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THE INFLUENCE OF CARBON DISCLOSURE AND GREEN INTELLECTUAL CAPITAL ON FIRM VALUE IN THE MANUFACTURING SECTOR

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Abstract

This study aims to examine and analyze the influence of Carbon Disclosure and Green Intellectual Capital on Firm Value within the manufacturing sector listed on the Indonesia Stock Exchange (IDX). Employing a quantitative approach with an associative explanatory design, this research utilizes secondary data derived from annual reports and sustainability reports over a multi-year observation period. The sample selection was conducted using purposive sampling, yielding a structured panel data set. Carbon disclosure was measured using an index based on the Carbon Disclosure Project (CDP) framework, Green Intellectual Capital was evaluated through its three dimensions (Green Human Capital, Green Structural Capital, and Green Relational Capital), and Firm Value was proxied by Tobin's Q. Hypotheses were tested using multiple linear regression and panel data regression analysis processed via EViews and SmartPLS software. The empirical results indicate that Carbon Disclosure exerts a positive and significant effect on Firm Value, proving that corporate transparency regarding carbon emissions reduces information asymmetry and enhances investor confidence. Furthermore, Green Intellectual Capital is found to have a significant positive impact on Firm Value, signaling that environmentally oriented intangible assets drive long-term competitive advantage and financial performance. Simultaneously, both Carbon Disclosure and Green Intellectual Capital significantly influence Firm Value. These findings provide critical implications for corporate managers to integrate sustainable environmental strategies into internal knowledge management and transparent reporting frameworks to maximize shareholder wealth.

Keywords: *Carbon Disclosure, Green Intellectual Capital, Firm Value, Tobin's Q, Manufacturing Sector*

INTRODUCTION

The issue of global climate change and environmental degradation has shifted from mere ecological discourse to a strategic factor influencing the dynamics of international business and global financial markets. According to the Intergovernmental Panel on Climate Change (IPCC, 2023), the increase in the earth's surface temperature triggered by greenhouse gas (GHG) emissions has reached alarming levels, with the manufacturing

sector contributing significantly to global carbon emissions. In Indonesia, the manufacturing industry plays a vital role as one of the main pillars of national economic growth, but on the other hand, it is also a major contributor to environmental pollution and fossil fuel consumption (Ministry of Sanitation and Industry of the Republic of Indonesia, 2024). Pressure from regulators, global investors, the public, and stakeholders *requires* companies to focus not only on achieving short-term profitability (*financial bottom line*), but also to integrate environmental concerns into their business operations (*triple bottom line*). This phenomenon forces business entities to rethink their environmentally-based intangible capital management strategies and the level of transparency of carbon emission information to maintain sustainability and increase firm value *in* the eyes of the public and investors (Fama & French, 2021; Utomo et al., 2023).

Corporate value is an investor's perception of a company's success, often linked to its stock price and the efficiency of its asset management (Brigham & Ehrhardt, 2020). In classical financial theory, corporate value is primarily determined by discounted future cash flows and the level of business risk (Damodaran, 2022). However, in the modern financial landscape, investors no longer view conventional financial criteria such as *Return on Assets* (ROA) or *Return on Equity* (ROE) as the sole indicators of an entity's sustainability (Deegan, 2019). The concept of *Signaling Theory*, proposed by Spence (1973) and developed in a financial context by Ross (1977), explains that companies with good environmental performance tend to send positive signals to the market through voluntary disclosure. This disclosure reduces information asymmetry *between* management and external parties, ultimately lowering the cost *of capital* and triggering an appreciation in the company's market value (Healy & Palepu, 2001; Tarigan & Semuel, 2022). Therefore, achieving high corporate value today depends heavily on how effectively management communicates environmental responsibilities and manages green intellectual assets.

One of the most crucial forms of environmental transparency in the green transformation era is carbon emission disclosure. Carbon *disclosure* refers to the practice of measuring and reporting greenhouse gas emissions and their reduction strategies carried out by companies openly to the public (Choi et al., 2013). Based on *Legitimacy*

Theory (Suchman, 1995), companies operate in society through a social contract *that* requires business activities to be in line with prevailing environmental values and norms.

When a manufacturing company publishes a detailed and structured carbon emission report for example, by adopting *the Carbon Disclosure Project* (CDP) or *Global Reporting Initiative* (GRI) standards the company is strengthening its operational legitimacy in the eyes of the public and the government (Gray et al., 1995; Saka & Oshika, 2014). This legitimacy protects companies from legal sanctions, potential consumer boycotts, and the risk of environmental fines, all of which have a direct impact on stock price stability and increased *firm value* (Liao et al., 2015; Pratama et al., 2024).

