



Greenwashing and Eco-Efficiency in Firm Valuation: The Moderating Role of Earnings Management

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Abstract

Background: Growing sustainability concerns have increased investor attention to environmental practices, while greenwashing and eco-efficiency may shape market perceptions of firm value. At the same time, earnings management can affect the credibility of financial information and potentially influence how investors interpret sustainability signals.

Objective: This study examines the effects of greenwashing and eco-efficiency on firm value and evaluates earnings management as a moderating variable among energy-sector companies listed on the Indonesia Stock Exchange during 2020–2024.

Methods: A quantitative associative design was applied using secondary data from financial statements, annual reports, sustainability reports, and Indonesia Stock Exchange data. Purposive sampling yielded 20 companies and 100 firm-year observations. Firm value was measured using Tobin's Q, greenwashing was assessed through GRI-based content analysis, eco-efficiency was measured using ISO 14001 certification, and earnings management was measured using discretionary accruals estimated through the Modified Jones Model.

Results: Greenwashing had no significant effect on firm value, and eco-efficiency likewise had no significant effect on firm value. Earnings management had a positive effect on firm value. However, earnings management did not moderate the relationship between greenwashing and firm value or between eco-efficiency and firm value. These findings indicate that investors may respond more strongly to reported earnings information than to environmental claims or certification.

Conclusion: The study concludes that sustainability-related signals alone do not determine firm value in Indonesia's energy sector. Earnings information remains more influential, while earnings management does not strengthen or weaken the effects of greenwashing and eco-efficiency on firm value.

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INTRODUCTION

For organizations to maintain long-term sustainability, enterprises must balance the achievement of short-term financial goals with their commitments to environmental protection and broader social responsibilities. Amid growing global attention to sustainable corporate practices, the magnitude of financial investments in environmentally friendly business operations has increased considerably, with leading institutional investors progressively integrating Environmental, Social, and Governance (ESG) factors into their investment assessment processes.

Enhanced stakeholder pressure regarding environmental accountability can prompt

certain organizations to employ greenwashing strategies intended to rapidly improve stakeholder perceptions and market reputation without implementing meaningful operational changes.

When organizational management engages in the selective dissemination of environmental data, emphasizing favorable sustainability representations while concealing negative operational consequences, public confidence in corporate environmental assertions declines considerably.

The international financial market consequences of greenwashing are exemplified by the emissions standards manipulation incident involving a major vehicle manufacturer, in which testing procedures were deliberately altered to misrepresent environmental compliance performance despite substantially higher actual emissions under real-world driving conditions. Empirical evidence establishes that capital market participants respond rapidly and substantially to inaccuracies in environmental disclosures, resulting in significant reductions in organizational market value and shareholder wealth.

Authentic environmental commitment is demonstrated through the adoption of eco-efficiency initiatives, involving coordinated efforts to maximize the efficient use of natural resources and minimize waste generation and its harmful ecological impacts.

Earnings management, which involves intentional adjustments to accounting records and reported financial metrics, remains a significant focus of academic inquiry and professional scrutiny in the fields of accounting and finance. This practice is often undertaken to achieve specific financial objectives or to meet performance benchmarks established by the market. Discretionary accruals serve as diagnostic indicators for identifying management's influence on the preparation of financial reports. Elevated levels of discretionary accruals typically indicate lower reliability and credibility of reported earnings.

Research examining energy-sector organizations demonstrates that firms embracing eco-efficiency programs typically obtain higher market valuations than enterprises employing traditional operational approaches, as investors generally perceive environmental conservation efforts as signals of competitive advantage and commitment to sustainability. Prior studies also demonstrate that integrated approaches to natural resource conservation and waste reduction strengthen an organization's standing in financial markets, while the existence of reliable environmental disclosure practices creates favorable conditions for obtaining additional investment resources.

Evidence reported by alternative sources suggests that possession of environmental management system certifications, including ISO 14001, has no statistically significant influence on equity market valuation. Investors in securities markets frequently interpret these certifications as evidence of administrative compliance rather than as genuine improvements in environmental performance.

Investigations examining these divergent empirical findings have identified particular contingency factors. Specifically, capital structure strength, quantified through leverage metrics, and organizational profitability may represent critical moderators influencing whether investments in environmental efficiency result in enhanced corporate valuation.

Empirical evidence substantiates this proposition through research documenting that stakeholder appreciation of environmental investments depends fundamentally on demonstrated consistency and sustainability in operating profitability. Accordingly, favorable market reception of environmental sustainability signals requires enterprises to maintain solid financial foundations and consistent profitability.

This assertion receives empirical confirmation from Amalia et al. (2017) and Malik et al. (2026), which suggests that stakeholder receptivity toward green business initiatives is substantially contingent upon an organization's ability to generate reliable and stable operating earnings. Concurrently, Damas et al. (2021) and Apriandi and Hexana (2023) characterize credible documentation of environmental performance as a fundamental prerequisite for establishing the authenticity and trustworthiness of efficiency disclosures. In the absence of empirical evidence of environmental performance achievements, sustainability and efficiency claims disseminated by the enterprise are likely to encounter limited market acceptance.

Investigations conducted among extractive-industry enterprises reveal that earnings management activities exert statistically significant adverse effects on corporate valuation

metrics, attributable to investors' interpretation of managerial manipulation of accrual figures as a negative performance indicator.

Contrasting evidence is reported by investigations of government-controlled corporate entities, which demonstrate that earnings management practices are positively associated with corporate valuation, suggesting that managerial attempts to present favorable profit performance through short-term optimization strategies may successfully communicate perceived improvements in performance.

An examination of telecommunications-sector enterprises similarly documents a positive correlation between earnings management activities and equity valuation, with external investors frequently maintaining favorable assessments despite potential underlying deterioration in actual financial performance. An investigation by Miranti & Nugroho (2025) examining the telecommunications sector substantiates the positive effect of earnings management activities on valuation, demonstrating that although such interventions may diminish the authenticity of reported financial conditions, external market assessments frequently remain substantially favorable.

This finding of a nonsignificant effect receives support from Tiolensa Kristina Situmorang et al. (2025), who examined the financial services sector within Indonesia's securities market. Their findings suggest that banking-sector participants demonstrate substantial financial sophistication, enabling them to distinguish between authentic and artificially constructed profit information and, consequently, to discount manipulated earnings announcements.

