

Research Paper

THE IMPACT OF DIGITAL TRANSFORMATION ON ESG PERFORMANCE: THE MODERATING ROLE OF GREEN INNOVATION

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ABSTRACT

This study examines the impact of digital transformation on ESG performance, with green innovation as a moderating variable, focusing on manufacturing companies in Indonesia. Digital transformation is considered a strategic initiative that not only enhances operational efficiency but also supports environmental sustainability and social responsibility. Using a quantitative approach, the study analyzes secondary data from annual reports of manufacturing companies listed on the Indonesia Stock Exchange. The results indicate that digital transformation has a positive and significant impact on ESG performance, and green innovation has been shown to strengthen this effect. These findings suggest that adopting digital technologies can enhance a company's competitiveness by improving its sustainability performance. The study highlights the importance of integrating digital strategies with environmental goals to strengthen long-term business value. Companies are encouraged to adopt digital tools not only for efficiency but also as part of their commitment to sustainable development. The findings also open avenues for further research opportunities, particularly in exploring other mediating or moderating variables, combining several industries or employing mixed methods such as interviews or case studies which could provide deeper insights into how digital transformation and green innovation are practiced in the field.

Keywords: Digital transformation, ESG performance, Green Innovation, Manufacturing Companies, Digital Technology

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INTRODUCTION

The ESG concept represents an approach to sustainable development that incorporates environmental, social, and governance aspects into both investment strategies and corporate planning (Aydoğmuş, Gülay, Ergun, 2022). Compared to traditional Corporate Social Responsibility (CSR), this framework offers a broader perspective and functions as a valuable instrument for fostering long-term corporate growth and achieving high-quality economic progress (Wu & Li, 2023). Since the launch of the 2030 Agenda for Sustainable Development, the concept of ESG was initially introduced by the United Nations Global Compact through the Environmental Planning and Financial Action body (Chen, Mao, Gao, 2023). The three letters in the acronym ESG represent environmental, social, and corporate governance (Huang, Fang, Xue, Gao, 2023).

Corporate digital transformation has become one of the main topics in both academia and business practice in recent years (Schwertner, 2017). The United Nations highlights the role of digital technology in enhancing sustainability in the 2030 Agenda (Zhong, Zhao, Yin, 2023). Along with increasing attention to sustainability issues, efforts to improve corporate environmental, social, and governance performance have become increasingly important. The integration of digital technologies such as Artificial Intelligence (AI), big data, blockchain, and virtual reality is believed to have great potential in driving social and economic transformation toward a more sustainable direction (Wang & Esperança, 2023). Green information technology innovation also plays an important role in supporting the digitalization process of companies and reducing negative environmental impacts, particularly carbon emissions (Amalo, Husen, Kupang, 2024). This aligns with national policies such as the Action Plan to Achieve Peak Carbon Emissions by 2030 launched in 2021 (Zhao, Li, Li, 2023). This policy encourages the implementation of green manufacturing projects, the promotion of sustainable design, the development of environmentally friendly manufacturing systems, as well as the construction of green factories and industrial zones (Zhao, Li, Li, 2023). On the other hand, the continuous advancement of globalization has brought significant changes to global economic, social, and political dynamics. These changes require companies to be more adaptive and innovative in executing their business strategies, including in implementing digital transformation that supports the achievement of sustainable development goals (Zhang, Yang, Lv, 2022).

Meanwhile, the rapid growth of globalization has brought significant changes in global economic, social, and political dynamics (Gereffi, 2018). These changes require companies to be more adaptive and innovative in implementing business strategies, including digital transformation that supports the achievement of sustainable development goals (Rochmawati, Hatimatunnisani, Veranita, 2023). Emerging technologies—such as cloud computing, the Internet of Things (IoT), the Internet of Services (IoS), big data analytics, and AI—are considered key elements of Industry 4.0. AI, for example, enables rapid detection of defects in mass production with minimal data, improving operational efficiency and reducing waste (Zeba, Dabić, Čičak, Daim, Yalcin, 2021).

