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THE INFLUENCE OF GREEN INTELLECTUAL CAPITAL, GREEN INNOVATION, AND CARBON EMISSIONS DISCLOSURE ON FIRM VALUE WITH ENVIRONMENTAL PERFORMANCE AS A MODERATING VARIABLE

Marjuki[1]*, Nofryanti[2]
[1.2]Universitas Pamulang, Indonesia
*Corresponding Author:
marzukiuki71@gmail.com

Abstract
This research aims to investigate the impact of green intellectual capital, green innovation, and carbon emissions disclosure on firm value, and to explore whether environmental performance moderates this relationship. Using a sample of 156 data points from 52 energy and transportation companies' observation the period trend 2023, the study employs panel data regression and moderated regression analysis to test the hypotheses. The findings reveal that green innovation has a positive influence on firm value. However, green intellectual capital and carbon emissions disclosure do not significantly impact firm value. Moreover, while environmental performance moderates the relationship between green intellectual capital and green innovation and firm value, it does not moderate the relationship between carbon emissions disclosure and firm value.

Keywords: Green Intellectual Capital, Green Innovation, Carbon Emissions Disclosure, Firm Value, Environmental Performance

1. Introduction

Companies are generally established with the primary goal of generating as much profit as possible. This is driven by the desire to increase shareholder value and ensure the company's long-term survival. Every company will strive to enhance its productivity to compete in gaining market share and maximizing profits (Pristianingrum, 2017). Industry 5.0 offers significant opportunities for companies that can adapt and innovate. However, the challenges are also considerable. With the right strategy, companies can leverage these opportunities and remain competitive in this increasingly complex era. If a company cannot effectively compete with its rivals, this will likely significantly impact its financial performance. This situation, in addition to causing a decline in financial performance, also has the potential to create negative perceptions among other stakeholders. In this context, the company's primary focus should always be on strategies to enhance corporate value. Investors are more interested in investing in companies that have demonstrated exemplary performance in increasing corporate value. According to Utomo et al. (2022), corporate value is an important aspect in assessing a company's performance.

The rise and fall of a company's value can be measured by the price-to-book value (PBV) (Komarudin et al., 2019). The Price to Book Value can also determine whether the stock price offered by the company is considered expensive or cheap. PBV also indicates how well a company can create value relative to the capital invested. A higher PBV ratio can be interpreted as the company being more successful in creating shareholder value (Khasanah, 2019).

The phenomenon of the combined stock value of the energy sector listed on the Indonesia Stock Exchange mirrors the performance of the Indonesian economy, which experienced a decline in economic growth in 2023. Similarly, the stock value of the energy sector also declined. In 2022, the combined stock value reached 2,171.3 rupiahs; in 2023, it dropped to 2,106.35 rupiahs. In the effort to achieve the desired corporate performance, there is an urgent need for stakeholders to push companies to be more concerned about their surrounding environment, given the increasing negative impact of environmental damage. Corporate activities, which were initially measured solely by profit, are now beginning to shift towards considering social and environmental issues in their financial reports (Nofryanti, 2020).

Several environmental factors can influence corporate value, the first being Green Intellectual Capital. Green Intellectual Capital can help organizations achieve competitive advantage and improve their economic performance while reducing negative environmental impacts (Benevene et al., 2021). With the concept of Green Intellectual Capital, companies are expected to take more progressive steps in maintaining environmental sustainability while making this a supporting factor for their business growth (Imaningati & Vestari, 2016). In a study conducted by Tonay & Murwaningsari (2022), which examined the impact of Green Intellectual Capital on corporate value, the results showed that Green Intellectual Capital has a positive influence on corporate value. From these results, it is evident that Green Intellectual Capital plays a crucial role in guiding and driving companies and their employees to achieve their goals.

In addition to Green Intellectual Capital, Green Innovation also influences corporate value. As mentioned by Dewi and Rahmianingsih (2020), Green Innovation has a positive impact on corporate value. Green Innovation, or environmental innovation, aims to reduce negative environmental impacts through various efforts such as waste reduction, pollution prevention, and the implementation of environmental management systems. Research conducted by Putri Fabiola & Khusnah (2022) found that Green Innovation positively influences corporate value.

Besides Green Intellectual Capital and Green Innovation, Carbon Emission Disclosure also affects corporate value. Carbon emissions are a component of greenhouse gas emissions, which play a significant role in climate change (Amaliyah & Solikhah, 2019). Carbon Emission Disclosure, as part of sustainability reporting, is expected to provide positive signals and meet the information needs of investors, enabling companies to gain support from influential stakeholders, which affects the company's survival. Research by Rahmanita (2020) found that Carbon Emission Disclosure positively influences corporate value. These results indicate that stakeholders no longer consider profit as the sole business focus. Investors will consider investing if the company demonstrates good environmental responsibility.

This study uses environmental performance as a moderating variable to assess the impact of Green Intellectual Capital, Green Innovation, and Carbon Emission Disclosure on corporate value. Environmental performance can moderate because it serves as an international standard for environmental management systems (EMS) designed to help companies identify, prioritize, and manage environmental risks as part of their normal business practices. Research conducted by Hafidz & Deviyanti (2022) examined the impact of environmental performance on corporate value, showing that environmental performance influences corporate value. By implementing environmental performance management, companies are expected to maintain environmental balance in every stage of their business processes, including their activities, products, and services. This will

help achieve superior performance that not only benefits the company but also supports environmental preservation.

Based on the above discussion, the researcher is interested in exploring how environmental performance moderates the relationship between Green Intellectual Capital, Green Innovation, Carbon Emission Disclosure, and corporate value.

