The Role of SDGs Disclosure on the Effect of Green Innovation, Greenhouse Gas Emissions, and Eco-Efficiency on Firm Value

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ABSTRACT

This research aimed to determine the role of SDGs disclosure in moderating the effects of green innovation, GHG emissions, and eco-efficiency on firm value. The sample for this research consisted of companies included in the SRI-KEHATI index from 2018 to 2022. A quantitative approach was used, with panel data processed using EVIEWS 10. The sample was selected using purposive sampling, resulting in 16 companies. Over a period of five years, this provided a total of 80 observations. Secondary data were obtained from the internet, specifically from the official IDX website (www.idx.co.id), the *Yayasan Keanekaragaman Hayati Indonesia* website (www.kehati.or.id), and the official websites of each company. The results of this study indicated that green innovation and GHG emissions had a partial effect on firm value. An increase in green innovation enhanced firm value, whereas an increase in GHG emissions led to a decrease in firm value. Eco-efficiency, however, did not have a significant effect on firm value. Additionally, SDGs disclosure moderated the impact of green innovation and GHG emissions on firm value, but it did not moderate the effect of eco-efficiency on firm value.

Keywords: Sustainable Development Goals Disclosure, Green Innovation, Greenhouse Gas Emissions, Eco-efficiency, Firm Value

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INTRODUCTION

Firm value refers to the measure or estimate of the total firm value, reflecting how valuable the company is in the eyes of investors and the market as a whole (Mahmudah et al., 2023; Yao et al., 2019). Corporate value is important because it can be an indicator of the company's performance. It provides an overview of the company's financial performance and growth prospects. Additionally, Yao et al., (2019) explained that investors use corporate value as a consideration when making investment decisions. There are several financial performance factors that investors consider in determining corporate value, such as liquidity (Batten & Vo, 2019; Nguyen et al., 2016), leverage (Ibhagui & Olokoyo, 2018), capital structure (Dinh & Pham, 2020; Nurlaela et al., 2019; Sudiyatno et al., 2020), and profitability (Tui et al., 2017; Winarso & Christina, 2019).

As global awareness increases regarding issues of poverty, inequality, climate change, environmental degradation, peace, and justice, there is a strong incentive for companies to contribute to environmental and societal sustainability. Companies also need to implement innovation processes and develop environmentally friendly products to maintain their own sustainability and that of the environment. Environmental performance or actions such as green innovation (GI), greenhouse gas reduction (GHG), and eco-efficiency (ECO) can be important factors in assessing a company's success (Rounaghi, 2019). Therefore, investors and other stakeholders are currently demanding not only financial performance reporting but also requiring companies to report their impact on the environment and society (Maama & Appiah, 2019; Mahmudah et al., 2023).

One of the global commitments made by various countries to maintain sustainable development is the agreement on the Sustainable Development Goals (SDGs) by the United Nations (UN) member countries in 2015. The SDGs serve as a guide for all countries to end poverty, reduce inequality, and protect the environment. They consist of 17 goals and 169 targets, which are expected to be achieved by 2030. Several previous studies have concluded that environmental performance, such as green innovation (GI) (Husnaini & Tjahjadi, 2021; Tang et al., 2018; D. Zhang et al., 2019; F. Zhang et al., 2020), greenhouse gas reduction (GHG) (Cooper et al., 2018; Lee & Cho, 2021; Mahmudah et al., 2023; Nishitani & Kokubu, 2011) eco-

efficiency (ECO) (Osazuwa & Che-Ahmad, 2016; Sinkin et al., 2008; Yao et al., 2019),influence on corporate value. However, there are inconsistent results, and not many studies have tested the role of SDGs in moderating the influence of environmental performance on corporate value, especially in Indonesia. Issues regarding sustainable development are relevant to development challenges in Indonesia. Indonesia's commitment to achieving the SDGs is not only about fulfilling global agreements but also about improving the long-term welfare of its society.

This matter motivated this research to analyze the role of SDGs in moderating environmental actions such as green innovation (GI), greenhouse gas reduction (GHG), and eco-efficiency (ECO) on corporate value. This research aimed to prove that increasing GI, reducing GHG emissions, and improving ECO is not only a social obligation but can also be a profitable business strategy. This is important to encourage more companies to take proactive action on sustainability. It is hoped that the results of this research will serve as a guide for managers, investors, and other stakeholders in making decisions that are both sustainable and profitable for the company.

The 17 SDGs goals include several environmental goals. To bring the SDGs into reality, all parties must work together, including the economic sector. As an important part of the economic driver, companies are expected to be involved in implementing SDGs throughout their operations. The UN makes the SDGs measurable, so they provide indicators for investors to assess companies' efforts. With these indicators, investors can invest in a measurable manner, which helps them make better investment decisions. In today's global market, there is a growing emphasis on sustainability. Companies are increasingly expected to adopt green innovations and reduce their environmental footprint to enhance their long-term viability and profitability. This trend is driven by consumer demand, regulatory pressures, and investor preferences. Previous research by Lawati and Hussainey (2022) found that SDGs disclosure had a positive correlation with business financial performance. Apart from achieving the goal of making profits in the short term, the company also has a long-term goal to ensure that the company can survive. Maximizing company's value is one way to ensure its sustainability. Firm value is considered important because it can show the market's perception of the company (Hirdinis, 2019). One proof that a company is performing well is high firm value. Therefore, an increase in firm value shows the prosperity of shareholders.

Stakeholders consider environmental performance in addition to economic and social performance (Agustia et al., 2019). Regarding environmental performance, companies can implement a green innovation strategy, as in research by Agustia et al (2019) which found that green innovation had a positive and significant impact on firm value. If carried out regularly and applied to all business processes, a green innovation strategy can prevent an increase in carbon gas emissions and help fight global warming (Nan et al., 2022). This will have a positive impact on the company's carbon emission intensity and environmental performance.