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Digital Transformation and ESG Performance

Digital transformation refers to the utilization of digital technologies to reshape business processes across production, operations, and management (Ebert & Duarte, 2018). It is widely recognized as an effective approach to fostering sustainable and high-quality growth (Wu & Li, 2023).

The implementation of digital transformation helps to mitigate principal–agent conflicts within a company, which in turn enhances its ESG performance (Wang & Esperança, 2023). According to agency theory, the division between ownership and managerial control often gives rise to conflicts of interest between managers and shareholders. Since managers cannot spread

business risks by investing in various firms, they may prioritize stable earnings over the company's long-term growth (Inderst & Stewart, 2018). As a consequence, managerial decisions may sometimes reflect short-term considerations in operational activities (Wu & Li, 2023). Moreover, the long-term orientation of environmental protection and socially responsible investments inherent in the ESG framework results in delayed and cyclical impacts on overall performance. Therefore, according to agency theory, managers who focus primarily on personal income are inclined to avoid ESG-related investments (Whelan, Atz, Clark, 2015). Nevertheless, through digital transformation and the adoption of advanced technologies, the internal flow of information within the organization becomes more efficient and transparent (Zhang, Yang, Lv, 2022)

The impact of digital transformation strategies on a company's ESG performance is reflected in three main aspects (Wang & Hou, 2024). First, digital technology helps companies identify and address environmental issues efficiently, thereby enhancing environmental responsibility (Sui & Yao, 2023). Second, digital transformation promotes green integration within and beyond the supply chain, in line with the company's commitment to social responsibility (Sui & Yao, 2023). Third, good corporate governance strengthens the capacity for digital investment by reducing principal-agent problems and financing constraints (Zhao, Li, Li, 2023).

Digital transformation plays a role in easing financing constraints faced by companies, which subsequently improves their ESG performance. The significant expenses involved in carrying out ESG initiatives, along with limited resources, are key factors behind the relatively low ESG performance in many firms (Wang, Hong Long, 2023). Currently, digital transformation is seen as a major pathway for the future growth of businesses, and various government policies have been introduced to promote stronger integration between the digital economy and the real economy (Wu & Li, 2023).

H1: Digital transformation has a positive impact on ESG performance.

The Moderating Role of Green Innovation

Green innovation refers to a company's efforts to reduce emissions through science-based methods (Meilani & Sukmawati, 2023). It includes developing environmentally friendly materials and products, such as recyclable or non-toxic items (Zailani, Govindan, Iranmanesh, Shaharudin, 2015). Green innovation saves energy, protects the environment, increases production efficiency, and promotes sustainable use of natural resources. In the digital era, improvements in ESG performance are strongly supported by green innovation, which is often driven by digital transformation (Zailani, Govindan, Iranmanesh, Shaharudin, 2015). In simpler terms, first, from the environmental perspective, various efforts such as the use of better technology, improved environmental management, and pollution reduction rely heavily on digital and smart technologies (Bibri & Krogstie, 2020). Investments in the digital sector can also drive the emergence of environmentally friendly innovations within companies (Xie, Huo, Zou, 2019). Second, from the social perspective, a company's responsibility is reflected in its ability to meet the needs of stakeholders and build good relationships with them (Xie, Huo, Zou, 2019). This fosters collaboration among parties, strengthens green integration within the supply chain, and ultimately further enhances green innovation (Zhao, Li, Li, 2023).

Digital transformation has a positive impact on a company's green innovation by improving the efficiency of information flows and facilitating better monitoring of managerial behavior by shareholders (Huang, Fang, Xue, Gao, 2023). This reduces managerial opportunism and encourages long-term decision-making that aligns with the company's interests (Ebert & Duarte, 2018). In addition, digital advancements support resource advantages by enhancing human capital and fostering better collaboration among innovative organizations (Ebert & Duarte, 2018). These digital capabilities facilitate information

disclosure, reduce information asymmetry, and strengthen opportunities for external financing, thereby supporting the sustainable capital investments needed for green innovation activities (Wu & Li, 2023).