2. Theoretical Background

2.1 Signaling Theory

Signaling theory was first introduced by Spence as an effort to provide information that accurately describes issues to external parties willing to invest despite the absence of certainty. According to Brigham and Houston (2019), signaling theory is a theory that demonstrates the actions of company management to convey the company's prospects to investors. By receiving positive signals, investors and potential investors are more likely to be interested, perceiving that the company can manage its resources effectively. Furthermore, companies that implement sound strategies, focusing not only on profit-seeking but also on environmental sustainability, can attract the interest of investors concerned about environmental issues. This contributes to the company's positive image (Dewi & Rahmianingsih, 2020).

2.2 Resource Based View Theory

According to Wernerfelt (1984), the Resource-Based View (RBV) Theory refers to a collection of assets and skills possessed by a company. These assets and skills are considered highly valuable as they are key factors in creating a sustainable competitive advantage for the company. Based on this concept, Green Innovation can be interpreted as a corporate asset comprising innovations, both in products and adapted systems, which provide significant benefits in supporting environmental sustainability. Additionally, it serves as an effective strategy in helping companies achieve and maintain firm value, as explained (Rizki & Hartanti, 2021).

2.3 Stakeholder Theory

The theory formulated by Edward Freeman emphasizes the importance of companies providing benefits to various stakeholders, including the government, employees, shareholders, the community, customers, suppliers, and other parties, by offering relevant information about the company's activities. The information provided includes company activities that directly impact them, such as pollution, sponsorship programs, and safety initiatives (Ulum, 2017). According to Agustia et al. (2019), stakeholder theory can be applied by implementing green strategies to effectively portray the company's environmental performance, thereby enhancing corporate value by attracting investor interest in companies with strong environmental performance. Additionally, the role of regulators is crucial in determining the tolerance limits for carbon emissions and ensuring compliance with environmental regulations.

2.4 Firm Value

Firm value refers to the price that investors consider reasonable to pay for ownership of a company, based on the expectation of future profits. A high corporate valuation gives investors' confidence in the company's current performance and allows them to assess its potential for future growth (Ernita Sianturi, 2015). In this study, the author focuses on using the market price-to-book value (PBV) ratio as the primary indicator for evaluating

corporate value. According to Brigham & Houston (2019), the Price-to-Book Value (PBV) ratio is calculated by dividing the stock price by the book value per share

Corporate Value = Price per Share / Book Value per Share

2.5 Green Intellectual Capital

Green Intellectual Capital refers to the capacity, relationships, and other aspects of environmental protection and innovation, both at the individual and organizational levels within a company. Chen (2008) is recognized as a pioneer in the concept of Green Intellectual Capital. He integrated the concept of intellectual capital with environmental issues to describe forms of compensation or remedies arising from environmental problems. According to Fitri et al. (2022), Green Intellectual Capital can be described as a combination of individual capabilities and their understanding of the environment in which they operate to gain a competitive advantage. Green Intellectual Capital is a valuable, difficult-to-imitate, and rare intangible asset that can provide a competitive edge for a company. The measurement of the Green Intellectual Capital variable in this study is based on research conducted by Chang & Chen (2012), where the items to be disclosed consist of 5 items for Green Human Capital, 6 items for Green Structural Capital, and three items for Green Relational Capital. The formula is as follows:

GIC = (Number of Items Disclosed) / (14 Items (Total Items))

2.6 Green Innovation

Green innovation is one of the strategies companies use to achieve their strategic goals. This strategy involves using new or modified technologies, systems, practices, and production processes to reduce negative environmental impacts or prevent environmental damage. As defined by Chen et al. (2006), green innovation encompasses various types of innovation, both in hardware and software forms, that focus on products or processes supporting environmental sustainability. According to Putri Fabiola and Khusnah (2022), green innovation encourages companies to transform production waste into value-added products that can generate additional revenue. This study uses a measurement developed by Agustia et al. (2019), which includes four indicators: renewable technology, eco-friendly materials and packaging, and recyclable components or materials. The formula used is:

GI = (Number of Items Disclosed) / (6 Items (Total Items)

2.7 Carbon Emission Disclosure

Carbon emissions refer to releasing carbon-containing gases into the Earth's atmosphere due to the combustion of carbon-based materials (Borduas & Donahue, 2018). Carbon emission disclosure is one of the elements in the carbon accounting process, which involves companies measuring, recognizing, recording, presenting, and disclosing their carbon emissions (Irwhantoko & Basuki, 2016). Companies that provide more information on carbon emissions can minimize the negative impact on their corporate value. This is because carbon emission information helps investors understand the climate change risks faced by the company and make more informed investment decisions. However, capital expenditures can increase carbon emissions unless they are green investments (Karimi Takalo et al., 2021). In this study, Carbon Emission Disclosure is measured using a checklist developed by Choi et al. (2013), including several items across five climate change and carbon emissions categories. The formula used is:

CED = (Number of Items Disclosed) / (18 Items (Total Items))

2.8 Environmental performance

Environmental performance is the measurable result of an environmental management system related to controlling environmental aspects and assessing environmental performance based on environmental policies, objectives, and targets (ISO 14001). Environmental performance reflects an organization's achievements in optimizing its capabilities while reducing the negative impacts of its business operations on the environment (Adyaksana & Pronosokodewo, 2020). Environmental disclosure refers to information about environmental issues that affect a company's future activities, risks, and environmental policies (Gerged et al., 2021). In the environmental management system, ISO issues the ISO 14001 certification. This certification is an international environmental management system (EMS) standard designed to help companies identify, prioritize, and manage environmental risks as part of their standard business practices. According to Aprilasani (2017), the economic benefits of ISO 14001 EMS include improving overall environmental performance, providing a framework for pollution prevention efforts, enhancing efficiency and potential cost savings, and improving the company's image. In this study, environmental performance is measured using a dummy variable: if a company has obtained ISO 14001 certification, the value is 1, and if not, the value is 0 (Amanda Oktariyani & Rachmawati, 2021).