Existing regulations and laws regarding environmental protection have not been able to fully prevent environmental damage from occurring. Data in the 2022 Environmental Performance Index (EPI) report showed that Indonesia only received an environmental conservation score of 28.2 out of a scale of 100. According to this data, Indonesia is in 164th place out of 180 countries. Low index values are accepted by countries that do not prioritize environmental sustainability. Meanwhile, the high score was received due to the commitment to long-term performance and investment in preserving the environment, preserving natural resources, and paying special attention to greenhouse gas emissions. It can be seen how important the environment is for a company. The survival of the company is very dependent on safety and environmental sustainability. Companies will always need a supply of natural resources for their production activities. Therefore, companies must treat the environment as one of the company's stakeholders (Utomo, 2019).

The motivation for researching the effect of green Innovation, GHG emissions, and eco-efficiency on firm value, with SDGs disclosure as a moderating variable, lies in the growing importance of sustainability in business strategy and investment decisions. There is research gap that was needed to be addressed, including the moderating role of SDGs disclosure. While there is substantial research on the direct impact of green innovation, GHG emissions, and eco-efficiency on firm value, less is known about how SDGs disclosure moderated these relationships. The role of SDGs disclosure in amplifying or mitigating the effects of sustainability practices on firm value remains underexplored. Most studies ocused on the direct benefits of sustainability initiatives without considering how transparency in SDGs disclosure influences these outcomes. There was a need for research that investigated how effective SDGs reporting impacted the relationship

between sustainability efforts and firm value. Addressing these gaps will enhance our understanding of how sustainability practices and transparency contributed to firm value and inform better policies and strategies for businesses and investors.

LITERATURE REVIEW

Theoretical Review

Stakeholder theory

Stakeholder theory emphasizes that companies are not only responsible to shareholders, but also to various parties who have an interest in the company's activities. Stakeholders are involved in making normative and strategic business decisions (to achieve the best results in the long term), according to Freeman (1984). In this context, companies are assessed not only on their financial performance, but also on how they meet stakeholders' expectations regarding social, environmental, and sustainability issues.

Many stakeholders are increasingly concerned about the company's carbon-intensive operations which exacerbate the collective issue of climate change. In response to this growing environmental concern from stakeholders, green innovation which involves in the development of environmentally friendly technologies and sustainability-oriented business processes can be considered as an essential. Accordingly, SDG disclosure serves as a communication mechanism to show stakeholders that the company has invested in green innovation. This disclosure helps strengthen companies' relationships with pro-sustainability stakeholder, thereby enhancing reputation and investment attractiveness, which subsequently contributes to company value.

Legitimacy theory

Social values related to business activities conforming to accepted behavior within a larger social system are known as legitimacy, according to Dowling and Pfeffer (1975). Legitimacy, according to this Theory, is a business component that applies implicitly based on a social contract between business entities and society. To gain access to products and market resources, organizations will operate outside the boundaries determined by

society (Campbell et al., 2002). Legitimacy theory is one of the key theories in understanding how companies seek to maintain or enhance their social legitimacy in the eyes of the public and stakeholders.

In relation to SDG disclosure, this theory can explain how such disclosure serves to influence the relationship between green innovation, greenhouse gas emissions, and eco-efficiency on company value. Based on legitimacy theory, companies implement SDG disclosure to reveal their efforts in green innovation, demonstrating that they contribute to environmental sustainability, which is in line with public expectations. By openly reporting emission reductions, companies can mitigate the risk of losing legitimacy due to public pressure or regulation, which in turn helps protect or even increase the company's value. When companies successfully maintain or enhance their social legitimacy through SDG disclosure, they can attract more sustainability-conscious investors, increase share prices, gain the loyalty of consumers who value corporate social responsibility, and reduce regulatory or public criticism risks. All these factors contribute to increased company value, both in the short term (through reputation) and in the long term (through operational sustainability).

Signaling theory

In 1973, Spence (1973) found that companies that performed well will disclose financial information as a signal to the market. Connelly et al. (2011) stated that the provider side decides how to communicate the information (or give a signal), and the receiving side decides how to understand the signal given.

Signaling theory plays an important role in explaining how companies communicate positive information to external parties, particularly investors, consumers, and other stakeholders in order to build a good image and increase trust. Sustainable Development Goals (SDG) disclosure acts as a signal to gain the confidence of environmentally conscious stakeholders. This theory helps clarify how such disclosure can strengthen the relationship between green innovation, greenhouse gas emissions, and eco-efficiency in relation to company value.

Empirical Review

Zhang et al. (2020) concluded in their study that: (1) green innovation can drive an increase in firm value at intermediate and high levels; (2) disclosure of environmental and social information positively impacts firm value; (3) the interaction effect between green innovation and social disclosure on firm value is substitutive and will gradually weaken as firm value increases. Wicaksono et al. (2021) found that green innovation had a significant positive effect on firm value, and carbon emission disclosure also had a significant positive effect on firm value. Other studies by Agustia et al. (2019) and Dai & Xue (2022) also stated that green innovation affected firm value.

Choi & Luo (2021) revealed that carbon emissions had a negative impact on firm value. The negative impact of carbon emissions on firm value indicated that managers, particularly those in countries with stringent environmental regulations, need to consider market penalties for greenhouse gas emissions and perform cost-benefit analyses on environmentally controversial projects. Additionally, investors should carefully estimate future environmental liabilities caused by high carbon emissions that are not disclosed in financial reports. Cooper et al. (2018) indicated that a company's reputation for social responsibility cannot prevent adverse firm value effects caused by high greenhouse gas emissions produced by the company.