Green innovation significantly enhances a company's ESG performance by aligning with the environmental, social responsibility, and corporate governance dimensions, which are essential for measuring sustainability (Rachmawati, 2023). Adopting green innovation demonstrates a commitment to social responsibility and environmental management, thereby enhancing ESG performance (Liu, Huang, Su, Zhou, 2024). In addition, green innovation improves a company's reputation, attracts investors, and secures capital support, facilitating the adoption of ESG principles (Liu, Huang, Su, Zhou, 2024). Green innovation also drives technological advancement and cost efficiency in environmentally friendly production, enabling companies to fulfill their environmental responsibilities and further improve overall ESG performance (Wu & Li, 2023).

H2: Green innovation moderates the relationship between digital transformation and ESG Performance, such that the relationship is stronger when green innovation is high.

Based on the hypothesis development above, the conceptual framework of this research can be illustrated as follows:

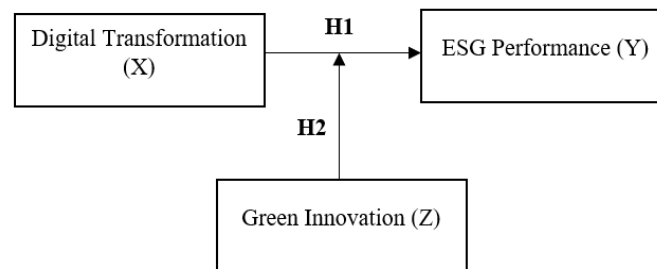


Figure 1. Conceptual Framework

RESEARCH METHODOLOGY

Sample and Data

This research employs a quantitative approach with the objective of examining the hypotheses concerning the influence of digital transformation on ESG performance and green innovation among manufacturing firms in Indonesia. The data sample is derived from the annual reports of publicly listed companies on the Indonesia Stock Exchange (BEI) for the years 2019-2023, as this period captures the rapid acceleration of digital adoption in response to industry and the Covid-19 pandemic, alongside the increasing emphasis on ESG reporting in Indonesia's regulatory and corporate landscape (Susilawati, 2023). The population in this research includes all manufacturing companies recorded on the BEI. A probability sampling method was applied to determine the sample (Pace, 2021).

The criteria for selecting samples in this research are as follows:

No	Criteria
1	Manufacturing firms that were listed on the Indonesia Stock Exchange (BEI) between 2019 and 2023
2	Firms that did not provide complete financial reports during the observation period

Applying these criteria resulted in a final sample of 148 companies. The data were analyzed using multiple linear regression with the help of SPSS software. Several tests were carried out in this research, including the normality test, multicollinearity test, heteroscedasticity test, multiple linear regression analysis, and the moderated regression analysis (MRA).

Variable Definition

No	Variable Type	Variable	Description
1	Independent Variable	Digital Transformation (X)	Digital transformation is defined as the application of digital technologies to transform and enhance business processes in the areas of production, operations, and management. In this study, the level of digital transformation is measured based on the frequency of disclosure of digital-related terms (such as artificial intelligence, blockchain, cloud computing, and others) contained in the company's annual reports. The digital transformation score is calculated using the natural logarithm of the total number of such terms (Su, Wang, Li 2023).
2	Dependent Variable	ESG Performance (Y)	ESG performance reflects a company's achievements in the aspects of Environment, Social, and Governance. In this study, ESG performance is measured based on the GRI or G4 indicators, which consist of 34 environmental indicators, 48 social indicators, and 22 governance indicators (Sosial & Sains, 2024). Each relevant item disclosed is assigned a score of 1, while items not disclosed are assigned a score of 0. The ESG score is then calculated by dividing the number of disclosed items by the total number of indicators, where a higher score indicates better ESG performance (Wang & Esperança, 2023).
3	Moderating Variable	Green Innovation (Z)	Green innovation is defined as the initiatives undertaken by firms to minimize their ecological footprint through advancements in technology and production processes including the creation of eco-friendly materials. In this research, the extent of green innovation is assessed by calculating the natural logarithm of the total number of green patents or innovations than the company has either submitted or officially received (Meilani & Sukmawati, 2023).

