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Green Accounting and Environmental Performance: Evidence from Renewable Energy, Recycled Materials and Environmental Costs

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Kata kunci: *Energi Terbarukan, Bahan Daur Ulang, Biaya Lingkungan*

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Abstract

Purpose: This study aims to analyze the effect of Green Accounting, proxied by renewable energy, recycled materials, and environmental costs, on environmental performance in mining and energy sector companies listed in the Indonesian Sharia Stock Index (ISSI) during the 2021–2025 period.

Method: This research employed quantitative approach using secondary data obtained from annual reports, sustainability reports, and the Corporate Environmental Performance Rating Program (PROPER) reports. The sample was selected using a purposive sampling technique, resulting in 21 companies with a total of 105 panel observations. Data were analyzed using panel data regression with EViews 14, and the Random Effect Model (REM) was selected as the most appropriate model based on panel model selection tests.

Research Findings: The findings indicate that recycled materials have a positive and significant effect on environmental performance, whereas renewable energy and environmental costs do not have a significant effect. Simultaneously, the three Green Accounting proxies do not significantly affect environmental performance.

Contribution: These findings provide empirical support for Sharia Enterprise Theory by demonstrating that the implementation of Green Accounting through the utilization of recycled materials contributes to improving environmental performance. This study is expected to provide practical insights for companies and stakeholders in strengthening sustainable environmental management practices.

Abstrak

Tujuan Penelitian: Penelitian ini bertujuan untuk menganalisis pengaruh Green Accounting yang diproksikan melalui energi terbarukan, bahan daur ulang, dan biaya lingkungan terhadap kinerja lingkungan pada perusahaan sektor pertambangan dan energi yang terdaftar di Indeks Saham Syariah Indonesia (ISSI) periode 2021–2025.

Metode: Penelitian menggunakan pendekatan kuantitatif dengan data sekunder yang diperoleh dari annual report, sustainability report, dan laporan Program Penilaian Peringkat Kinerja Perusahaan dalam

Pengelolaan Lingkungan Hidup (PROPER). Sampel penelitian dipilih menggunakan teknik purposive sampling sehingga diperoleh 21 perusahaan dengan total 105 observasi. Analisis data dilakukan menggunakan regresi data panel melalui aplikasi EViews 14 dengan model Random Effect Model (REM) sebagai model terbaik berdasarkan hasil uji pemilihan model.

Temuan Penelitian: Hasil penelitian menunjukkan bahwa secara parsial bahan daur ulang berpengaruh positif dan signifikan terhadap kinerja lingkungan, sedangkan energi terbarukan dan biaya lingkungan tidak berpengaruh signifikan terhadap kinerja lingkungan. Secara simultan, ketiga variabel Green Accounting tidak berpengaruh signifikan terhadap kinerja lingkungan perusahaan.

Kontribusi: Penelitian ini memberikan kontribusi empiris terhadap pengembangan Syariah Enterprise Theory dengan menunjukkan bahwa implementasi Green Accounting melalui pemanfaatan bahan daur ulang memiliki peran dalam meningkatkan kinerja lingkungan. Penelitian ini diharapkan menjadi referensi bagi perusahaan dan pemangku kepentingan dalam meningkatkan praktik pengelolaan lingkungan yang berkelanjutan.

INTRODUCTION

Issues regarding climate change, environmental degradation, and the declining quality of natural resources have become major concerns for the international community in recent decades. Industrial activities particularly in the mining and energy sectors contribute significantly to greenhouse gas emissions, the exploitation of natural resources, and environmental pollution. These conditions have prompted governments, investors, and the public to demand that companies look beyond mere economic profit and assume responsibility for social and environmental aspects by adopting sustainable business practices. One emerging approach to achieving this goal is the implementation of "Green Accounting," an accounting system that integrates environmental considerations into a company's operational activities and reporting.

The adoption of Green Accounting has become increasingly important alongside the growing focus on the Sustainable Development Goals (SDGs), sustainable finance policies, and the implementation of sustainability reporting in Indonesia. Through Green Accounting, companies are expected to manage energy consumption, optimize resource utilization, reduce waste, and effectively allocate environmental costs, thereby enhancing their environmental performance. In Indonesia, environmental performance is measured, in part, through the Company Performance Rating Assessment Program in Environmental Management (PROPER), administered by the Ministry of Environment and Forestry (KLHK). PROPER serves as an indicator of a company's level of compliance and commitment to sustainable environmental management.