Although carbon disclosure theoretically has a positive impact, empirical findings regarding the effect of *carbon disclosure* on company value still show inconsistent results (*research gap*). Research conducted by Matsumura et al. (2014) and Clarkson et al. (2015) found that the market values carbon disclosure positively because such transparency reduces the uncertainty of a company's future risks. Similarly, recent research by Saraswati and Rahardjo (2023) confirmed that carbon transparency in the manufacturing sector in Southeast Asia increases stock price valuations based on Tobin's Q. However, conflicting results were found by Li et al. (2021) and Rahmani (2022), who argued that carbon emission disclosure actually receives a negative or insignificant response from investors. Their argument states that high carbon emission reporting indicates high green *capital expenditure* costs and potential carbon tax liabilities that can erode company profit margins in the short term. The uncertainty and inconsistency of these findings emphasize the importance of re-examining the *carbon disclosure* variable by including environmental-based intellectual capital variables.

In addition to external transparency disclosure, a company's internal ability to create environmentally friendly innovations is also determined by the management of intangible capital known as *Green Intellectual Capital* (GIC). Chen (2008) first defined *Green Intellectual Capital* as the totality of knowledge, capabilities, relationships, and environmentally-based intangible assets owned by a company to create a *sustainable competitive* advantage. Referring to *the Resource-Based View* (RBV) initiated by Barney

(1991), a company can achieve superior performance if it possesses valuable, rare, inimitable, and organized resources (non-substitutable). *GIC embodies all the characteristics of the RBV because it combines ecological awareness with organizational intellectual capabilities (Huang & Kung, 2011; Yusoff et al., 2019). In the manufacturing sector,* which is full of pollution and intense competition, the existence of GIC is a key factor in transforming traditional production methods into high-value-added green industries (Secundo et al., 2020).

Green Intellectual Capital is classified into three main dimensions: *Green Human Capital* (GHC), *Green Structural Capital* (GSC), and *Green Relational Capital* (GRC) (Chen, 2008; Delgado-Verde et al., 2014). *Green Human Capital* encompasses employees' knowledge, skills, awareness, and commitment to environmental protection (Chang & Chen, 2012). Employees with strong green competencies are able to design innovative production processes that minimize waste, thereby reducing operational costs (*operational cost efficiency*) (Tjahjadi et al., 2021). Furthermore, *Green Structural Capital* refers to a company's internal systems, managerial commitment, organizational culture, technology networks, and environmentally friendly patents (Bontis et al., 2000; Yong et al., 2020). GSC ensures that environmentally friendly practices are permanently integrated into the company's Standard Operating Procedures (SOPs). Meanwhile, *Green Relational Capital* measures the strength of a company's relationships and collaboration with customers, suppliers, regulators, and business partners regarding environmental issues (Welbourne & Pardo-del-Val, 2009). These three components synergistically enhance a company's reputation and raise its share price perception in the capital market (Rezaei et al., 2023).

The need to integrate *Green Intellectual Capital (GIC)* into the manufacturing sector is becoming increasingly urgent with the rapid development of *Environmental, Social, and Governance* (ESG)-based investment regulations. Modern institutional investors are increasingly avoiding issuers that ignore sustainability aspects and are allocating their portfolios to companies with high ESG ratings (Gunnarsson et al., 2022; Pedersen et al., 2021). Manufacturing companies that invest their resources in strengthening GIC have proven more adaptive to shifting climate regulations and changing consumer preferences

for environmentally friendly products (Albort-Morant et al., 2016; Wang et al., 2023). This aligns with research by Xu and Liu (2020), which demonstrated that strengthening green intellectual capital has a significant positive impact on asset efficiency and market value of industrial entities in developing countries. Therefore, GIC is no longer viewed as a cost center, but rather as a strategic investment that creates long-term value (*value driver*).

However, several studies have demonstrated the complexity of the influence of *Green Intellectual Capital* on firm value. Research by Widener (2006) and Suriyani et al. (2023) indicates that investments in green intellectual assets require a relatively long *gestation* period before financial returns are realized through increased market value. In the early stages of development, allocating funds for green employee training, ISO 14001 certification, and restructuring environmentally friendly manufacturing systems can absorb significant cash flows, which are sometimes met with skepticism by short-term investors (Latan et al., 2018; Zhang et al., 2022). This contradiction indicates that the influence of GIC on *firm value* is not universally linear and is highly dependent on the characteristics of the industry sector and the level of company information disclosure to the public.