Parallel empirical results from Nursida et al. (2025), who investigated the packaged-goods sector, demonstrate an absence of a direct relationship between dimensions of earnings management activities and corporate market valuation. This inconsistent empirical pattern substantiates the view that the consequences of earnings management vary substantially according to industry characteristics, necessitating the use of moderators as an academically sound approach for reconciling these contradictory empirical findings.

Theoretically, earnings management serves as an appropriate moderating mechanism because investors predominantly depend on the credibility and quality of financial reports as their principal framework for evaluating and interpreting additional nonfinancial corporate communications and sustainability disclosures.

Beyond structural governance elements, the incorporation of conservative accounting methodologies constitutes an essential component in moderating the market's response to corporate disclosures. Environmental and sustainability reporting may receive greater market acceptance and generate greater market confidence when organizations adhere to rigorous standards of accounting conservatism.

In energy-sector firms, systematic disclosure regarding environmental sustainability initiatives and the effectiveness of energy conservation measures represents a strategically significant component of corporate communication. International investment entities are progressively incorporating environmental sustainability considerations into their valuation and risk-assessment frameworks.

METHOD

This quantitative research applies an associative research design to examine the relationships among greenwashing and eco-efficiency dimensions in relation to corporate market valuation, and additionally evaluates earnings-management activity as a moderating factor. Secondary data were obtained from financial reports, annual corporate reports, sustainability documents, corporate web publications, and securities exchange registries from the energy sector covering the period from 2020 to 2024.

RESULTS AND DISCUSSION

Descriptive Statistics

Data corresponding to the independent, dependent, and moderating variables were analyzed using EViews 13. Descriptive statistics present measures of central tendency, dispersion, and distributional characteristics.

Table 1*Descriptive Statistical Test*

	X1_GW	X2_ECO	Y_NP	Z_ML
Mean	0.606538	0.780000	1.152861	-0.042099
Median	0.711538	1.000000	0.972453	-0.054756
Maximum	1.000000	1.000000	3.587327	0.302451
Minimum	0.076923	0.000000	0.273967	-0.203977
Std. Dev.	0.325066	0.416333	0.563826	0.081695
Skewness	-0.300299	-1.351853	2.174038	1.135728
Kurtosis	1.598963	2.827506	8.056024	5.934490
Jarque-Bera	9.681763	30.58241	185.2881	57.37811
Probability	0.007900	0.000000	0.000000	0.000000
Sum	60.65385	78.00000	115.2861	-4.209923
Sum Sq. Dev.	10.46111	17.16000	31.47209	0.660734
Observations	100	100	100	100

Source: EViews data processing ver-13 (2026)

Table 2 presents descriptive statistical measures for 100 firm-year observations derived from companies in the energy sector over the 2020–2024 study period.

The greenwashing measure (X1) has a mean value of 0.606538 and a standard deviation of 0.325066. Because the standard deviation is lower than the mean, the observations exhibit relatively limited dispersion around the mean.

Eco-efficiency (X2) has a mean value of 0.780000 and a standard deviation of 0.416333. This relatively low standard deviation indicates that the observations are concentrated relatively close to the mean. A minimum score of 0.000000 was recorded for PT Indika Energy Tbk (2020–2024), PT Indo Tambangraya Megah Tbk (2020–2024), PT Mitra Energi Persada Tbk (2020–2024), PT Samindo Resources Tbk (2020–2021), and PT Wintermar Offshore Marine Tbk (2020–2021). Conversely, the maximum score of 1.000000 was attained by PT ABM Investama Tbk, PT Alamtri Resources Indonesia Tbk, PT AKR Corporindo Tbk, PT Bumi Resources Tbk, PT Darma Henwa Tbk, PT BUMA International Group Tbk, PT Energi Mega Persada Tbk, PT Mitrabahtera Segara Sejati Tbk, PT Medco Energi Internasional Tbk, PT Perusahaan Gas Negara Tbk, PT IMC Pelita Logistik Tbk, PT Bukit Asam Tbk, PT Petrosea Tbk, and PT Pelayaran Tamarin Samudra Tbk during 2020–2024.

Firm value (Y) has a mean of 1.152861 and a standard deviation of 0.563826. Because the standard deviation is lower than the mean, firm-value observations exhibit relatively limited dispersion. PT Indo Tambangraya Megah Tbk recorded the lowest firm value, 0.273967, in 2020, whereas PT Mitra Energi Persada Tbk recorded the highest firm value, 3.587327, in 2021.

Earnings management (Z) has a mean of -0.042099 and a standard deviation of 0.081695. Because the standard deviation exceeds the absolute value of the mean, the observations exhibit considerable variation relative to the mean. The lowest value, -0.203977, was recorded for PT Energi Mega Persada Tbk in 2020, whereas the highest value, 0.302451, was observed for PT Bumi Resources Tbk in 2022.

Panel Data Regression Model

Imani et al. (2025) distinguishes three main specifications for panel-data regression: the Pooled Least Squares or Common Effect Model, the Fixed Effect Model, and the Random Effect Model.

Pooled Least Square or Common Effect Model (CEM)**Table 2***Pooled Least Square or Common Effect Model*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.699997	0.106064	6.599778	0.0000
X1_GW	-0.183909	0.115770	-1.588569	0.1154
X2_ECO	-0.208421	0.090603	-2.300376	0.0236

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Z_ML	1.332079	0.461747	2.884866	0.0048
R-squared	0.151790	Mean dependent var		0.369801
Adjusted R-squared	0.125284	S.D. dependent var		0.399918
S.E. of regression	0.374028	Akaike info criterion		0.910207
Sum squared resid	13.43013	Schwarz criterion		1.014414
Log likelihood	-41.51037	Hannan-Quinn crister.		0.952382
F-statistic	5.726519	Durbin-Watson stat		0.942769
Prob(F-statistic)	0.001197			

Source: EViews data processing ver-13 (2026)

The Pooled Least Squares specification produces an adjusted R-squared value of 0.125284, indicating that the model explains approximately 12.52% of the variation in the dependent variable. The remaining 87.48% is associated with factors not included in the model.

Fixed Effect Model (FEM)

After estimating the Common Effect Model, the analysis proceeded with the Fixed Effect Model, the results of which are presented in Table 3.