This study focuses on mining and energy companies listed on the Indonesian Sharia Stock Index (ISSI) for the 2021–2025 period. This sector was selected due to industry characteristics involving relatively high levels of natural resource exploitation and environmental impact compared to other sectors. Furthermore, companies included in the ISSI are required not only to meet economic performance targets but also to adhere to business

principles that prioritize social and environmental responsibility. Consequently, research into the impact of Green Accounting implementation on environmental performance within this sector is highly relevant.

Various prior studies have examined the relationship between Green Accounting and environmental performance, yet the results remain inconsistent. indicates that the adoption of renewable energy positively influences corporate environmental performance by reducing carbon emissions and enhancing energy efficiency (Wahyuni et al., 2022). Similar findings who stated that the use of recycled materials improves resource efficiency and enhances corporate environmental performance (Melenia et al., 2023)

However, other studies present contrasting results. Melenia et al. (2023) found that environmental costs do not significantly affect environmental performance, as the effectiveness of such spending depends heavily on the policies and governance of individual companies. These divergent findings suggest that the relationship between Green Accounting implementation and environmental performance warrants further investigation, particularly within the mining and energy sectors, which possess operational characteristics distinct from other industries.

The novelty of this study lies not only in the use of renewable energy, recycled materials, and environmental costs as proxies for Green Accounting, but also in the specific research context of mining and energy companies listed on the Indonesian Sharia Stock Index (ISSI). Companies included in ISSI operate within an investment framework that emphasizes compliance with sharia principles, providing a distinctive context for examining corporate environmental responsibility. In addition, this study covers the 2021–2025 period and employs panel data regression to capture variations across companies and over time. Therefore, this study contributes empirical evidence regarding the implementation of Green Accounting and environmental performance within a sharia-oriented investment context, particularly in industries with substantial natural resource utilization and environmental impacts.

Given this context, there is a research gap regarding the inconsistent findings concerning the impact of renewable energy, recycled materials, and environmental costs on corporate environmental performance. Furthermore, most previous studies have focused on manufacturing firms or utilized varying observation periods. This study aims to address this gap by analyzing mining and energy companies listed on the ISSI index between 2021 and 2025, employing a panel data regression approach to account for data variations across both companies and time periods.

This research is grounded in Sharia Enterprise Theory. Sharia Enterprise Theory posits that a company bears responsibility not only to shareholders but also to society, the environment, and God; consequently, the management of natural resources must be conducted in a responsible and sustainable manner. The novelty of this study lies in its examination of the impact of Green Accounting proxied by renewable energy, recycled materials, and environmental costs on the environmental performance of mining and energy sector companies listed on the ISSI during the 2021–2025 period, utilizing panel data regression analysis. The combination of the research subjects, the up-to-date observation

period, and the use of three Green Accounting proxies is expected to provide an empirical contribution to the development of literature on environmental accounting and offer insights for companies to enhance the quality of their environmental management.

LITERATURE REVIEW

Syariah Enterprise Theory

Syariah Enterprise Theory (SET) is an evolution of Enterprise Theory that positions Allah SWT as the focal point of accountability for all corporate activities. Under this theory, a company is viewed as having responsibilities not only toward shareholders but also toward all stakeholders including the community, the government, the environment, and future generations. Consequently, corporate success is measured not merely by profitability but also by the ability to fulfill the trust (amanah) of maintaining a balance among economic, social, and environmental aspects.

From the perspective of Sharia Enterprise Theory, natural resources are a trust that must be utilized responsibly to ensure corporate activities do not cause environmental degradation. This principle aligns with the concept of khalifah fil ardh (vicegerent on earth), which holds that humans have a duty to preserve and sustain the environment as an act of accountability to Allah SWT. Therefore, companies adhering to Sharia principles are expected to integrate environmental considerations into both their operational activities and corporate reporting.

The adoption of Green Accounting represents one method of fulfilling this responsibility. Green Accounting encourages companies to manage energy use efficiently, utilize recycled materials, and allocate environmental costs as part of efforts to mitigate negative environmental impacts. Implementing Green Accounting is expected to enhance the quality of a company's environmental management, as reflected in its rating under the Company Performance Rating Program in Environmental Management (PROPER).

