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The Effect of Environmental Performance and Environmental Costs on Firm Value with Profitability as a Mediating Variable

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ABSTRACT
Purpose: This study examines the effect of environmental performance and environmental costs on firm value, with profitability as a mediating variable, in energy sector companies listed on the Indonesia Stock Exchange between 2022 and 2024.
Research methodology: Using a quantitative approach, 75 firm-year observations were selected through purposive sampling from annual and sustainability reports. Firm value is proxied by Tobin's Q, profitability by ROA, and environmental variables by disclosure indices. The data were analyzed using multiple regression, path analysis, and the Sobel test.
Results: Environmental performance negatively affects profitability, whereas environmental costs have no significant effect. Both variables do not directly influence firm value. Profitability positively affects firm value and mediates the effect of environmental performance but not that of environmental costs.
Conclusions: The capital market in the Indonesian energy sector is more financially oriented than environmentally oriented in determining firm value.
Limitations: This study focuses only on the energy sector and has a short observation period.
Contribution: This study enriches the empirical evidence on sustainability and firm value relationships in emerging markets.

Keywords: *Environmental Performance, Environmental Costs, Energy Sector, Firm Value, Profitability*

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1. Introduction

Firm value represents the market's aggregated assessment of managerial effectiveness, growth prospects, and the capacity to generate sustainable economic returns. In contemporary capital markets, valuation is a forward-looking indicator shaped by investor expectations regarding risk exposure and strategic resilience (Albuquerque, Koskinen, Yang, & Zhang, 2020). Traditional financial metrics are increasingly complemented by environmental, social, and governance (ESG) considerations, as

investors integrate climate transition risks and regulatory tightening into valuation models (Bolton & Kacperczyk, 2021; Friede, Busch, & Bassen, 2015).

Increasingly, investors incorporate environmental, social, and governance (ESG) indicators when evaluating long-term risk and corporate sustainability, particularly in environmentally sensitive industries such as energy (Fatemi, Glaum, & Kaiser, 2018; Gillan, Koch, & Starks, 2021). Firms that demonstrate strong environmental responsibility are often perceived as more resilient and capable of maintaining investor confidence during periods of market uncertainty (Broadstock, Chan, Cheng, & Wang, 2021; Lins, Servaes, & Tamayo, 2017). This shift reflects a broader transformation in capital markets, in which stakeholder-oriented governance and sustainability disclosures are becoming key determinants of corporate value creation (Yoshikawa, Nippa, & Chua, 2021).

This dynamic is particularly pronounced in the energy sector, which is characterized by high carbon intensity and significant ecological footprints. In emerging economies such as Indonesia, energy companies face heightened scrutiny and stricter regulatory frameworks, such as mandatory sustainability disclosures (POJK No. 51/2017). Non-compliance poses material risks, including financial penalties and loss of social legitimacy (Pramasasti, Yusuf, & Respati, 2025). Consequently, environmental performance measured by effectiveness in managing emissions and resources and environmental costs expenditures for pollution prevention and green technology have become strategic imperatives (Ruka & Rashidirad, 2019).

Stakeholder theory suggests that aligning environmental responsibility with stakeholder expectations can enhance operational efficiency and market trust, ultimately manifesting in improved profitability and firm value (Abu et al., 2021). However, empirical evidence specifically focusing on the Indonesian energy sector remains limited, particularly regarding the mediating role of profitability in transmitting environmental initiatives into market valuation. Addressing this gap, this study examines the influence of environmental performance and costs on firm value, with profitability as a mediating variable, in energy sector companies listed on the Indonesia Stock Exchange during 2022–2024.

2. Literature Review and Hypothesis/Es Development

2.1 Stakeholder Theory

Stakeholder theory views companies as social entities that must manage their relationships with all interested parties to ensure sustainability. Balancing the diverse expectations of regulators and communities is a strategic imperative in the energy sector. Transparent environmental performance and accountable cost management serve as signals that build public trust and catalyze sustainable profitability (Harahap, Juliana, & Lindayani, 2018). Corporate governance mechanisms and transparent sustainability disclosures strengthen stakeholder relationships and enhance organizational accountability (Jizi, Salama, Dixon, & Stratling, 2014). Empirical studies further demonstrate that ESG-oriented management practices contribute to improved corporate performance and long-term sustainability (Atan, Alam, Said, & Zamri, 2018; Gillan et al., 2021).

2.2 Legitimacy Theory

Legitimacy theory, as defined by Suchman (1995), is based on a "social contract, " in which a firm's survival depends on societal acceptance. For energy companies, regulatory and social pressure necessitates superior environmental management to close the "legitimacy gap." Effective management provides economic benefits through increased profitability and reduced legal or reputational risks.

2.3 Firm Value

Firm value reflects market perceptions of a company's overall performance and future prospects. A higher firm value indicates that investors have strong confidence in the company's ability to generate sustainable returns (Tobin, 1969). In capital markets, firm value is commonly measured using market-based indicators, such as Tobin's Q, which captures the relationship between market valuation and the replacement cost of company assets.