2.9 Hypothesis Formula

The variables that will be tested in this research will be developed in a conceptual framework which can be described as follows:

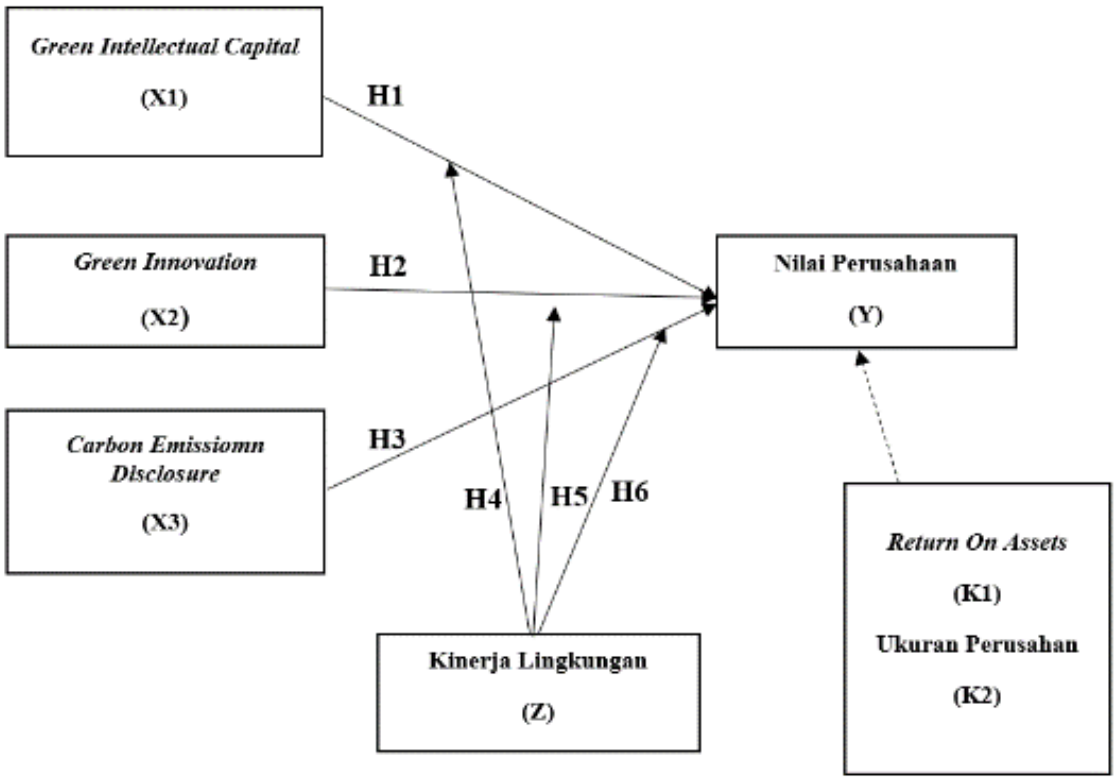

Figure 1. Conceptual Framework

H1: It is hypothesized that Green Intellectual Capital has an influence on corporate value.
H2: It is hypothesized that Green Innovation influences corporate value.

H3: It is hypothesized that Carbon Emission Disclosure has an influence on corporate value.
H4: It is hypothesized that Environmental Performance moderates the influence of Green Intellectual Capital on corporate value.
H5: It is hypothesized that Environmental Performance moderates the influence of Green Innovation on corporate value.
H6: It is hypothesized that Environmental Performance moderates the influence of Carbon Emission Disclosure on corporate value.

3. Methods

The type of data used in this study is secondary data, consisting of annual reports and sustainability reports from companies in the energy and transportation sectors listed on the Indonesia Stock Exchange (IDX) for 2021-2023. The data was obtained from www.idx.go.id and the official websites of each company. This study uses purposive sampling to determine the sample. The sample consists of 52 companies over 3 years, resulting in 156 observational data points. The criteria used for sample selection in this study are:

a. Companies in the energy and transportation sectors listed on the Indonesia Stock Exchange (IDX) for the 2021-2022.
b. Companies that have published complete Annual Reports and Sustainability Reports for the 2021-2023.

The collected data is then analyzed using descriptive statistics, panel data selection tests, moderation regression analysis, classical assumption tests (normality, multicollinearity, heteroscedasticity, and autocorrelation), and hypothesis testing (t-statistic test, f-statistic test, and coefficient of determination). Data analysis in this study will utilize computer technology, specifically Econometric Views (EViews) version 13.

The data in this study will be tested using two types of regression methods: multiple linear regression and Moderated Regression Analysis (MRA). The regression models used are as follows:

Multiple Regression Test:

$$Y = \alpha + \beta Xit1 + \beta X2it + \beta X3it + \beta X4it + \beta X5it + \varepsilon$$

Moderation Regression Analysis Test:

$$Y = \alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4\ X1*Z + \beta 5X2*Z + \beta 6X3*Z + e$$

Information:
Y: Company Value
α: Constant
β1 – β6: Regression Coefficient
X1: Green Intellectual Capital
X2: Green Innovation
X3: Carbon Emission Disclosure
Z: Environmental Performance

4. Results and Discussion

4.1 Descriptive Statistic

The description in this research includes 5 variables, namely Green Intellectual Capital, Green Innovation and Carbon Emission Disclosure on Company Value with Environmental Performance as a Moderating Variable in Energy and Transportation Sector Companies 2021-2023.