In this study, Sharia Enterprise Theory serves as the conceptual framework explaining that companies implementing Green Accounting through the use of renewable energy, the utilization of recycled materials, and the effective allocation of environmental costs demonstrate superior environmental responsibility, thereby potentially improving their environmental performance.

Prior Research

Research on Green Accounting and environmental performance has produced varying empirical findings. Wahyuni et al. (2019) found that Green Accounting implementation through renewable energy, recycled materials, and environmental cost allocation had a positive contribution to the environmental performance of mining and energy companies in Indonesia. This finding suggests that environmental-oriented accounting practices can support improvements in corporate environmental management.

Regarding recycled materials, the utilization of recycled materials can reduce dependence on virgin raw materials, minimize waste generation, and improve resource efficiency. These practices are consistent with the principles of sustainable resource management and may contribute to better environmental performance. Melenia et al. (2023)

also examined Green Accounting implementation in cement, energy, and mining companies and demonstrated that the environmental effects of Green Accounting practices may differ depending on the specific environmental indicator and company practices.

In contrast, environmental costs do not necessarily produce a significant improvement in environmental performance. Melenia et al. (2023) reported that environmental costs may not have a significant effect when environmental expenditures are not accompanied by effective environmental management policies. Therefore, the amount of environmental expenditure alone does not necessarily reflect the effectiveness of a company's environmental management.

The differences among previous findings indicate that the relationship between Green Accounting and environmental performance remains context-dependent. These inconsistencies provide a basis for re-examining the relationship using a more specific sample, namely mining and energy companies listed on ISSI during the 2021–2025 period.

Research Gap

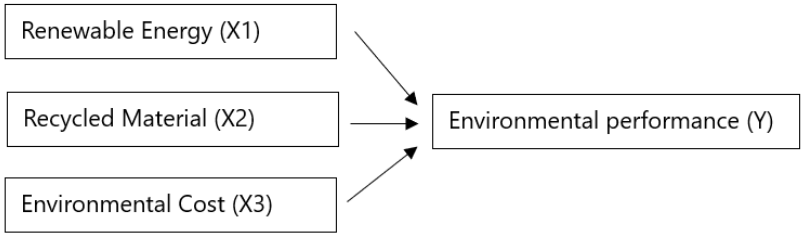
Previous studies have reported inconsistent findings regarding the relationship between Green Accounting and environmental performance. Wahyuni et al. (2019) found that the implementation of Green Accounting through renewable energy, recycled materials, and environmental cost allocation contributed positively to the environmental performance of mining and energy companies in Indonesia. In contrast, Melenia et al. (2023) reported that the effects of Green Accounting practices were not uniform across environmental indicators, particularly because the effectiveness of environmental expenditure depends on how such costs are managed and implemented by individual companies. These differences indicate that the environmental effects of Green Accounting cannot be generalized across companies and sectors.

Furthermore, previous studies have predominantly examined manufacturing companies or broader industrial samples, while empirical studies focusing specifically on mining and energy companies listed on the Indonesian Sharia Stock Index (ISSI) remain limited. This study therefore extends previous research by examining three Green Accounting proxies, namely renewable energy, recycled materials, and environmental costs, in mining and energy companies listed on ISSI during the 2021–2025 period. The use of panel data also enables the study to consider differences across companies and changes over time. These characteristics provide a more specific empirical context for examining the relationship between Green Accounting and environmental performance.

Conceptual Framework

This study is grounded in Sharia Enterprise Theory, which posits that a company bears responsibilities toward Allah SWT, humanity, and the environment. These responsibilities are fulfilled through the implementation of Green Accounting, proxied by renewable energy, recycled materials, and environmental costs. These three variables are hypothesized to influence corporate environmental performance, as measured by PROPER ratings.

The relationships between the variables in this study are illustrated as follows.



Hypothesis Development

1. The Effect of Renewable Energy on Environmental Performance

   Renewable energy refers to energy derived from natural resources that can be replenished sustainably, such as solar, wind, hydroelectric, geothermal, and biomass energy. The use of renewable energy can reduce reliance on fossil fuels, thereby curbing greenhouse gas emissions and enhancing energy efficiency. Based on Sharia Enterprise Theory, the utilization of renewable energy reflects a company's responsibility to preserve the environment as part of the trust (Amanah) regarding natural resource management. Therefore, higher renewable energy usage is expected to lead to better corporate environmental performance.