Table 3

Fixed Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.491700	0.125979	3.903042	0.0002
X1_GW	0.145232	0.157328	0.923116	0.3588
X2_ECO	-0.176401	0.129365	-1.363586	0.1767
Z_ML	1.719646	0.548258	3.136561	0.0024
Effects Specification				

Cross-section fixed (dummy variables)

R-squared	0.514614	Mean dependent var		0.369801
Adjusted R-squared	0.375933	S.D. dependent var		0.399918
S.E. of regression	0.315927	Akaike info criterion		0.732023
Sum squared resid	7.685350	Schwarz criterion		1.331212
Log likelihood	-13.60114	Hannan-Quinn crister.		0.974525
F-statistic	3.710763	Durbin-Watson stat		1.620738
Prob(F-statistic)	0.000010			

Source: EViews data processing ver-13 (2026)

The Fixed Effect Model produces an adjusted R-squared value of 0.375933, equivalent to 37.59%. Accordingly, the predictors explain approximately 37.59% of the variation in the dependent variable, whereas the remaining 62.41% is associated with factors outside the model specification.

Random Effect Model (REM)

After estimating the Fixed Effect Model, the Random Effect Model was subsequently evaluated. The estimation results are presented in Table 4.

Table 4

Random Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.599347	0.112645	5.320697	0.0000
X1_GW	-0.054870	0.122009	-0.449719	0.6539
X2_ECO	-0.169720	0.095281	-1.781264	0.0780
Z_ML	1.517466	0.453344	3.347271	0.0012
Effects Specification				

Variable	Coefficient	Std. Error	t-Statistic	Prob.
			S.D.	Rho
Cross-section random			0.175439	0.2357
Idiosyncratic random			0.315927	0.7643
Weighted Statistics				
R-squared	0.118082	Mean dependent var		0.231948
Adjusted R-squared	0.090522	S.D. dependent var		0.340986
S.E. of regression	0.325187	Sum squared resid		10.15168
F-statistic	4.284543	Durbin-Watson stat		1.224659
Prob(F-statistic)	0.006967			
Unweighted Statistics				
R-squared	0.137438	Mean dependent var		0.369801
Sum squared resid	13.65737	Durbin-Watson stat		0.910302

Source: EViews data processing ver-13 (2026)

The Random Effect Model produces an adjusted R-squared value of 0.090522, or approximately 9.05%. Accordingly, the explanatory variables account for approximately 9% of the variation in firm value, whereas the remaining 90.95% is associated with unobserved factors outside the model specification.

Model Selection

Chow Test (*Likelihood Ratio*)

The Chow test evaluates whether the Common Effect Model or Fixed Effect Model provides the more appropriate specification. The corresponding results are presented in Table 5.

Table 5

Chow Test

Effects Test	Statistic	D.F.	Prob.
Cross-section F	3.029330	(19,77)	0.0003
Cross-section Chi-square	55.818447	19	0.0000

Source: EViews data processing ver-13 (2026)

Table 5 reports a cross-section F-test probability of 0.0003, which is below the 0.05 significance level. The null hypothesis of the Common Effect Model is therefore rejected, supporting the selection of the Fixed Effect Model over the Common Effect Model.

Hausman Test

The Hausman test was conducted to determine whether the Fixed Effect Model or Random Effect Model was more appropriate for the panel-data analysis, presented in Table 6.

Table 6

Hausman Test

Test Summary	Chi-Sq. Statistic	Chi-Sq. D.F.	Prob.
Cross-section random	8.710267	3	0.0334

Source: EViews data processing ver-13 (2026)

As reported in Table 6, the probability value of 0.0334 is below 0.05. Therefore, the null hypothesis is rejected, and the Fixed Effect Model is selected over the Random Effect Model.

Model Selection Test

The results of the panel-data specification tests are summarized in in Table 7.

Table 7

Model Selection Test Results

No	Method	Testing	Results
1	Chow Test	Common Effect Vs Fixed Effect	Fixed Effect Model

No	Method	Testing	Results
2	Hausman Test	Fixed Effect Vs Random Effect	Fixed Effect Model

Source: Model Selection Results, 2026

Table 7 indicates that both the Chow and Hausman tests select the Fixed Effect Model. Therefore, the subsequent analysis employs the Fixed Effect Model.

Classical Assumption Tests

Normality Test

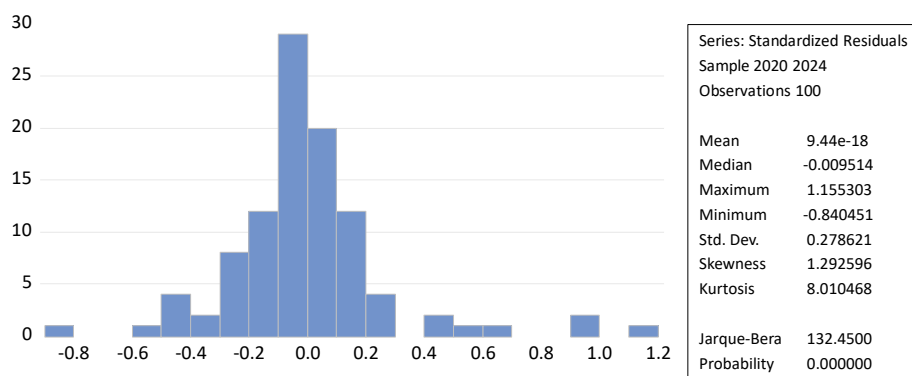


Figure 1. Normality Test

Figure 1 reports a Jarque-Bera statistic of 132.4500 and a probability value of 0.000000, which is below the 0.05 significance level, indicating that the residuals are not normally distributed. Nevertheless, Gujarati and Porter (2009) and Griffiths (2026) explain that when the number of observations exceeds 30, the sampling distribution of the estimator tends to approximate normality under the central limit theorem, reducing the practical importance of formal residual normality testing in sufficiently large samples.

Multicollinearity Test

Multicollinearity refers to a linear association among explanatory variables.

Table 8

Multicollinearity Test

	X1_GW	X2_ECO	Z_ML
X1_GW	1.000000	0.031405	0.032581
X2_ECO	0.031405	1.000000	-0.075635
Z_ML	0.032581	-0.075635	1.000000

Source: EViews data processing ver-13 (2026)

Table 8 indicates no evidence of problematic multicollinearity, as all pairwise correlation coefficients are below the 0.80 threshold. Therefore, the earnings management, greenwashing, and eco-efficiency variables do not exhibit problematic multicollinearity.