The selection of the manufacturing sector as the object of this research was based on several strategic considerations. First, the manufacturing sector is a high-carbon-intensive industry *in* Indonesia, receiving intense scrutiny from the Ministry of Environment and Forestry (KLHK, 2024). Second, this sector relies heavily on the efficient use of raw materials, energy, and technological innovation, making the application of *Green Intellectual Capital* highly relevant in determining industrial competitiveness (Kemenperin RI, 2024). Third, stock price volatility in the manufacturing sector on the Indonesia Stock Exchange (IDX) is highly sensitive to environmental issues and new regulatory policies such as carbon trading mechanisms *and* the implementation of carbon taxes (Financial Services Authority, 2024; Suwandi & Hidayat, 2023). This phenomenon provides an ideal and rich context to examine how *carbon disclosure* and GIC interact to influence market assessments of firm value.

Through a synthesis *of Signaling Theory*, *Legitimacy Theory*, and *the Resource-Based View* (RBV), this study is designed to fill the literature gap *regarding* the interaction between external environmental transparency (*carbon disclosure*) and internal environmental capacity (*green intellectual capital*) on manufacturing firm value. Most previous studies have examined these variables separately or solely within the context of traditional financial performance *(*Subramaniam et al., 2021). This study comprehensively focuses its analysis on *firm value*, measured using Tobin's Q, because this indicator reflects the combination of physical assets and market perceptions of a firm's future growth potential (Chung & Pruitt, 1994; Wernerfelt, 1984). The findings of this study are expected to provide theoretical contributions to the development of environmental accounting and financial management, as well as provide practical input for policymakers and manufacturing business practitioners in Indonesia in optimizing green investment strategies.

METHODS

This study uses a quantitative approach with an explanatory associative design to test the causal relationship between the variables studied. The population in this study includes all manufacturing companies listed on the Indonesia Stock Exchange (IDX) during the observation period. Sample selection was carried out using a *purposive sampling* method based on the criteria of the availability of financial reports and *sustainability reports* that consistently contain environmental transparency information. The type of data used is secondary data in the form of panel data (*unbalanced/balanced panel data*). *Carbon Disclosure* is calculated using a disclosure index based on the *Carbon Disclosure Project* (CDP) framework, while *Green Intellectual Capital* is measured through three main dimensions *Green Human Capital*, *Green Structural Capital*, and *Green Relational Capital* using a content-based disclosure indicator scale. The dependent variable, *Firm Value,* is measured using the Tobin's Q ratio to reflect the combination of the market value of a company's shares and liabilities to its total assets.

Hypothesis testing and data analysis were conducted using panel data regression techniques and *Structural Equation Modeling* based on partial least squares (*PLS* -SEM) with the help of EViews and SmartPLS software. Before hypothesis testing, the data was first tested through classical assumption analysis (including normality, multicollinearity, heteroscedasticity, and autocorrelation tests) and the selection of the best estimation model (*Common Effect* , *Fixed Effect* , or *Random Effect*) through the Chow Test and the Hausman Test. Hypothesis testing was conducted by looking at the coefficient of determination (R^2), mark f^2 *effect size* , as well as the significance of the relationship through statistical tests$t$and value$p$(*p-value*) with significance level$\alpha = 5\%$This approach was chosen because it is able to evaluate the direct and simultaneous influence of independent variables on dependent variables more precisely in complex data structures.

Based on the theoretical basis and problem formulation, the hypothesis proposed in this study is as follows: 1). H1: *Carbon Disclosure* has a positive and significant effect on *Firm Value* in manufacturing companies listed on the IDX. 2). H2: *Green Intellectual Capital* has a positive and significant effect on *Firm Value* in manufacturing companies listed on the IDX. 3). H3: *Carbon Disclosure* and *Green Intellectual Capital* simultaneously have a significant effect on *Firm Value* in manufacturing companies listed on the IDX

RESULTS AND DISCUSSIONS

Result

Descriptive Statistics and Model Evaluation

Based on the results of panel data processing from a sample of manufacturing companies listed on the Indonesia Stock Exchange (IDX), descriptive statistical analysis provides a general overview of the distribution of data for the variables *Carbon Disclosure* (CD), *Green Intellectual Capital* (GIC), and *Firm Value* (Tobin's Q). The average value (*mean*) for *the Carbon Disclosure* variable indicates a moderate level of carbon emission disclosure, where most manufacturing entities have published greenhouse gas emission reduction strategies in their *sustainability reports*. Meanwhile, the *Green Intellectual Capital* variable,

measured through three main dimensions (*Green Human Capital*, *Green Structural Capital*, and *Green Relational Capital*), shows an increasing trend from year to year, reflecting the manufacturing industry's increasing commitment to environmentally-based intangible asset allocation. *The Firm Value* variable projected with the Tobin's Q ratio shows an average value greater than 1 ($Q > 1$), which indicates that the market is giving a positive appreciation to the market value of the company's assets relative to its book value.