   Empirically, Wahyuni et al. (2019) found that the implementation of Green Accounting through renewable energy contributed to improved environmental performance in mining and energy companies in Indonesia. This finding supports the argument that the utilization of renewable energy can become an important mechanism for reducing environmental impacts associated with conventional energy use. However, differences in the level of renewable energy adoption and the characteristics of companies may result in different environmental outcomes. Therefore, based on Sharia Enterprise Theory and previous empirical evidence, this study proposes the following hypothesis:

   H1: Renewable energy has a positive effect on environmental performance.

2. The Effect of Recycled Materials on Environmental Performance

   The use of recycled materials is a form of Green Accounting implementation aimed at improving resource efficiency and reducing the volume of waste generated by a company. Based on Sharia Enterprise Theory, the use of recycled materials reflects a company's responsibility to utilize resources wisely in order to maintain environmental balance. Thus, greater utilization of recycled materials is expected to result in better corporate environmental performance.

   The empirical relationship between recycled materials and environmental performance is also supported by previous research. Wahyuni et al. (2019) indicated that the implementation of Green Accounting through the utilization of recycled materials contributed to improving environmental performance. The use of recycled

materials can reduce the demand for virgin resources and minimize waste generation, thereby supporting more efficient resource utilization.

From the perspective of Sharia Enterprise Theory, such practices represent the fulfillment of corporate responsibility in managing resources entrusted by Allah SWT. Companies that reduce resource waste and utilize materials more efficiently demonstrate an effort to maintain environmental balance. Therefore, greater utilization of recycled materials is expected to contribute to improved environmental performance.

H2: Recycled materials have a positive effect on environmental performance.

3. The Effect of Environmental Costs on Environmental Performance

Environmental costs are expenditures allocated by a company for environmental preservation activities, such as waste management, pollution control, environmental rehabilitation, and other conservation efforts. From the perspective of Sharia Enterprise Theory, the allocation of environmental costs reflects a company's responsibility toward the environment as part of a trust that must be accounted for. The more effectively environmental costs are allocated, the better the quality of the company's environmental management is expected to be, thereby enhancing environmental performance.

Previous empirical findings regarding environmental costs remain inconsistent. Wahyuni et al. (2019) demonstrated that environmental cost allocation could contribute to improved environmental performance, while Melenia et al. (2023) found that environmental costs did not significantly affect environmental performance. These differences indicate that environmental expenditure alone may not be sufficient to improve environmental performance because its effectiveness depends on the allocation, management, and implementation of environmental programs.

Environmental performance is measured using the PROPER rating issued by the Ministry of Environment and Forestry (KLHK). The PROPER rating is converted into an ordinal numerical scale based on the company's environmental performance category. The rating is assigned as follows: Gold = 5, Green = 4, Blue = 3, Red = 2, and Black = 1. A higher score indicates better environmental performance.

Renewable energy is measured based on the proportion of renewable energy utilization reported by the company in its annual report or sustainability report. The measurement reflects the extent to which renewable energy is utilized in the company's operational activities.

Recycled materials are measured based on the proportion or amount of recycled materials utilized by the company relative to the total materials used, according to information disclosed in the annual report or sustainability report.

Environmental costs are measured based on the environmental expenditure disclosed by the company in its annual report or sustainability report. The measurement represents the financial resources allocated to environmental

management activities, including waste management, pollution control, environmental rehabilitation, conservation, and other environmental programs

From the perspective of Sharia Enterprise Theory, environmental costs represent part of the company's responsibility in maintaining environmental sustainability. However, such responsibility must be accompanied by effective management so that expenditures generate tangible environmental benefits. Therefore, based on theoretical considerations and previous empirical findings, this study proposes:

H3: Environmental costs have a positive effect on environmental performance.

Research Method

This study employs a quantitative approach with an explanatory research design, aiming to examine the impact of Green Accounting proxied by renewable energy, recycled materials, and environmental costs on corporate environmental performance. A quantitative approach was selected for its ability to explain relationships between variables through hypothesis testing based on empirically derived, statistically analyzed data.