In recent years, firm value has increasingly been associated not only with financial performance but also with non-financial aspects, such as environmental responsibility and sustainability practices. Investors are beginning to consider environmental, social, and governance (ESG) information when evaluating corporate performance and risk (Bolton & Kacperczyk, 2021). Companies that integrate sustainability into their business strategies tend to experience better market valuation because such practices signal long-term risk management and responsible corporate behavior (Almarshad, Alwaely, AlKhawaldeh, Al Qaryouti, & Ahmad, 2024).

Empirical studies also indicate that sustainability initiatives and environmental responsibility may contribute to improving firm value through enhanced reputation and stakeholder trust (Khan et al., 2023). Companies that demonstrate strong environmental commitments are more likely to gain legitimacy from stakeholders, which ultimately supports the creation of long-term firm value (Suchman, 1995). Several empirical studies confirm that ESG disclosure positively influences market valuation by reducing information asymmetry and strengthening investor trust (Fatemi et al., 2018; Li, Gong, Zhang, & Koh, 2018). Similarly, firms that integrate sustainability into their corporate strategy often experience higher market valuations due to improved transparency and risk management (Velte, 2017).

Furthermore, environmental disclosures and sustainability reporting play an important role in shaping investor perceptions. Firms that provide transparent environmental information tend to attract more investments and reduce information asymmetry in the market (Pramasasti et al., 2025). Therefore, environmental practices have become an important determinant of firm value in modern corporate governance.

2.4 Environmental Performance

Environmental performance refers to a company's ability to manage and minimize the environmental impact of its operational activities. This reflects how effectively a firm implements environmental management practices, including pollution control, waste management, and resource efficiency (Orazalin, 2020). Strong environmental performance is often associated with improved corporate reputation and increased stakeholder trust. Companies that demonstrate responsible environmental behavior are perceived as more sustainable and less exposed to environmental risks, which may enhance their long-term competitiveness (Wahidahwati & Ardini, 2021). Environmental performance is increasingly linked to corporate sustainability and responsible investment practices.

Previous studies suggest that environmental performance can contribute to improved financial outcomes by increasing operational efficiency and reducing environmental liabilities (Zhang, Rong, & Ji, 2019). Firms that invest in environmentally friendly technologies and sustainable production processes often achieve cost savings and improved resource utilization. Additionally, environmental initiatives may strengthen corporate legitimacy in the eyes of stakeholders. According to legitimacy theory, organizations seek to align their operations with societal expectations to maintain their legitimacy and ensure continued access to resources (Liu & Zhang, 2017). As environmental concerns continue to grow globally, companies are under increasing pressure to demonstrate responsible environmental behavior.

Sustainable environmental management practices are increasingly viewed as strategic resources that contribute to long-term organizational performance and competitiveness (Almarshad et al., 2024). Meta-analytic studies have also indicated a positive relationship between sustainability performance and financial outcomes across various industries (Friede et al., 2015). However, the relationship between environmental performance and financial outcomes remains complex. Some studies suggest that environmental initiatives require substantial investments that may initially reduce short-term profitability before generating long-term benefits (Friede et al., 2015). Therefore, the impact of environmental performance on corporate outcomes may depend on how effectively these initiatives are integrated into business strategies.

2.5 Environmental Cost

Environmental costs represent the expenditures incurred by companies to manage environmental impacts and comply with environmental regulations. These costs may include waste management, environmental monitoring, pollution control, and investments in environmentally friendly technologies (Henri, Boiral, & Roy, 2016). Environmental costs are an important component of corporate sustainability strategies because they reflect a company's commitment to environmental responsibility. Firms that allocate sufficient resources to environmental management are more likely to improve their environmental performance and reduce long-term environmental risks.

However, environmental costs can also be perceived as additional operational expenses, which reduce short-term financial performance. Some companies view environmental investments primarily as compliance costs rather than strategic investments, which may limit their effectiveness in creating economic value (Qiu et al., 2016). Despite this perception, recent studies indicate that environmental investments may create long-term benefits by improving operational efficiency and enhancing corporate reputation. Companies that effectively manage environmental costs can transform sustainability initiatives into strategic advantages that support long-term value creation (Broadstock et al., 2021).

Environmental expenditures may initially increase operational costs; however, when integrated with innovation and efficiency strategies, they can enhance long-term corporate competitiveness and sustainability performance (Broadstock et al., 2021; Zhang et al., 2019). Moreover, the relationship between environmental costs and corporate performance may depend on how these expenditures are integrated into broader sustainability strategies. When environmental investments are aligned with innovation and efficiency improvements, they can positively contribute to financial and market performance (Zhang et al., 2019).

