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The missing link between Artificial Intelligence and green innovation: evidence from indonesian publicly listed firms

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A b s t r a c t

Digital transformation is driving companies to adopt Artificial Intelligence to increase efficiency while supporting environmental sustainability. This research is conducted to examine the influence of Artificial Intelligence on Green Innovation and test the role of Green Management Innovation as a moderating variable. The research adopts a quantitative approach based on secondary data collected from the firm's annual and sustainability reports for the 2020-2024 period, with a total sample of 100 observations selected using the purposive sampling method. The research utilized panel data regression through STATA software, applying Random Effects estimation and robust standard errors clustered, while incorporating moderation effect analysis and control variables including firm size, firm age, firm performance, and state-owned enterprise. The results of the study show that Artificial Intelligence does not have a significant effect on Green Innovation. On the other hand, there is a significant positive relationship between Green Management Innovation and Green Innovation. In addition, the results of the moderation test show that Nevertheless, the relationship between Artificial Intelligence and Green Management Innovation is not statistically significant, suggesting that there is a lack of empirical evidence to support that Green Management Innovation influences the connection between Artificial Intelligence and Green Innovation. These findings suggest that managerial capabilities play a more important role than technological capabilities in promoting Green Innovation among publicly listed companies in Indonesia. Therefore, companies are recommended to strengthen Green Management Innovation capabilities and integrate AI adoption with green management practices to support Green Innovation more effectively.

Introduction

As a major driver of technological transformation, artificial intelligence (AI) has changed business operations and accelerated industrial development. AI is applied in production, decision making, and business model innovation. (Babina et al., 2024) show that AI supports the development of intelligent, automated, and digitally enabled enterprises. More recent evidence also indicates that AI can affect firm outcomes through sustainability-oriented innovation, although these effects may depend on the type of green innovation adopted (Haryanto et al., 2026). By improving resource utilization, process automation, and data-driven decision-making, AI may reduce environmental impacts. However, the mechanisms through which AI contributes to green innovation, particularly in developing economies, remain insufficiently understood.

Therefore, companies need to implement an approach that is in line with the principles of sustainability and address the negative impact of the climate crisis through green innovation . GI is a timely and important strategy, as it is capable of creating novelty and increasing value for organizations and society by reducing negative impacts on the environment. GI is also very important to achieve sustainable development, especially in developing countries and create more and better quality job opportunities (H. Chen et al., 2025; Fazal-e-Hasan et al., 2023; Qin et al., 2026).

Although research on GI is growing rapidly in various countries, empirical results regarding the influence of AI on GI still show inconsistencies. Some studies have found positive influences, while others have shown that these influences are not significant or depend on the company's internal conditions and capabilities in managing and directing the technology. These inconsistencies indicate that additional studies are required to better understand the circumstances under which AI contributes to environmentally oriented innovation.

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In the Indonesian context, environmental problems are a serious concern. According to the Centre for Research on Energy and Clean Air (CREA, 2025), based on IQAir's 2024 World Air Quality Report, Indonesia is ranked as the 15th country with the highest PM2.5 levels in the world and the average concentration is about 7.1 times higher than the WHO's annual guidelines. This condition shows the urgency for companies in Indonesia to develop GI in response to increasing environmental pressures. Therefore, this study seeks to fill this gap by analyzing the influence of artificial intelligence on green innovation with green management innovation as a moderator variable, and considering company characteristics as a control variable in companies going public in Indonesia.

Green management innovation (GMI) is a managerial approach that focuses on organizational systems, policies, and practices oriented toward environmental sustainability. GMI provides a strategic pathway for low-carbon transformation by integrating sustainability principles into daily operations. It also reflects an organizational culture that emphasizes resource conservation and environmental protection (Haryanto, et al., 2026; Wang et al., 2025; Zhang & Zhu, 2025).