Table 1. Descriptive Statistics Test Results

	NP	GIC	GI	CED	ROA	UP	KL
Mean	1.6073	0.4080	0.4295	0.3568	0.1139	28.3960	0.6282
Median	0.9323	0.4286	0.5000	0.3889	0.0725	28.8830	1.0000
Maximum	32.6241	1.0000	0.7500	0.8889	0.7960	35.8448	1.0000
Minimum	-60.7928	0.0714	0.0000	0.0000	-0.6302	15.2147	0.0000
Std. Dev.	6.8616	0.1850	0.2355	0.2287	0.2109	3.2903	0.4848
Skewness	-3.3397	0.4650	-0.1554	0.2921	0.3864	-1.4626	-0.5306
Kurtosis	50.6693	3.0763	2.0823	2.2967	5.9532	6.9539	1.2815
Jarque-Bera	15060.31	5.6604	6.1023	5.4331	60.5728	157.2365	26.5151
Probability	0.0000	0.0590	0.0473	0.0661	0.0000	0.0000	0.0000
Sum	250.7393	63.6427	67.0000	55.6667	17.7672	4429.768	98.0000
Sum Sq. Dev.	7297.594	5.3062	8.5994	8.1052	6.8963	1678.076	36.43590
Observations	156	156	156	156	156	156	156

Source: Secondary data processed through EViews 13, 2025

The results of the descriptive statistical analysis are as follows:

a. The average value for the Corporate Value variable is 1.6073, indicating that the corporate value of companies in the energy and transportation sectors is relatively good. However, the standard deviation is 6.8616, more significant than the mean (6.8616 > 1.6073). This suggests that the data distribution is not very good, reflecting a disparity in corporate values. The maximum value is 32.6241, achieved by PT Transcoal Pacific Tbk in 2021, while the minimum is -60.7928. This negative value occurred due to a capital deficit, where liabilities exceeded assets at PT Capitalinc Investment Tbk in 2021.
b. The average value for the disclosure of the Green Intellectual Capital variable as a medium between companies and stakeholders regarding actions taken by companies as a form of their participation in environmental preservation and care (Setiawan et al., 2022). The disclosure of green intellectual capital has shown a figure of 0.4080 or 40.80%. This does not yet indicate optimal results, as it is still below 50%. However, this already shows a positive sign as there is an awareness of the importance of harmony between economic, social, and environmental aspects, thereby creating sustainable development (Suherman & Kurniawati, 2023). With a standard deviation value of 0.18502, the standard deviation value is smaller than the mean, which is 0.18502 < 0.4080. This means the data distribution is quite good. The maximum value is 1.0000, and the minimum value is 0.0714, indicating that no samples did not disclose Green Intellectual Capital.
c. The average value for the Green Innovation variable is 0.4295, indicating that this sector has also not yet shown optimal results in terms of Green Innovation. With a standard deviation value of 0.2355, which is smaller than the mean (0.4295), it means the data distribution is quite good. The maximum value is 0.7500, and the minimum value is 0.0000, indicating that there are companies that do not implement Green Innovation.
d. The average value for the Carbon Emission Disclosure variable is 0.3568 or 35.68%, indicating that the disclosure of Carbon Emission Disclosure is not yet optimal. With a standard deviation value of 0.2355, which is smaller than the mean (0.4295), it means the data distribution is quite good. The maximum value is 0.75000, and the minimum

value is 0.0000, indicating that there are companies that do not disclose the Carbon Emission Disclosure indicators.

e. The average value for the Return On Assets variable is 0.1139 or 11.39%, which means that the return on assets has a fairly good value because the research conducted by Suryaningsum, S., & Ayusulistyaningrum, D. (2024) concluded that the average ROA value of energy companies in Indonesia is 8.11%. The standard deviation value of 0.2109 is greater than the mean of 0.1139, which means that there is a poor data distribution or has a lot of data variants, this shows that the ROA data in this study contains extreme values. The maximum value of the ROA variable is 0.7960 and the minimum value is -0.6302, which was obtained by the company Garuda Indonesia (Persero) Tbk in 2021.
f. The average value of the firm size variable that has been transformed using Natural Logarithm is 28.3959. The Firm Size variable will be proxied by Firm Size = Ln (Total Assets) because the natural logarithm is intended to minimize data with excessive fluctuations. In addition, using natural logarithms is also intended to simplify the number of assets that may reach trillions of rupiah without changing the actual proportions (Siti Nuridah et al., 2023). The standard deviation value is 3.2903, and the data distribution is quite good because the standard deviation value is smaller than the mean value. The maximum value of the firm size variable is 35.8448, and the minimum value is 15.2147.
g. The average value of the environmental performance variable is 0.6282, which means that the average company that implements environmental performance with a proxy environmental management system with ISO 14001 certification is 62% of the total 52 samples, which means that many companies have implemented environmental management systems as many as 32 samples and 20 samples have not implemented environmental management systems. With a standard deviation value of 0.4848, this value is smaller than the mean, which is 0.62821, which means that the data distribution is quite good. The maximum value is 1.0000 and the minimum value is 0.0000.

4.2 Selection of Panel Data Model

Table 2. Conclusion of Panel Data Regression Model Testing

No.	Method	Testing	Result
1.	Uji Chow	Common Effect vs Fixed Effect	Fixed Effect
2.	Uji Hausman	Random Effect vs Fixed Effect	Fixed Effect

Source: Secondary data processed through EViews 13, 2025

After conducting the Chow and Hausman tests to determine the regression model between the Common Effect, Fixed Effect, and Random Effect models, the selected model is the Fixed Effect model.