The study utilizes secondary data obtained from annual reports, sustainability reports, PROPER reports published by the Ministry of Environment and Forestry (KLHK), and other relevant supporting documents. These data were sourced from official company websites, the Indonesia Stock Exchange (IDX), and the Indonesia Sharia Stock Index (ISSI). Secondary data were chosen because they are officially published, verifiable, and aligned with the research requirements.

The study population consists of all mining and energy sector companies listed on the Indonesia Sharia Stock Index (ISSI) during the 2021–2025 period. Sample selection was conducted using a purposive sampling technique based on the following criteria:

1. Companies listed continuously on the ISSI throughout the research period
2. Publication of complete annual reports and sustainability reports
3. Disclosure of information regarding renewable energy, recycled materials, and environmental costs
4. Availability of accessible environmental performance data.

Based on these criteria, 21 companies were selected as the research sample, resulting in 105 panel data observations (21 companies × 5 years).

The dependent variable in this study is environmental performance, measured using the ratings from the Company Performance Rating Assessment Program in Environmental Management (PROPER). The independent variables consist of renewable energy (X_1), recycled materials (X_2), and environmental costs (X_3) as proxies for Green Accounting. Data collection was carried out using the documentation method, identifying information within annual and sustainability reports via documentation sheets and checklists developed based on the indicators for each variable.

Data analysis was conducted using EViews 14 software with a panel data regression approach. The analysis stages included descriptive statistical analysis, panel data model estimation (Common Effect Model, Fixed Effect Model, and Random Effect Model), and selection of the best model via the Chow Test, Hausman Test, and Lagrange Multiplier (LM)

Test. This was followed by a multicollinearity test, panel data regression estimation, the coefficient of determination (Adjusted R^2), a simultaneous test (F-test), and a partial test (t-test). The regression model used in this study is formulated as follows:

$$EP=\alpha+\beta_1RE+\beta_2RM+\beta_3EC+\varepsilon$$

Information:
EP = Environmental Performance
α = Konstanta
β_1–β_3 = Koefisien regresi
RE = Renewable Energy
RM = Recicled Material
EC = Environmental Cost
ε = Error term

RESULT AND DISCUSSION

Research Results

Panel Data Regression Analysis Results

Based on the panel data regression model testing, the Random Effect Model (REM) was selected. The estimation results using the Panel EGLS (Cross-section Random Effects) method are presented in Table 1.

Variabel	Koefisien (β)	t-Statistic	Probabilitas
X1	0,316	1,244	0,216
X2	0,427	2,043	0,043
X3	0,762	0,953	0,342
Constanta	3,595	-	-

R^2 = 0.024

Source: EViews 14 output, processed data (2026).

Based on these estimation results, the panel data regression equation is obtained as follows:

$$Y = 3.595142 + 0.316911X_1 + 0.427944X_2 + 0.762067X_3 + \varepsilon$$

Note:
Y = Environmental Performance
X_1 = Renewable Energy
X_2 = Recycled Materials
X_3 = Environmental Cost
ε = Error term

The equation shows that all regression coefficients are positive. This implies that increases in renewable energy, recycled materials, or environmental costs tend to be accompanied by improvements in environmental performance, although not all variables demonstrate a statistically significant effect.

Discussion

1. The effect of Renewable Energy on Environmental Performance

   The test results indicate that the renewable energy variable has a regression coefficient of 0.316911 with a probability value of 0.2162, which exceeds the significance level of 0.05. Consequently, renewable energy does not have a significant effect on environmental performance; thus, the first hypothesis (H1) is not supported by the research data.

   These findings suggest that the increased use of renewable energy among the sampled mining and energy sector companies has not yet yielded a significant change in environmental performance ratings. This situation may arise because the utilization of renewable energy is still in the early stages of implementation, or because its proportion remains relatively small compared to conventional energy use, meaning its impact on PROPER assessments is not yet clearly evident.

   From the perspective of Sharia Enterprise Theory, companies bear a mandate to preserve the environment through responsible resource management. Although the research results show no significant effect, the adoption of renewable energy still reflects the company's commitment to fulfilling this responsibility as part of sustainability principles.

2. The effect of Recycled Materials on Environmental Performance

   Test results indicate that the recycled materials variable has a regression coefficient of 0.427944 with a probability value of 0.0436, which is less than 0.05. Thus, recycled materials have a positive and significant influence on environmental performance, meaning the second hypothesis (H2) is accepted.