Ito (2018), analyzing the impact of SDG activities in Japan, stated that a company's contribution to the SDGs positively impacted firm value if it can increase the investor base, i.e., SDGs can enhance the value of a company that is recognized. Furthermore, research by Nerlinger & Wilkens (2020) concluded that corporate engagement with the SDGs had a significant impact on firm value only for some SDGs, whichwere mostly also materially important. A company achieved a more holistic sustainability performance if, in addition to aligning its organization with ESG criteria, it also included sustainable products and services.

HYPOTHESES DEVELOPMENT

Green Innovation on Firm Value

The Legitimacy Theory, which defines legitimacy as social values associated with a company and in accordance with accepted behavior in a larger social system, supports the influence of green innovation (GI) on corporate value (Dowling & Pfeffer, 1975). By implementing a green innovation approach, businesses can gain legitimacy and increase their chances of long-term survival by responding to environmental concerns. Jiang et al., (2018) concluded that GI not only plays an important role in promoting environmental performance, but also increases corporate value. Investors tend to respond positively to companies that demonstrate a commitment to environmental sustainability through good financial performance (Ramadhan et al., 2023).

The level of productivity and innovation can help companies achieve and maintain corporate value. GI can be a competitive advantage for companies that apply it across business lines (Agustia et al., 2019). Companies that invest in GI can experience improved financial performance in the long term. While there may be high initial costs, the long-term benefits of increased efficiency and enhanced reputation can increase firm value (F. Zhang et al., 2020). In line with the research results of Jiang et al., (2018), Augustia et al. (2019) and Zhang et al. (2020) which also stated that GI had a positive effect on corporate value. Based on this the hypotheses was:

H1: Green innovation has a positive impact on firm value

Greenhouse Gas Emissions on Firm Value

The Stakeholder Theory supports the influence of greenhouse gas emissions on firm value. According to Freeman and Reed (1983), stakeholders are certain groups who will support a company, without whose support the company would cease to exist. Support from stakeholders greatly influences the existence of a company (Ghozali & Chariri, 2007). Therefore, considering stakeholder interests helps a company achieve its goals.

The existence of regulations regarding greenhouse gases has attracted the attention of many parties, including company stakeholders. As a result, companies are under pressure to act on this issue. With the continued movement towards a low-carbon economy, GHG emissions are becoming more dangerous for businesses. GHG emissions contribute to climate change, which can be detrimental to the environment and society. GHG emissions have a negative impact on corporate value. This is because companies with high GHG emissions face criticism from investors or even stricter regulations from the government (Nishitani & Kokubu, 2011). Additionally, investors are also concerned about the financial impact of GHG emissions (Cooper et al., 2018).

Nishitani and Kokubu (2011), Cooper et al., (2018),(Choi & Luo, 2020), and Sun et al., (2022) stated that GHG had a negative impact on corporate value. Especially in developing countries, the negative influence of GHG on corporate value is stronger because environmental regulations in developing countries are less stringent. Thus, regulations in this case play a role in influencing investors' perceptions of GHG which can then influence corporate value. Based on the explanation above, the hypothesis was:

H2: GHG has a negative effect on firm value.

Eco-Efficiency on Firm Value

Companies must be able to align environmental, economic and social sustainability goals (Utomo, 2019). Companies consider society as an important component in their long-term growth, so they will act in accordance with societal norms, according to Dowling & Pfeffer's (1975) Legitimacy Theory. Eco-efficiency, the idea of using fewer resources to produce more goods and services while reducing waste and environmental pollution, is one approach that can be implemented.

Companies that demonstrated their commitment to environmentally friendly practices gain a good reputation in the eyes of investors and other stakeholders. This form of implementing eco-efficiency generally reduces waste and resource use, thereby reducing operational costs and increasing corporate value (Ayoib & Osazuwa, 2015). These results are also in line with research by Osazuwa & Che-Ahmad, (2015). This is because investors

are increasingly concerned about sustainability issues. The concept of eco-efficiency states that this is one way to maintain products to be more useful while also reducing the environmental impact of the company's production ac

tivities.

Environmental and social performance is one factor that influences corporate value. Companies that fulfill their social responsibilities, such as implementing eco-efficiency, have a unique attraction for investors. Consequently, the company gains support from investors and the community (Kurnianta & Dianawati, 2020). Eco-efficiency affects corporate value by increasing profitability and reducing operational costs. Companies that implement an eco-efficiency strategy can reduce costs and increase profits, which can then increase corporate value (Savitri & Abdullah, 2023). Based on the explanation above, the research hypothesis was:

H3: Eco-efficiency has a positive effect on firm value.

SDGS Disclosure Moderates Green Innovation on Firm Value

The Organization for Economic Cooperation and Development (OECD) defines "green innovation" as "the development of new or improved products, processes, marketing methods, organizational structures, and/or institutional arrangements that, intentionally or not, contribute to the reduction of environmental impacts compared to alternative practices" (OECD, 2009). Green innovation includes changes to production processes and product designs that are more environmentally friendly. In research conducted by Zhang et al. in 2020, it was found that: (1) green innovation can increase the value of companies at the medium and high levels; (2) disclosure of social and environmental information has a positive impact on corporate value; and (3) the combined effect of green innovation and social disclosure on corporate value is a substitution that will gradually decrease as corporate value increases.

Sutrisno et al., (2024) concluded that SDGs moderate the influence of environmental performance on corporate value. SDGs provide a framework to direct company actions to protect the environment and contribute to sustainable goals. Companies that disclose their SDGs tend to have lower financial volatility, higher sales growth, and a better chance of surviving

in the long term. This shows that SDGs disclosure has a positive effect on corporate value (Schramade, 2017).