2.6 Profitability as a Mediating Variable

Profitability represents a company's ability to generate earnings from operational activities. It is one of the most important indicators used by investors to evaluate corporate performance and financial stability (Santoso & Nugrahanti, 2022). Firms with higher profitability are generally considered more efficient at utilizing their resources and creating value for shareholders. Profitability may also serve as an important mechanism linking sustainability practices with firm value. Environmental initiatives often influence corporate financial performance through improved efficiency, risk management, and enhanced reputation (Abu et al., 2021). These improvements can ultimately translate into higher profitability.

Several studies have highlighted the mediating role of profitability in the relationship between CSR and firm value. When sustainability initiatives contribute to improved financial performance, they may indirectly increase firm value by strengthening investor confidence (Khan et al., 2023). The mediation effect of profitability can be explained through the resource-based view, which suggests that companies can develop competitive advantages through unique capabilities and strategic resource management (Almarshad et al., 2024). Environmental initiatives that enhance operational efficiency and innovation may therefore improve profitability and subsequently increase firm value. From a methodological perspective, mediation analysis is commonly used to examine indirect relationships among variables. Bozkurt, Celik, and Gligor (2026) propose that a mediating variable helps explain the mechanism through which an independent variable influences a dependent variable. In this context, profitability may explain how environmental performance and environmental costs influence firm value.

2.7 Variable Definitions

- Firm Value: Represented by Tobin's Q, which captures investor perceptions of growth prospects and managerial efficiency (Tobin, 1969).
- Environmental Performance: A source of competitive advantage derived from the natural-resource-based view, focusing on minimizing ecological footprints.
- Environmental Costs: Resource allocations for pollution prevention and restoration that enhance transparency and structural efficiency.

- Profitability: Measured via return on assets (ROA), serving as a mediator between non-financial activities and market valuation.
- Firm Size and Leverage: Control variables representing resource capacity (Ln Total Assets) and financial risk/capital structure (DAR).

2.8 Conceptual Framework and Hypothesis Development

The Effect of Environmental Performance on Firm Value and Profitability Environmental performance signals the quality of risk management and compliance with social norms. Based on the NRBV, the ability to manage natural resources efficiently can impact production costs and waste, which in turn influences profit margins (ROA). This efficiency and legitimacy level affect how the market appreciates the firm's value.

H_1: Environmental performance affects firm value.
H_3: Environmental performance affects profitability.

The Effect of Environmental Costs on Firm Value and Profitability Environmental costs represent allocations for green technology and waste mitigation. While these are expenditures, they mitigate future liabilities and influence structural efficiency. Stakeholder theory suggests that the market evaluates these expenditures based on their contribution to long-term business sustainability.

H_2: Environmental costs affect firm value.
H_4: Environmental costs affect profitability.

The Mediating Role of Profitability Capital markets evaluate firms based on expected future cash flows. Profitability (return on assets) reflects managerial efficiency, which influences investor interest and stock prices. In this framework, profitability is expected to function as a transmission mechanism between environmental initiatives and market valuation.

H_5: Profitability affects firm value.
H_6: Profitability mediates the effect of environmental performance on firm value.
H_7: Profitability mediates the effect of environmental costs on firm value.

3. Methodology

3.1 Research Approach and Object

This study employs a quantitative approach to examine the causal relationships between variables in energy sector companies listed on the Indonesian Stock Exchange (IDX) for the period 2020–2024. The primary focus is the influence of environmental performance and environmental costs on firm value, with profitability as a mediating variable.

3.2 Sample and Data

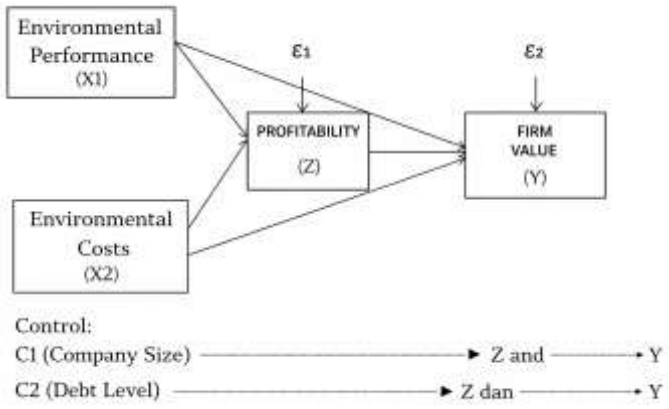
Using a *purposive sampling* technique, 15 companies met the criteria (listed on the IDX, not suspended, and publishing GRI-based sustainability reports). The total number of observations over five years was 75 panel data points. Secondary data were collected through documentation studies of annual reports and sustainability reports.

3.3 Operational Definition of Variables

1. Dependent Variable (*Y*): Firm Value (Tobin's Q).
2. Independent variables: environmental performance (*X1–GRI* 300 score) and environmental costs (*X2–cost-to-asset* ratio).
3. Mediating Variable (*Z*): Profitability (ROA).
4. Control Variables: Firm size (*K1–Ln total* assets) and leverage (*K2–DAR*).