After obtaining the regression model, the researcher wants to choose the best model, so the best model is selected according to the researcher. The researcher carries out the selection of the best model to determine between 2 models:

Table 3. Selection of the Best Model

	Variable Dependent: Nilai Perusahaan			
	Model 1		Model 2	
	Model 1	Model 1 (MRA)	Model 2	Model 2 (MRA)
Constant	106.1146	-18.21328	1.4325	75.1049

Control Variable				
ROA	-8.4220** (3.8150)	-12.6245** (3.7819)	-8.6718** (3.8389)	-12.6245** (3.7873)
UP	-3.753672 (2.4050)	-12.1093 (3.7819)		
Independent Variable				
GIC	-2.0528 (7.92273)	75.9634** (33.6539)	-2.9849 (7.9567)	83.6076** (33.4356)
GI	11.3492** (5.0224)	19.2936** (6.3322)	12.1556** (5.0315)	19.1038** (6.3677)
CED	-2.790901 (8.4874)	-2.0788 (11.3744)	-7.9602 (7.8704)	-6.3949 (11.0455)
KL		18.2404 (11.9129)		20.8707 (11.8438)
Moderation				
GIC_KL		-76.4807** (35.1240)		-85.5869** (34.7642)
GI_KL		-27.4038** (10.5705)		-26.4372** (10.6111)
CED_KL		12.9354 (13.2185)		12.8801 (13.2954)
Model Information				
Observation	156	156	156	156
Prob(F-Statistic)	0.0000	0.0000	0.0000	0.0000
Adjusted R2	0.4532	0.4453	0.5403	0.5350
F-Statistic	3.2939	3.2626	4.0367	4.0221

Source: Secondary data processed through EViews 13, 2025
Note: **p<0.05 and the numbers in parentheses represent the standard errors.
After testing, the researcher chose to use model 1 because this model was the best according to the researcher.

4.3 Classic Assumption Test

4.3.1 Normality Test

The normality test aims to test whether the regression model for confounding or residual variables has a normal distribution.

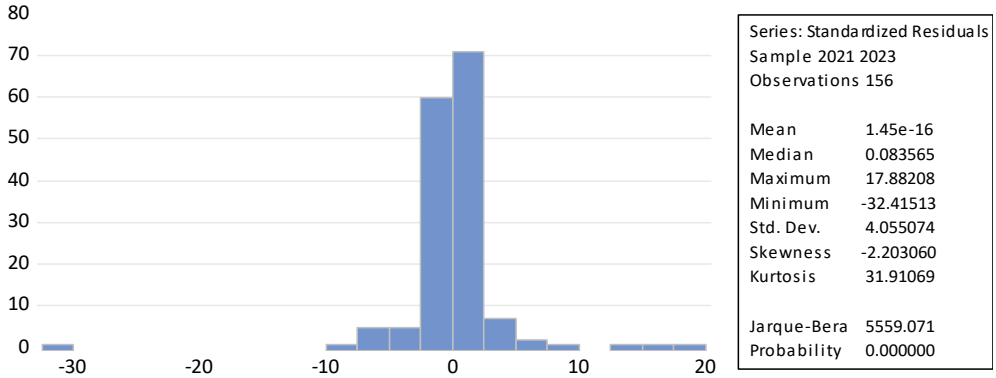

Figure 2. Normality Test
Source: Secondary data processed through EViews 13, 2025

Based on the histogram from the normality test above, it can be observed that the Jarque-Bera probability is greater than the significance value (0.0000 > 0.05). This indicates that the data in this study is not normally distributed. According to Gujarati (2012), the normality test is not a requirement for BLUE (Best Linear Unbiased Estimator), and some perspectives suggest that this condition is not mandatory. Santosa and Hidayat (2015) further explain that the normality test is essential for datasets with fewer than 50 or even fewer than 30 observations. However, for larger datasets, this normality test can be disregarded.

4.3.2 Multicollinearity Test

The multicollinearity test aims to determine whether the regression model exhibits a high correlation between the independent variables. If the correlation value exceeds 0.90, it is suspected that multicollinearity exists in the model.

Table 4. Multicollinearity Test

	GI	GIC	CED	ROA	UP
GI	1	0.5427	0.6215	0.2728	0.3084
GIC	0.5427	1	0.4652	0.1089	0.2409
CED	0.6215	0.4652	1	0.2175	0.4288
ROA	0.2728	0.1089	0.2175	1	0.0482
UP	0.3084	0.2409	0.4288	0.0482	1

Source: Secondary data processed through EViews 13, 2025

Based on the table above, it can be observed that the relationship between the independent variables—Green Intellectual Capital, Green Innovation, Carbon Emission Disclosure, Return on Assets, and company size—does not exhibit a high correlation value. The highest correlation is 0.6215, which is between Green Intellectual Capital and Carbon Emission Disclosure. Since 0.6215 is less than 0.90, it can be concluded that the model does not show signs of multicollinearity.

4.3.3 Heteroscedasticity Test

If the significance value is greater than 0.05, then the regression model does not exhibit heteroscedasticity. A good regression model is one that demonstrates homoscedasticity or the absence of heteroscedasticity.

Table 5. Heteroscedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
Null hypothesis: Homoskedasticity			
F-statistic	1.71982	Prob. F(5,150)	0.1333
Obs*R-squared	8.45821	Prob. Chi-Square(5)	0.1327
Scaled explained SS	204.1350	Prob. Chi-Square(5)	0.0000

Source: Secondary data processed through EViews 13, 2025

Based on the table above, the results of the Heteroscedasticity test can be seen that there is no heteroscedasticity problem. This is because the probability value is greater than 0.05.

4.3.4 Autocorrelation Test

One test that can be used to detect autocorrelation is the Breusch-Godfrey test, also known as the Lagrange Multiplier test. If the probability value is greater than α = 5%, there is no autocorrelation. Conversely, if the probability value is less than α = 5%, it indicates the presence of autocorrelation.