Previous research has largely focused on the direct link between Artificial Intelligence and Green Innovation. However, evidence regarding the role of Green Management Innovation in determining the effectiveness of Artificial Intelligence in supporting Green Innovation remains limited, especially in developing countries like Indonesia. Recent evidence from Indonesian firms also indicates that the effect of AI on firm outcomes can vary according to the type of green innovation adopted (Haryanto et al., 2026). Therefore, this study expands on the existing literature by investigating Green Management Innovation as a moderating variable in the relationship between Artificial Intelligence and Green Innovation. This study therefore integrates technological and managerial perspectives to examine AI and GI in a sustainability context.

Based on the research background and identified gap, the research questions are as follows: (1) Does Artificial Intelligence influence Green Innovation? (2) Does Green Management Innovation influence Green Innovation? and (3) Does Green Management Innovation moderate the relationship between Artificial Intelligence and Green Innovation?

Accordingly, this study aims to examine the effect of Artificial Intelligence on Green Innovation, investigate the influence of Green Management Innovation on Green Innovation, and analyze the moderating role of Green Management Innovation in the relationship between Artificial Intelligence and Green Innovation among publicly listed companies in Indonesia.

Literature Review

The Resource-Based View (RBV), introduced by (Barney, 1991) explains that a firm's competitive advantage derives from resources that are valuable, rare, difficult to imitate, and non-substitutable. In this study, AI and GMI are treated as strategic resources and organizational capabilities that may enable firms to develop green innovation. This perspective is consistent with evidence that organizational resources can support sustainability-related responsibilities and disclosure practices (Haryanto et al., 2025).

Meanwhile, to the Dynamic Capabilities theory, companies must be able to combine, develop, and reconfigure their internal and external competencies to cope with rapid environmental changes. This theory highlights the importance of dynamic ability to adapt new technologies and management strategies to create a sustainable competitive advantage. In this study, GMI serves as a form of dynamic capability that allows companies to effectively leverage AI to drive GI (Teece et al., 1997).

Green Innovation

Green innovation comes as a foundation for sustainable development, illustrating the importance of environmental management and economic vitality (Dzhunushalieva & Teuber, 2024). The transformative potential of GI has the capacity to stimulate economic growth while maintaining environmental sustainability, an idea that is increasingly supported by empirical evidence (Chavira et al., 2023).

Innovation has become a critical component in improving the competitiveness and success of organizations, particularly within complex business environments (Du et al., 2024). Furthermore, the importance of green technological innovation is underscored by the emergence of new technologies that facilitate organizational sustainability. Improving GI efficiency specifically focuses on transforming inputs into high-quality sustainable outputs. This is in line consistent with the wider framework of green development, which aims to maintain a balance between economic outcomes and environmental sustainability. Therefore, improving GI efficiency can be considered a key component of a company's green development strategy (Liu et al., 2025).

Hypothesis Development

The Influence of Artificial Intelligence on Green Innovation

Artificial Intelligence plays a role in encouraging green innovation (Miozza et al., 2026; Wei Tan, 2023; Zejjari & Benhayoun, 2024; Haryanto, 2026) through various mechanisms based on technological capabilities. First, AI allows companies to conduct predictive analytics to optimize energy use and improve the efficiency of production processes, thereby supporting green process innovation. Second, AI can optimize the supply chain through real-time demand analysis and inventory management, which has implications for waste reduction and reduced environmental impact. Third, AI also contributes to the development of environmentally friendly innovations through increasing production efficiency, reducing emissions, and optimizing the use of materials in the manufacturing process (Xue et al., 2025).

In addition (Fang et al., 2023), recent studies indicates that AI has a critical role in improving resource efficiency and decreasing waste generation through data-driven process optimization, which will ultimately drive the advancement of sustainable innovation. Thus, the use of AI not only increases operational efficiency, but also becomes a major driver in the development of green innovation at the company level.

H1: Artificial Intelligence has a significant positive effect on Green Innovation

The Influence of Green Management Innovation on Green Innovation

Green management innovation is a managerial approach that focuses on the implementation of organizational systems, policies and practices that are oriented towards environmental sustainability. Through GMI, companies can transform the way they manage resources, production processes, and decision-making to support the creation of more environmentally friendly innovations. Effective green managerial practices, such as the implementation of environmental management systems, sustainability-related employee training, and the integration of green policies in company strategies, are able to create an organizational culture that supports green innovation in a sustainable manner (Roh et al., 2022; S. Wang et al., 2022).