A sustainability report Is one of the reports made by a company. This report collects information about company performance in economic, environmental and social terms. Studies by Zhang et al (2020) and Khan et al (2021) found that SDGs disclosure has a large impact on company performance, suggesting that it may moderate the influence of green innovation on corporate value. Based to this explanation, the proposed hypothesis was:

H4: SDGs disclosure moderates the effect of green innovation on firm value

SDGs Disclosure Moderates The Effect of GHG Emissions on Firm alue

One of the 17 sustainable development goals is to reduce greenhouse gas emissions worldwide. Apart from having a good opportunity to influence environmental impacts, participating in the implementation of the 17 sustainability goals also has a positive impact on corporate value because investors today consider social, environmental and financial aspects. As stated in Signal Theory, management will take action to inform investors about the company's condition due to limited information available to outside parties. In sustainability reports, companies show investors that they are doing everything they can to reduce greenhouse gas emissions, which is one of the SDGs (Lopez, 2020).

According to research conducted by Nerlinger & Wilkens (2020), several products and services have a significant influence on business value in relation to sustainable development goals. Therefore, it is suspected that disclosing information about the sustainability goals implemented by the company can moderate the relationship between firm value and greenhouse gas emission. Lopez (2020) concluded that by integrating SDGs, companies not only fulfill their social responsibilities, but also create new business opportunities and goals. This shows that SDGs can strengthen corporate value. Septrina et al., (2023) also concluded that SDGs had a positive effect on corporate value. Investors and consumers are increasingly considering the social and environmental impact of the businesses and products they

support. In addition, companies are increasingly favoring partners that demonstrate a commitment to sustainable business practices such as GHG reduction. Therefore, it is hypothesized that disclosing information about the sustainability goals implemented by the company can moderate the relationship between corporate value and greenhouse gas emission variables, so that:

H5: SDGs disclosure moderates the effect of GHG emissions on firm value

SDGs Disclosure Moderates The Effect of Eco-efficiency on Firm Value

Companies engage in activities to restore environmental protection and implement environmentally friendly practices, known as environmental performance (Hill et al., 2018). A company's ability to improve environmental performance is one of many factors that can increase corporate value (Khanifah et al., 2020).

In accordance with the Signaling Theory, the steps a company has taken to manage its environment can be further disclosed to attract investors. According to the Theory, management will take action to provide signals to investors to prevent unprofitable choices due to a lack of information from outside parties. Investors can ultimately consider the company's condition in different ways. According to Ito (2018), business naturally contributes to the SDGs to increase corporate value. Based on this explanation, the following hypothesis was postulated:

H6: SDGs disclosure moderates the effect of eco-efficiency on firm value

The following is the conceptual framework that was used to explain the relationship between these variables.

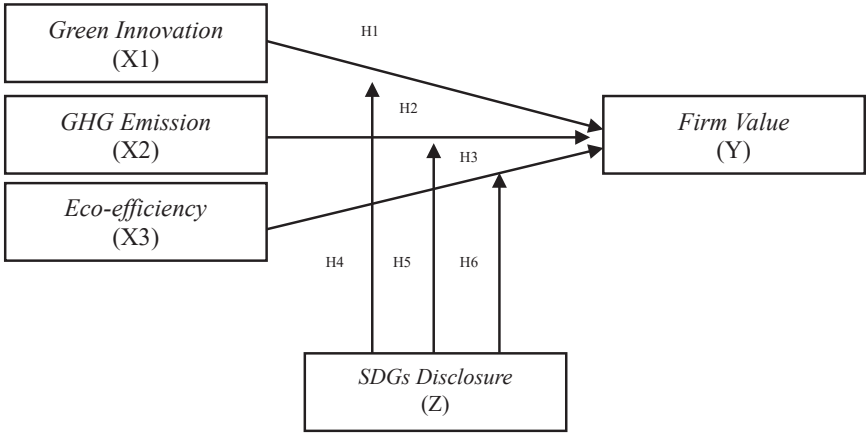

Figure 1: The Conceptual Framework

METHODOLOGY

Population and Sample

The research was carried out by collecting data from several related sites. Financial information was available on the official website of the Indonesian Stock Exchange (www.idx.co.id), data on index evaluation results was accessed via the official website of the Indonesian Biodiversity Foundation (www.kehati.or.id), the official website of each company to obtain data related to sustainability reports. The research time is April-June 2023.

Companies that were included in the SRI-KEHATI index issuers were the population used, and the total was 41 companies. We chose the SRI-KEHATI Index because it selected issuers by applying sustainable and responsible investment (SRI) principles and environmental, social, and governance (ESG) principles. The SRI-KEHATI Index emphasized ESG points in the Indonesian stock market. According to data from KEHATI's official website (kehati.or.id/id/indeks-sri-kehati), since its inception, this index had received a positive response from investors. From the existing population, the researcher selected a sample using non-probability sampling using a purposive sampling technique, namely a technique where the sample is determined using certain criteria. The criteria were as follows:

Table 1: Sampling Criteria

No.	Criteria	Numbers
1.	Non-bank companies included in the SRI-KEHATI index issuers in 2018-2022	34
2.	Companies that do not publish sustainability reports in the period 2018-2022	(7)
3.	Companies with incomplete information	(11)
	Number of companies that qualify as samples	16
	Number of observations (16 x 5 years)	80

Data analysis in this study was conducted using Eviews version 12. Eviews (Econometric Views) is an interactive computer program for statistical and econometric analysis. Eviews was developed by economists and is primarily used in the fields of economics or financial economics (Aljandali & Tatahi, 2018). First, we selected the estimation model and then proceeded to conduct classical assumption tests on the data. Then we employed multiple regression analysis to evaluate the direct and interactive effects of green innovation, GHG emission, and eco-efficiency on firm value. This method was suitable as it allowed for the examination of complex relationships between firm value and multiple independent variables. Moderated regression analysis was utilized to explore how SDGs disclosure moderated the effect of green innovation, GHG emission, and eco-efficiency on firm value. This approach was appropriate as it enabled the investigation of interaction effects, providing insights into how the strength of the relationship between green innovation GHG emission, and eco-efficiency on firm value with the support of SDGs disclosure.