4	Controls Variable	Firm Size, Leverage, Firm Age, Growth	Firm size refers to the scale of a company's operations, typically measured by total assets, total sales, or market capitalization (Gómez Martínez et al., 2024). Leverage measures the extent to which a company finances its assets through debt relative to equity (Negara et al., 2024). Firm age indicates how long a company has been in operation since its establishment or listing (Wulandari & Febriantina, 2024). Growth reflects the rate at which a company expands its operations, revenues, or assets over a period (Ho, Nguyen, Dang, 2024).
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Model Settings

$ESG = \beta_0 + \beta_1 DT_{i,t} + \beta Controls_{i,t} + \sum Industry + \sum Year + \epsilon_{i,t}$ (1)

Keterangan:
(DT : Digital Transformation; Controls : Control Variables; ESG : ESG Performances)

$GI_{i,t} = \beta_0 + \beta_1 DT_{i,t} + \beta Controls_{i,t} + \sum Industry + \sum Year + \epsilon_{i,t}$ (2)

Keterangan:
(GI : Green Innovation; DT: Digital Transformation)

$ESG_{i,t} = \beta_0 + \beta_1 DT_{i,t} + \beta_2 GI_{i,t} + \beta Controls_{i,t} + \sum Industry + \sum Year + \epsilon_{i,t}$ (3)

Keterangan:
(GI : Green Innovation)

$ESG_{i,t} = \beta_0 + \beta_1 DT_{i,t} + \beta_2 GI_{i,t} + \beta Controls_{i,t} + \sum Industry + \sum Year + \epsilon_{i,t}$ (3)

Keterangan:
(GI : Green Innovation)

RESULTS AND DISCUSSION

Research Result

In this section, the research results relate to the impact of digital transformation on ESG performance and the role of green innovation in manufacturing companies in Indonesia during the period 2019–2023. The research results to be presented include the classical assumption tests, the Moderated Regression Analysis (MRA), as well as the hypothesis testing, which will be explained as follows:

1. Normality Test

Normality test is conducted to determine whether the residuals in a regression model are normally distributed. To assess the normality of the data, the Kolmogorov–Smirnov test can be applied (Kwak & Park, 2019).

Table 1. Normality Test

Test	Value	Description
Asymp. Sig. (2-tailed)	200	Normal

In this study, the normality test was carried out using the Kolmogorov–Smirnov method. The test results show an Asymp. Sig (2-tailed) value of 0.200 (Demir, 2022). Since this value is greater than 0.05, it indicates that the regression model follows a normal distribution (Fiandini, Nandiyo, Husaeni, Husaeni, Mushiban, 2024).

The purpose of the normality test is to ensure that the residual is normally distributed, so that the regression model is valid for testing the hypotheses. In addition, the normality test can also affect the outcomes of T-test and F-test (Hanusz, Tarasinska, Zielinski, 2016), because without confirming normality, the result of T-test and F-test cannot be interpreted accurately (Liang, Fu, Wang 2019).

2. Multicollinearity Test

A multicollinearity test is conducted to determine whether there is a correlation among the independent variables in a regression model (Daoud, 2018). When the VIF value is below 10, it suggests that multicollinearity is not present. An ideal regression model is expected to show no correlation among its independent variables (Shrestha, 2020).

Table 2. Multicollinearity Test

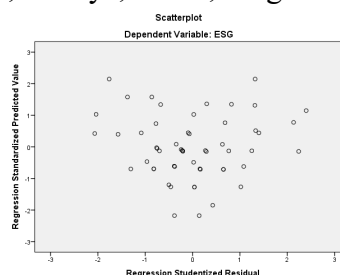
Variable	<i>Collinearity Statistic (VIF)</i>	Description
Digital Transformation	1.001	No multicollinearity occurs
Green Innovation	1.001	No multicollinearity occurs

Referring to the table above, the multicollinearity test results indicate that the VIF values for all independent variables are below 10. Thus, it can be inferred that there is no multicollinearity among the independent variables within the regression model (Azizah, Arum, Wasono, 2021).