According to (Xie & Wang, 2024), GMI not only serves as an administrative policy, but also as a strategic driver that strengthens the company's ability to develop GI, such as product and process innovation oriented towards emission reduction and energy efficiency. The results reveal that the higher the level of green managerial innovation, the greater the company's ability to implement green innovation. According to the Dynamic Capabilities Theory, companies must have the ability to integrate, build, and reconfigure resources to respond to ever-changing environmental changes (Teece et al., 1997). In this case, GMI can be considered a form of dynamic capability that allows companies to turn their resources into products from GI.

H2: Green Management Innovation has a significant positive effect on Green Innovation

The Role of Green Management Innovation in Moderating the Influence of Artificial Intelligence on Green Innovation

Several studies show that the influence of Artificial Intelligence on environmental outcomes is influenced by managerial capabilities and organizational practices. However, the effectiveness of the application of AI in driving green innovation is greatly influenced by the extent to which companies have an adaptive and environmentally oriented management system (Al Halbusi et al., 2025).

Basically, AI is a technological capability that provides data analysis capabilities, process automation, and operational efficiency. However, if there are no environmentally oriented management policies and practices, the use of AI will focus more on cost efficiency than achieving sustainability goals. Therefore, GMI plays a crucial role in providing strategic direction for the use of AI to fit the company's environmental goals (Che et al., 2026).

According to GMI, companies are better able to integrate artificial intelligence into their green strategies, such as real-time emissions monitoring, data-driven energy efficiency, and more accurate environmental decision-making. Thus, the interaction between AI as a technological capability and GMI as a strategic direction determines the effectiveness of the company in producing GI (Y. Chen & Jin, 2023).

H3: Green Management Innovation moderates the influence of Artificial Intelligence on Green Innovation

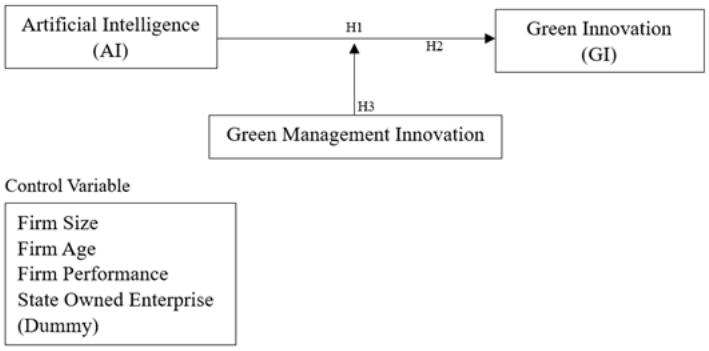


Figure 1. Conceptual framework

Research Methods

Table 1. Purposive Sampling

No	Criteria Applied	Total
1	Companies listed on the Indonesia Stock Exchange (IDX) at the beginning 2020–2024 study period.	713
2	Public companies publishing a standalone Sustainability Report in 2020 as the initial document-screening frame	121
3	Companies with annual and sustainability reports available for the 2020–2024 data collection and sufficient information to measure AI, GI, and GMI using keyword-based content analysis	20
4	Companies with complete data for all research variables and control variables	20
Total Sample Company		20
Research Period (years)		5
Number of Research Data Samples		100

The research utilized purposive sampling through a sequential screening procedure. The starting population included 713 firms that were listed on the Indonesia Stock Exchange (IDX) at the beginning of the 2020–2024 observation timeframe. For the initial document-screening framework, 121 public companies that released independent Sustainability Reports in 2020 were examined. The sample was then filtered according to the accessibility of annual and sustainability reports necessary for the 2020–2024 data gathering and the presence of adequate disclosures to assess Artificial Intelligence, Green Innovation, and Green Management Innovation through the established keyword-driven content analysis. Twenty companies satisfied these criteria and had comprehensive data for all research and control variables. Consequently, the ultimate sample comprised 20 companies, leading to 100 firm-year observations.

A total of 20 publicly listed companies met the predetermined sampling criteria and were included in the final sample. The profiles of the selected companies are presented in table 2.