Table 6. Autocorrelation Test

Breusch-Godfrey Serial Correlation LM Test:			
Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	5.5930	Prob. F(2,148)	0.0045
Obs*R-squared	10.9621	Prob. Chi-Square(2)	0.0041

Source: Secondary data processed through EViews 13, 2025

Based on the results in the table above, it can be observed that the chi-square probability value is 0.0041, which is smaller than 0.05. This indicates that the regression model used in this study has an autocorrelation problem. According to Gujarati (2012), autocorrelation typically occurs in time series data. Testing for autocorrelation in non-time series data (such as cross-sectional or panel data) is unnecessary or meaningless.

4.4 Panel Data Regression Analysis

4.4.1 Multiple regression analysis

The Fixed Effects Model panel data regression results and the best model selected are shown in the following table:

Table 7. Multiple regression analysis

Variabel	Coefficient	Std. Error	t-Statistic	Prob.
C	106.1146	6.7169	1.5798	0.1173
GIC	-2.0528	7.9227	-0.2591	0.7961
GI	1.1349	5.0224	2.2597	0.0260
CED	-2.7909	8.4874	-0.3288	0.7430
ROE	-8.4220	3.8150	-2.2076	0.0296
UP	-3.7537	2.4050	-1.5607	0.1218

Source: Secondary data processed through Eviews 13, 2025

The regression equation is as follows:

$$Y = \alpha + \beta 1\, GIC + \beta 2\, GI + \beta 3\, CED + \beta 4\, ROE + \beta 5\, UP + \varepsilon$$

NP = 106.1146 - 2.0528 (GIC) + 1.1349 (GI) -2.7909 (CED) -8.4220 (ROA) -3.7537 (UP) e

1) Constant Value (α) = 106.1146. This means that if the value of all independent variables is equal to zero, then the Firm Value variable is equal to 106.1146.
2) The coefficient for the Green Intellectual Capital variable (X1) is -2.0528. This indicates that a one-unit increase in the Green Intellectual Capital disclosure index value will decrease Firm Value by 2.052844 units, measured as the stock price relative to the book value. The statistical test results show that the beta sign contradicts the proposed hypothesis, as Green Intellectual Capital has a negative effect on firm value.
3) The coefficient for the Green Innovation variable (X2) is 1.1349. This means that a one-unit increase in the Green Innovation disclosure index will significantly ($p < 0.05$) increase the firm value by 1.1349 units, measured as the stock price relative to the book value. The statistical test results show that the beta sign aligns with the proposed hypothesis, indicating that the Green Innovation variable significantly affects firm value. This finding is also theoretically consistent, as Green Innovation has a positive effect on firm value.
4) The coefficient for the Carbon Emissions Disclosure variable (X3) is -2.7909. This indicates that a one-unit increase in the Carbon Emissions Disclosure index will decrease Firm Value by 2.7909 units, measured as the stock price relative to the book value. The statistical test results show that the beta sign contradicts the proposed

hypothesis, as Carbon Emissions Disclosure has a negative effect on firm value.

5) The coefficient for the Return On Assets variable (X4) is -8.4220. This means that a one-unit increase in the Return On Assets variable will decrease Firm Value by 8.4220 units, measured as the stock price relative to the book value. Although this control variable, Return On Assets, affects firm value, the statistical test results show that the beta sign contradicts the proposed hypothesis, as Return On Assets has a negative effect on firm value.
6) The coefficient for the Firm Size variable (X4) is -3.7537. This indicates that a one-unit increase in the firm size variable will decrease Firm Value by 3.7537 units, measured as the stock price relative to the book value. The statistical test results show that the beta sign contradicts the proposed hypothesis, as firm size has a negative effect on firm value.

4.4.2 Moderated Regression Analysis

Moderated regression analysis is used to examine the influence of the independent variable on the dependent variable, as well as the moderating variable's ability to moderate the relationship between the independent and dependent variables.

Table 8 Moderated Regression Analysis

Variabel	Coefficient	Std. Error	t-Statistic	Prob.
C	75.1049	64.7451	1.1600	0.2489
GIC	75.9634	33.6539	2.2572	0.0262
GI	19.2936	6.3322	3.0469	0.0029
CED	-2.0788	11.3745	-0.1828	0.8553
ROA	-12.1093	3.7819	-3.2019	0.0018
UP	-3.2691	2.2446	-1.4564	0.1485
KL	18.2404	11.9130	1.5311	0.1290
GIC*KL	-76.4807	35.1240	-2.1775	0.0319
GI*KL	-27.4038	10.5705	-2.5925	0.0110
CED*KL	12.9354	13.2185	0.9786	0.3302

Source: Secondary data processed through EViews 13, 2025

$$Y = 75.1049 + 75.9634X1 + 19.2936X2 - 2.0788X3 - 12.1093K1 - 3.2691K2 + 18.2404M - 76.4807M*X1 - 27.4038M*X2 + 12.9354M*X3 + e$$

1) Constant Value (α) = 75.1049**.** This means that if the value of all independent variables is equal to zero, then the Firm Value variable is equal to 75.1049.
2) The coefficient for the interaction variable of Green Intellectual Capital (X1) with Environmental Performance (M) is -76.4807. This indicates that a one-unit increase in the interaction variable of Green Intellectual Capital (X1) with Environmental Performance (M) will significantly ($p < 0.05$) reduce the effect of Green Intellectual Capital on Firm Value by 76.4807 units, measured as the stock price relative to the book value. The statistical test results show that the beta sign contradicts the proposed hypothesis, as the interaction variable of Green Intellectual Capital (X1) with Environmental Performance has a negative effect on firm value.
3) The coefficient for the interaction variable of Green Innovation (X2) with Environmental Performance (M) is -27.4038. This means that a one-unit increase in the interaction variable of Green Innovation with Environmental Performance will significantly ($p < 0.05$) reduce the effect of Green Innovation on Firm Value by 27.4038 units, measured as the stock price relative to the book value. The statistical

test results show that the beta sign contradicts the proposed hypothesis, as the interaction variable of Green Innovation with Environmental Performance has a negative effect on firm value.