Heteroscedasticity Test

The heteroscedasticity test evaluates whether the variance of the regression residuals differs across observations.

Table 9

Heteroscedasticity Test

F-statistic	1.160378	Prob. F(3.96)	0.3290
Obs*R-squared	3.499289	Prob. Chi-Square(3)	0.3209
Scaled explained SS	14.49242	Prob. Chi-Square(3)	0.0023

Source: EViews data processing ver-13 (2026)

The Breusch-Pagan procedure reported in Table 9 produces an Obs*R-squared probability value of 0.3209. Because this value exceeds 0.05, the null hypothesis of homoscedasticity is not rejected. Thus, the model does not provide evidence of heteroscedasticity. Although the probability associated with the Scaled Explained SS statistic is 0.0023, the interpretation of the Breusch-Pagan test should be based on the specified test statistic and its corresponding probability value.

Autocorrelation Test

Autocorrelation was assessed using the Durbin-Watson (DW) statistic. Santoso (2012, p. 242) considers a regression specification to be free from autocorrelation when the calculated DW value falls between -2 and 2.

Table 10

Autocorrelation Test

R-squared	0.514614	Mean dependent var	0.369801
Adjusted R-squared	0.375933	S.D. dependent var	0.399918
S.E. of regression	0.315927	Akaike info criterion	0.732023
Sum squared resid	7.685350	Schwarz criterion	1.331212
Log likelihood	-13.60114	Hannan-Quinn crister.	0.974525
F-statistic	3.710763	Durbin-Watson stat	1.620738
Prob(F-statistic)	0.000010		

Source: EViews data processing ver-13 (2026)

The calculated Durbin-Watson statistic is 1.620738 and therefore falls within the -2 to 2 interval. Based on the criterion adopted in this study, the regression model does not indicate an autocorrelation problem.

Panel Data Regression Test

Table 11

Panel Data Regression Test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.491700	0.125979	3.903042	0.0002
X1_GW	0.145232	0.157328	0.923116	0.3588
X2_ECO	-0.176401	0.129365	-1.363586	0.1767
Z_ML	1.719646	0.548258	3.136561	0.0024

Source: EViews data processing ver-13 (2026)

The estimated panel-regression equation characterizing the relationships among greenwashing, eco-efficiency, earnings management, and firm value is as follows:

$$\text{Firm Value} = 0.491700 + 0.145232 (\text{Greenwashing}) - 0.176401 (\text{Eco-efficiency}) + 1.719646 (\text{Earnings Management})$$

The coefficients are interpreted as follows:

- 1) The intercept of 0.491700 represents the predicted value of firm value when all explanatory variables are equal to zero.
- 2) Greenwashing has a positive coefficient of 0.145232, indicating that, holding the other predictors constant, a one-unit increase in greenwashing is associated with a 0.145232 increase in firm value.
- 3) Eco-efficiency has a negative coefficient of -0.176401. Accordingly, holding the other variables constant, a one-unit increase in eco-efficiency is associated with a 0.176401 decrease in firm value.
- 4) Earnings management has a positive coefficient of 1.719646. Accordingly, holding the other variables constant, a one-unit increase in earnings management is associated with a 1.719646 increase in firm value.

Determination Coefficient Test (*Adjusted R2*)

Table 12

Determination Coefficient Test (Adjusted R2)

R-squared	0.514614	Mean dependent var	0.369801
Adjusted R-squared	0.375933	S.D. dependent var	0.399918
S.E. of regression	0.315927	Akaike info criterion	0.732023
Sum squared resid	7.685350	Schwarz criterion	1.331212
Log likelihood	-13.60114	Hannan-Quinn crister.	0.974525
F-statistic	3.710763	Durbin-Watson stat	1.620738
Prob(F-statistic)	0.000010		

Source: EViews data processing ver-13 (2026)

Table 12 reports an R-squared value of 0.514614 and an adjusted R-squared value of 0.375933. Thus, the model explains approximately 37.59% of the variation in firm value after adjusting for the number of predictors, whereas the remaining 62.41% is associated with factors not incorporated into the regression model.

Hypothesis Test

Simultaneous Significant Test (F Test)

Table 13

Test F

R-squared	0.514614	Mean dependent var	0.369801
Adjusted R-squared	0.375933	S.D. dependent var	0.399918
S.E. of regression	0.315927	Akaike info criterion	0.732023
Sum squared resid	7.685350	Schwarz criterion	1.331212
Log likelihood	-13.60114	Hannan-Quinn crister.	0.974525
F-statistic	3.710763	Durbin-Watson stat	1.620738
Prob(F-statistic)	0.000010		

Source: EViews data processing ver-13 (2026)

The F-test probability reported in Table 13 is 0.000010, below 0.05. Hence, greenwashing, eco-efficiency, and earnings-management activity simultaneously have a statistically significant influence on firm valuation.

Partial Significance Test (t-test)

Table 14

T test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.491700	0.125979	3.903042	0.0002
X1_GW	0.145232	0.157328	0.923116	0.3588
X2_ECO	-0.176401	0.129365	-1.363586	0.1767
Z_ML	1.719646	0.548258	3.136561	0.0024

Source: EViews data processing ver-13 (2026)

The partial t-tests evaluate the contribution of each independent variable to firm valuation and form the basis for evaluating the proposed hypotheses.

- 1) For greenwashing, the t-statistic is 0.923116 and the probability is 0.3588, which exceeds 0.05. Greenwashing therefore does not exert a statistically significant influence on firm valuation.
- 2) Eco-efficiency produces a t-statistic of -1.363586 and a probability of 0.1767. Since the probability is above 0.05, its influence on firm valuation lacks statistical significance.
- 3) Earnings management yields a t-statistic of 3.136561 with a probability of 0.0024, below 0.05. This finding confirms that the effect on this variable is statistically significant firm valuation.