Table 2. Profile of Selected Companies

No	Company Name	Code	Industry/Sector
1	PT Astra International Tbk	ASII	Industrials
2	PT Unilever Indonesia Tbk	UNVR	Consumer Non-Cyclicals
3	PT Semen Indonesia (Persero) Tbk	SMGR	Basic Materials
4	PT Indofood CBP Sukses Makmur Tbk	ICBP	Consumer Non-Cyclicals
5	PT Telkom Indonesia (Persero) Tbk	TLKM	Infrastructures
6	PT Pertamina Geothermal Energy Tbk	PGEO	Infrastructures
7	PT Mitra Pinasthika Mustika Tbk	MPMX	Consumer Cyclicals
8	PT Bank Central Asia Tbk	BBCA	Financials
9	PT Jasa Marga (Persero) Tbk	JSMR	Infrastructures
10	PT BFI Finance Indonesia Tbk	BFIN	Financials
11	PT Bank Mandiri (Persero) Tbk	BMRI	Financials
12	PT Bank Rakyat Indonesia (Persero) Tbk	BBRI	Financials
13	PT Bank Negara Indonesia (Persero) Tbk	BBNI	Financials

No	Company Name	Code	Industry/Sector
14	PT Golden Energy Mines Tbk	GEMS	Energy
15	PT Map Boga Adiperkasa Tbk	MAPB	Consumer Cyclicals
16	PT Salim Ivomas Pratama Tbk	SIMP	Consumer Non-Cyclicals
17	PT Wijaya Karya (Persero) Tbk	WIKA	Infrastructures
18	PT Adhi Karya (Persero) Tbk	ADHI	Infrastructures
19	PT Mayora Indah Tbk	MYOR	Consumer Non-Cyclicals
20	PT Resource Alam Indonesia Tbk	KKGI	Energy

The research was conducted from February to June 2026. This study adopts a quantitative method with a causal associative design to test the impact between variables through hypothesis testing. The quantitative approach was chosen because this study aims to measure the relationship between independent, moderate, and dependent variables by utilizing numerical data and objective statistical analysis (Creswell & Creswell, 2022; Sekaran & Bougie, 2022). The object of this study is 20 companies listed on the Indonesia Stock Exchange (IDX) that implement sustainability and technology practices. The research population included all Go Public companies that successively published annual reports and sustainability reports throughout the observation period. The selection of public companies as subjects is determined by their responsibilities in information disclosure, including disclosures regarding digital and environmental strategies (Haryanto et al., 2026; Violeta et al., 2025).

The research employs purposive sampling, a method in which samples are selected according to predetermined criteria in order to represent the purpose of the research. The criteria determined include: (1) Companies listed on the Indonesia Stock Exchange (IDX) during the 2020-2024 observation period, (2) Publishing annual reports and comprehensive sustainability reports, and (3) Disclosing information on environmentally friendly innovation activities and the application of artificial intelligence technology. In accordance with these criteria, 20 companies fulfilled all the sampling criteria and were selected as the final sample, resulting in 100 firm-year observations for the 2020-2024 observation period. The research examines the effect of Artificial Intelligence influences Green Innovation, the effect Green Management Innovation affects Green Innovation, and the moderation role of Green Management Innovation on the relationship between Artificial Intelligence and Green Innovation, while controlling for firm size, firm age, firm performance, and state-owned enterprise. Panel data regression was utilized to investigate these connections through STATA software, and model selection methods were implemented to identify the most appropriate panel estimator.

Table 3. List of Variables

		Variable Name	Size	Source
Variable Dependence	Green Innovation	GI	Ln (keyword frequency + 1)	((Ning et al., 2023)
Independent Variables	Artificial Intelligence	AI	Ln (keyword frequency + 1)	((Y. Chen & Jin, 2023)
Moderation Variables	Green Management Innovation	GMI	Ln (keyword frequency + 1)	(Y. S. Chen et al., 2006; Li, 2010; Loughran & Mcdonald, 2016; D. Zhang et al., 2019)
Variable Control	Firm Size	Size	Natural logarithm of total assets	(Haryanto, Hartono, et al., 2025)
	Firm Age	Age	Ln (observation year – establishment year)	(H. Chen et al., 2025)
	Firm Performance	Return on asset (ROA)	Net income/total assets	(Haryanto, Jennifer, et al., 2026)
	State Owned Enterprise	SOE	1 for state owned enterprises, 0 for others	(Y. Chen & Jin, 2023)

Therefore, in this study, keyword frequencies were obtained using content analysis of annual reports and sustainability reports (Suparman et al., 2025) to obtain the company's AI, GI, and GMI index.

