Advancing Sustainability Through Artificial Intelligence: Implications for Firm Value in Indonesia

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Abstract: This research seeks to explore the influence of AI adoption on ESG performance and further assess the mediation effect of ESG performance in the relation between AI adoption and firm value. The research was carried out from 2020 to 2023 on companies in Indonesia, yielding 288 observational data points. A multivariate analysis was performed utilising partial least squares structural equation modelling (PLS-SEM) to assess the hypothesis. The findings from hypothesis testing demonstrate that AI adoption has a significant favourable impact on ESG performance. Similarly, ESG performance significantly enhances firm value. Additionally, the indirect effects analysis reveals that ESG performance effectively mediates the positive relationship between AI adoption and firm value. AI enhances ESG performance by serving as a strategic resource, improving efficiency, and advancing sustainability to meet stakeholder expectations, further enhancing corporate value. This research encourages government support, managerial integration, and standardised policies for AI-driven business sustainability.
Keywords: Artificial Intelligence Adoption; ESG Performance; Firm Value.

Abstrak: Penelitian ini bermaksud untuk mengkaji dampak adopsi AI terhadap kinerja ESG dan menilai efek mediasi kinerja ESG dalam hubungan antara adopsi AI dengan nilai perusahaan. Penelitian ini dilakukan dari tahun 2020 hingga 2023 pada perusahaan-perusahaan di Indonesia, menghasilkan 288 data observasi. Analisis multivariat dilakukan dengan menerapkan pemodelan *Partial Least Square Structural Equation Modeling* (PLS-SEM) untuk menguji hipotesis. Hasil pengujian hipotesis membuktikan bahwa adopsi AI memiliki dampak positif yang signifikan pada kinerja ESG. Demikian pula, kinerja ESG secara signifikan meningkatkan nilai perusahaan. Selain itu, analisis pengaruh tidak langsung menunjukkan bahwa kinerja ESG secara efektif memediasi hubungan positif antara adopsi AI dan nilai perusahaan. AI meningkatkan kinerja ESG dengan berfungsi sebagai sumber daya strategis yang meningkatkan efisiensi dan menciptakan keberlanjutan untuk memenuhi harapan pemangku kepentingan, yang selanjutnya meningkatkan nilai perusahaan. Penelitian ini mendorong dukungan pemerintah, integrasi manajerial, dan kebijakan standar untuk mencapai keberlanjutan bisnis yang didukung oleh AI.
Kata Kunci: Adopsi Kecerdasan Buatan; Kinerja ESG; Nilai Perusahaan.

INTRODUCTION

As a corporate sustainability initiative, environmental, social, and governance (ESG) has grown in recent decades (Bagh et al., 2024). Global issues such as ecological change, employee well-being, and regulatory non-compliance are driving the application of ESG in accounting (Chams & García-Blandón, 2019). Surveys show that 88 per cent of International Business Council (IBC) members support the idea that universal ESG reporting can benefit companies, financial markets, and the economy (World Economic Forum, 2020). In addition, 77 per cent of global investors are interested in sustainable investing, with high returns being their priority for investing in companies with good ESG performance. Furthermore, over 70 per cent of investors believe strong ESG practices can

fulfil return expectations (Morgan Stanley Institute for Sustainable Investing, 2024). This phenomenon proves that ESG has become integral to a profitable business strategy.

Stakeholders are increasingly pushing companies to be more environmentally and socially responsible with comprehensive disclosure of ESG aspects (Veeravel et al., 2024), for example, through annual reports (AR) and sustainability reports (SR) (Papoutsi & Sodhi, 2020). Many countries and regulatory agencies now require transparency of ESG reports (Liu et al., 2022), including in Indonesia, after the issuance of the Financial Services Authority Regulation (POJK) No.51/POJK.03/2017, which regulates sustainability reporting obligations for the entities in financial services, issuers, and publicly traded companies. ESG has become a measurement tool for corporate sustainability performance (Aydoğmuş et al., 2022; Bissoondoyal-Bheenick et al., 2023) and corporate non-financial performance (Howard-Grenville, 2021). ESG integration can drive long-term value, meet investor expectations, and build a strategic edge (Olsen et al., 2021; Wu et al., 2023).

Nonetheless, ESG implementation is not without challenges. In practice, ESG initiatives in Indonesian companies are still considered low compared to Malaysia and Thailand (Nareswari et al., 2023). Companies face difficulties accurately measuring environmental and social impacts, coupled with cost pressures associated with ESG implementation at the pilot stage. However, as technology and markets evolve, barriers to ESG implementation can be minimised by applying digital solutions (Asif et al., 2023; Truant et al., 2023). Nowadays, technology can be a supporting resource in creating effectiveness and efficiency in business operations. Thus, companies can achieve their competitive advantage (Wamba-Taguimdje et al., 2020).

Artificial intelligence (AI) is already widely used to support human life aspects, including corporate business (J. Chen et al., 2024). AI adoption can increase labour productivity, create personalisation, save time, and improve quality. (PwC's, 2019) analysis projects that the rapid adoption of AI can enhance worldwide GDP by 14 per cent or around $15.700 trillion by 2030. In business sustainability, AI enables companies to analyse large amounts of data quickly and efficiently, offering more profound insights into company operations' social and environmental impacts. AI can be a revolutionary technology that helps companies significantly improve ESG performance (Sætra, 2023). AI contributes to tackling sustainability issues (Musleh Al-Sartawi et al., 2022) and overcoming challenges in ESG implementation (Truant et al., 2023).

