




# “Effects of green intellectual capital, green accounting, and green innovation on firm value: The moderating role of return on assets”

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# EFFECTS OF GREEN INTELLECTUAL CAPITAL, GREEN ACCOUNTING, AND GREEN INNOVATION ON FIRM VALUE: THE MODERATING ROLE OF RETURN ON ASSETS

## Abstract

This study examines the influence of green intellectual capital, green accounting, and green innovation on firm value and return on assets. Green intellectual capital refers to the knowledge and expertise of environmental sustainability, green accounting involves incorporating environmental costs into financial reporting, and green innovation focuses on developing environmentally friendly technologies and processes. Indicators for evaluating these factors include the Green Intellectual Capital Index, Global Reporting Index disclosures for green accounting, and green process and product innovation dimensions for green innovation. The study employs Warp PLS to analyze data from 88 companies listed on the Sustainable and Responsible Investment (SRI-KEHATI) index on the Indonesia Stock Exchange. The findings indicate that green accounting significantly enhances firm value, while green innovation does not show a direct impact. However, all three factors positively influence return on asset (ROA). The moderating role of ROA was found to strengthen the relationship between green intellectual capital and green accounting with firm value, but it did not moderate the effect of green innovation. ROA was used as an indirect financial indicator to formulate the company's profitability and strategic sustainability planning. These results highlight the importance of embedding sustainability into business strategies to enhance financial and environmental performance.

## Keywords

environment, sustainability, green intellectual capital, green accounting

## JEL Classification

L21, M41, Q56

## INTRODUCTION

Environmental sustainability has become a cornerstone of corporate strategy as businesses face increasing pressure from stakeholders, including investors, consumers, and regulators, to adopt eco-friendly practices (Guo et al., 2023; Kafeel et al., 2023; Liu, 2023). Companies are integrating green intellectual capital, green accounting, and green innovation into their operations, not only to reduce environmental impact but also to enhance their financial performance and firm value. Green intellectual capital enables firms to innovate, improve resource efficiency, and minimize environmental risks, which can lead to better financial performance and competitive advantages (Malik et al., 2020). Similarly, green accounting involves incorporating environmental costs and benefits into financial reporting, promoting transparency, and improving investor confidence (Al-Dhaimesh, 2020; Astuti et al., 2022c). By accounting for environmental impacts, firms can optimize resource usage, reduce waste, and demonstrate commitment to sustainability, thereby boosting firm value (Maama & Appiah, 2019). Green innovation is another critical factor, focusing on developing new technologies, products, and processes that reduce environmen-

tal harm (Xie et al., 2019). However, these benefits often take time to materialize, as green innovation requires significant initial investment (Zhang, 2023; Widiyaningsih & Jati, 2024). Despite the growing body of literature on the individual impacts of green intellectual capital, green accounting, and green innovation on firm performance, the combined effects of these factors remain underexplored. In addition, the novelty of this study is the examination of the moderating role of return on assets (ROA) in sustainability-focused firms.

## 1. LITERATURE REVIEW

The knowledge-based view theory underscores the importance of knowledge, advanced technology, rigorous research, and superior service quality in boosting company performance and value. Previous studies emphasize that effective management of human, technological, and financial resources is crucial for achieving high corporate performance. The natural resource-based view suggests that environmental shifts begin with the management of intangible assets, which are crucial for securing a competitive edge and enhancing a company's value (Egbunike & Okoro, 2018). Human resource development should focus on enhancing cost allocation efficiency (Ethika et al., 2019). The concept of green accounting aligns with the resource-based view theory in its treatment of costs (Peng et al., 2024). The knowledge-based view theory highlights the role of knowledge, technology, and research in improving company performance and value, while effective resource management is key to corporate success. The natural resource-based view emphasizes the need to manage intangible assets, such as human capital and green accounting, to gain a competitive edge and enhance company value.

Agency theory posits that the principal, as the company owner, is responsible for providing financial resources and facilities to the organization (Arfara & Samanta, 2023; Astuti et al., 2022a). In contrast, the agent manages the company and is tasked with maximizing the owner's profits and ensuring proper reporting on the company's environmental management efforts (Al-Zu'bi & Albloush, 2022; Astuti et al., 2022b). The agent must also disclose the competencies of human resources, especially those skilled in technology, innovation, and cutting-edge research, to address environmental concerns such as pollution and emissions (Bombiak, 2021). This includes produc-

ing eco-friendly products that differentiate the company from competitors, thereby increasing profitability and enhancing firm value (Rejeki & Ahmar, 2022). However, conflicts often arise between the principal and agent, as principals focus on cost-efficiency, while agents may allocate resources toward environmental initiatives to bolster the company's reputation and human resource quality (Yuvianita et al., 2022). This study also draws on the knowledge-based view theory, which argues that companies should capitalize on their intangible assets, like human capital and innovation, as these assets are difficult for competitors to replicate and are key to gaining a competitive advantage (Dinarjito & Ahmar, 2023; Dzage et al., 2024). Thus, agency theory underscores the inherent tension between owners and managers regarding resource allocation, while the knowledge-based view emphasizes leveraging intangible assets to drive company success.