Each analytical method was chosen based on its ability to address specific research questions and to handle the complexity of the data and relationships involved. Regression analysis, moderated regression, panel data models each provided unique insights into how green innovation, GHG emissions, eco-efficiency, and SDGs disclosure affected firm value.

Variables and Measurements

Green Innovation. This variable was measured through content analysis of previous research by Xie et al. (2019). Assessment for process-related green innovation, namely: a) has the aim of reducing consumption and increasing resource and energy efficiency, b) uses recycled materials,

recycling techniques and environmental technology, c) implements environmental campaigns, d) uses pollution control equipment, and e) adopt pollution control projects and technologies. The assessments for green innovation related to products are: a) changing product designs to avoid pollutants or toxic compounds in the production process, b) improving and designing environmentally friendly packaging for existing and new products, and c) modifying product designs aimed at increasing efficiency. Each of these will be given a score of 1 if it is included in the company's sustainability report so the maximum score is 8.

$$GI\ SCORE = \frac{Number\ of\ GI\ items\ disclosed}{Maximum\ number\ of\ GI\ items\ to\ disclosed} \text{ x } 100\% \quad (1)$$

Greenhouse Gas Emission. This research used the CO2e intensity formula as a proxy for GHG Emissions based on previous research by Andewi Rokhmawati et al (2015). The greenhouse gas equivalent amount was calculated based on guidance from State Street Global Advisor in Carbon Footprinting: An Investor Toolkit. CO2e intensity was formulated as follows:

$$CO2e\ Intensity_{(t)} = \frac{Tons\ of\ Co2e}{Revenue_{(t)}} \quad (2)$$

A company's eco-eficiency shows a company's efforts to reduce resource consumption and emissions (Yoon et al., 2018). In this research, eco-efficiency was measured using the formula used in research by Lucato et al (2013). The company's efficiency level was divided into two indicators:

$$e_1 = \frac{Monthly\ Net\ Revenue}{Monthly\ Energy\ Consumption} \quad (3)$$

$$e_2 = \frac{Monthly\ Net\ Revenue}{Monthly\ Water\ Consumption} \quad (4)$$

The formula for calculating the number of eco-efficiency levels:

$$EM_t = \frac{e1\ x\ e2}{4} \quad (5)$$

Firm Value. According to Hardiyansyah et al. (2020), firm value is measured as the price that buyers are willing to pay when selling the company. In this research, Tobin's Q number was used to measure firm value. This ratio shows the company's current profitability and the company's ability to develop in the future (Zhang et al., 2020). Tobin's Q is formulated as follows:

$$Tobin's\ Q = \frac{Total\ Market\ Value + Total\ Book\ Value\ of\ Liabilities}{Total\ Book\ Value\ of Asset} \quad (6)$$

Sustainable Development Goals Disclosure. SDGs are a global campaign agreed by world leaders, including Indonesia, to end poverty, reduce inequality and protect the environment. Only SDGs environmental goals, namely goals number 6 (clean water and sanitation), 7 (clean and affordable energy), 11) Sustainable Cities and Communities; (12) Responsible Consumption and Production; (13) Climate Action; (14) Life Below Water; (15) Live on Land were discussed in this research. Each of these goals were given a score of 1 if it was included in the company's sustainability report so the maximum score was 5. The following formula was used to calculate the SDGs Disclosure score:

$$SDGs\ Disclosure\ Score = \frac{Number\ of\ SDGs\ Disclosed}{Maximum\ number\ of\ SDGs\ items\ to\ disclosed} \text{x } 100\% \quad (7)$$

Regression analysis was used in this study because it can measure the strength of influence between two or more variables. Furthermore, moderation regression analysis was used to determine the role of moderation variables. The regression model in this study was as follows.

Equation 1: $FV = \beta + \beta 1X1 + \beta 2X2 + \beta 3X3 + e$ (1)

Equation 2: $FV = \beta + \beta 1X1_t + \beta 2X2 + \beta 3X3 + \beta 4X1Z + \beta 5X2Z + \beta 6.X3Z + e$ (2)

Where Y was the firm value, X1 was green innovation, X2 is greenhouse gas emissions, X3 was eco-efficiency, and Z was SDGs disclosure.

RESULT AND DISCUSSION

Selection of Estimation Models

CHOW test (CEM vs FEM)

This test was carried out to choose between the common effect model or the fixed effect model.

Table 2: Common Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.077739	0.094578	0.821963	0.4137
X1	0.670614	0.066231	10.12544	0.0000
X2	-0.056417	0.010519	-5.363213	0.0000
X3	0.005136	0.004607	1.114807	0.2685
Z	-0.209212	0.038057	-5.497280	0.0000

Source: Data processed with Eviews, 2023

Table 3: Fixed Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.032282	0.095858	0.336768	0.7375
X1	0.484537	0.025596	18.93037	0.0000
X2	-0.057195	0.009276	-6.166069	0.0000
X3	0.005457	0.003684	1.481297	0.1438
Z	-0148116	0.020579	-7.197333	0.0000

Source: Data processed with Eviews, 2023

Table 4: CHOW Test

Effects Test	Statistic	d.f.	Prob.
Cross-section F	46.992779	(15,60)	0.0000
Cross-section Chi-square	203.631174	15	0.0000

Source: Data processed with Eviews, 2023

From the chow test Table above, it can be seen that the prob value was <0.05. Therefore, the model chosen was fixed effect. Next, model testing continued with the Hausman test to compare the fixed effect model and the random effect model.