Table 4. Keywords

Artificial Intelligence	Artificial intelligence, AI, Machine Learning, Deep Learning, Big Data, Data Analytics, Predictive Analytics, Automation, Algorithm, Intelligent Automation, Cloud Computing, Digital Transformation
Green Innovation	Green Innovation, Environmental Innovation, Sustainable Innovation, Green Technology, Low-carbon Innovation, Carbon Reduction, Renewable Energy, Energy Efficiency, Waste Reduction, Sustainable Product, Green Product Development
Green Management Innovation	Green Management Innovation, Environmental Management, Sustainable Management, ESG Management, Environmental Strategy, Sustainability Strategy, Green Supply Chain Management, Corporate Sustainability, Environmental Performance, ISO 14000

Validity and Reliability of Keyword-Based Measures

The validity of the keyword-oriented measures was established through content validity. The keyword dictionaries for Artificial Intelligence, Green Innovation, and Green Management Innovation were utilized and modified from previous studies and chosen based on their conceptual significance to each construct. Each keyword was aligned with the theoretical definition of the related variable to ensure consistency between the measurement indicators and the constructs being examined. Reliability was ensured by consistently utilizing the same predefined keyword dictionary, document-search method, and counting rule across all annual reports and sustainability reports for every company and observation year. The identical transformation method, ln(keyword frequency + 1), was consistently implemented on the AI, GI, and GMI metrics. Since the research utilized secondary-document content analysis instead of a multi-item questionnaire, internal-consistency metrics like Cronbach's alpha were not used.

The analysis of the data was conducted using STATA software. First, descriptive statistical analysis was conducted to outline the features of the research variables, including Green Innovation, Green Management Innovation, Artificial Intelligence, firm size, firm age, firm performance, and state-owned enterprise (SOE). Second, Pearson correlation analysis was conducted to examine the direction and strength of the relationships among the research variables. Third, a panel data regression analysis was used to examine the research hypotheses since the dataset includes repeated firm-year observations from 20 companies across the 2020–2024 period, resulting 100 firm-year observations. Two regression models were calculated. Model 1 investigated the direct impacts of Artificial Intelligence and Green Management Innovation on Green Innovation, whereas Model 2 incorporated the interaction term between Artificial Intelligence and Green Management Innovation to assess the moderating influence of Green Management Innovation. Control variables included firm size, firm age, firm performance, and state-owned enterprise.

Two regression models were employed. Model 1 was used to examine the direct effects of AI and GMI on GI, while Model 2 was used to examine the moderating effect of GMI on the relationship between AI and GI. The moderating effect was tested by including the interaction term between AI and GMI (AI x GMI) in the regression model Firm size, firm age, firm performance, and SOE status were included as control variables. Prior to estimating the regression models, the Variance Inflation Factor (VIF) was utilized to evaluate multicollinearity. To diminish unneeded multicollinearity in the moderation model, Artificial Intelligence (AI) and Green Management Innovation (GMI) were centered around their means prior to forming the interaction term (AI × GMI). The VIF values varied from 1.07 to 1.50, averaging at 1.30, suggesting no issues with multicollinearity. Heteroskedasticity was analyzed through the Breusch-Pagan/Cook-Weisberg test and White's test. The Breusch-Pagan test resulted in a p-value of 0.1579, suggesting no signs of heteroskedasticity, while White's test resulted in a p-value of 0.0179, suggesting the existence of heteroskedasticity. Consequently, the ultimate regression models were calculated using robust standard errors clustered by firm.