Therefore, it can be inferred that multicollinearity does not occur among the independent variables in the regression model. The main purpose of conducting a multicollinearity test is to verify that there is no strong inter-correlation among the independent variables, ensuring that hypothesis testing remains valid (Mardiatmoko, 2020). When multicollinearity exists, it becomes challenging to identify the individual contribution of each variable. In contrast, the absence of multicollinearity shows that the independent variables are not strongly related to one another, which allows the testing process to run more smoothly and the interpretation of the results to be more accurate (Effiyaldi, Pasaribu, Suratno, Kadar, Gunardi, Naibaho, Hati, Aryati, 2022).

3. Heteroscedasticity Test

Heteroscedasticity test is to check whether the residuals (errors) have unequal variances at different levels of the predictor or independent variables (Klein, Gerhard, Buchner, Diestel, 2016). When the residual variance is consistent (homoscedasticity), the regression model is regarded as reliable (Ilori & Tanimowo, 2022). Conversely, if the residual variance fluctuates or is not uniform (heteroscedasticity), it may result in inefficient coefficient estimates and compromise the validity of statistical tests, such as the t-test or F-test (Sholihah, Aditiya, Evani, Maghfiroh, 2023).



Picture 2. Scatterplot

From picture II, it is evident that the plotted points are dispersed randomly and do not form any particular pattern, indicating that the model is free from heteroscedasticity (Irfan, 2018). Therefore, it can be concluded that the results of the t-test or F-test can be trusted to support the hypothesis (Purba, Tarigan, Sinaga, Tarigan, 2021).

4. Autocorrelation Test

The autocorrelation test is carried out to determine whether there is a correlation or relationship between the residuals (errors) of one observation and those of another observation within a regression model (Chen, 2016). If autocorrelation occurs, the t-test and F-test are no longer valid (Chen, 2016).

Table 3. Autocorrelation Test

Test	Value	Description
Durbin Watson	1.863	There is no autocorrelation

Based on the results above, the Durbin–Watson (DW) value obtained is 1.863, while the upper bound (dU) is 1.681 (Rarindra & Saputra, 2020). Referring to the Durbin–Watson criteria, a condition where $dU < DW < 4 - dU$ indicates the absence of both positive and negative autocorrelation. Since $4 - DW = 4 - 1.863 = 2.137$, it is clear that $DW > dU$ and $4 - DW > dU$ (Wahyuliza & Dewita, 2018). Therefore, it can be concluded that the regression model is free from issues of positive or negative autocorrelation (Eprima, Trisna, Gede, 2015).

5. Multiple Linear Regression Analysis

The F Test

The F-test is used to determine whether all independent variables collectively have a significant effect on the dependent variable (Qurnia & Sukestiyarno, Agoestanto, 2017).

Table 4. F-Test Results

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.011	2	.006	10.797	.000 ^b
	Residual	.027	52	.001		
	Total	.039	54			

Table 4 indicates that the calculated F-value of 10.797 is greater than the F-table value of 2.79, with a significance level of 0.000, which is below 0.05 (Siraj, Ahmad, Ijtihadie, 2022).

This demonstrates that, collectively, Digital Transformation and Green Innovation variables significantly influence ESG performance (Delacre, Leys, Mora, Lakens, 2020).

The Coefficient of Determination Test

The coefficient of determination test is used to measure the extent to which the variation in the dependent variable can be explained by the independent variables in the model (Nakagawa, Johnson, Schielzeth, 2017).

Table 5. Coefficient of Determination Test Result

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.542 ^a	.293	.266	.02289

According to the test results, the coefficient of determination is 0.266, which is equivalent to 26.6%. This means that the independent variables explain 26.6% of the

variation in the dependent variable, while the remaining 73.4% is affected by other factors not examined in this study (Saputra & Zulmaulida, 2020). Therefore, it can be concluded that the effect of Digital Transformation on ESG performance moderated by Green Innovation is well explained and supports the hypothesis tested using the applied model (Chicco, Warrens, Jurman, 2021).

The t-Test

The t-test is conducted to determine whether each independent variable individually has a significant effect on the dependent variable (Mishra, Singh, Pandey, Mishra, Pandey, 2019).