3.4 Path Analysis

Path analysis was used to test simultaneous causal relationships, including both direct and indirect effects through a mediating variable. The flow of relationships between variables is illustrated as follows:



The path analysis equations based on the formulated hypotheses are as follows:
H_1 ($X_1 \rightarrow Z$) $Z = \beta_1X_1 + \beta_6K_1 + \beta_7K_2 + \varepsilon$
H_2 ($X_2 \rightarrow Z$) $Z = \beta_2X_2 + \beta_6K_1 + \beta_7K_2 + \varepsilon_1$
H_3 ($X_1 \rightarrow Y$) $Y = \beta_3X_1 + \beta_8K_1 + \beta_9K_2 + \varepsilon_2$
H_4 ($X_2 \rightarrow Y$) $Y = \beta_4X_2 + \beta_8K_1 + \beta_9K_2 + \varepsilon_2$
H_5 ($Z \rightarrow Y$) $Y = \beta_5Z + \beta_8K_1 + \beta_9K_2 + \varepsilon_2$
H_6 ($X_1 \rightarrow Z \rightarrow Y$, Indirect Effect) $Z = \beta_1X_1 + \beta_6K_1 + \beta_7K_2 + \varepsilon_1$ $Y = \beta_5Z + \beta_8K_1 + \beta_9K_2 + \varepsilon_2$
H_7 ($X_2 \rightarrow Z \rightarrow Y$, Indirect Effect) $Z = \beta_2X_2 + \beta_6K_1 + \beta_7K_2 + \varepsilon_1$ $Y = \beta_5Z + \beta_8K_1 + \beta_9K_2 + \varepsilon_2$

Description**:**
X_1 : Environmental Performance
X_2 : Environmental Costs
Z : Profitability
Y : Firm Value
K_1 : Firm Size
K_2 : Leverage (Debt Level)
e1, e2 : Error terms

3.5 Statistical Testing Procedures

Prior to hypothesis testing, classical assumption tests (normality, multicollinearity, heteroscedasticity, and autocorrelation) are conducted to ensure model validity. Hypothesis testing was performed as follows:

1. t-Test (Partial): Measures the significance of each variable's influence ($p < 0.05$).
2. Coefficient of Determination (R^2): Assesses the model's ability to explain the variation in the dependent variable.
3. Sobel Test: Tests the significance of the indirect effect (*X* to *Z* to *Y*). If the z-value is > 1.96, the mediation is declared to be statistically significant.

4. Results and Discussion

4.1 Descriptive Statistical Analysis

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Firm Value	75	0.49	1.55	0.98	0.25
Environmental Performance	75	0.26	0.92	0.61	0.17
Environmental Costs	75	0.00002	0.09	0.008	0.02
Profitability	75	-0.1	0.61	0.11	0.15
Company Size	75	62,040,753	16,007,412,972	4,117,497,506	4,136,371,966
Debt Level	75	0.04	0.96	0.45	0.23

Descriptive statistics provided a numerical overview of the data distribution for the research variables (Table 1). This summary includes the mean, minimum, maximum, and standard deviation and serves as the basis for evaluating data adequacy prior to inferential analysis (Sekaran, 2016).

a. Firm Value (Y): The average Tobin's Q of 0.9785, with a standard deviation of 0.24867, indicates a relatively stable but varied market valuation. The range from 0.49 to 1.55 reflects differences in investor perceptions regarding governance quality and the company's prospects in maintaining public legitimacy (Suchman, 1995).
b. Environmental Performance (X_1) The variable shows a mean of 0.6096 with a range of 0.26–0.92. This suggests that most companies have implemented environmental practices that meet stakeholder expectations, although there is variation in the strategic depth of implementation.
c. Environmental Costs (X_2): A low average (0.008514) with a minimum value near zero (0.00002) indicates that environmental funding allocations remain limited and are often viewed as operational expenses rather than strategic investments. This variation potentially affects the long-term sustainability of corporate legitimacy.
d. Profitability (Z) The mean ROA of 0.1137 indicates an asset utilization efficiency of 11.37%. The presence of negative values (− 0.10) and a maximum of 0.61 illustrates significant heterogeneity in financial conditions, which impacts the capacity to fund environmental initiatives.
e. Firm Size (K_1) The sample is dominated by large-scale companies with average assets of IDR 4.11 trillion. The high standard deviation indicates significant asset heterogeneity, in which larger firms face more intensive regulatory oversight and public pressure to comply with environmental norms.
f. Leverage (K_2): The average leverage of 0.4544 shows that 45.44% of assets are debt financed. The extreme range (0.04–0.96) reflects differing financing strategies, where debt levels influence a company's strategic flexibility in managing market performance.