The Shapiro-Wilk test was utilized to assess residual normality. The test yielded a p-value of 0.3746, suggesting that the assumption of residual normality was upheld. Serial correlation was evaluated by examining the relationship between the regression residuals and their lagged values from the previous period. The outcome was not statistically significant ($r = 0.1731$; $p = 0.1246$), suggesting no strong evidence for first-order serial correlation. The selection of panel models occurred in three phases. Initially, the Chow/F test was employed to assess the pooled OLS model against the fixed-effects model. The test yielded a p-value of 0.0000, suggesting that the fixed-effects model was more suitable than pooled OLS. Secondly, the Breusch-Pagan Lagrange Multiplier (LM) test was utilized to evaluate pooled OLS against the random-effects model. The test resulted in a p-value of 0.0000, suggesting that the random-effects model was more suitable than pooled OLS. Ultimately, the Hausman test was performed to choose

between fixed-effects and random-effects models. The Hausman test resulted in a p-value of 0.5032; therefore, the random-effects model was chosen as the final estimation model. According to the outcomes of model selection and diagnostic tests, the final regression models were estimated using Random Effects regression with robust standard errors clustered by firm.

Model 1 examined the direct effects of Artificial Intelligence and Green Management Innovation on Green Innovation, while Model 2 incorporated the interaction term between Artificial Intelligence and Green Management Innovation to examine the moderating effect of Green Management Innovation.

The Wald chi-square test and the coefficient of determination (R^2) were used to assess model suitability. A model was deemed statistically significant when the Wald test yielded a p-value under 0.05. Hypothesis testing was performed relying on the estimated regression coefficients and their p-values, applying a 5% significance level as the main standard. Results that were significant only at the 10% level were viewed as marginal significance instead of being considered equivalent to significance at the 5% level.

To examine the effect of Artificial Intelligence on Green Innovation and the moderating role of Geen Management Innovation, the following multiple regression equations are used:

Model 1 (Direct Effect)

$$GI_i = \beta 0 + \beta_1 AI_i + \beta_2 GMI_i + \beta_3 SIZE_i + \beta_4 AGE_i + \beta_5 ROA_i + \beta_6 SOE_i + ui + \varepsilon i$$

Model 2 (Moderating Effect)

$$GI_i = \beta 0 + \beta_1 AI_i + \beta_2 GMI_i + \beta_3\ (AI \times GMI)_i + \beta_4 SIZE_i + \beta_5 AGE_i\ + \beta_6 ROA_i + \beta_7 SOE_i + ui + \varepsilon i$$

Where GI represents Green Innovation, AI represents Artificial Intelligence, GMI represents Green Management Innovation, SIZE represents company size, AGE represents company age, ROA represents company performance measured through return on assets, SOE represents state-owned enterprise status, where i denotes firm, t denotes year, u_i denotes the firm-specific random effect, and ε_it denotes the idiosyncratic error term and ε represents error term.

Results and Discussion

Based on the results of data processing in Table 5. Descriptive Statistics, the variables of this study show differences in characteristics among companies. The green innovation variable has an average value of 0.967 and a standard deviation of 0.831. This shows that the GI rate of companies going public in Indonesia is still moderate, with considerable variation. A minimum value of 0 indicates that the company has not done anything about the GI, while a maximum value of 3.584 indicates that the company is already doing it quite intensely.

With an average value of 2.136 and a standard deviation of 1.274, the AI variable shows that AI adoption by companies has not been evenly distributed. Furthermore, the GMI variable has an average of 3.976 and a standard deviation of 0.947. This suggests that most businesses have started to implement environmentally oriented management practices, although the level of implementation still varies.

Judging from the control variables, the average company size of 17,688 indicates that large-scale companies dominated the research sample. The average age of the company of 3,773 indicates that the company in the sample has been operating for a considerable period of time. Meanwhile, the ROA has an average value of 0.082, which indicates a relatively low to moderate level. The SOE variable has an average of 0.450, which indicates that about 45% of the sample are state-owned enterprises, and the rest are non-state-owned enterprises.