Table 6. The t-test Results

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1	(Constant)	.257	.010	25.617	.000
	DT	.033	.009	.409	.001
	GI	.033	.011	.345	.005

Based on Table 6, all variables, namely DT and GI, show a Sig. value smaller than 0.05, which means that all of them have a significant impact on the dependent variable (Lakens, 2017).

The t-test results show that: (a) Digital Transformation (X) has a significant effect on ESG performance (Y) with a Sig. value of 0.001 and a t-calculated value of 0.005; (b) Green Innovation (Z) also has a significant effect with a Sig. value of 0.005 and a t-calculated value of 2.955 (Afifah, Mudzakir, Nandiyanto, 2022).

6. Moderated Regression Analysis (MRA)

The Moderated Regression Analysis (MRA) is used to examine whether the moderator variable (Green Innovation) strengthens or weakens the relationship between the independent variable (Digital Transformation) and the dependent variable (ESG Performance) (Putra & Lestari, 2023).

Table 7. MRA Test Result

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1	(Constant)	.264	.010	25.711	.000
	GI	.025	.012	.257	.038
	DT	-.061	.046	-.750	.191
	DTxGI	.112	.053	1.189	.042

As shown in Table 7, Green Innovation is capable of moderating the relationship between Digital Transformation and ESG performance, evidenced by a t-statistic of 2.088 and a p-value of 0.042 (< 0.05) (Putra & Lestari, 2023).

Discussion

The Impact of Digital Transformation on ESG Performance

Based on the research findings, digital transformation has a positive and significant effect on ESG performance. This is because the implementation of digital technologies—such as process automation, data analytics, the Internet of Things (IoT), and integrated information systems—can improve operational efficiency, transparency, and corporate accountability. As

a result, companies that undergo digital transformation tend to demonstrate better performance in environmental, social, and governance aspects (Wang, Hong, Long 2023).

This positive relationship can be attributed to several factors. First, digital tools facilitate production automation, which leads to reduce energy and raw material consumption. These efficiency gains enable companies to better identify and manage ESG-related risks, thereby reducing the occurrence of environmental incidents and improving environmental performance (Zhao, Li, Li, 2023). Second, digital tools provide companies with the means to promptly publish and update ESG reports. This enhanced transparency allows them to effectively communicate ESG achievements, foster a positive brand image, strengthen the trust of external stakeholders, and attract a broader base of customers and investors. The integrated effect of these two aspects enables companies to effectively fulfill their ESG responsibilities and generate non-economic value through digital transformation (Yin, 2025).

According to stakeholder theory, digital transformation enables companies to better identify and respond to stakeholder needs, enhance transparency and communication, and, as a result, improve the credibility and effectiveness of ESG efforts (Guo & Pang, 2025). Overall, digital transformation not only enhances a company's ability to meet ESG standards but also optimizes resource allocation and stakeholder relationships, driving a comprehensive improvement in ESG performance (Zhang & Huang, 2024). The results of this study are in line with the research conducted by (Li, Ding, Park, Zhang, 2025; Guo & Pang, 2025) which states that digital transformation has a positive and significant impact on ESG performance.

The Effect of Digital Transformation on ESG Performance Moderated by Green Innovation

Based on the research findings, it is shown that green innovation is able to positively and significantly moderate the relationship between digital transformation and ESG performance (Xu & He, 2025). When a company undertakes digital transformation, its impact on ESG performance becomes stronger and more positive if the company simultaneously adopts green innovation. Therefore, organizations that integrate digital technologies into their green innovation processes are more likely to achieve superior ESG outcomes (Wang & Esperança, 2023). These findings are consistent with the innovation value theory and with prior research conducted by (Liu, 2020), which states that digitalization drives comprehensive innovation across all business activities. These findings indicate that ESG practices play a dual role in promoting both the optimization of company performance and the fulfillment of social responsibilities (Whelan, Atz, Clark, 2015). The growing emphasis on environmental preservation and sustainable development further reinforces the urgency of adopting green development concepts within the business sector. This situation provides strong incentives for companies to increase their investments in innovative technologies oriented toward environmental sustainability (Xu & He, 2025).