Moderated Regression Analysis (MRA)

Descriptive Statistics

Table 15*MRA Descriptive Statistics*

	Y_NP	X1_GW	X2_ECO	Z_ML	X1Z_MODGW	X2Z_MODECO
Mean	1.152861	0.606538	0.780000	-0.042099	-0.024678	-0.035384
Median	0.972453	0.711538	1.000000	-0.054756	-0.018471	-0.026694
Maximum	3.587327	1.000000	1.000000	0.302451	0.267553	0.302451
Minimum	0.273967	0.076923	0.000000	-0.203977	-0.173844	-0.203977
Std. Dev.	0.563826	0.325066	0.416333	0.081695	0.058278	0.070321
Skewness	2.174038	-0.300299	-1.351853	1.135728	1.052329	0.862974
Kurtosis	8.056024	1.598963	2.827506	5.934490	8.717526	7.239159
Jarque-Bera	185.2881	9.681763	30.58241	57.37811	154.6654	87.28900
Probability	0.000000	0.007900	0.000000	0.000000	0.000000	0.000000
Sum	115.2861	60.65385	78.00000	-4.209923	-2.467824	-3.538420
Sum Sq. Dev.	31.47209	10.46111	17.16000	0.660734	0.336242	0.489555
Observations	100	100	100	100	100	100

Source: EViews data processing ver-13 (2026)

Table 15 summarizes descriptive statistics for 100 firm-year observations from energy-sector companies over 2020–2024 after the moderating variable is incorporated.

Panel Data Regression Model

Pooled Least Square or Common Effect Model (CEM)

The moderated model was first estimated using the Common Effect specification, and the corresponding output appears in Table 16.

Table 16*Pooled Least Square Test or Common Effect MRA Model*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.663899	0.109270	6.075794	0.0000
X1_GW	-0.110105	0.128324	-0.858020	0.3931
X2_ECO	-0.224188	0.099345	-2.256673	0.0263
Z_ML	0.161431	1.054102	0.153146	0.8786
X1Z_MODGW	2.041056	1.445950	1.411568	0.1614
X2Z_MODECO	-0.133303	1.063227	-0.125376	0.9005
R-squared	0.170577	Mean dependent var		0.369801
Adjusted R-squared	0.126458	S.D. dependent var		0.399918
S.E. of regression	0.373777	Akaike info criterion		0.927810
Sum squared resid	13.13267	Schwarz criterion		1.084120
Log likelihood	-40.39051	Hannan-Quinn crister.		0.991072
F-statistic	3.866347	Durbin-Watson stat		0.953981
Prob(F-statistic)	0.003134			

Source: EViews data processing ver-13 (2026)

For the moderated specification, the Common Effect Model generates an adjusted R-squared of 0.126458, or about 12%. The predictors account for 12% of variation in the outcome, whereas the other 88% relates to factors beyond the model.

Fixed Effect Model (FEM)

The analysis then moved from the Common Effect specification to the Fixed Effect Model. The corresponding estimates are shown in Table 17.

Table 17*MRA Model Fixed Effect Test*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.467225	0.127175	3.673878	0.0004
X1_GW	0.271680	0.178035	1.525999	0.1312
X2_ECO	-0.251455	0.138482	-1.815799	0.0734
Z_ML	0.818080	1.057155	0.773851	0.4415
X1Z_MODGW	2.290456	1.495212	1.531860	0.1298
X2Z_MODECO	-0.703457	1.086795	-0.647276	0.5194
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.529509	Mean dependent var		0.369801
Adjusted R-squared	0.378951	S.D. dependent var		0.399918
S.E. of regression	0.315162	Akaike info criterion		0.740857
Sum squared resid	7.449526	Schwarz criterion		1.392150
Log likelihood	-12.04286	Hannan-Quinn crister.		1.004447
F-statistic	3.516991	Durbin-Watson stat		1.659144
Prob(F-statistic)	0.000016			

Source: EViews data processing ver-13 (2026)

The moderated Fixed Effect Model reports an adjusted R-squared of 0.378951, equivalent to approximately 37%. Accordingly, 37% of dependent-variable variation is attributable to the predictors and 63% remains attributable to other factors.

Random Effect Model (REM)

Once the Fixed Effect Model had been estimated, the Random Effect specification was evaluated, producing the following results in Table 18.

Table 18*MRA Model Random Effect Test*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.560900	0.117049	4.792010	0.0000
X1_GW	0.046666	0.138937	0.335877	0.7377
X2_ECO	-0.204647	0.104866	-1.951518	0.0540
Z_ML	0.508342	0.988210	0.514407	0.6082
X1Z_MODGW	2.052042	1.367648	1.500417	0.1369
X2Z_MODECO	-0.346555	1.000357	-0.346432	0.7298
Effects Specification				
		S.D.	Rho	
Cross-section random		0.194122	0.2750	
Idiosyncratic random		0.315162	0.7250	
Weighted Statistics				
R-squared	0.136337	Mean dependent var		0.217269
Adjusted R-squared	0.090398	S.D. dependent var		0.335859
S.E. of regression	0.320319	Sum squared resid		9.644783
F-statistic	2.967753	Durbin-Watson stat		1.273687
Prob(F-statistic)	0.015650			
Unweighted Statistics				
R-squared	0.151471	Mean dependent var		0.369801
Sum squared resid	13.43518	Durbin-Watson stat		0.914349

Source: EViews data processing ver-13 (2026)

The moderated Random Effect Model has an adjusted R-squared of 0.090398, or about 9%. The model therefore accounts for 9% of variation in the outcome variable, leaving 91% to influences outside the specification.

Model Selection

Chow Test (Likelihood Ratio)

For the moderated model, the Chow procedure compares the suitability of the Common Effect and Fixed Effect specifications. Its results appear in Table 19.

Table 19

Chow MRA Test

Effects Test	Statistic	D.F.	Prob.
Cross-section F	3.011398	(19,75)	0.0004
Cross-section Chi-square	56.695302	19	0.0000

Source: EViews data processing ver-13 (2026)

Table 19 shows an F-probability of 0.0004, lower than 0.05. The Fixed Effect specification is therefore selected over the Common Effect alternative.

Hausman Test

A Hausman test was subsequently conducted to choose between Fixed Effect and Random Effect estimators. The statistical output is reported in Table 20

Table 20

MRA Hausman Test

Test Summary	Chi-Sq. Statistic	Chi-Sq. D.F.	Prob.
Cross-section random	8.101308	50	0.1507

Source: EViews data processing ver-13 (2026)

Table 20 reports a probability of 0.1507, which exceeds 0.05. On this basis, the Random Effect Model is preferred to the Fixed Effect Model.