4.2 Classical Assumption Tests

4.2.1 Normality Test

The normality test ensures that the regression residuals are normally distributed to maintain the validity of the path analysis results (Sekaran, 2016). This study used the one-sample Kolmogorov-Smirnov (K-S) method. As shown in Table 3, Model 1 (with profitability as the dependent variable) yielded an Asymp. Sig. (2-tailed) value of 0.074. Since this exceeds the 0.05 threshold, the null hypothesis (H_0) was accepted, confirming that the residual data for Model 1 were normally distributed.

Table 2. Model 1 normality test

		Unstandardized Residual
N		75
Normal Parameters	Mean	0
	Std. Deviation	0.11818821
Most Extreme Differences	Absolute	0.098
	Positive	0.098
	Negative	-0.074
Test Statistic		0.098
Asymp. Sig. (2-tailed)		0.074
Dependent Variable: Profitability		

Furthermore, the normality test results for Model 2, with firm value as the dependent variable, show an apartment. Sig. (2-tailed) of 0.075, which exceeds the 0.05 threshold. This indicates that the residuals in Model 2 were normally distributed.

Table 3. Model 2 normality test

		Unstandardized Residual
N		75
Normal Parameters	Mean	0
	Std. Deviation	0.19111024
Most Extreme Differences	Absolute	0.097

	Positive	0.097
	Negative	-0.059
Test Statistic		0.097
Asymp. Sig. (2-tailed)		0.075
Dependent Variable: Firm Value		

Overall, both Models 1 and 2 satisfy the normality assumption. Therefore, the regression models are appropriate for further classical assumption testing and path analysis, and the estimated coefficients can be interpreted statistically.

4.2.2 Multicollinearity Test

The multicollinearity test detects strong linear relationships among independent variables, which can compromise regression validity (Sekaran, 2016). Multicollinearity is absent if the tolerance value is > 0.10 and the variance inflation factor (VIF) is < 10.

Table 4. Model 1 multicollinearity test

	Unstandardized Coefficients	**Collinearity Statistics**	**VIF**
	B	Tolerance	
(Constant)	0.18		
Environmental Performance	-0.224	0.811	1.232
Environmental Costs	0.458	0.974	1.026
Firm Size	0.008	0.599	1.668
Debt Level	-0.378	0.677	1.477
Dependent Variable: Profitability			

The results of Model 1 show that all independent variables (environmental performance, environmental costs, firm size, and leverage) meet these criteria, with tolerance values ranging from 0.599 to 0.974 and VIF values between 1.026 and 1.668.

Table 5. Model 2 multicollinearity test

	Unstandardized Coefficients	**Collinearity Statistics**	**VIF**
	B	Tolerance	
(Constant)	-0.517		
Environmental Performance	0.127	0.751	1.332
Environmental Costs	-1.454	0.970	1.031
Profitability	1.259	0.652	1.535
Firm Size	0.037	0.596	1.677
Debt Level	0.342	0.496	2.014
Dependent Variable: Firm value			

Similarly, Model 2 indicates that all variables (including profitability) satisfy the threshold, with tolerance values ranging from 0.496 to 0.970 and VIF values between 1.031 and 2.014. Thus, both models are free from multicollinearity issues, ensuring the validity of the subsequent path analysis.

4.2.3 Heteroscedasticity Test

The heteroscedasticity test detects unequal residual variance across observations, which could lead to inefficient estimates (Sekaran, 2016). This study utilizes Spearman's rho correlation method, in which homoscedasticity is confirmed if the significance value (Sig. 2-tailed) between unstandardized residuals and independent variables is > 0.05.

Table 6. Model 1 heteroscedasticity test

		Environmental Performance	Environmental Costs	Firm Size	Debt Level	Unstandardized Residual
Environmental Performance	Correlation Coefficient	1	0.064	0.207	-0.096	0.105
	Sig. (2-tailed)	.	0.586	0.075	0.411	0.370
	N	75	75	75	75	75
Environmental Costs	Correlation Coefficient	0.064	1.000	-0.069	0.030	0.158
	Sig. (2-tailed)	0.586	.	0.557	0.796	0.176
	N	75	75	75	75	75
Firm Size	Correlation Coefficient	0.207	-0.069	1.000	0.363**	0.167
	Sig. (2-tailed)	0.075	0.557	.	0.001	0.153
	N	75	75	75	75	75
Debt Level	Correlation Coefficient	-0.096	0.030	0.363**	1.000	0.080
	Sig. (2-tailed)	0.411	0.796	0.001	.	0.495
	N	75	75	75	75	75
Unstandardized Residual	Correlation Coefficient	0.105	0.158	0.167	0.080	1.000
	Sig. (2-tailed)	0.370	0.176	0.153	0.495	.
	N	75	75	75	75	75
Dependent Variable: Profitability						

The results for Model 1 (Profitability) show that all independent variables–Environmental Performance (0.370), Environmental Costs (0.176), Firm Size (0.153), and Leverage (0.495)–have significance values above 0.05. This confirms that there is no significant correlation between the residuals and independent variables, indicating that Model 1 satisfies the homoscedasticity assumption.