Hausman test (FEM vs REM)

Table 5: Random Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.045685	0.089808	0.508689	0.6125
X1	0.491880	0.024949	19.71548	0.0000
X2	-0.057036	0.008315	-6.859087	0.0000
X3	0.004962	0.003358	1.477950	0.1436
Z	-0.152261	0.020058	-7.591096	0.0000

Source: Data processed with Eviews, 2023

Table 6: Hausman Test

Test Summary	Chi-Sq. Statistic	d.f.	Prob.
Cross-section random	8.476312	4	0.0756

Source: Data processed with Eviews, 2023

From the Hausman test Table above, it can be seen that the prob. value was > 0.05. Therefore, the model chosen was the random effect model. Because REM was selected, the test was continued with the Langrange Multiplier test.

Langrange multiplier test (CEM vs REM)

Table 7: LM Test

Null (no rand. effect) / Alternative	Cross-section One-sided	Period One-sided	Both
Breusch-Pagan	102.9128 (0.0000)	0.035063 (0.8515)	102.9479 (0.0000)
Honda	10.14460 (0.0000)	-0.187252 (0.5743)	7.040905 (0.0000)
King-Wu	10.14460 (0.0000)	-0.187252 (0.5743)	4.488282 (0.0000)
GHM	--	--	102.9128 (0.0000)

Source: Data processed with Eviews, 2023

The results of the LM test with Breusch-Pagan above showed that probability value was 0.0000 < 0.05. Therefore, the model chosen was the random effect model. Next, classical assumptions were tested using the selected assumption model.

Classic Assumption Test

Normality test

The aim of the normality test is to test a regression model where confounding or residual variables have a normal distribution (Hamid et al., 2020).

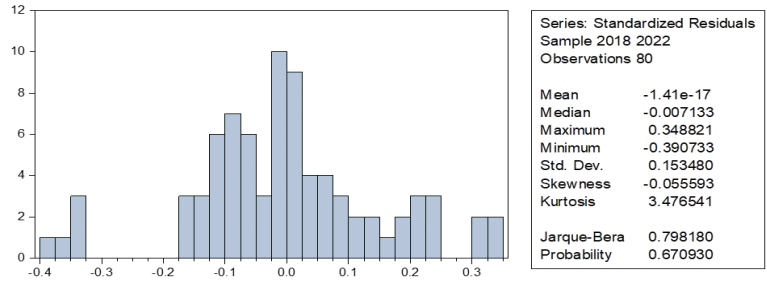

Figure 2: Normality Test Results

The probability value was 0.670930. This value met the requirements of the data normality test, as the value of prob.was > 0.05 and the data was normal.

Multicollinearity test

The multicollinearity test is used to determine whether there are deviations from the classic assumption of multicollinearity, the linear relationship between the independent variables of the regression model (Matondang & Nasution, 2021).

Table 8: Multicollinearity Test Results

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	0.008945	32.11970	NA
X1	0.004386	2.868016	1.141008
X2	0.000111	6.347812	1.637311
X3	2.12e-05	48.26642	1.680119
Z	0.001448	2.081657	1.082203

Source: Data processed with Eviews, 2023

The results of the multicollinearity test above showed that each variable had a VIF value < 10. This meant that there was no multicollinearity in the regression model.

Heteroscedasticity Test

The presence of variables in the regression model that are not the same (constant) indicates the tendency of heteroscedasticity. On the other hand, if the variance of the regression model variables has the same value (constant), this shows tendency of homoscedasticity (Hamid et al., 2020). The heteroscedasticity test was carried out using the Breusch-Pagan-Godfrey Test.

Table 9: Heteroscedasticity Test Results

Statistic	Value	Test	Probability
F-statistic	0.440217	Prob. F (4,75)	0.7791
Obs*R-squared	1.835173	Prob. Chi-Square (4)	0.7660
Scaled explained SS	2.340938	Prob. Chi-Square (4)	0.6733

Source: Data processed with Eviews, 2023

From the results of the breusch-pagan-godfrey test above, it was seen that the value of prob. Chi square > 0.05. This value showed that heteroscedasticity did not occur in the regression model.

Partial test (t-test)

Partial test (t-test) is a test carried out to determine whether there is an influence of the independent variable on the dependent variable.

Table 10: Partial Test Results (t-Test)

Dependent Variable: Y
Method: Panel EGLS (Cross-section random effects)
Date: 07/06/23 Time: 20:31
Sample: 2018 2022
Periods included: 5
Cross-sections included: 16
Total panel (balanced) observations: 80
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.024486	0.118173	0.207204	0.8364
X1	0.436833	0.032161	13.58284	0.000
X2	-0.065233	0.010987	-5.937516	0.000
X3	0.006641	0.004474	1.484321	0.1419

Source: Data processed with Eviews, 2023

From the test results it was seen that the value of probability for variables X1 and X2 < 0.05. It meant that variables X1 and X2 had a significant impact on variable Y. While for X3 the probability value > 0.05

which reflected that variable X3 did not have a significant impact on variable Y. This meant that changes in X3 didnot significantly affect Y, suggesting that X3 was not an important predictor or determinant of Y in the context of the analysis.

Moderation Testing

In this research, MRA was used to test the role of moderating variables of SDGs disclosure on the impact of green innovation, greenhouse gas emissions and eco-efficiency on firm value.