In the environmental context, AI can be utilised to analyse weather data, helping to overcome the impacts of climate disruption caused by emissions of greenhouse gases (Cowls et al., 2023), reduce product waste (Hao & Demir, 2024), improve agricultural quality, water, and energy efficiency, as well as optimise the use of natural resources (Akter, 2024). In addition, AI plays a role in biodiversity conservation through ecosystem monitoring (Ayoola et al., 2024), demonstrating its potential to support sustainability and environmental responsibility. On the social aspect, AI enables companies to manage labour more fairly and inclusively and improve product safety and quality to ensure community welfare. Thus, AI can strengthen corporate social responsibility (P. Chen et al., 2024). In governance, AI is an effective tool to monitor and evaluate internal company policies, detect fraud (Rehman, 2022), speed up processes, reduce costs, select sustainable suppliers, initiate a circular economy, manage supply chain risks, share knowledge, and create synergies between demand and supply (Hao & Demir, 2024).

However, while AI has many great opportunities to support companies' business activities, its application in ESG analysis is still not a standard and standardised practice

(Minkkinen et al., 2024). This is due to delays in the implementation and restructuring process (Brynjolfsson et al., 2019). While AI-related research is plentiful, few studies have specifically examined the role of AI in improving ESG performance. Some scholars have tested the favourable effect of AI adoption on ESG performance, such as (Li et al., 2024), (R. Chen & Zhang, 2024), and (J. Chen et al., 2024), all of which were conducted in China. On the contrary, the AI application may make the ESG performance of the company poor due to the analysis of big data that may cause inaccuracies, incompleteness, inconsistency, or untimeliness (Khoruzhy et al., 2022). Additionally, contradictions related to moral and ethical values towards social aspects (Khoruzhy et al., 2022; Suárez Giri & Sánchez Chaparro, 2024). Therefore, if AI adoption is not implemented prudently, it could pose significant risks to the company. This situation has led to a significant gap in the effect of AI adoption on ESG performance.

On the other hand, stakeholders demand that companies enhance their ESG performance. This is directly related to efforts to generate positive company values (Ahmad et al., 2021; Wang et al., 2023). However, prior research offers mixed and often contradictory findings on the effect of ESG on firm value. Some studies indicate a favourable relationship (Ahmad et al., 2021; Aydoğmuş et al., 2022; Bissoondoyal-Bheenick et al., 2023; Tang et al., 2024; Wu et al., 2024), suggesting that adopting sustainability practices can boost a company's appeal to investors and strengthen stakeholder trust. Conversely, other studies report unfavourable effects (Byun, 2018; Mishra et al., 2024), arguing that implementing ESG initiatives imposes additional costs, potentially diminishing short-term profitability. Furthermore, several studies fail to find conclusive empirical evidence linking ESG practices to firm value, sparking ongoing debate about their relevance and effectiveness in enhancing corporate value (Atan et al., 2018).

Thus, this research seeks to overcome this gap by exploring the role of AI adoption on ESG performance and assessing the mediation effect of ESG performance in the relationship between AI adoption and firm value in Indonesia. This research offers significant benefits by addressing the lack of literature on how AI can enhance ESG performance, especially within the Indonesian context. The research results can guide stakeholders, including government, company managers, and regulators, by highlighting the potential of AI adoption in generating positive firm value through the more effective and efficient implementation of ESG practices.

THEORETICAL REVIEW

Stakeholder Theory. Introduced in 1984 by Freeman, stakeholder theory offers a comprehensive framework for perceiving organisational management and corporate business ethics. It emphasises the significance of companies integrating ethical and moral values into their decision-making procedures (El-Deeb et al., 2023; Freeman et al., 2018). Stakeholder theory integrates economic and public values in estimating firm value and considers fundamental moral and ethical aspects (El-Deeb et al., 2023).

Companies are expected to consider the demands and accommodate each stakeholder's aspirations without prejudice, e.g., requests to disclose important matters to assess the company's credibility (Burritt & Christ, 2023). Thus, companies must always fulfil stakeholders' expectations by maintaining sustainable performance (Veeravel et al., 2024). Therefore, a company's survival and success rely on managers' ability to ensure stakeholder satisfaction (Dakhli, 2022). One of the most important demands of

stakeholders is related to information transparency, which is crucial for them (Al Amosh & Mansor, 2021; Zamil et al., 2023). Corporate disclosure practices are closely related to stakeholder pressures and are considered one of the voluntary steps companies take to reinforce their alliances with stakeholders to run a sustainable business.

As expanded by Donaldson & Preston in 1995, the theory of stakeholders can be studied through three different perspectives, including normative, instrumental, and descriptive. Firstly, the normative perspective focuses on stakeholders' inherent values and rights, considering them the primary goal without considering their impact on the corporation's value. Secondly, the instrumental perspective highlights the contribution of stakeholders to corporate objectives, and their effective management can potentially result in improved strategic and financial outcomes. Lastly, the descriptive perspective recognises that the ESG factors realistically affect a company's operational and financial performance. (Rendtorff & Bonnafous-Boucher, 2023) emphasise that value creation through stakeholders is strategically oriented towards medium- to long-term survival and development. However, this approach requires companies to deal with non-shareholder agents that can limit access to resources, so strategies are needed to balance and fulfil the interests of various parties.

Stakeholder attention to ESG disclosure as a sustainable practice is closely linked to firm performance (Zhao et al., 2018). Despite the costs associated with social and environmental initiatives, stakeholder satisfaction can create long-run value by attracting investors and consumers. Managing good relationships with stakeholders can improve financial performance (Yoon & Chung, 2018), build a positive reputation, and strengthen trust, which ultimately sustainably increases profitability and firm value (Ikram et al., 2020; Korkmaz & Nur, 2023). Based on stakeholder theory, a company's contribution to stakeholders encourages investment commitment (Shah & Guild, 2022) while strengthening competitiveness and business continuity through harmonious relationships (Buallay, 2022; Freeman et al., 2018).

Resource-Based View Theory. Resource Based View (RBV) theory emphasises the importance of a firm's internal capacity and expertise in creating and maintaining business advantage (Barney, 2018; Barney et al., 2021). This theory believes essential resources determine company performance (Chatterjee et al., 2024). RBV theory suggests that a company can gain good performance and achieve a competitive edge by effectively leveraging its distinctive, valuable, inimitable, rare, and irreplaceable resources (Ghasemaghaei, 2021).