Table 7. Model 2 heteroscedasticity test

		Environmental Performance	Environmental Costs	Profitability	Firm Size	Debt Level	Unstandardized Residual
Environmental Performance	Correlation Coefficient	1.000	0.064	0.059	0.207	-0.096	-0.012
	Sig. (2-tailed)	.	0.586	0.617	0.075	0.411	0.916
	N	75	75	75	75	75	75
Environmental Costs	Correlation Coefficient	0.064	1.000	0.117	-0.069	0.030	0.170
	Sig. (2-tailed)	0.586	.	0.316	0.557	0.796	0.145
	N	75	75	75	75	75	75
Profitability	Correlation Coefficient	0.059	0.117	1.000	0.069	-0.500**	0.089
	Sig. (2-tailed)	0.617	0.316	.	0.556	0.000	0.448
	N	75	75	75	75	75	75
Firm Size	Correlation Coefficient	0.207	-0.069	0.069	1.000	0.363**	-0.059
	Sig. (2-tailed)	0.075	0.557	0.556	.	0.001	0.613
	N	75	75	75	75	75	75
Debt Level	Correlation Coefficient	-0.096	0.030	-0.500**	0.363**	1.000	-0.044
	Sig. (2-tailed)	0.411	0.796	0.000	0.001	.	0.708
	N	75	75	75	75	75	75
Unstandardized Residual	Correlation Coefficient	-0.012	0.170	0.089	-0.059	-0.044	1.000
	Sig. (2-tailed)	0.916	0.145	0.448	0.613	0.708	.
	N	75	75	75	75	75	75
Dependent Variable: Firm Value							

Specifically, in Model 2, the significance values range from 0.145 to 0.916. This lack of significant correlation between the residuals and independent variables confirms that both models satisfy the homoscedasticity assumption. Consequently, the research models are considered efficient and fulfill the Best Linear Unbiased Estimator (BLUE) criteria.

4.2.4 Autocorrelation Test

The autocorrelation test identifies correlations between residuals across time periods (Santoso & Nugrahanti, 2022). Independence is established if the Durbin-Watson (D-W) value falls between -2 and +2. Based Model 1 (Profitability) yielded a D-W value of 0.687

Table 8. Model 1 autocorrelation test

R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
0.590	0.348	0.311	0.12152	0.687
Dependent Variable: Profitability				

Table 9. Model 2 autocorrelation test

R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
0.640	0.409	0.367	0.19791	1.439
Dependent Variable: Firm value				

Model 2 (firm value) recorded a D-W value of 1.439. As both values are within the acceptable range, neither model exhibits autocorrelation symptoms. This indicates that the residuals are independent, supporting the model's reliability for path analysis and fulfilling the BLUE criteria.

4.3 Path Analysis Results

Table 10. Model 1 path analysis results

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.180	0.346	-	0.522	0.603
Environmental Performance	-0.224	0.094	-0.254	-2.374	0.020
Environmental Costs	0.458	0.774	0.058	0.592	0.556
Firm Size	0.008	0.013	0.077	0.620	0.537
Debt Level	-0.378	0.075	-0.591	-5.044	0.000
Dependent Variable: Firm Value					

Table 11. Model 2 path analysis results

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-0.517	0.564	-	-0.917	0.363
Environmental Performance	0.127	0.160	0.085	0.796	0.429
Environmental Costs	-1.454	1.263	-0.108	-1.152	0.253
Profitability	1.259	0.195	0.742	6.469	0.000
Firm Size	0.037	0.020	0.216	1.806	0.075
Debt Level	0.342	0.143	0.315	2.399	0.019
Dependent Variable: Firm Value					

After fulfilling the classical assumptions, a path analysis was performed to examine the causal relationships among the variables. The results for Models 1 (Table 11) and 2 (Table 12) are summarized as follows:

1. Environmental Performance on Profitability (H_1): The path coefficient is significantly negative (-0.224; p = 0.020), indicating that higher environmental compliance standards lead to reduced operational profits in the short term.

2. Environmental Costs on Profitability (H_2): The coefficient is positive (0.458) but statistically insignificant (p = 0.556), suggesting that environmental spending does not directly drive profit increases.
3. Environmental Performance on Firm Value (H_3): The coefficient is positive (0.127) but insignificant (p = 0.429), implying that environmental performance alone does not immediately enhance market valuation.
4. Environmental Costs on Firm Value (H_4): The relationship is negative (-1.454) and insignificant (p = 0.253), indicating that environmental costs are not a primary valuation driver for investors.
5. Profitability on Firm Value (H_5): The coefficient is strongly positive and highly significant (1.259; p = 0.000). This confirms that financial performance remains the primary indicator rewarded by the market with higher firm valuations.