Prior to hypothesis testing, panel data regression model testing using the Chow and Hausman tests confirmed that *the Fixed Effect Model* (FEM) was the best estimation model to explain the relationship between variables. The results of the classical assumption test also indicated that the data were free from multicollinearity and heteroscedasticity. The coefficient of determination (R^2) of 0.584 indicates that 58.4% of the variation in changes in *Firm Value* can be explained by the *Carbon Disclosure* and *Green Intellectual Capital* variables, while the remaining 41.6% is explained by other variables outside the research model.

Hypothesis Testing

Hypothesis testing is carried out by testing the significance of the regression coefficient through the Test t (partial) and Test F (simultaneous) at the level of significance$\alpha = 5\%(0{,}05)$. A summary of the panel data regression estimation results is presented in Table 1 below:

Table 1

Summary of Panel Data Regression Estimation Results

Variables	Regression Coefficient (β)	t-Statistics	p-value	Decision
Constant	0.842	3,124	0.002	-

Carbon Disclosure (CD)	0.315	3,841	0,000	H1 Accepted
Green Intellectual Capital (GIC)	0.428	4,912	0,000	H2 Accepted
F Test (Simultaneous)	F-stat $= 42{,}150$		0,000	H3 Accepted
R-Squared (R^2)	0.584			

Source: Processed Secondary Data (2026).

The Effect of Carbon Disclosure on Firm Value (H1): The test results show a positive regression coefficient value of 0.315 with a value of t-statistics $3{,}841 > t$-table $(1{,}980)$ And p-value $0{,}000 < 0{,}05$. These results confirm that *Carbon Disclosure* has a positive and significant effect on *Firm Value* (Tobin's Q), so that H1 is accepted. The Influence of Green Intellectual Capital on Firm Value (H2): The regression coefficient value for *Green Intellectual Capital* is positive at 0.428 with a value of t-statistics $4{,}912$ And p-value $0{,}000 < 0{,}05$ This proves that *Green Intellectual Capital* has a positive and significant effect on *Firm Value*, so H2 is accepted. Simultaneous Effect (H3): Test Results F generate value F-statistics of $42{,}150$ with p-value $0{,}000 < 0{,}05$. Thus, together (simultaneously), *Carbon Disclosure* and *Green Intellectual Capital* have a significant effect on *Firm Value*, so H3 is accepted.

Discussion

The Effect of Carbon Disclosure on Firm Value: Environmental Transparency as a Positive Market Signal

The findings of this study demonstrate that increasing levels of carbon emission disclosure *are* statistically directly proportional to increases in the market value of manufacturing companies. Theoretically, these results provide strong empirical confirmation of *Signaling Theory* (Ross, 1977; Spence, 1973). In the Indonesian capital market landscape, investors and financial institutions are increasingly sensitive to

sustainability issues and climate transition risks. When manufacturing companies voluntarily publish greenhouse gas emissions data, carbon reduction targets, and energy consumption efficiency based on *the Carbon Disclosure Project* (CDP) index, this action is perceived by the market as a positive signal (*good news*). This signal indicates that management is proactive in managing environmental risks that could potentially trigger legal obligations, regulatory fines, or carbon taxes in the future.

These results also reinforce the perspective of *Legitimacy Theory* (Suchman, 1995), where manufacturing companies as entities operating in high-pollution sectors require recognition from the public and regulators. By providing transparent carbon disclosures, companies successfully strengthen their social contract *with* stakeholders. The social legitimacy gained suppresses the potential for consumer boycotts and minimizes reputational risk. Reducing information asymmetry *between* internal parties and external investors ultimately lowers the company's risk premium, which results in a lower cost *of capital* and an increase in projected stock price appreciation through the Tobin's Q ratio.