Artificial intelligence (AI) can be an essential resource that empowers firms to carve out a distinctive position in the competitive landscape (Mariani et al., 2023; Usai et al., 2021). Adopting AI in business brings the benefits of running operations more effectively and efficiently. AI as an intangible resource is increasingly important for firms to achieve business progress (Belhadi et al., 2024; Mikalef & Gupta, 2021) and bring business advantage (Chaudhuri et al., 2024).

RBV theory often explains the link between resources, capabilities, and firm performance (Barney, 2018; Barney et al., 2021; Y. Chen & Lin, 2021). In this context, AI can be considered an essential resource, while ESG practices represent a firm's capabilities in achieving and maintaining business sustainability. Using AI as an important resource is expected to improve the firm's capability to carry out sustainability or ESG practices, which ultimately has a favourable impact on increasing the firm's value as a performance indicator.

Artificial Intelligence. Artificial intelligence (AI) embraces a wide field of computational techniques capable of carrying out tasks that normally demand human intellectual capabilities (Y. S. Lee et al., 2022). AI is the ability of a system to understand, recognise, draw conclusions, and learn from data to achieve specific organisational and social goals (Mikalef & Gupta, 2021). Thus, AI technology uses algorithms and computational techniques to conduct activities that demand cognitive abilities, such as natural language processing, machine learning, and computer vision, to automate or accelerate decision-making and achieve organisational and societal goals.

AI and its technologies can fundamentally shape better business processes and organisational innovation (PwC, 2019; Sjödin et al., 2021). In addition, AI has played a crucial role in strengthening corporate competitiveness (J. Lee et al., 2019) by creating competitive advantage (Giustiziero et al., 2023) and corporate sustainability (Nishant et al., 2020). Implementing AI can significantly enhance productivity, customer experience, and decision-making, ultimately boosting company competitiveness (Gupta et al., 2020; Leszkiewicz et al., 2022). For instance, AI helps corporations analyse massive data sets to identify trends, optimise processes, and improve decision-making quality (Badmus et al., 2024). AI-based technologies can also enhance customer experience by providing personalised recommendations, automating repetitive tasks, and offering instant support (Nwachukwu & Affen, 2023). Specifically in sustainability practices, AI can be leveraged to simulate diverse ESG scenarios, allowing companies to visualise possible future outcomes and realign their strategies based on the results (Lim, 2024).

Environmental, Social, and Governance (ESG). ESG is a blueprint related to corporate sustainability performance. Sustainable practices arise against the backdrop of risks arising from each ESG pillar that impact profitability, success in achieving targets, and company survival (Noeth, 2024). The three aspects of ESG have gradually become the three key dimensions the international community considers when evaluating company sustainability (Tan & Zhu, 2022). The disclosure of ESG factors can serve as a measure for assessing and evaluating firm performance during operations and analysing the impacts that may arise from its operating activities (Hanggraeni, 2023).

The social responsibility index considers ESG to create competitive financial advantages and long-term social impact (Mohammad & Wasiuzzaman, 2021). ESG practices can also act as value-adding activities by creating value for the company, ultimately protecting all stakeholders' interests (Byun, 2018). Proactively managing ESG factors offers companies several advantages, such as strengthening ties with stakeholders, such as investors, clients, employees, and the broader community (Duan et al., 2023).

(Al-Shaer & Zaman, 2018) stated that sustainable development and sustainability reporting can make companies more transparent and accountable strategically and operationally. On the other hand, ESG reporting can increase public trust in companies and the industry. ESG theory has been approved as an attempt to redistribute - or in some cases, 'redistribute' - value from shareholders to employees, communities, and other priorities related to social and environmental (Morrison, 2021).

Firm Value. The firm value represents the total present value of all expected income generated throughout a business's operations. Essentially, it encompasses current and future benefits a company can produce, quantified through appropriate valuation methods and pricing models (Dang et al., 2020). (Irnawati, 2021) further elaborates that the firm market value, often represented by its stock market valuation, is significantly influenced by the investment practices prevalent in the capital market. These practices, shaped by

investor sentiment and economic trends, significantly impact how the market evaluates a company.

According to (Sukamdi, 2023), investors are willing to purchase a company at a specific price if it is highly valued and believed to offer substantial future returns. This perspective highlights the importance of a firm's internal operations, financial health, and external market conditions in determining its overall worth.

High firm value is also a signal of strong market confidence, extending beyond the company's current performance to encompass its prospects. As (Yuliusman & Putra, 2022) noted, a high valuation reflects positive perceptions of the company's existing operations and conveys optimism about its potential for growth and profitability. This underscores the critical interplay between market perceptions, investor behaviour, and firm performance in shaping a company's value.

Impact of AI Adoption on ESG Performance. ESG as a sustainability practice arises against the backdrop of risks caused by the three ESG elements that can harm the company's profitability, target achievement, and survival (Noeth, 2024). (Al-Shaer & Zaman, 2018) revealed that the disclosure of ESG initiatives makes companies seen as transparent and accountable regarding strategy and operations. This is based on stakeholder theory, which reveals that companies are expected to meet every stakeholder expectation (Al Amosh & Mansor, 2021; Burritt & Christ, 2023; Veeravel et al., 2024; Zamil et al., 2023), where ESG initiatives are one aspect that can meet these expectations.

Furthermore, from the viewpoint of RBV theory, AI as a strategic resource can strengthen a company's capability to implement ESG initiatives by visualising the potential future landscape and adjusting appropriate strategies based on the visualisation results (Lim, 2024). Companies that utilise AI in business processes, especially in carrying out ESG initiatives, may be able to increase competitiveness (J. Lee et al., 2019) by creating company competitiveness (Giustiziero et al., 2023) and corporate sustainability (Nishant et al., 2020). Thus, AI can improve the ESG evaluation process (Truant et al., 2023) through better resource management, including reducing waste and preventing potential losses due to regulatory non-compliance or poor reputation (PwC, 2019). This is supported by research in China, proving that AI adoption favours ESG performance (J. Chen et al., 2024; R. Chen & Zhang, 2024; Li et al., 2024).