4.4 Mediation Effect (Sobel Test)

The Sobel test evaluates the significance of the indirect effect of environmental performance (X_1) and environmental costs (X_2) on firm value (Y) through profitability (Z). Following Siddik and Veronica (2024), mediation is significant at the 5% level if the absolute Z-statistic (Z) exceeds 1.96.

Table 12. Model 1 sobel test

	Unstandardized Coefficients	
	B	Std. Error
(Constant)	0.180	0.346
Environmental Performance	-0.224	0.094
Environmental Costs	0.458	0.774
Dependent Variable: Profitability		

Table 13. Model 2 sobel test

	Unstandardized Coefficients	
	B	Std. Error
(Constant)	-0.517	0.564
Environmental Performance	0.127	0.16
Environmental Costs	-1.454	1.263
Profitability	1.259	0.195
Dependent Variable: Firm value		

a. The Effect of Environmental Performance on Firm Value through Profitability

$$z = \frac{ab}{\sqrt{(b^2\,Sa^2) + (a^2\,Sb^2)}}$$

$$z = \frac{-0.224\ x\ 1.259}{\sqrt{(1.259^2\ 0.094^2) + (-0.224^2\ 0.195^2)}}$$

$$z = \frac{-0.282}{\sqrt{0.016}}$$

$$z = \frac{-0.282}{0.126}$$

$$z = -2{,}23$$

Based on the estimation results of Models 1 and 2, the path coefficient of environmental performance on profitability is −0.224 (SE = 0.094), while the coefficient of profitability on firm value is 1.259 (SE = 0.195). The Sobel test produces a Z value of −2.23. Although the Z value is negative, significance in the Sobel test is assessed using its absolute value, as the test evaluates the magnitude of the indirect effect rather than its direction. Since |Z| = 2.23 exceeds the critical value of 1.96, the indirect effect of environmental performance on firm value through profitability is statistically significant. Thus, profitability acts as a mediating variable in this relationship.

b. The Effect of Environmental Cost on Firm Value through Profitability

$$z = \frac{ab}{\sqrt{(b^2\,Sa^2) + (a^2\,Sb^2)}}$$

$$z = \frac{0.458\ x\ 1.259}{\sqrt{(1.259^2\ 0.774^2) + (0.458^2\ 0.195^2)}}$$

$$z = \frac{0.576}{\sqrt{0.957}}$$

$$z = \frac{0.576}{0{,}978}$$

$$z = 0{,}59$$

The path coefficient of environmental cost on profitability is 0.458 (SE = 0.774), whereas the coefficient of profitability on firm value is 1.259 (SE = 0.195). The Sobel test yields a Z value of 0.59. Because the absolute Z value (0.59) is lower than the critical value of 1.96, the indirect effect of environmental cost on firm value through profitability is not statistically significant. Therefore, profitability does not mediate the relationship between environmental cost and firm value.

4.5 Hypothesis Testing

4.5.1 t-Test Results

The t-test evaluates the partial effect of each independent variable on the dependent variable within a valid regression model. A variable is considered significant if the p-value is below 0.05, and the interpretation also considers the direction of the regression coefficient (positive = direct relationship; negative = inverse relationship).

Table 14. Hypothesis Testing Results

Relationship	Beta	t	Sig.	Hypothesis Decision
$X_1 \rightarrow Z$	-0.254	-2.374	0.020	H_1 Rejected
$X_2 \rightarrow Z$	0.058	0.592	0.556	H_2 Rejected
$X_1 \rightarrow Y$	0.085	0.796	0.429	H_3 Rejected
$X_2 \rightarrow Y$	-0.108	-1.152	0.253	H_4 Rejected
$Z \rightarrow Y$	0.742	6.469	0.000	H_5 Accepted
Sobel Test				
$X_1 \rightarrow Z \rightarrow Y$	2.23 > 1.96 (Negative Coefficient)			H_6 Accepted
$X_2 \rightarrow Z \rightarrow Y$	0.59 < 1.96			H_7 Rejected

Based on the estimation results,

1. H_1: Environmental Performance → Profitability
   Environmental performance was significant (p = 0.020) but had a negative coefficient (β = −0.254). This indicates that higher environmental performance reduces profitability in the short term. As the direction contradicts the hypothesis, H_1 is rejected.
2. H_2: Environmental Cost → Profitability
   The environmental cost was not significant (p = 0.556; β = 0.058). Thus, environmental expenditure did not influence profitability. H_2 is rejected.
3. H_3: Environmental Performance → Firm Value
   Environmental performance did not significantly affect firm value (p = 0.429; β = 0.085). Although positive, the effect was statistically insignificant. H_3 is rejected.
4. H_4: Environmental Cost → Firm Value
   The environmental cost was not significant (p = 0.253; β = −0.108). The negative coefficient suggests that the market may perceive environmental costs as unproductive; however, the effect was statistically weak. H_4 is rejected.
5. H_5: Profitability → Firm Value
   Profitability has a highly significant positive effect on firm value (p = 0.000; β = 0.742). Higher profitability increases firm value. H_5 is accepted.