   These results indicate that the greater a company's utilization of recycled materials, the better its environmental performance. The use of recycled materials can reduce the consumption of primary raw materials, lower waste volume, and enhance resource-use efficiency. Such efforts support improvements in the quality of the company's environmental management, as reflected in the PROPER assessment.

   This finding aligns with Sharia Enterprise Theory, which emphasizes the importance of maintaining a balance between economic activities and environmental preservation. Utilizing recycled materials represents a form of corporate responsibility regarding efficient resource management and the minimization of negative environmental impacts.

3. The effect of Environmental Costs on Environmental Performance

   Test results indicate that the environmental costs variable has a regression coefficient of 0.762067 with a probability value of 0.3426, which is greater than 0.05. Consequently, environmental costs do not have a significant influence on environmental performance, meaning the third hypothesis (H3) is not supported.

   These results demonstrate that the magnitude of environmental costs incurred by a company is not necessarily accompanied by an improvement in environmental

performance. This may be attributed to variations in the effectiveness of environmental cost utilization across companies. High environmental expenditure does not automatically lead to improved environmental management quality if the funds are not allocated optimally or are not directly oriented toward enhancing environmental performance.

From the perspective of Sharia Enterprise Theory, the allocation of environmental costs remains a form of corporate responsibility toward environmental preservation. However, the theory also implies that this responsibility must be realized through effective management to ensure tangible benefits for the environment.

4. Coefficient of Determination

The Adjusted R-squared value of 0.024207 indicates that renewable energy, recycled materials, and environmental costs collectively explain approximately 2.42% of the variation in environmental performance. Meanwhile, approximately 97.58% of the variation is associated with other factors outside the variables included in this research model.

The relatively low explanatory power indicates that environmental performance is multidimensional and cannot be explained solely through the three Green Accounting proxies examined in this study. Other factors, such as corporate governance, environmental policies, technological innovation, firm size, regulatory compliance, and managerial practices, may also contribute to differences in environmental performance. Therefore, the regression results should be interpreted within the scope of the variables and research period examined rather than as a comprehensive explanation of all determinants of environmental performance.

CONCLUTIONS AND RECOMENDATION

Conclusions

This study aims to analyze the impact of Green Accounting proxied by renewable energy, recycled materials, and environmental costs on the environmental performance of mining and energy sector companies listed on the Indonesian Sharia Stock Index (ISSI) during the 2021-2025 period, utilizing panel data regression analysis with the Random Effect Model (REM). The results indicate that, individually, only recycled materials have a positive and significant effect on environmental performance. Meanwhile, renewable energy and environmental costs do not significantly affect environmental performance. Furthermore, simultaneous test results show that the three Green Accounting variables, when combined, do not yet exert a significant influence on the companies' environmental performance.

The results provide partial empirical support for Sharia Enterprise Theory, particularly in relation to the utilization of recycled materials. The significant positive effect of recycled materials on environmental performance indicates that responsible and efficient resource utilization can be associated with improved environmental performance. However, the absence of significant effects from renewable energy and environmental costs indicates that the relationship between environmental responsibility and environmental performance is not uniform across all Green Accounting practices examined in this study.

These findings suggest that the implementation of Green Accounting should not be viewed as a single practice but as a combination of environmental management activities whose effectiveness may differ according to the type of practice, implementation, and company characteristics.

Recommendations

Based on the empirical findings, companies are encouraged to optimize the utilization of recycled materials because this variable demonstrated a positive and significant relationship with environmental performance. Companies can strengthen the integration of recycled materials into operational processes, improve material efficiency, and reduce waste generation as part of environmental management efforts.

Regarding renewable energy and environmental costs, the recommendations are directed toward strengthening implementation and effectiveness rather than concluding that these practices directly improve environmental performance. Companies may evaluate the effectiveness of renewable energy utilization and environmental expenditure by ensuring that environmental investments are integrated with measurable environmental management programs.

For future research, additional variables such as corporate governance, firm size, profitability, eco-innovation, regulatory compliance, and sustainability disclosure may be incorporated to provide a broader explanation of environmental performance. Future studies may also extend the observation period and include other industrial sectors to examine whether the relationships identified in this study remain consistent across different contexts.

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