Lagrange Multiplier Test

The Lagrange Multiplier test compares the Common Effect and Random Effect specifications in the panel model. The outcomes are displayed in Table 21.

Table 21

MRA Lagrange Multiplier Test

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	10.34284 (0.0013)	0.566791 (0.4515)	10.90963 (0.0010)
Honda	3.216029 (0.0006)	-0.752855 (0.7742)	1.741727 (0.0408)
King-Wu	3.216029 (0.0006)	-0.752855 (0.7742)	0.656912 (0.2556)
Standardized Honda	3.784444 (0.0001)	-0.450176 (0.6737)	-1.603482 (0.9456)
Standardized King-Wu	3.784444 (0.0001)	-0.450176 (0.6737)	-2.120102 (0.9830)
Gourieroux, et al.	--	--	10.34284 (0.0021)

Source: EViews data processing ver-13 (2026)

The Breusch-Pagan Lagrange Multiplier result in Table 21 provides a probability of 0.0010, below 0.05. The null specification is rejected, supporting the Random Effect Model as the preferred estimator.

Model Selection Results

The complete set of panel-model selection outcomes is presented in the following

summary in Table 22.

Table 22

MRA Model Selection Test Results

No	Test Model	Selected Models
1	Chow Test	Fixed Effect Model
2	Hausman Test	Random Effect Model
3	Lagrange Multiplier Test	Random Effect Model

Source : Model Selection Results, 2026

As reported in Table 22, the Chow test favors the Fixed Effect Model, whereas the Hausman and Lagrange Multiplier tests favor the Random Effect Model. Taken together, these selection tests support use of the Random Effect Model in the analysis.

Classical Assumption Tests

Normality Test

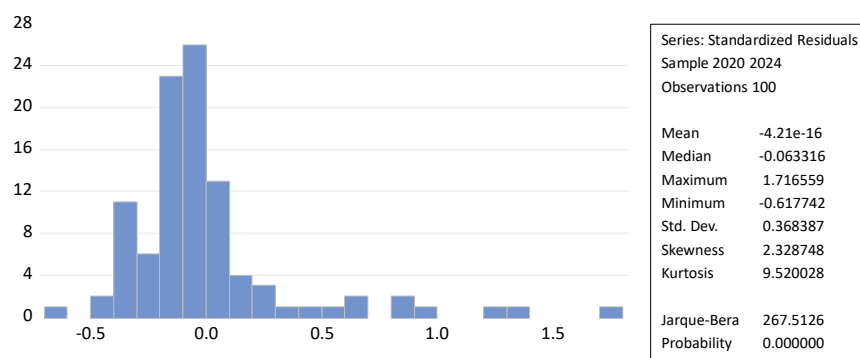


Figure 2. MRA Normality Test

Figure 2 gives a histogram statistic of 267.5126 and a probability of 0.000000, which is below 0.05 and indicates a non-normal distribution. Gujarati and Porter (2009) and Griffiths (2026), however, note that when observations exceed 30, the sampling-error distribution is approximately normal and a separate normality test becomes less consequential.

Multicollinearity Test

Multicollinearity arises when explanatory variables exhibit linear dependence. Following Allison (2012) and Kyriazos and Poga (2023), this study evaluates the issue by confirming that correlations among explanatory variables remain below 0.90. The test results are reported next:

Table 23

MRA Multicollinearity Test

	X1_GW	X2_ECO	Z_ML	X1Z_MODGW	X2Z_MODECO
X1_GW	1.000000	0.031405	0.032581	-0.168829	0.062624
X2_ECO	0.031405	1.000000	-0.075635	-0.033124	-0.268579
Z_ML	0.032581	-0.075635	1.000000	0.857801	0.818994
X1Z_MODGW	-0.168829	-0.033124	0.857801	1.000000	0.772071
X2Z_MODECO	0.062624	-0.268579	0.818994	0.772071	1.000000

Source: EViews data processing ver-13 (2026)

The correlations presented in Table 23 are all below 0.90, indicating no severe multicollinearity among earnings-management activity, greenwashing, and eco-efficiency. Allison (2012) and Kyriazos and Poga (2023) accounts for that structural multicollinearity created by interaction terms is not inherently harmful as it does not bias the estimated interaction coefficient or its statistical significance.

Heteroscedasticity Test

Table 24

MRA Heteroscedasticity Test

F-statistic	0.543671	Prob. F(5,94)	0.7427
Obs*R-squared	2.810589	Prob. Chi-Square(5)	0.7292
Scaled explained SS	11.30525	Prob. Chi-Square(5)	0.0457

Source: EViews data processing ver-13 (2026)

Table 24 presents a Breusch-Pagan probability of 0.7292. As this value is higher than 0.05, the regression residuals meet the constant-variance requirement and no heteroscedasticity is detected.

Autocorrelation Test

The moderated model was also assessed for serial correlation through the Durbin-Watson statistic. Under Santoso's (2012) criterion, a value within the interval from -2 to 2 suggests that autocorrelation is absent.

Table 25

MRA Autocorrelation Test

R-squared	0.136337	Mean dependent var	0.217269
Adjusted R-squared	0.090398	S.D. dependent var	0.335859
S.E. of regression	0.320319	Sum squared resid	9.644783
F-statistic	2.967753	Durbin-Watson stat	1.273687
Prob(F-statistic)	0.015650		

Source: EViews data processing ver-13 (2026)

The Durbin-Watson value is 1.273687, which lies inside the -2 to 2 interval. The evidence therefore supports the conclusion that the regression estimates are not affected by autocorrelation.