Table 5. Descriptive Statistics

Variable	Mean	Median	Std. Dev.	Minimum	Maximum
Dependent variable					
GI	0.967	1.099	0.831	0.000	3.584
Independent variable					
AI	2.136	2.079	1.274	0.000	4.905
Moderation variable					
GMI	3.976	3.818	0.947	2.079	6.142
Control variable					
SIZE	17.688	17.742	2.576	12.417	21.610
AGE	3.773	3.795	0.604	1.946	4.860

Variable	Mean	Median	Std. Dev.	Minimum	Maximum
ROA	0.082	0.037	0.155	-0.119	1.178
SOE	0.450	0.000	0.500	0.000	1.000

Source: Processed from research data (2026)

The correlation test in Table 6 is to show that the GMI variable has a positive correlation with GI. This shows that the higher the GMI level, the higher the company's GI level. Meanwhile, no significant association was found between the AI and GI variables. Therefore, the application of AI is not necessarily directly related to GI improvement.

The SOE variable showed a positive relationship with GI, suggesting that state-owned companies were more likely to do GI than non-state-owned companies. In contrast, there was no significant relationship between variables in the research model.

Correlation tests are usually used to determine the possibility of multicollinearity between independent variables. A not too high correlation value indicates that the relationship between independent variables is not strong, so it can be concluded that there is no indication of multicollinearity that can affect the results of the analysis (Hair et al., 2019).

Table 6. Correlation Test Results

	GI	GMI	AI	SIZE	AGE	ROA	SOE
GI	1.000						
GMI	0.460***	1.000					
	(0.000)						
AI	-0.009	0.209**	1.000				
	(0.931)	(0.037)					
SIZE	0.052	0.375***	0.197**	1.000			
	(0.610)	(0.000)	(0.049)				
AGE	0.032	0.281***	0.376***	0.234**	1.000		
	(0.752)	(0.005)	(0.000)	(0.019)			
ROA	-0.133	-0.123	-0.091	0.144	-0.078	1.000	
	(0.188)	(0.223)	(0.366)	(0.154)	(0.442)		
SOE	0.210**	0.418***	0.399***	0.148	0.237**	-0.312***	1.000
	(0.036)	(0.000)	(0.000)	(0.141)	(0.018)	(0.002)	

Table 7. Model Selection and Diagnostic Tests

Test	Result	Decision
Chow/F test	p = 0.0000	Fixed Effects preferred to pooled OLS
Breusch-Pagan LM test	p = 0.0000	Random Effects preferred to pooled OLS
Hausman test	p = 0.5032	Random Effects selected
VIF	Mean = 1.30; range 1.07 – 1.50	No multicollinearity problem
Breusch-Pagan heteroskedasticity	p = 0.1579	No heteroskedasticity detected
White test	p = 0.0179	Heteroskedasticity indicated
Shapiro-Wilk	p = 0.3746	Normality not rejected
Residual-lag correalation	r = 0.1731; p = 0.1246	No significant serial correlation

The regression results show that Green Innovation was not significantly influenced by Artificial Intelligence. This indicates that AI adoption has not yet translated into higher levels of GI among the sampled firms. In contrast, Green Management Innovation had a positive and significant effect on GI, suggesting that stronger environmentally oriented management practices are associated with greater green innovation.

The impact of Green Management Innovation as a moderator was analyzed using the interaction term between AI and GMI. The interaction coefficient is negative ($\beta = 0.038$) yet not statistically significant ($p > 0.05$). As a result, there is a lack of empirical evidence showing that GMI influences the connection between AI and Green Innovation. Accordingly, H3 is unsupported. Meanwhile, control

variables such as Firm Size, Firm Age, Firm Performance (ROA), and State-Owned Enterprise (SOE) did not show a significant influence on green innovation in the research model.