H1: AI adoption has a favourable impact on ESG performance.

Impact of ESG Performance on Firm Value. Following stakeholder theory, companies committed to ESG practices receive excellent stakeholder support (Ikram et al., 2020; Korkmaz & Nur, 2023; Yoon & Chung, 2018). A commitment to ESG demonstrates the company's responsibility to create long-term value in line with stakeholder expectations (Hanggraeni, 2023; Rendtorff & Bonnafous-Boucher, 2023). Companies implementing sustainability policies through ESG initiatives have fulfilled society's ethical and moral values.

Companies with better ESG performance will be viewed positively by stakeholders, including investors in the market, which can further increase demand for shares at the stock price. When the share price rises, the company's market value will increase, which will amplify the firm's value. The results of previous studies support this statement by stating that good ESG performance will have a favourable effect on firm value, for example, the results of (Ahmad et al., 2021) in the UK, (Bissoondoyal-Bheenick et al.,

2023) in G20 countries, research by (Wu et al., 2024) in China, as well as study from (Aydoğmuş et al., 2022) and (Tang et al., 2024).

H2: ESG performance has a favourable impact on firm value.

Impact of AI Adoption on Firm Value Through ESG Performance. Grounded in stakeholder theory, the application of AI in business processes enables companies to fulfil stakeholder needs effectively, especially those related to transparency, accountability, and sustainability (Al Amosh & Mansor, 2021; Veeravel et al., 2024; Zamil et al., 2023). AI empowers companies to track and report ESG performance more precisely, strengthening positive relationships with investors, consumers, and society. Meanwhile, following the RBV theory, AI is a rare and valuable resource that strengthens a company's internal capabilities, such as the capability to analyse ESG data in real-time, which can ultimately strengthen both firm value and competitiveness (Barney, 2018; Barney et al., 2021; Chatterjee et al., 2024; Ghasemaghaei, 2021).

Several previous studies have suggested that AI adoption can favourably influence ESG performance (J. Chen et al., 2024; R. Chen & Zhang, 2024; Li et al., 2024). The AI application in business operations allows companies to effectively and efficiently carry out ESG activities using automation and big data. Conversely, good ESG performance will increase firm value (Ahmad et al., 2021; Bissoondoyal-Bheenick et al., 2023; Wu et al., 2024; Aydoğmuş et al., 2022; Tang et al., 2024). Enhanced ESG performance correlates with higher company value, which is influenced by the positive views of stakeholders. Thus, departing from these two conditions, it can be concluded that AI adoption has an indirect favourable impact on firm value through good ESG performance.

H3: ESG performance mediates the favourable impact of AI adoption on firm value

In line with the hypotheses outlined earlier, the conceptual model for this study is illustrated in **Figure 1**.
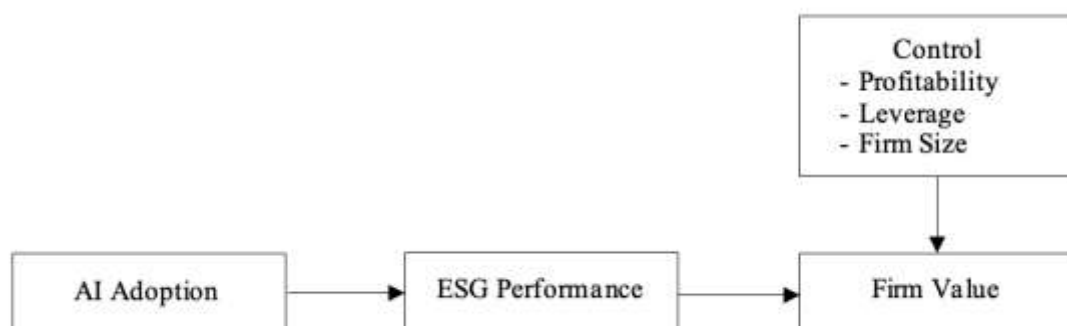
Figure 1. Reaserch Model

METHODS

This study focused on publicly traded companies in the Indonesia Stock Exchange (IDX) from 2020 to 2023. Companies that obtained ESG scores from Refinitiv during the research period were assigned to the sample using a purposive sampling technique. A total of 47 companies were designated as samples because they had obtained complete ESG

scores and were actively traded on the IDX consecutively during the study period. Thus, the total observation data for this research is 288 data.

The main research variables in this research include AI adoption, ESG performance, and firm value, as presented in **Table 1**. Alongside the primary variables, this research incorporates some control variables to account for the effect of independent on the dependent variable. The control variables include profitability, proxied by return on assets (ROA); leverage, measured by the debt ratio (DR); and firm size, represented by the natural logarithm of total assets (LN_Assets).

This research applies the variance-based Partial Least Squares Structural Equation Modeling (PLS-SEM) approach owing to its proficiency in simultaneously analysing causal correlation among latent constructs while addressing potential measurement errors within structural models (Hair, Black et al., 2019; Hair et al., 2022). In addition, since this research is explanatory, PLS-SEM is considered the most suitable method (Hair, Risher, et al., 2019). Drawing from the protocols from (Hair et al., 2022), the measurement model evaluation is conducted separately to ensure data quality and structural model consistency. This evaluation includes scale property analysis to ensure convergent validity, discriminant validity, and reliability of the measurement model using Smart PLS.

Robustness tests were conducted by replacing each research variable with an alternative indicator. A robustness test aims to confirm that the outcomes of a study or model remain stable across different conditions or assumptions. The AI adoption variable uses the AI_Text indicator, an indicator calculation based on the number of keywords with the formula of natural logarithm one plus the count of AI keywords (Li et al., 2024). Then, ESG performance still uses the ESG Score from Refinitiv but is simplified with natural logarithms. Furthermore, the firm value indicator is replaced with total enterprise value (TEV) (Habib, 2023). Meanwhile, profitability is replaced with return on equity (ROE), leverage is replaced with debt to assets ratio (DAR), and company size uses the binary variable when the asset value is more than $10 million; it is given the number 1, and if below that, it is given the number 0.