Panel Data Regression Test

Table 26

MRA Panel Data Regression Test

C	0.560900	0.117049	4.792010	0.0000
X1_GW	0.046666	0.138937	0.335877	0.7377
X2_ECO	-0.204647	0.104866	-1.951518	0.0540
Z_ML	0.508342	0.988210	0.514407	0.6082
X1Z_MODGW	2.052042	1.367648	1.500417	0.1369
X2Z_MODECO	-0.346555	1.000357	-0.346432	0.7298

Source: EViews data processing ver-13 (2026)

Using the coefficients reported in Table 26, the effects of greenwashing, eco-efficiency, earnings-management activity, and both interaction terms on firm valuation can be expressed in the following regression equation:

Firm Value = 0.560900 + 0.046666 (Greenwashing) – 0.204647 (Eco-efficiency) + 0.508342 (Earnings Management) + 2.052042 (Greenwashing × Earnings Management) – 0.346555 (Eco-efficiency × Earnings Management). Each parameter is accounted for below:

- 1) The intercept is 0.560900, representing the expected firm valuation when every predictor and interaction term equals zero.
- 2) The coefficient for greenwashing is 0.046666. With other terms held constant, a one-unit raise in greenwashing corresponds to a 0.046666 rise in firm valuation.
- 3) Eco-efficiency has a coefficient of -0.204647, which suggests that a one-unit raise corresponds to a 0.204647 decline in firm valuation, conditional on the balance of predictors.
- 4) The estimated coefficient of earnings-management activity is 0.508342. Accordingly,

increasing earnings-management activity by one unit corresponds to a 0.508342 raise in firm valuation when other variables are unchanged.

- 5) The greenwashing–earnings-management activity interaction yields a positive coefficient of 2.052042, indicating a positive conditional association with firm valuation.
- 6) The interaction between eco-efficiency and earnings-management activity has a coefficient of -0.346555, denoting a negative conditional association with firm valuation.

Determination Coefficient Test (*Adjusted R2*)

Table 27

Determination Coefficient Test (Adjusted R2) MRA

R-squared	0.136337	Mean dependent var	0.217269
Adjusted R-squared	0.090398	S.D. dependent var	0.335859
S.E. of regression	0.320319	Sum squared resid	9.644783
F-statistic	2.967753	Durbin-Watson stat	1.273687
Prob(F-statistic)	0.015650		

Source: EViews data processing ver-13 (2026)

Table 27 reports an R-squared of 0.090398. Taken together, greenwashing, eco-efficiency, earnings management, and the two interaction terms explain approximately 9% of firm-value variation; the remaining 91% reflects influences omitted from the regression.

The moderated regression lowers adjusted R-squared from 0.375933 in the baseline specification to 0.090398 in the interaction specification, whereas the intercept raises. The interaction terms consequently add no meaningful predictive information. Empirically, Z fails to moderate the X–Y relationships, and the simpler non-moderated regression provides the more efficient specification.

Hypothesis Test

Moderated Regression Analysis (MRA) Test

Table 28

Moderated Regression Analysis (MRA) Test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.560900	0.117049	4.792010	0.0000
X1_GW	0.046666	0.138937	0.335877	0.7377
X2_ECO	-0.204647	0.104866	-1.951518	0.0540
Z_ML	0.508342	0.988210	0.514407	0.6082
X1Z_MODGW	2.052042	1.367648	1.500417	0.1369
X2Z_MODECO	-0.346555	1.000357	-0.346432	0.7298

Source: EViews data processing ver-13 (2026)

The t-test results in Table 28 evaluate the interaction effects and provide the empirical basis for decisions concerning H4 and H5, as detailed below:

- 1) For the interaction between greenwashing and earnings-management activity, the t-statistic is 1.500417 and the probability is 0.1369, above 0.05. Earnings management therefore neither strengthens nor attenuates the influence of greenwashing on firm valuation and is classified as a predictor moderator.
- 2) The eco-efficiency–earnings-management activity interaction provides a t-statistic of -0.346432 and a probability of 0.7298, exceeding 0.05. Accordingly, earnings-management activity does not amplify or attenuate the association between eco-efficiency and firm valuation and functions as a predictor moderator.

Discussion

The Effect of Greenwashing on Firm Value

The statistical evaluation of greenwashing produces a probability value of 0.3588, which exceeds the conventional 0.05 significance level, and a coefficient of 0.145232. These results

indicate that greenwashing does not have a statistically significant effect on firm value.

These findings are consistent with previous empirical research indicating that capital-market participants do not necessarily regard selective environmental disclosures as mechanisms for enhancing firm value. This may reflect greater stakeholder awareness in identifying greenwashing behavior, which can undermine information credibility and financial-reporting integrity and consequently encourage investors to conduct more rigorous evaluations of corporate environmental claims.

The empirical findings of this study differ from those of Freshtriana and Kim (2025), who examined manufacturing companies included in the LQ45 index. Their study found a significant positive relationship between greenwashing and firm value, suggesting that securities-market participants may respond favorably to environmental claims during shorter-term valuation periods. The present findings also differ from those of Xu et al. (2025) and Huang (2023), who reported that greenwashing, together with intentional information manipulation, generated significant negative market reactions and ultimately reduced firm value.

These results can be interpreted in light of Legitimacy Theory, which posits that deliberate alteration of environmental communication and misleading environmental claims may encounter difficulties in establishing substantive legitimacy among capital-market participants. From a signaling-theory perspective, communications that distort environmental conditions may constitute unreliable signals or noise, thereby limiting their ability to reduce information asymmetry.

The Effect of Eco-efficiency on Firm Value

The empirical findings indicate that eco-efficiency does not have a statistically significant effect on firm value. This result is consistent with previous research suggesting that eco-efficiency disclosures may have limited influence on market valuation. One possible explanation is that the implementation and disclosure of eco-efficiency practices remain relatively discretionary in the study context, resulting in insufficiently detailed information for investors to incorporate these practices into their valuation decisions.

These findings are consistent with Dianti and Puspitasari (2024), who concluded that eco-efficiency disclosure does not significantly influence firm value. This may occur because environmental-performance implementation and disclosure practices in Indonesia remain predominantly discretionary, limiting the availability of comprehensive information for investors when evaluating firm value.

These results differ from Noor et al. (2022), Satrio and Kunto (2020), and Rahelliamelinda and Handoko (2024), who documented a positive effect of eco-efficiency. Their findings suggest that markets may value environmentally friendly cost savings as a source of competitive advantage. The present results also differ from Nurrohman et al. (2026), who found a negative effect and attributed it to the substantial initial costs of eco-efficient technologies, which may reduce current profits. In contrast, the present evidence suggests that investors in the sampled firms respond neutrally to eco-efficiency when forming market valuations.

The finding that eco-efficiency does not significantly influence firm value suggests that capital-market participants may not yet incorporate eco-efficiency practices systematically into their valuation decisions. From a signaling-theory perspective, eco-efficiency disclosures may have limited signaling effectiveness because of insufficient credibility, inconsistent disclosure quality, or difficulties in quantifying their economic consequences. Consequently, such disclosures may not substantially reduce information asymmetry.