CONCLUSION AND SUGGESTION

Manufacturing companies in Indonesia are in an increasingly complex phase in facing the demands of the global market, regulatory pressures, as well as the expectations of society and investors regarding business sustainability. In recent years, the ESG concept has become one of the key indicators for assessing a company's success and long-term sustainability. ESG is not merely a form of Corporate Social Responsibility (CSR) that is voluntary in nature, but has evolved into a performance standard that influences investor decisions, stakeholder considerations, and corporate reputation. Companies that are able to demonstrate good ESG performance are considered more prepared to face long-term risks such as environmental risks, legal risks, and even financial risks.

On the other hand, digital transformation has become a key driver of change across various sectors, including manufacturing. The era of Industry 4.0 brings technologies such as IoT, AI, big data analytics, cloud computing, and blockchain. These technologies offer significant opportunities for companies to improve operational efficiency, reduce costs, and create more environmentally friendly products and processes. For the manufacturing industry, digital transformation is no longer merely an option but has become a necessity to maintain competitiveness in a highly dynamic global market.

In addition, external pressures are also becoming stronger. The Indonesian government, through various national policies such as the plan to achieve peak carbon emissions by 2030, is encouraging companies to reduce the environmental impact of their industrial activities. At the international level, the implementation of the Sustainable Development Goals also requires companies to adopt sustainability strategies, both in their production processes and internal governance.

In this situation, manufacturing companies are not only required to produce cost-efficient products but also to ensure that their production processes are environmentally conscious and socially responsible. Green innovation then emerges as an answer to these challenges. Through green innovation, companies can create recyclable products, reduce the use of hazardous materials, and minimize waste and carbon emissions. However, the success of this innovation is greatly influenced by the company's digital readiness. Without adequate support from digital transformation, efforts toward green innovation are often hampered by limited information, inefficient processes, and non-integrated systems.

Therefore, the current situation can be described as a strategic crossroads. Manufacturing companies in Indonesia must be able to integrate digital technology with sustainability strategies in order to achieve optimal ESG performance. The integration of digitalization and green innovation is not merely about complying with regulations or following global trends, but also serves as a key factor in creating long-term value, enhancing competitiveness, and ensuring that companies remain relevant in the future business landscape.

Based on the research results, it can be concluded that the objectives of this study—namely to analyze the impact of digital transformation on ESG performance moderated by green innovation in Indonesian manufacturing companies—have been achieved. First, digital transformation is proven to have a positive and significant effect on ESG performance. Second, green innovation is found to positively and significantly moderate the relationship between digital transformation and ESG performance.

From a theoretical perspective, this research contributes to the existing body of literature on the role of digital transformation and green innovation in enhancing ESG performance. It reinforces both agency theory and stakeholder theory by demonstrating that the adoption of digital technologies can reduce conflicts of interest and improve transparency, which ultimately leads to better ESG outcomes. From a practical standpoint, the findings of this study provide valuable insights for managers in manufacturing companies, encouraging them to more actively integrate digital transformation with green innovation strategies. By doing so, companies may achieve higher operational efficiency, meet sustainability demands, strengthen their reputation, and attract investors who prioritize ESG considerations.

This study is subject to several limitations. First, the scope of the research is confined to manufacturing firms listed on the Indonesia Stock Exchange during the 2019–2023 period, which means the findings may not be fully applicable to other sectors. Second, the data relied solely on annual reports, which may not provide detailed insights into the actual implementation of digital transformation and green innovation within each company.

For future studies, it is recommended to broaden the sample beyond the manufacturing sector or combine several industries to obtain more comprehensive findings. Researchers are also encouraged to include potential mediating variables, such as access to green financing or

the legitimacy of organizations that support the implementation of green innovation. In addition, employing mixed methods—such as interviews or case studies—could provide deeper insights into how digital transformation and green innovation are practiced in the field. Extending the observation period is also advised in order to capture long-term trends in the relationship between digital transformation, green innovation, and ESG performance.

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