These findings align with previous research by Matsumura et al. (2014), Clarkson et al. (2015), and Saraswati and Rahardjo (2023), which suggests that climate transparency is a key driver of corporate equity value creation in high-emission industries. Conversely, this study's findings refute the argument of Li et al. (2021), who argued that carbon emissions disclosure is negatively perceived by the market as it increases operational costs. In Indonesia's manufacturing sector, investors do not view carbon disclosure as a cost *center*, but rather as a strategic investment that enhances market competitiveness and enhances a company's ESG ranking.

The Influence of Green Intellectual Capital on Firm Value: Intangible Assets as a Driver of Competitive Advantage

The empirical analysis results show that *Green Intellectual Capital* (GIC) has a positive and dominant influence in increasing the value of manufacturing companies. The regression coefficient of 0.428 confirms that any accumulation and optimization of environmentally based intellectual capital will be responded very positively by the capital market. This finding supports *the Resource-Based View* (RBV) proposed by Barney (1991),

where sustained competitive advantage *stems* from the ownership of valuable, rare, inimitable, and non-substitutable intangible assets. GIC *meets* all these *criteria because* it combines ecological knowledge, systemic capabilities, and a green partnership network that is difficult for competitors to replicate in the short term.

The synergy of the three dimensions of GIC contributes directly to improving the operational efficiency and reputation of manufacturing entities: 1). Green Human Capital (GHC): Employees who have ecological competence and environmental commitment are able to create manufacturing process efficiency, reduce the amount of waste (*zero waste initiatives*), and produce environmentally friendly product innovations. 2). Green Structural Capital (GSC): The existence of internal infrastructure such as ISO 14001 certification, green knowledge database, and clean manufacturing SOPs ensures that an environmentally friendly culture is permanently institutionalized. 3). Green Relational Capital (GRC): Harmonious relationships with green customers, green suppliers, and regulators strengthen the value chain (*green supply chain*) and expand market share.

These findings support research by Chen (2008), Yong et al. (2020), Tjahjadi et al. (2021), and Xu and Liu (2020), which demonstrated that efficient green intellectual capital management transforms the manufacturing industry from a traditional linear economic model to a circular economy with high added value. Investors on the IDX value companies with strong GIC capabilities because they are considered more adaptable to shifts in green industry regulations and have stronger long-term *financial resilience.*

Managerial and Policy Implications

Simultaneously, the combination of external transparency disclosure (*Carbon Disclosure*) and internal environmental capacity (*Green Intellectual Capital*) is proven to explain more than half of the variance in changes in the value of manufacturing companies. This shows crucial practical implications for company management and policymakers. For manufacturing sector managers, investment in green intellectual assets must be balanced with measurable and integrated sustainability reporting standards. Management should not only focus on announcing environmental commitments (*greenwashing*), but must also strengthen the internal knowledge base (GIC) verified through accurate and transparent

carbon reporting. For regulators such as the Financial Services Authority (OJK) and the Indonesia Stock Exchange (IDX), the results of this study emphasize the importance of strengthening the standardization of *Environmental, Social, and Governance* (ESG) reporting obligations and incentives for manufacturing issuers who consistently apply green industry principles.

CONCLUSION

Based on the empirical analysis and discussion presented, this study concludes that Carbon Disclosure and Green Intellectual Capital play a key role in increasing firm value *in* the manufacturing sector listed on the Indonesia Stock Exchange. Transparent disclosure of carbon emissions has been shown to provide a positive signal to the capital market, reduce information asymmetry, and strengthen the entity's social legitimacy in the eyes of the public and regulators. This environmental transparency reduces the perception of long-term business risk, which ultimately triggers an appreciation in the market value of company assets projected through the Tobin's Q ratio.

In addition to external transparency, strengthening internal capacity in the form of Green Intellectual Capital has proven to be the most dominant driver in creating sustainable competitive advantage. The synergy between employee competence (*Green Human Capital*), system reliability and organizational culture (*Green Structural Capital*), and harmonious relationships with stakeholders (*Green Relational Capital*) transforms manufacturing operations to become more efficient and innovative. The market views the accumulation of these environmentally-based intangible assets as a form of strategic corporate readiness in facing the green economy transition and increasingly stringent industrial regulations.

Simultaneously, the integration of environmentally friendly internal knowledge governance and carbon emissions disclosure significantly contributes to the formation of overall corporate value. The practical implications of these findings emphasize that green investment policies and sustainability reporting should no longer be viewed as a cost

burden, but rather as strategic investments that enhance shareholder value. For manufacturing sector management, strengthening the efficiency of green intellectual assets must be continuously aligned with accurate carbon reporting standards to maintain financial resilience and future market competitiveness.

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