Table 1. Research Variables

Variables	Definition	Indicators	Reference
AI adoption	The state in which the company has implemented AI in its business operation activities	Binary variable (AI_Dummy), value one is given if the company has adopted AI in a particular year and the following year, zero if it has not adopted AI.	(Li et al., 2024), (Y. S. Lee et al., 2022), (Rahman et al., 2024), and (Czarnitzki et al., 2023).
ESG performance	The company's sustainability performance is gauged using three primary pillars: environmental, social, and governance.	Refinitiv ESG Score (ESG_Score)	(Apergis et al., 2022), (Bissoondoyal-Bheenick et al., 2023), and (Aydoğmuş et al., 2022)
Firm value	The market's perception of a firm's economic value reflects its financial performance, business prospects, and reputation among its stakeholders.	- Tobin's Q (TQ) = (Market capitalisation+total liabilities)/total assets	(Bissoondoyal-Bheenick et al., 2023), (Tang et al., 2024), and (Wu et al., 2024)
		- Price to book value (PBV) = Market price	(Khalifaturofi'ah & Setiawan, 2024)

Variables	Definition	Indicators	Reference
		per share/Book value per share	

RESULTS

Descriptive Statistics. The descriptive statistics in **Table 2** show significant variation in the variables under study.

Table 2. Descriptive Statistics

Variables	N	Mean	Median	Min	Max	Std. Deviation
AI_Dummy	188	0.436	0.000	0.000	1.000	0.496
ESG_Score	188	53.980	54.597	15.881	88.731	19.395
PBV	188	3.893	1.544	-0.926	146.333	12.292
TQ	188	1.602	1.145	0.308	14.647	1.621
ROA	188	0.062	0.045	-0.171	0.455	0.076
DR	188	0.231	0.194	0.000	0.716	0.194
LN_Assets	188	8.451	8.343	5.915	11.858	1.326

Source: processed output from SmartPLS 4 (2024)

For the AI adoption variable, the mean value of 0.436 indicates that about 44 per cent of companies have adopted AI. In contrast, the median value is 0.000, indicating that most companies have not adopted AI. ESG performance scores have a mean of 53.980 and an almost equal median, reflecting a relatively symmetrical distribution, although there is a wide range from very low (15.881) to high (88.731) ESG scores. PBV values show a mean value of 3.893, with an extensive range from -0.926 to 146.333, reflecting the presence of companies with very low and very high market valuations. The mean value of TQ is 1.602, showing that most companies are already valued higher than their replacement cost. However, there is considerable variation from the lower of 0.308 to the higher of 14.647.

Table 3. Validity and Reliability

Construct	Item	Loading Factor	α	CR	AVE
AI adoption	AI_Dummy	1.000	1.000	1.000	1.000
ESG performance	ESG_Score	1.000	1.000	1.000	1.000
Firm value	PBV	0.823	0.664	0.854	0.745
	TQ	0.902			
Profitability	ROA	1.000	1.000	1.000	1.000
Leverage	DR	1.000	1.000	1.000	1.000
Firm size	LN_Assets	1.000	1.000	1.000	1.000

Source: processed output from SmartPLS 4 (2024)

Measurement Model. Assessing the reflective measurement model is fundamental for evaluating the validity and reliability of the measured constructs (Hair et al., 2022). The validity and reliability of the model are determined by examining key indicators, including Cronbach's alpha (α), composite reliability (CR), and average variance extracted (AVE), as outlined in **Table 3**. In this study, Cronbach's alpha values of all variables

surpass the recommended 0.600 threshold, which is considered an acceptable level of internal consistency (Sugiyono, 2022). Furthermore, each variable's composite reliability (CR) values also surpass the preferred standard of 0.700, demonstrating strong reliability and internal consistency within the model (Hair et al., 2022).

Table 4. Discriminant Validity

	AI Adoption	ESG Performance	Firm Value	Profitability	Leverage	Size
AI adoption	1.000					
ESG performance	0.240	1.000				
Firm value	0.089	0.099	0.863			
Profitability	-0.013	0.175	0.513	1.000		
Leverage	-0.138	-0.371	-0.009	-0.354	1.000	
Size	0.307	0.403	-0.298	-0.304	-0.053	1.000

Source: processed output from SmartPLS 4 (2024)

The AVE and loading factor values are utilised to assess the reflective constructs' convergent validity and respective dimensions. Convergent validity is confirmed when the value of the AVE for each construct goes beyond the suggested benchmark of 0.500 (Hair et al., 2022). In the present study, all AVE values have exceeded the suggested threshold, demonstrating that the reflective constructs correlate well with their indicators. Additionally, the factor loading for each indicator item is greater than 0.700, which is in line with the recommendations of (Hair et al., 2022), further confirming the measurement model quality. These results demonstrate that this research's reflective constructs and dimensions are valid and reliable, ensuring the measurement model is strong and appropriate for subsequent analysis.

Discriminant validity aims to evaluate whether indicators can be sufficient to distinguish from other indicators. The value is obtained from the square root of the AVE of each variable, where each value must exceed the inter-construct correlation. In this present study, the square root of the AVE for each construct exceeds the correlations between constructs (**Table 4**). This demonstrates that each construct is distinct and measures a unique aspect of the conceptual framework, satisfying the criteria for discriminant validity.