Table 8. Regression Test Results

	(1) GI	(2) GI
AI_c	0.027	0.031
	(0.079)	(0.074)
GMI_c	0.317***	0.322***
	(0.091)	(0.089)
SIZE	-0.030	-0.026
	(0.056)	(0.053)
AGE	-0.099	-0.105
	(0.241)	(0.240)
ROA	-0.212	-0.225
	(0.398)	(0.415)
SOE	0.101	0.092
	(0.293)	(0.291)
AIxGMI_c		-0.038
		(0.083)
_cons	1.837*	1.816*
	(1.002)	(0.998)
N	100.000	100.000
Within R2	0.158	0.158
Between R2	0.273	0.297
Overall R2	0.224	0.238

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The results show that AI has no significant impact on GI among Indonesian publicly listed companies. This finding differs from Haryanto et al. (2026) who report that the performance implications of AI depend on the type of green innovation adopted, and from studies that identify positive contributions of AI to sustainable and environmental innovation. A possible explanation is that AI implementation in Indonesian publicly listed companies remains focused primarily on operational efficiency, automation, and digital transformation rather than on environmental innovation goals.

As a result, the environmental benefits of AI have not yet been fully translated into green innovation outcomes. The RBV indicates that technological resources alone are insufficient to generate sustainable competitive advantage. The effectiveness of AI in generating GI may depend on collaborative capabilities, management commitment, and a sustainability-focused strategy. Thus, the insignificant result may indicate that many firms have not yet achieved the strategic alignment needed to translate AI investments into GI.

The results further indicate that GMI has a positive and significant impact on GI, supporting H2. This finding is consistent with Roh et al, (2022), S. Wang et al. (2022), Xie & Wang. 2024), Haryanto et al. (2025) who emphasize that environmentally focused management practices and organizational resources can support sustainability-related outcomes. The positive influence of GMI can be explained through Dynamic Capabilities Theory. Firms must be able to integrate, build, and reconfigure internal and external resources to respond effectively to environmental change (Teece et al., 1997).

In this study, GMI acts as a dynamic capability that enables organizations to transform existing resources into sustainability-focused innovations. Sustainable management practices provide strategic guidance, increase environmental awareness, and support the allocation of resources to environmentally friendly innovation projects. Consequently, companies with better environmental management capabilities are in a superior position to recognize sustainability opportunities and transform them into innovative solutions. These findings confirm that managerial skills play a vital role in determining an organization's success in achieving environmental sustainability.

The moderating effect of GMI on the relationship between AI and GI is not statistically significant; therefore, H3 is not supported. Although the interaction coefficient is negative, the effect is not statistically significant, suggesting that GMI does not meaningfully alter the relationship between AI and GI in the sampled firms. This result is comparable to Haryanto et al. (2026) who find that the moderating

role of green innovation is not uniform across its dimensions. AI and GMI may therefore contribute to GI through relatively independent mechanisms. A possible explanation is that AI adoption remains focused on operational efficiency, automation, data management, and digital transformation rather than on specific environmental innovation goals.

One possible explanation is that firms with sophisticated green management systems rely more on managerial policies, sustainability strategies, and organizational environmental practices than on sophisticated digital technologies to realize GI. As a result, environmental innovation may be more influenced by managerial and organizational mechanisms than by AI-based technological capabilities, making the additional contribution of AI less visible in companies with highly developed environmental management practices. These results contribute to the Resource-Based View and Dynamic Capabilities literature. This study specifically shows that technological resources such as AI do not directly generate GI. On the other hand, managerial capabilities reflected in GMI appear to have a greater influence in transforming organizational resources into sustainability-focused innovation outcomes.

Conclusion

This research examined the impact of AI on GI and evaluated the role of GMI as a moderating factor among publicly listed firms in Indonesia. The results indicate that AI did not have a statistically significant impact on GI. In contrast, GMI had a positive and significant effect on GI, indicating that sustainability-oriented management strategies are important for enhancing GI. However, no statistically significant evidence was found that GMI moderates the relationship between AI and GI.

This research has numerous constraints. Initially, the sample was confined to publicly traded companies in Indonesia, potentially restricting the applicability of the results to other industries or nations. Moreover, the assessment of AI, GMI, and GI depended on analyzing keyword frequency in annual and sustainability reports, which might not entirely reflect the true execution and impact of these practices in organizations. Consequently, upcoming studies should consider utilizing different measurement methods, like survey instruments, environmental performance metrics, or innovation measures based on patents. Moreover, subsequent studies might broaden the sample to incorporate private enterprises or firms from different nations to enhance the generalization of the results and offer more profound understanding of the connection between Artificial Intelligence and Green Innovation.

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