Table 11: Moderation Test Results

Dependent Variable: Y
Method: Panel EGLS (Cross-section random effects)
Date: 07/06/23 Time: 20:36
Sample: 2018 2022
Periods included: 5
Cross-sections included: 16
Total panel (balanced) observations: 80
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.178346	0.091395	-1.951377	0.0560
X1	7.576279	2.899541	2.612924	0.0115
X2	-0.033612	0.019055	-1.763984	0.0832
X3	-0.004234	0.009718	-0.435706	0.6647
Z	7.386380	2.915371	2.533599	0.0141
X1Z	-7.529326	2.916100	-2.581985	0.0125
X2Z	0.050523	0.017083	2.957565	0.0045
X3Z	0.013744	0.009393	1.463215	0.1490

Source: Data processed with Eviews, 2023

From the test results it was seen that the value of prob. For variables X1Z and X2Z it was < 0.05 while for X3Z the value of prob.was > 0.05. It meant that variables Z could moderate the effect of variable X1 and X2 on variable Y. On the contrary, variable Z could not moderate the effect of variable X3 to Y.

The discussion regarding these results is presented as follows:

Green Innovation on Firm Value

Based on partial test results, it was found that the green innovation variable had a positive effect on the firm value variable, where the significance value was 0.0000 <0.05 so it was concluded that hypothesis 1 was accepted.

These results are supported by the Legitimacy Theory, which emphasized that when companies manage their business, they participated in the social system that existed in society. By adopting a green approach to innovation, businesses can gain legitimacy and increase their chances of long-term survival by addressing environmental issues. This can be seen in the coefficient value which pointedin a positive direction, firm value will increase along with the increase in green practices implemented by the company, which will have an impact on company performance and value.

This finding is supported by previous research such as research by Dai & Xue (2022), Wicaksono et al (2021), Zhang et al (2020), Agustia et al (2019), and Yao et al (2019) which also obtained results Similarly, green innovation had a positive effect on firm value.

GHG Emission on Firm Value

Based on partial test results, it was found that the greenhouse gas emission variable had a negative effect on the firm value variable, where the significance value was 0.0000 < 0.05 so it was concluded that Hypothesis 2 was accepted.

These results are supported by the Stakeholder Theory. This Theory basically says that companies must provide benefits to stakeholders or stakeholders apart from acting in their own interests.

With the emergence of regulations regarding greenhouse gas emissions, companies continue to try to improve efficiency so that they can reduce their emissions every year. Research shows that there is a negative correlation between greenhouse gas emissions and firm value: the higher a company's emissions, the lower its value. Previous studies, such as those conducted by Choi & Luo (2020), Saka & Oshika (2018), and Cooper (2018), support this finding.

Eco-efficiency on Firm Value

Based on partial test results, it was found that the eco-efficiency variable had no effect on the firm value variable, where the significance value was 0.1419 > 0.05 so it was concluded that Hypothesis 3 was rejected.

The results showed that the environmental efficiency variable dids not affect firm value. This showed that the level of environmental efficiency of a company to fulfill legitimacy between the company and society was not able to help convince investors to invest in it. This finding supports previous research by Safitri et al., (2019), which found that there was no significant direct influence between environmental efficiency and firm value. Environmentally friendly goods and services are often considered unprofitable because they cost more money. Ultimately, this is seen as a wasteful activity that can reduce firm value to investors.

Indonesian companies in sectors like manufacturing may experience limited firm value impact from eco-efficiency due to lower regulatory enforcement compared to more developed markets. The "Green Industry" initiatives promoted by the Indonesian government may have had varying levels of effectiveness across different sectors. Government policies such as the "Low Carbon Development" initiative aim to promote eco-efficiency. However, the effectiveness of these policies in enhancing firm value may be inconsistent across sectors and regions. While some Indonesian firms benefit from government incentives for eco-efficient practices, others may face challenges in translating these practices into tangible financial benefits due to varying levels of regulatory support and market readiness.

Eco-efficiency is an essential indicator of sustainable development. Eco-efficiency measurement is calculated in the form of value or cost related to the economic aspect of the product or service and the influence of the environment on indicators such as materials, energy, and water. In simple terms, the concept of eco-efficiency produces more with less environmental impact (Petchkaewkul et al., 2016). Data from the Global Carbon Budget states that the level of CO_2 emissions in Indonesia from 1889-2022 continued to increase until it reaches 2.5 tons in 2022. So, more effort and time is needed to reduce CO2 emissions, especially in Indonesia, and maximize the company's value. The results of this study are also in line with Eisenmenger et al., (2020).

According to Martawadaya et al. (2021), while the transition to a green economy is featured in the national constitution and the 2020–2024 development plan, the economic recovery efforts following the Covid-19 pandemic have largely neglected environmental concerns. This reflects a gap between strategic planning and actual implementation. Despite the opportunity to bolster the green economy through substantial government stimulus, the country continues to rely heavily on extractive industries and primary commodities that harm the environment, thus not fully leveraging the chance to advance green economic goals.

SDGs Disclosure Moderates Green Innovation on Firm Value

The test results showed that the SDGs disclosure variable can moderate the effect of the green innovation variable on the firm value variable, where the significance value was 0.0125 < 0.05 so it can be concluded that Hypothesis 4 is accepted. However, the coefficient value showed -7.529326, which meant that SDGs moderated by weakening the effect of green innovation on firm value. The results obtained by the researchers were in line with research by Kurniawan, Sofyani, and Rahmawati (2018) which showed that disclosure of sustainability in the environmental category had a negative effect on firm value.