Furthermore, the Goodness of Fit (GoF) test is employed to gauge the overall quality and sufficiency of the proposed research model. The GoF test assesses how well the model fits the measured data by considering the measurement and structural components. The GoF value is computed based on the AVE's geometric mean and the dependent variable's average R-squared. This combined measure thoroughly evaluates the explanatory model power and its construct validity. A GoF value below 0.250 indicates a model with a trim fit, suggesting limited explanatory power. A value between 0.250 and 0.360 represents a model with a medium fit, demonstrating moderate adequacy. Finally, a GoF value exceeding 0.360 indicates a high fit, signifying strong explanatory power and alignment with the data. GOF value can be computed using the following formulation:

$$GOF = \sqrt{AVE \times R_{square}} \quad \text{...} \quad (1)$$

$$GOF = \sqrt{0.958 \times 0.195} \quad \text{..} \quad (2)$$

$$GOF = 0.432 \quad \text{..} \quad (3)$$

The value of GoF for this research model is calculated to be 0.432. This value surpasses the threshold for a strong fit, indicating that the model demonstrates an excellent overall goodness of fit. Given the high GoF value, the research model may achieve a robust balance between the measurement and structural components. This result validates the reliability and consistency of the constructs and their interrelationships, acknowledging the model's suitability for further interpretation and hypothesis testing.
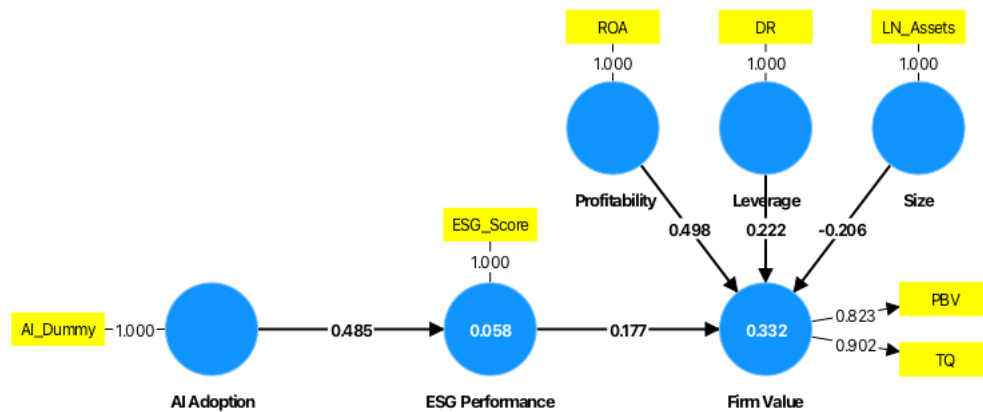

Figure 2. SEM analysis
Source: processed output from SmartPLS 4 (2024)

Structural Model. Before examining the hypotheses, this study assessed multicollinearity by evaluating the variance inflation factor (VIF) value. To avoid general method bias, the recommended VIF value should be below 3 (Hair et al., 2022). In this study, the VIF value for each variable is below the recommended value, suggesting that the model does not suffer from multicollinearity issues. SEM analysis is visualised in **Figure 2**.

Table 5. Direct Effect Analysis

Direct Effect	Path coefficients	t-statistic	p-values
AI adoption → ESG performance	0.485***	3.407	0.000
ESG performance → Firm value	0.177***	2.919	0.002
Profitability → Firm value	0.498***	4.646	0.000
Leverage → Firm value	0.222***	4.182	0.000
Size → Firm value	-0.206***	2.948	0.002

Notes ***, **, and * denote significance levels of less than 0.010, 0.050, and 0.100, respectively.
Source: processed output from SmartPLS 4 (2024)

Furthermore, hypothesis testing was performed by running the bootstrapping technique. The path coefficient values between constructs were measured to test the hypotheses. All hypothesised path coefficients are statistically significant, and H_1 and H_2 are supported by the test results, as presented in **Table 5**. The first hypothesis argues that AI adoption favourably impacts ESG performance is accepted (β equal to 0.485; t equal to 3.407; p less than 0.010). Likewise, the second hypothesis proposes that ESG performance favourably impacts firm value and is accepted (β equal to 0.177; t equal to 2.919; p less

than 0.010). The R-squared values for ESG performance and firm value are 0.058 and 0.332, respectively. Meanwhile, the control variables (profitability, leverage, and firm size) were found to have significant statistics.

Table 6 outlines the findings from the indirect effect test, where ESG performance is analysed as a mediator linking AI adoption and firm value. Based on the test results, the indirect effect of AI adoption on firm value through ESG performance confirms a statistically significant result (β equal to 0.086; t equal to 2.013; p less than 0.022). Thus, H3 is supported.

Table 6. Indirect Effect Analysis

Direct Effect	Path coefficients	t-statistic	p-values
AI adoption → ESG performance → Firm value	0.086**	2.013	0.022

Notes ***, **, and * denote significance levels of less than 0.010, 0.050, and 0.100, respectively.
Source: processed output from SmartPLS 4 (2024)

Robustness Test. To verify the strength of the results obtained from the primary model, this research performed a thorough robustness test by replacing each research variable with alternative indicators theoretically linked to the original variables in the model. This approach was designed to determine whether the findings would remain stable even when different measurements or representations of the variables were used. After conducting this test, the study found that the direct and indirect effects hypothesised in the model were remarkably consistent, even with the use of alternative indicators, as evidenced in the results presented in **Table 7**. This consistency in the outcomes suggests that the relationships outlined in the model hold across various operationalisations of the variables. Therefore, the robustness test indicates that the conclusions drawn from the study remain unaffected by changes in the indicators of the research variables. The findings confirm that the initial conclusions are robust and resilient to variations in the measurement approach.

Table 7. Robustness Test

Direct Effect	Path coefficients	t-statistic	p-values
AI adoption → ESG performance	0.212***	2.808	0.003
ESG performance → Firm value	0.050***	2.570	0.005
Profitability → Firm value	-0.056*	1.483	0.069
Leverage → Firm value	0.130***	4.814	0.000
Size → Firm value	2.207***	9.865	0.000
Indirect Effect			
AI adoption → ESG performance → Firm value	0.011**	1.934	0.027

Notes ***, **, and * denote significance levels of less than 0.010, 0.050, and 0.100, respectively.
Source: processed output from SmartPLS 4 (2024)

DISCUSSION

Impact of AI Adoption on ESG Performance. This study reveals that adopting artificial intelligence has a considerable and positive effect on firms' ESG performance. This finding provides strong empirical support for the literature by highlighting the need to harness AI as a strategic advantage to enhance a firm's internal capabilities and overall competitive advantage. AI technologies empower firms to optimise various business processes, such as streamlining operations, visualising future strategic landscapes, and adjusting sustainability strategies more precisely (Lim, 2024). This ability to forecast and adapt to changing environmental, social, and governance dynamics enables firms to stay ahead of industry trends, manage risks more effectively, and align their operations with evolving stakeholder expectations.

