secondary data refers to information acquired indirectly by researchers, often through external sources such as documents.

The study targeted the entire population of BUMNs in Indonesia, with samples selected from those that published both annual reports and sustainability reports containing information on environmental performance within the timeframe of 2018 to 2022. The final sample comprised 31 companies, providing a comprehensive dataset for the research.

- 3.1. Dependent Variables, consisting of Profitability, Corporate Governance (GCG), Company Size, Leverage, and Energy Consumption
- 3.2. Independent Variables, consisting of Environmental Performance measured through the produced Carbon Gas Emissions.
- 3.3. Control Variables, consisting of Corporate Maturity measured by the Company's Business Age.

In this research, panel regression analysis is employed to estimate the influence of the independent variable on the dependent variable. Panel data, utilized in this analysis, represents a combination of cross-sectional and time-series data. The panel regression model applied in this research is as follows:

$$Y = \alpha + \beta_1 \chi_1(\text{CE}) + \beta_2 \chi_2(\text{ROE}) + \beta_3 \chi_3(\text{AV}) + \beta_4 \chi_4(\text{DAR}) + \beta_5 \chi_5(\text{GCG}) + \beta_6 \chi_6(\text{Age}) + \epsilon \dots$$

Where Y represents Carbon Emissions, α is the constant value, Energy Consumption (CE), Return on Equity (ROE), Asset Value (AV), Debt to Asset Ratio (DAR), Corporate Governance Score (GCG), and Company Age (Age).

RESULTS AND FINDINGS

Descriptive Statistics

The descriptive statistics of the data collected in this research is presented in Table 1.

Table 1. Descriptive Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Carbon Emissions	155	5.4539	3.0277	-3.54	14.510
ROE	155	-0.0538	0.6540	-4.9623	0.440
GCG	155	91.9749	4.2534	78.16	99.010
Size	155	18.0492	1.7430	14.14044	21.413
DAR	155	0.6154	0.2356	0.00	1.404
Energy Consumptions	155	5.706159	3.722397	-4.60517	13.06164

From the results of the data analysis, it is evident that the average value of the dependent variable, Carbon Gas Emissions, is 5.45. This implies that, on average, business activities in state-owned companies generate a carbon emissions level of 5.45. The range of values for carbon emissions varies significantly, with the minimum recorded at -3.54 for the BUMN with the smallest carbon emissions, and the maximum at 14.5 for the BUMN with the highest carbon emissions. This variability in values indicates distinct characteristics among the types of state-owned enterprises considered in this study.

Auto Correlation

In this study, a correlation matrix presented in Table 2 is utilized to examine potential multicollinearity issues using the Variance Inflation Factor (VIF). The research findings indicate that the average VIF value is below 0.8, in line with the guideline proposed by (Ghozali, I., 2016).

Table 2. Correlation Matrix and VIF

	CE	EC	ROE	Size	DAR	GCG
CE	1					
EC	0.668	1				
ROE	0.227	0.173	1			
Size	0.440	0.404	0.248	1		
DAR	-0.480	-0.473	-0.311	0.082	1	
GCG	0.286	0.453	0.226	0.240	-0.392	1

Regression analysis

OLS regression analysis was performed in the data analysis, which results are shown in Table 3.

Table 3. Panel Regression Test

Variables	Carbon Emissions	
	Coefficient	P > [t]
Energy Consumptions	0.369	0000***
ROE	-0.036	0.895
SIZE	0.561	0.000***
DAR	-4.424	0.000***
GCG	-0.091	0.042*
AGE	-0.004	0.743
Observation	155	
Number of Firm	31	
R-Square (Within)	0.5798	
Prob > F	0.000	

*=p<0.05; **=p<0.01; ***=p<0.001

DISCUSSION

In the first hypothesis, the panel data regression analysis reveals a coefficient of 0.369 and a significance level of 0.000, indicating a statistically significant positive relationship between Energy Consumption and Carbon Emissions. These findings support the assertion that the Energy Consumption variable is positively associated with the Carbon Emission variable, thereby providing support for H6.

These results align with the findings of Khan *et al.*, (2022), who similarly concluded that energy intensity, development, and economic growth contribute positively to the carbon ecological footprint. Furthermore, this research echoes the conclusions of Mesagan and Chidi (2020), affirming that increased energy consumption leads to higher carbon pollution, and capital investment significantly impacts carbon emissions. Additionally, the study emphasizes that strategic capital investment, aimed at enhancing energy efficiency, can effectively reduce resulting carbon emissions.

In the second hypothesis, the panel data regression results for the relationship between Return on Equity (ROE) and Carbon Emissions yield a coefficient of -0.036 with a significance level of 0.895. Despite indicating a negative relationship, the lack of statistical significance suggests that H1 cannot be supported.