The Influence of Earnings Management on Firm Value

The partial regression results indicate that earnings management has a statistically significant positive effect on firm value, as evidenced by a probability value below the conventional significance threshold and a positive coefficient.

This result is consistent with Ice et al. (2025), who reported that earnings management significantly affects the value of mining firms, as capital-market participants may treat accrual-based earnings management as information relevant to financial-reporting quality. Ardifarah and Fitranita (2025) likewise documented a positive relationship, suggesting that investors may

interpret managerial intervention as short-term performance optimization. Similar evidence from state-owned enterprises was reported by Agustini et al. (2025), who attributed the valuation response to apparently stable profitability trends. Miranti and Nugroho (2025) also found a positive effect in the telecommunications subsector, where investors respond strongly to current earnings signals. In the infrastructure sector, Irwan and Horri (2025) further demonstrated that accrual-based earnings management can influence market perceptions and contribute to movements in share prices and firm value.

This result differs from Ramadhan et al. (2026) and Kharisty et al. (2025), whose evidence from the food-and-beverage and property sectors suggests that earnings management does not directly affect firm value because investors place greater emphasis on expected cash flows. Prasetyo and Suryanto (2026), Nursida et al. (2025), and Situmorang et al. (2025) reached similar nonsignificant conclusions. In contrast to those studies, the present findings suggest that the market incorporates information associated with earnings-management activity into its assessment of equity value.

The significant positive effect of earnings management on firm value suggests that such practices may influence market perceptions of current financial performance. From a signaling-theory perspective, reported earnings and related accounting choices may be interpreted by market participants as signals concerning performance and organizational prospects. However, this interpretation should not be taken to mean that earnings management necessarily improves underlying economic performance or long-term firm value.

Earnings Management Moderates the Effect of Greenwashing on Firm Value

The Moderated Regression Analysis results presented in Table 28 report a probability value of 0.1369 for the greenwashing × earnings-management interaction, which exceeds the conventional 0.05 threshold, with a coefficient of 2.052042. Therefore, H4 is rejected because earnings management does not significantly strengthen or weaken the effect of greenwashing on firm value. Under the moderation classification adopted in this study, earnings management is categorized as a predictor moderator.

As a contingency factor, earnings management does not empirically alter the effect of greenwashing on firm value. This finding suggest that investors may evaluate greenwashing and profit-quality manipulation separately. Xu et al. (2025) and Alagöz et al. (2025) likewise imply that markets may distinguish financial-engineering risk from environmental-reputation risk. Accordingly, evidence of potentially misleading environmental disclosure may be evaluated independently of the extent of accrual-based earnings management.

This result contrasts with Freshtriana and Kim (2025) and Huang (2023), who associated distorted environmental information with internal financial indicators in shaping market valuation. It also differs from Ice et al. (2025), Ardifarah and Fitranita (2025), and Agustini et al. (2025), who identify earnings management as an important fundamental signal for investors. This difference highlights a contribution of the present study: within the simultaneous interaction model, earnings management neither significantly amplifies nor attenuates the effect of greenwashing on firm value.

The nonsignificant moderation result may indicate a separation between legitimacy strategies (Ashforth & Gibbs, 1990; Von Billerbeck, 2023). Greenwashing may be intended to address social and environmental expectations, whereas earnings management may serve financial or contractual objectives. Investors may therefore treat the two practices as distinct strategies. From a signaling perspective, this separation may result in signal blurring, whereby financial-accounting and environmental signals are not interpreted as an integrated message and consequently provide limited incremental informational value to capital-market participants (Cahan et al., 2016; Lee et al., 2026).

Earnings Management Moderates the Influence of Eco-efficiency on Firm Value

Table 28 reports a probability value of 0.7298 for the eco-efficiency × earnings-management interaction, which exceeds 0.05, and a coefficient of -0.346555. Therefore, H5 is rejected. Earnings management does not significantly strengthen or weaken the effect of eco-efficiency on firm value and is categorized as a predictor moderator under the classification

adopted in this study.

These results suggest that profit-management strategies, encompassing both accrual-based adjustments and real business decisions made by corporate management, do not empirically function as a contingency mechanism that enhances or diminishes the effect of eco-efficiency on firm value.

This result differs from Tantra et al. (2026), Nurrohmah et al. (2026), and Dianti and Puspitasari (2024), who found that green operational disclosure and eco-efficiency were associated with capital-market responses. It also contrasts with the Ice et al. (2025), Ardifarah and Fitranita (2025), Irwan and Horri (2025), and Miranti and Nugroho (2025), which identify earnings management as a signal considered by market participants. These differences highlight the distinctive contribution of the present findings: within the simultaneous interaction model, earnings management neither significantly increases nor decreases the effect of eco-efficiency on firm value among the sampled firms.

The absence of a significant moderating effect of earnings management on the relationship between eco-efficiency and firm value suggests a separation between environmental legitimacy and financial-performance considerations in the valuation decisions of capital-market participants. This pattern reflects a multidimensional conceptualization of legitimacy, in which firms may simultaneously pursue environmental legitimacy through environmental practices and disclosure and financial legitimacy through reported accounting performance.

CONCLUSION

The empirical results demonstrate that greenwashing and eco-efficiency are not significantly associated with firm value among the sampled energy-sector companies, whereas earnings management has a significant positive effect on firm value. Furthermore, earnings management does not significantly moderate the effects of greenwashing or eco-efficiency on firm value.

This research has several analytical and methodological limitations. The analysis is limited to 20 energy-sector companies and 100 firm-year observations over the 2020–2024 study period, which may limit the generalizability of the findings to other industries and alternative periods. In addition, the study relies on the selected measures of greenwashing, eco-efficiency, earnings management, and firm value; alternative operationalizations may produce different results.

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AUTHOR CONTRIBUTION STATEMENT

All authors contributed significantly to the development of this research. Neni Nuryati contributed to the conceptualization, research design, data analysis, and preparation of the initial manuscript. Iin Rosini contributed to the development of the theoretical framework, methodology refinement, and critical review of the manuscript. Dian Widiyati contributed to data interpretation, manuscript revision, and validation of the research findings.

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