Additionally, AI efficiently manages vast amounts of ESG data, ensuring companies can better track, analyse, and report on their sustainability efforts (Truant et al., 2023). AI helps firms reduce waste, improve resource allocation, and boost operational efficiency through enhanced data management, contributing to more sustainable business practices. As a result, improving a company's sustainability performance through AI adoption enhances its operational efficiency and helps strengthen ties with stakeholders, thereby increasing their satisfaction and trust. This is particularly significant in the current business landscape, where stakeholders pay greater attention to how companies manage ESG issues. The positive outcomes observed in this study are consistent with the tenets of stakeholder theory, highlighting the critical need for companies to meet the expectations of a wide range of stakeholders, including investors, customers, and the wider community.

Furthermore, these findings align with recent research, such as the studies by (J. Chen et al., 2024), (R. Chen & Zhang, 2024), and (Li et al., 2024) demonstrate that companies adopting AI can more efficiently evaluate their ESG performance, mitigate non-compliance risks, and enhance their reputation. The consistency of these results across multiple studies reinforces the idea that AI adoption is a key catalyst in improving corporate sustainability, further solidifying AI's role as an essential driver of long-term success in ESG performance. This study confirms that AI is a critical technological advancement factor in attaining sustainable business practices and creating long-term value.

Impact of ESG Performance on Firm Value. This study also supports the second hypothesis, which posits that good ESG performance favourably impacts firm value. Considering the principles of stakeholder theory, companies that demonstrate strong ESG practices are viewed as more transparent, responsible, and accountable, which enhances their image among stakeholders. When a company is perceived as aligning its operations with social, environmental, and governance concerns, it fosters greater trust and confidence from investors and the public (Buallay, 2022; Freeman et al., 2018; Shah & Guild, 2022). This heightened trust is reflected in an increase in stock demand, which, in turn, drives up stock prices and the total market value of the firm.

This result concurs with the argument that greater ESG performance serves as a signal of the company's long-run sustainability and socially responsible practices, factors that investors and other key stakeholders increasingly value. This finding corroborates earlier investigations, including studies by (Ahmad et al., 2021), (Bissoondoyal-Bheenick et al., 2023), (Wu et al., 2024), (Aydoğmuş et al., 2022), and (Tang et al., 2024), which all suggest that businesses with robust ESG performance generally experience a significant

increase in their market value. This further validates the argument that ESG initiatives meet ethical and social responsibilities and yield concrete financial gains.

Moreover, the study confirms that a company's commitment to ESG is vital for building strong and long-term relationships with stakeholders, fostering excellent financial stability, and strengthening its competitive position in the global market. Companies prioritising ESG factors are more prepared to achieve sustainable financial success and long-term growth in a world that is becoming more globalised and socially aware. This research points out the critical role of ESG performance in promoting corporate reputation and financial outcomes, establishing it as a major contributor to a firm's value and global competitiveness.

The Impact of AI Adoption on Firm Value Through ESG Performance. The third hypothesis posits that ESG performance is a beneficial mediator in the relationship between AI adoption and firm value. This research finding provides compelling evidence that AI not only directly enhances ESG performance but also enhances firm value indirectly by strengthening ESG practices. This finding supports stakeholder theory, which emphasises corporate transparency, accountability, and responsibility in fulfilling the requirements of multiple stakeholders, such as investors, customers, and the broader communities. The study demonstrates that companies adopting AI technologies can more effectively monitor and manage their ESG performance, allowing them to communicate more transparently with their stakeholders (Kumar, 2024). This improved transparency builds trust and bolsters corporate legitimacy, which are key factors in strengthening stakeholder relationships and boosting overall firm value.

Regarding the resource-based view (RBV), AI is a critical strategic resource that enables firms to enhance market competitiveness, particularly by improving ESG data management. AI's capability to process and analyse large volumes of data efficiently and accurately allows companies to assess their sustainability efforts better, make informed decisions, and optimise their ESG strategies. This enhanced data management leads to more effective implementation of ESG practices and favourably influences how the company is perceived in the market.

Companies that demonstrate strong ESG performance increase investor confidence and position themselves as morally and ethically responsible entities. This reputation as a responsible business actor significantly contributes to increased firm value. The findings confirm that ESG performance is a crucial mediating factor, strengthening the link between AI adoption and firm value. Through robust ESG initiatives, companies can leverage AI not just as a technological tool but also as a method for achieving sustainable advancement, reinforcing the idea that AI adoption and good ESG performance together drive enhanced corporate value.

Theoretical Implications. The outcomes of this research offer solid evidence for stakeholder theory, which suggests that companies committed to sustainability practices, such as those related to ESG initiative principles, are better positioned to meet a broad range of stakeholders' expectations, including investors, customers, and society at large. Firms that actively embrace and integrate ESG principles into their operations build trust with their stakeholders by showing dedication to ethical and sustainable business practices. Artificial intelligence further enhances this relationship, fostering greater transparency, accountability, and trust between firms and their stakeholders.

AI enables firms to monitor, assess, and report their ESG performance more accurately, improving their ability to respond swiftly and effectively to stakeholder concerns. This improved capacity for reporting and responsiveness, in turn, strengthens

corporate legitimacy, as stakeholders view companies as more reliable, ethical, and aligned with societal expectations. By integrating AI into their ESG strategies, companies can remain adaptable and resilient, positioning themselves to build long-term value for the organisation and its stakeholders. This alignment with evolving societal expectations and regulatory requirements helps sustain corporate reputation and drives sustained growth.