These findings align with the study of Mesagan *et al.*, (2022), which posits that company performance has a negative but insignificant impact on pollution in both the short and long term. It is noteworthy that these results deviate from theoretical expectations, as conventional wisdom suggests that improved company performance should elevate economic productivity and, consequently, lead to increased pollution.

This outcome diverges from other research (Zhou et al., 2020) (Mesagan and Chidi, 2020) (Khan *et al.*, 2022), emphasizing the dynamic nature of the relationship between financial performance and environmental impact, which may fluctuate over time.

In the third hypothesis, the panel data regression analysis reveals a coefficient of 0.561 and a significance level of 0.000, indicating a statistically significant positive relationship between Asset Value and Carbon Emissions. Consequently, H3 cannot be supported. These findings diverge from various prior studies (Berchicci et al., 2017) (Woo et al., 2014) (Deng et al., 2019), which suggested that an increase in asset values positively impacts a company's environmental performance. The discrepancy is attributed to the argument that higher asset values, particularly in sustainable investment funding, contribute to enhanced environmental quality. Contrary to this, the present research aligns with Darnall *et al.'s* (2010) findings, emphasizing that smaller-sized companies exhibit greater adaptability and responsiveness in improving environmental performance, driven by the pressure of stakeholder expectations. Smaller companies, despite limited resources, tend to be more responsive to environmental challenges compared to larger corporations that may resist change for political reasons (Bowen, 2000).

In the fourth hypothesis, the panel data regression results for the relationship between Debt Ratio and Carbon Emissions yield a coefficient of -4.5424 with a significance level of 0.000. These results conclude that the Debt Ratio variable is significantly negatively related to the Carbon Emission variable, supporting H4. Similarly, Cuesta *et al.*, (2019) found that reducing carbon emissions positively impacts corporate financing from debt in European companies. Companies efficiently managing carbon risks receive more favorable debt terms, reflecting the market's and financial entities' recognition of sustainable practices (Jung et al., 2018).

In the fifth hypothesis, the panel data regression analysis yields a coefficient of -0.091 and a significance level of 0.042, indicating a statistically significant negative relationship between Good Corporate Governance (GCG) and Carbon Emissions. Therefore, H2 can be supported. Effective Good Corporate Governance practices positively influence Company Performance, particularly in terms of Environmental Performance (Mahrani and Soewarno, 2018) (Satrio, 2022). Additionally, Tjahjadi *et al.* (2021) found varying outcomes for different GCG indicators on financial, social, and environmental performance, emphasizing the nuanced impact of GCG on company performances.

The author also posits that other factors may contribute to the observed lack of correlation between profitability and environmental performance. Specifically, the financial and environmental performance trends in State-Owned Enterprises (BUMN) do not conform to the Kuznets environmental curve theory. Some companies

experience a decrease in profitability accompanied by a decline in reported carbon emissions, while others witness an increase in profitability coupled with an increase in carbon emissions reports. This observation challenges the notion that profitability alone consistently influences environmental performance, highlighting the complexity and variability of this relationship across different companies.

CONCLUSIONS

The primary objective of this research is to investigate the relationships and influences among Energy Consumption, Profitability, Size, Debt Ratio, and Corporate Governance on the Environmental Performance of State-Owned Enterprises (BUMN) in Indonesia. The dataset comprises all BUMNs that have published annual and sustainability reports containing information on carbon emissions for the period from 2018 to 2022. The findings indicate that Good Corporate Governance (GCG) Practices, Debt Ratios, Asset Value, and Energy Consumption exert a direct impact on environmental performance, whereas Profitability does not demonstrate a direct influence. Consequently, these results suggest the need for BUMNs to devise appropriate strategies for managing the environmental impact of their operations.

However, it is essential to acknowledge the limitations of this research. The study is geographically confined to Indonesia, focusing exclusively on BUMNs. This deliberate limitation was made to directly assess the performance trends of BUMNs in Indonesia concerning the interplay between financial performance and environmental impact. Another constraint is the absence of more detailed data that comprehensively describes the environmental performance of companies. The disclosure of environmental performance in sustainability reports is a relatively recent practice in Indonesia.

Future Research

Future research endeavors could address these limitations by employing more reliable environmental performance indicators, such as Environmental, Social, and Governance (ESG) scores. Expanding the scope of the study beyond BUMNs to include the private sector and potentially even government offices would provide a more comprehensive understanding of the dynamics at play. Additionally, conducting similar research in other countries would allow for a comparative analysis of performance trends between companies in both developing and developed nations, contributing to a broader and more nuanced perspective on the subject.

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