4) The coefficient for the interaction variable of Carbon Emissions Disclosure (X3) with Environmental Performance (M) is 12.9354. This indicates that a one-unit increase in the interaction variable of Carbon Emissions Disclosure with Environmental Performance will increase the effect of Carbon Emissions Disclosure on Firm Value by 12.9354 units, measured as the stock price relative to the book value. The statistical test results show that the beta sign aligns with the proposed hypothesis, as the interaction variable of Carbon Emissions Disclosure with Environmental Performance has a positive effect on firm value

4.5 Hypothesis Testing

Table 9. Coefficient of Determination

R-squared	0.6507	Mean dependent var	1.6073
Adjusted R-squared	0.4532	S.D. dependent var	6.8616

Source: Secondary data processed through EViews 13, 2025

Based on the output results above, the Adjusted R-squared value is 0.4532. This indicates that 45.32% of the Firm Value variable can be explained by the independent variables Green Intellectual Capital, Green Innovation, Carbon Emission Disclosure, Return On Assets, and Company Size while the remaining 54.68% is explained by other variables not examined in this study.

Table 10. F-test

F-statistic	3.2939	Durbin-Watson stat	2.2875
Prob(F-statistic)	0.0000		

Source: Secondary data processed through EViews 13, 2025

Based on the table above, the F-statistic is 3.2939 with a probability of 0.0000. The results show that the probability value is 0.0000, which is less than 0.05. This indicates that Green Intellectual Capital, Green Innovation, Carbon Emission Disclosure, Return On Assets, and Company Size collectively have a significant influence on firm value.

Table 11. T-test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	106.1146	6.7169	1.5798	0.1173
GIC	-2.0528	7.9227	-0.2591	0.7961
GI	1.1349	5.0224	2.2597	0.0260
CED	-2.7909	8.4874	-0.3288	0.7430
ROE	-8.4220	3.8150	-2.2076	0.0296
UP	-3.7537	2.4050	-1.5607	0.1218

Source: Secondary data processed through Eviews 13, 2025

1) The Effect of Green Intellectual Capital on Firm Value

The test results from the panel data regression analysis show a probability value greater than the significance level (0.7961 > 0.05). Therefore, H0 is accepted, and H1 is rejected. This leads to the conclusion that Green Intellectual Capital has no significant effect on Firm Value.

2) The Effect of Green Innovation on Firm Value.
   The test results from the panel data regression analysis show a probability value less than the significance level (0.0260 < 0.05). Therefore, H0 is rejected, and H2 is accepted. This leads to the conclusion that Green Innovation has a positive and significant effect on Firm Value.
3) The Effect of Carbon Emissions Disclosure on Firm Value.
   The test results from the panel data regression analysis show a probability value greater than the significance level (0.7430 > 0.05). Therefore, H0 is accepted, and H3 is rejected. This leads to the conclusion that Carbon Emissions Disclosure has no significant effect on Firm Value.
4) The Effect of Return On Assets on Firm Value.
   The test results from the panel data regression analysis show a probability value less than the significance level (0.0296 < 0.05). Therefore, H0 is rejected, and H7 is accepted. This leads to the conclusion that Return On Assets has a negative and significant effect on Firm Value.
5) The Effect of Firm Size on Firm Value.
   The test results from the panel data regression analysis show a probability value greater than the significance level (0.1218 > 0.05). Therefore, H0 is accepted, and H8 is rejected. This leads to the conclusion that Firm Size has no significant effect on Firm Value.

4.6 Discussion

The research results indicate that the Green Intellectual Capital (GIC) variable does not affect Firm Value. This is supported by the hypothesis test results, which show a probability value greater than the significance level (0.7961 > 0.05). These findings contradict the researcher's initial hypothesis, which was based on Signaling Theory. Signaling Theory assumes that companies use specific actions or signals to convey information to external parties, such as investors, about the company's quality or future prospects. In the context of GIC, companies that invest in green intellectual assets are expected to signal to the market that they are committed to sustainability and have strong long-term prospects. However, based on the descriptive statistical analysis, the average disclosure of Green Intellectual Capital is only 40.7%, with a median value of 0.40. Even if more GIC indicators are disclosed, it does not necessarily positively impact the company. If the disclosed indicators are not managed or utilized effectively, they may not influence the company's value, which in turn affects investors' decisions regarding stock investments. These findings align with research conducted by Septhiani & Machdar (2022), which also found that Green Intellectual Capital has no significant effect on firm value.

The results of this study indicate that the Green Innovation variable has a significant effect on Firm Value. This is evidenced by the probability value being smaller than the significance level (0.0260 < 0.05). These findings align with the Resource-Based View (RBV) Theory, which emphasizes the importance of unique and valuable resources owned by a company. According to this theory, resources that are rare, valuable, difficult to imitate, and irreplaceable are key to a company's long-term success. The study demonstrates that Green Innovation enhances firm value through the efficient use of raw materials and energy, the creation of new markets, the optimization of existing company shares, and the competitive advantages of its products. These results are consistent with

research conducted by Putri Fabiola & Khusnah (2022), which also found that Green Innovation has a positive effect on firm value.

The research results indicate that the Carbon Emission Disclosure variable does not affect Firm Value. This is supported by the hypothesis test results, which show a probability value greater than the significance level (0.7430 > 0.05). These findings contradict Stakeholder Theory, which posits that companies are accountable not only to shareholders but also to various other stakeholders, such as employees, customers, governments, and communities. Carbon emission disclosure is often seen as a company's effort to meet stakeholder expectations regarding environmental issues. However, this study reveals that not all investors place equal importance on environmental concerns. Some investors may prioritize short-term financial performance over long-term sustainability. As a result, whether or not a company discloses carbon emissions in its annual report does not significantly influence investor decisions or firm value. Additionally, carbon emission disclosure in Indonesia remains voluntary, and government regulations or policies related to carbon emissions have not been fully implemented by companies. These findings align with research conducted by Pratami & Aryati (2023).