Moreover, this study reinforces the RBV theory by emphasising the importance of AI as a rare and valuable core element that fosters a firm's market superiority. By leveraging AI technologies, companies can enhance their internal capabilities, particularly in managing ESG data more efficiently and accurately. This improves decision-making, optimises business processes, and leads to operational efficiencies. The strategic use of AI enables firms to gain a unique edge over competitors, empowering them to thrive amidst the challenges of the modern corporate landscape with greater agility.

This study supports the view that valuable, non-substitutable resources like AI can be crucial drivers of a company's competitive positioning, especially in a rapidly evolving market. The continued evolution of AI technologies means that its role as a strategic asset will become increasingly central to a company's sustainable longevity and success, allowing firms to adapt to changes in market dynamics and consumer expectations. As AI technology advances, its potential to shape competitive strategies and support sustainable business practices will only grow, solidifying its importance as a key enabler of long-term corporate success.

Practical Implications. This present study highlights noteworthy practical implications for governments, managers, and regulators, all of whom play pivotal roles in promoting the adoption and effective use of artificial intelligence to enhance ESG performance. Governments need to incentivise AI adoption, particularly among technologically lagging companies. This can be accomplished through various strategies, such as tax benefits, subsidies, and the development of targeted policies that encourage investment in AI technologies, focusing on sustainability goals.

Governments can also help by setting clear AI adoption standards and providing robust support through training programmes that enable companies to acquire the skills needed for effective AI implementation. Furthermore, aligning AI applications with best practices in governance and sustainability will be crucial to ensuring that AI adoption contributes favourably to ESG initiatives. By doing so, governments can create an environment where technology becomes a key driver of sustainable development, helping firms meet regulatory requirements and exceed stakeholder expectations regarding corporate responsibility and transparency.

For company managers, this study underscores the critical role they play in harnessing AI to improve ESG performance. Managers must address data-related challenges, ensuring ESG data is collected, processed, and reported accurately and efficiently. By leveraging AI, they can increase transparency in operations, enhance the company's credibility, and foster greater trust among stakeholders. Managers should also prioritise integrating ecological and ethical considerations in the development and application of AI systems, ensuring that technological advancements align with the company's sustainability objectives.

Maintaining open lines of communication with stakeholders is equally important. It strengthens the company's reputation and guarantees that the concerns of all stakeholders are considered in the decision-making processes. Managers who take a proactive approach will be better positioned to promote financial prosperity and favourable social impact, thus contributing to enduring business viability.

Regulators also serve a key function in fostering the adoption of AI within ESG practices. By developing innovative policies, such as fiscal incentives and the standardisation of technology-based reporting, regulators can cultivate a favourable environment for businesses to embrace AI solutions that align with ESG standards. By introducing such policies, regulators promote companies' adoption of advanced technologies and ensure these technologies are used appropriately.

Additionally, regulators can leverage AI to enhance risk-based supervision, allowing for more effective monitoring of corporate compliance with sustainability regulations. This could involve using AI to track and assess ESG performance across industries, identify potential risks, and enforce compliance with established standards. Ultimately, regulators should seek to create a framework where AI adoption in ESG is encouraged and effectively managed, ensuring that technology is a tool for responsible business practices and sustainable growth.

CONCLUSION

This study demonstrates that adopting artificial intelligence has a profoundly favourable effect on corporate environmental, social, and governance performance. This present finding aligns with the resource-based view theory, which identifies AI as a valuable strategic resource capable of enhancing operational efficiency, improving data management processes, and driving sustainability initiatives. Enhanced ESG performance is further shown to influence firm value by fostering stronger relationships with stakeholders, boosting investor confidence, and contributing to the firm's financial stability and competitive standing in the market. Following stakeholder theory, the research highlights how AI adoption enables companies to better meet stakeholder expectations by promoting greater transparency, accountability, and responsiveness. Furthermore, the study reveals that ESG performance is a mediating factor in the relationship between AI adoption and firm value. This finding underscores that AI facilitates the reinforcement of robust ESG practices and bolsters the firm credibility as a morally and ethically responsible organisation. A company can generate long-term value by positioning itself as a trustworthy and sustainable business entity, reinforcing its ability to succeed in a fast-paced and competitive global landscape.

This research highlights significant implications for governments, managers, and regulators. Governments should incentivise AI adoption through tax benefits, subsidies, and targeted policies to promote sustainable development, especially for technologically lagging companies. Setting AI adoption standards, investing in training programmes, and aligning AI applications with good governance practices are important steps to enhance ESG initiatives. Then, company managers are pivotal in utilising AI to improve ESG performance by addressing data-related issues, increasing transparency, and ensuring stakeholder participation in decision-making. Managers should also integrate ecological considerations in AI applications and maintain open communication to strengthen corporate reputation and sustainability. On the other hand, regulators are expected to encourage the adoption of AI in ESG practices through innovative policies, such as fiscal incentives and the standardisation of technology-based reporting. Regulators can also utilise AI for risk-based supervision and guarantee that the company complies with sustainability regulations.

This study is confined to the Indonesian region, which might constrain the relevance of its findings to different contexts. Therefore, the following studies could broaden their

scope to include studies in other regions, enabling a comparative analysis and providing more insightful and globally relevant conclusions. Such an approach would help understand how regional differences, including economic, cultural, and regulatory factors, influence the interplay between AI adoption, ESG performance, and firm value. Moreover, future research could also explore inter-industry studies to identify potential variations in the impact of AI adoption and ESG performance across different industrial sectors. Different sectors often have unique characteristics, challenges, and opportunities related to sustainability and technological adoption. Examining these differences could offer valuable insights into sector-specific best practices and strategies. Thus, future research could make a greater contribution to the advancement of sustainability theory by adopting a thorough approach that reflects regional and sectoral aspects.

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