6. Sobel Test (Mediation Analysis) H_6: Environmental Performance → Profitability → Firm Value
   The Sobel test yields Z = −2.23; using the absolute value (|Z| = 2.23 > 1.96), the indirect effect is significant. Profitability mediates the relationship between environmental performance and firm value. H_6 is accepted.
7. H_7: Environmental Cost → Profitability → Firm Value
   The Sobel test produces Z = 0.59 (< 1.96), indicating an insignificant indirect effect. Profitability does not mediate the relationship between environmental costs and firm value. H_7 is rejected.

4.5.2 Coefficient of Determination (R^2) Test Results

Table 15. Model 1 R^2 results

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.59	0.348	0.311	0.12152
Dependent Variable: Profitability			

Table 16. Model 2 R^2 results

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.64	0.409	0.367	0.19791
Dependent Variable: Firm value			

The coefficient of determination (R^2) was used to assess the explanatory power of the regression models. In Model 1, the correlation coefficient (R) is 0.59, indicating a moderate relationship between environmental performance, environmental costs, control variables, and profitability. The R-square value of 0.348 shows that 34.8% of the variation in profitability is explained by the model, while 65.2% is influenced by other factors. The adjusted R-square value of 0.311 suggests a moderate yet acceptable explanatory capacity. In Model 2, the correlation coefficient (R) increases to 0.64, reflecting a stronger relationship between the independent variables, including profitability as a mediator, and firm value. The R-square value of 0.409 indicates that 40.9% of the variation in firm value is explained by the model, with 59.1% attributed to external factors. The adjusted R-square value of 0.367 confirms that Model 2 demonstrates slightly stronger explanatory power than Model 1. Overall, both models exhibit moderate but adequate explanatory capacity for hypothesis testing.

4.5.3 F-Test Results

Table 16. Model 2 R^2 results

	Sum of Squares	df	Mean Square	F	Sig.
Regression	0.553	4	0.138	9.357	0.000
Residual	1.034	70	0.015		
Total	1.586	74			
Dependent Variable: Profitability					

Table 17. Model 2 R^2 results

	Sum of Squares	df	Mean Square	F	Sig.
Regression	1.873	5	0.375	9.564	0.000
Residual	2.703	69	0.039		
Total	4.576	74			
Dependent Variable: Firm value					

An F-test was conducted to evaluate the overall fit of the regression model. A model is considered appropriate if the significance value is below 0.05, indicating that the independent variables jointly affect the dependent variable. As shown in Table 16, Model 1 produces an F-value of 9.357 with a significance level of 0.000 (< 0.05), indicating that the model explaining profitability is statistically feasible. This implies that environmental performance, environmental costs, firm size, and leverage simultaneously influence profitability. Similarly, Table 17 shows that Model 2 generates an F-value of 9.564 with a significance level of 0.000 (< 0.05), confirming that the model explaining firm value is also statistically valid. Environmental performance, environmental costs, profitability, firm size, and

leverage jointly explain variations in firm value. Thus, both models demonstrate an adequate overall fit for hypothesis testing.

5. Conclusions

5.1 Conclusion

Based on regression, path, and mediation analyses of firms observed between 2020 and 2024, this study examines the effect of environmental performance and environmental costs on firm value with profitability as a mediating variable, while controlling for firm size and leverage. The results show that environmental performance significantly and negatively affects profitability, indicating short-term cost pressures, whereas environmental costs have no significant effect on profitability. Neither environmental performance nor environmental costs directly influence firm value, suggesting that the market does not immediately reward environmental initiatives. However, profitability has a positive and significant effect on firm value and mediates the relationship between environmental performance and firm value, although it does not mediate the effect of environmental costs. Firm size does not significantly affect profitability or firm value, whereas leverage shows a significant influence and functions as an important control variable.

5.2 Research Limitations

This study is limited by its sectoral focus, reliance on secondary disclosure data, relatively short observation period, limited model variables, and purely quantitative approach. Future research should expand industry coverage, extend the observation period, develop more comprehensive environmental performance measures, incorporate corporate governance variables, and apply mixed-method approaches to better capture managerial and strategic sustainability dynamics.

5.3 Suggestions and Directions for Future Research

Future research should expand the scope of the analysis by including multiple sectors and a longer observation period to enhance generalizability and capture long-term impacts. Researchers are also encouraged to incorporate additional variables, such as corporate governance, ESG disclosure quality, innovation capability, and regulatory factors, to provide a more comprehensive model. The development of more refined measures of environmental performance and environmental costs is necessary to better reflect actual corporate practices. Furthermore, future studies should consider using mixed-method approaches by combining quantitative analysis with qualitative insights to better understand managerial strategies and decision-making processes related to sustainability. Finally, comparative studies across countries or regions could provide deeper insights into how institutional environments influence the relationship between environmental factors and firm value.

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