The results of this study indicate that Environmental Performance is able to moderate the relationship between Green Intellectual Capital and Firm Value. This conclusion is based on the moderation regression analysis using the interaction test approach, which shows a probability value smaller than the significance level (0.0319 < 0.05). This demonstrates that Environmental Performance successfully acts as a moderating variable in the relationship between Green Intellectual Capital and Firm Value. The findings illustrate that Environmental Performance effectively moderates this relationship. As an international standard for environmental management systems (EMS), Environmental Performance helps companies identify, prioritize, and manage environmental risks as part of their regular business practices. ISO 14001, for instance, serves as a guideline for companies to implement sustainable and environmentally responsible practices, thereby enhancing their reputation among the public and stakeholders. This means that Environmental Performance plays a crucial role in the disclosure of Green Intellectual Capital by companies and can moderate the relationship between Green Intellectual Capital and Firm Value.

The results of this study indicate that Environmental Performance is able to moderate the relationship between Green Innovation and Firm Value. This conclusion is based on the moderation regression analysis using the interaction test approach, which shows a probability value smaller than the significance level (0.0110 < 0.05). This demonstrates that Environmental Performance successfully acts as a moderating variable that strengthens the relationship between Green Innovation and Firm Value, leading to the acceptance of the fourth hypothesis (H4). These findings illustrate that Environmental Performance effectively moderates the relationship between Green Innovation and Firm Value. With the implementation of strong environmental performance, companies can take strategic steps to adopt green innovations for environmentally friendly processes and products, as consumers increasingly prefer eco-friendly products (Husnaini & Tjahjadi, 2021). Given the growing consumer awareness of sustainability, companies in the energy and transportation sectors have significant opportunities to enhance firm value through green innovation. By developing environmentally friendly products and services, such as electric vehicles and solar panels, companies can attract environmentally conscious consumers. Additionally, companies can adopt cleaner and more efficient production

processes and collaborate with suppliers to build sustainable supply chains. Strong corporate policies and a commitment to sustainability are also crucial for the successful implementation of green innovation. Through green innovation, companies can not only reduce their environmental impact but also improve competitiveness, reputation, and long-term profitability. By integrating environmental performance and Green Innovation, mining and transportation companies can benefit from enhanced trust and reputation among investors and customers. Furthermore, local communities are less likely to be negatively affected by industrial activities, ensuring smoother operations and improved financial performance. This alignment of industrial activities with sustainability goals supports the long-term success of the company.

The results of this study indicate that Environmental Performance is unable to moderate the relationship between Carbon Emissions Disclosure and Firm Value. The moderation regression analysis, using the interaction test approach, reveals a probability value greater than the significance level (0.3302 > 0.05). This suggests that Environmental Performance does not successfully moderate the relationship between Carbon Emissions Disclosure and Firm Value. In other words, environmental performance, as an effort to preserve the environment, does not influence market value, and it cannot guarantee an increase in firm value. These findings are consistent with previous research conducted by Asnita (2019), which found that environmental performance does not affect firm value, and by Anggraeni (2015), which concluded that environmental performance cannot moderate the positive relationship between carbon emission disclosure and firm value. One possible explanation for these results is that not all investors prioritize environmental issues equally. Some investors may focus more on short-term financial performance rather than long-term sustainability. Additionally, environmental performance is challenging to measure accurately and comprehensively due to the variety of metrics used and the difficulty in comparing environmental performance across companies.

5. Conclusion

After analyzing the research data on how environmental performance moderates the relationship between green intellectual capital, green innovation, and carbon emission disclosure on the firm value of companies in the energy and transportation sectors listed on the Indonesia Stock Exchange during the 2021–2022 period, a sample of 52 companies was obtained. Below are the conclusions drawn from the research findings:

1) The regression results of this study indicate that Green Intellectual Capital does not affect firm value. This suggests that Green Intellectual Capital is not a strong signal for investors, and the disclosure of Green Intellectual Capital indicators does not necessarily benefit the company. Even if many indicators are disclosed, suboptimal management and utilization of these resources can prevent them from positively influencing the firm's value.
2) The regression results of this study show that Green Innovation has a positive effect on firm value. This implies that Green Innovation enhances firm value through the efficient use of raw materials and energy, the creation of new markets, the optimization of existing company resources, and the development of competitive advantages in products.
3) The regression results of this study reveal that Carbon Emissions Disclosure does not affect firm value. This indicates that some investors may prioritize short-term financial performance over long-term sustainability. Whether or not carbon emissions

are disclosed in the annual report does not significantly influence investor decisions, and thus, it does not impact firm value.

4) The regression results of this study demonstrate that Environmental Performance moderates the relationship between Green Intellectual Capital and firm value. This means that Environmental Performance serves as a guide for companies to adopt sustainable and environmentally responsible practices, helping to build a positive image and signal to the public and stakeholders.
5) The regression results of this study indicate that Environmental Performance moderates the relationship between Green Innovation and firm value. This suggests that with strong environmental performance, companies can strategically implement green innovations to develop environmentally friendly processes and products. Through green innovation, companies can not only reduce their negative environmental impact but also enhance their competitiveness, reputation, and long-term profitability.
6) The regression results of this study show that Environmental Performance does not moderate the relationship between Carbon Emission Disclosure and firm value. This implies that environmental performance, as an effort to preserve the environment, does not influence market value, and it cannot guarantee an increase in firm value. Not all investors prioritize environmental issues equally, as some may focus more on short-term financial performance rather than long-term sustainability.

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