The moderating effect of SDGs disclosure which weakened the influence of green innovation on firm value could be due to the fact that the research observation year includes a year in which sustainability reports are not yet required to be reported. The company refers to regulations from the Financial Services Authority which require issuers in certain years to report their environmental performance in a sustainability report based on the scale of their business. POJK No. 51/POJK.03/2017 contains the implementation of sustainable finance for issuers from public companies, Financial Services Institutions (LJK). In article 10 paragraph 6 POJK no. 51/POJK.03/2017 explains that only banking issuers and financial institutions are required to release sustainability reports before 2020.

SDGs Disclosure Moderates Greenhouse Gas Emissions on Firm Value

The test results showed that the SDGs disclosure variable can moderate the effect of the greenhouse gas emission variable on the firm value variable, where the significance value was 0.0045 < 0.05 so it was concluded that Hypothesis 5 was accepted. The coefficient value showed a result of 0.050523, which meant that SDGs moderated by strengthening the effect of greenhouse gas emissions on firm value.

As stated in the Signal Theory, management will take action to inform investors about the state of the company due to limited information from outside parties. Based on these statistical results, it can be concluded that these results are in accordance with the Signal Theory.

Disclosure of SDGs information related to the environment, especially Goal 13 regarding environmental action, can increase the influence of greenhouse gas emissions on firm value. This shows that the market reacts positively to information released regarding companies' openness about the greenhouse gas emissions they produce, companies' efforts to reduce greenhouse gas emissions, and the results of those efforts.

SDGs Disclosure Moderates Eco-efficiency on Firm Value

The test results showed that the SDGs disclosure variable cannot moderate the effect of the eco-efficiency variable on the firm value variable, where the significance value is 0.1490 > 0.05 so was concluded that Hypothesis 6 was rejected. The eco-efficiency variable moderated by SDGs disclosure cannot significantly influence firm value. The fact that the company has taken part in achieving sustainable environmental goals has yet to convince the market that it has managed its natural resources correctly. In addition, the national SDGs, especially in Indonesia, must be evaluated to achieve maximum results. Indonesia's development programs and impacts must be more balanced, and the development gap between western and eastern Indonesia is still vast. Achieving the SDGs requires the work of the government and all corporate stakeholders. So, achieving the SDGs target in a short period of time requires the synergy of all parties (DRPM ITS, 2024).

Investors may be aware of the phenomenon of "SDGs Washing", which is when companies make unclear or false claims about their contribution to the SDGs for marketing purposes without actually taking the necessary actions to support the achievement of the SDGs. According to research conducted by Heras-Saizarbitoria, Urbieta, and Boiral (2022), not many businesses provide specific information about their contribution and approach to the SDGs in detail.

If a company's SDGs disclosure is superficial or not well-integrated into its overall reporting, it might not have the desired impact on firm value. For instance, a company might list its sustainability goals without demonstrating concrete achievements or how these align with eco-efficiency measures. In Indonesia, companies might use different frameworks and metrics for reporting their SDGs efforts. For example, some firms may follow global standards like the Global Reporting Initiative (GRI), while others might use local or industry-specific guidelines, leading to varied and non-standardized disclosures.

Indonesian firms might invest in eco-efficiency and SDGs alignment with expected long-term benefits. However, if the market prioritizes immediate financial returns, such as quarterly earnings, the short-term impact of SDGs disclosure on firm value may appear insignificant. Moreover, industries such as agriculture and forestry may be more sensitive to sustainability disclosures due to environmental pressures and regulatory requirements. However, sectors like technology or services might not see the same degree of impact from SDGs disclosures, leading to variability in the moderating effect.

This results align with the research Damas et al., (2021). Companies often focus on short-term results and financial gains, which can prevent them from investing in sustainable innovation. The SDGs require a long-term approach that may only sometimes align with short-term business goals.

CONCLUSION

This research aimed to determine the role of SDGs disclosure in moderating the effects of green innovation, GHG emissions, and eco-efficiency on

firm value. Using the data samples taken from companies included in the SRI-KEHATI index from 2018 to 2022, the hypotheses were tested empirically. A quantitative approach was used, with panel data processed using EVIEWS 10. The sample was selected using purposive sampling, resulting in 16 companies. Over a period of five years, this provided a total of 80 observations. Secondary data were obtained from the internet, specifically from the official IDX website (www.idx.co.id), the *Yayasan Keanekaragaman Hayati Indonesia* website (www.kehati.or.id), and the official websites of each company.

The results were as follows: green innovation and GHG emissions had a partial effect on firm value. An increase in green innovation enhanced firm value, whereas an increase in GHG emissions led to a decrease in firm value. Eco-efficiency, however, did not have a significant effect on firm value. Additionally, SDGs disclosure moderated the impact of green innovation and GHG emissions on firm value, but it did not moderate the effect of eco-efficiency on firm value.

Several policy recommendations support green innovation, greenhouse gas emissions, and SDGS disclosure. The government must continue to provide policy support that encourages investment in green innovation, eco-efficiency, and reducing greenhouse gas emissions. This can be in the form of tax incentives, subsidies for research and development, and financial support for companies that implement green practices. In addition, it is necessary to encourage companies to disclose the SDGs in company reports because it can increase accountability and attract investors who care about sustainability. Collaboration between governments, academia, and the private sector is also needed to share knowledge and resources in developing green technologies. These partnerships can accelerate innovation and the implementation of sustainability practices. Implementing these policy recommendations is expected to create a more supportive environment for companies to implement green innovation, reduce greenhouse gas emissions, and increase eco-efficiency, which can ultimately increase company value. And, of course, contribute to sustainable development.

We discovered limitations in our study. We focused only on companies that hadbeen listed on the SRI-KEHATI index, so the result cannot be generalized. Therefore future studiescould widen the scope of research to other types of companies listed on the Indonesian Stock Exchange.

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