Firm value is a key measure of a company's performance, reflecting its ability to generate shareholder wealth, which is typically indicated by profit increases and stock price appreciation (Widiyaningsih & Jati, 2024; Zhang et al., 2023). Investors perceive an increase in firm value as a sign of effective resource management by company leaders, and it often signals the company's long-term growth potential. Xu et al. (2021) suggest that maintaining a competitive advantage requires companies to provide added value to customers, often through the application of green principles to natural and human resources (K. Li et al., 2024). This approach not only enhances firm value but also differentiates companies in the marketplace. Companies that issue sustainability reports tend to have a higher market value, as transparency in green practices appeals to environmentally-conscious investors (Revellino & Mouritsen, 2023; Liang et al., 2023). Furthermore, investors are more likely to invest in businesses that disclose green accounting practices and

green intellectual capital, as these practices signify a commitment to long-term sustainability (Malik et al., 2020; Liu, 2023). Numerous studies show that investors prefer companies dedicated to environmental sustainability, as this not only boosts the company's reputation but also enhances firm value in the market (Wang & Dou, 2023; Gonzalez & Peña-Vinces, 2022). Firm value is a crucial measure of a company's performance, indicating its ability to generate shareholder wealth, often linked to profit increases and stock price appreciation. Companies that adopt green principles and issue sustainability reports tend to have higher market value, as investors prioritize transparency in environmental practices and view these as signs of long-term growth potential and sustainability commitment.

Corporate environmental awareness activities can be enhanced by increasing employee knowledge and capacity to generate ideas and innovations that improve company performance while promoting environmental sustainability (Yusliza et al., 2020). To achieve this, companies should focus on cultivating their green intellectual capital, which involves developing human resources with advanced skills and a strong commitment to creating renewable, energy-efficient, and environmentally friendly products. This not only supports profitability but also aligns with sustainable practices. Green intellectual capital incorporates environmental factors into a company's intellectual capital, aiming to enhance employee competence and commitment, which ultimately creates additional corporate value (Xia et al., 2024; Xiao et al., 2023; Safitri et al., 2022). Companies with well-developed green intellectual capital are more efficient and productive, contributing to better resource management and competitive advantage (Malik et al., 2020; Benevene et al., 2021). Corporate environmental awareness can be improved by enhancing employee knowledge and fostering innovation that supports both company performance and environmental sustainability. Developing green intellectual capital, which integrates environmental considerations into human resource skills and commitment, not only boosts profitability but also creates competitive advantages through better resource management and efficiency.

As an intangible asset, green intellectual capital includes knowledge, experience, and innovations related to environmental conservation. Studies such as those by Sidik et al. (2019) have demonstrated its positive impact on company performance, indicating that fostering this asset can lead to substantial improvements in both sustainability and financial outcomes. Moreover, green accounting complements these efforts by integrating environmental and social aspects into the financial reporting process, ensuring business sustainability while supporting profitability. Green accounting practices evaluate the costs and benefits of a company's environmental initiatives, focusing on resource allocation toward the production of eco-friendly goods (Gonzalez & Peña-Vinces, 2022). Egbunike and Okoro (2018) and Astuti et al. (2022c) show that companies adopting green accounting can enhance their financial performance by appealing to the growing market of eco-conscious consumers, further solidifying their competitive advantage. Green intellectual capital, comprising knowledge and innovations focused on environmental conservation, has been shown to positively impact company performance, improving both sustainability and financial outcomes. Green accounting complements this by incorporating environmental and social aspects into financial reporting, helping companies optimize resource allocation for eco-friendly products, enhancing financial performance, and appealing to eco-conscious consumers.

Green innovation involves the development of products, technologies, and business processes designed to minimize environmental pollution from company operations and enhance the sustainability of environmentally friendly firms (He et al., 2023; Li et al., 2024). To strengthen firm value, competitive strategies must focus on creating energy-efficient, environmentally friendly, and cost-effective products (Yu et al., 2022). Current green innovations of interest to stakeholders include renewable energy technologies like solar power, hydropower, hydroelectricity, and biomass, which reduce reliance on fossil fuels and decrease carbon emissions (Sarfray et al., 2023; Schäfer et al., 2023; Wu et al., 2023). Technological and building innovations that lower energy consumption, such as

energy-efficient buildings and systems, aim to reduce production costs and improve product competitiveness (Yin & Zhao, 2024; Zhang & Ma, 2021; Zhong et al., 2024). Green innovation has been shown to positively influence company performance (Trevlopoulos et al., 2021). To produce environmentally friendly products and services, companies must develop human resources with expertise in green technology and innovation, which, in turn, can enhance financial performance and satisfy the needs of the community, investors, and shareholders. Green innovation involves developing products, technologies, and processes that reduce environmental pollution and enhance sustainability, such as renewable energy technologies and energy-efficient systems. By focusing on creating eco-friendly, cost-effective solutions and developing human resources skilled in green technology, companies can improve both financial performance and firm value, as supported by studies showing a positive link between green intellectual capital and firm value.

Green accounting has become an essential tool for companies, as it integrates environmental costs and social dimensions into financial reporting, reflecting the company's commitment to sustainability. By publishing sustainability reports, companies communicate to stakeholders not only their financial performance but also the environmental and social impacts of their operations, products, and services. By disclosing environmental information transparently, companies send a strong positive signal to shareholders, investors, and the public, which enhances their reputation and attracts investment (Ratmono et al., 2024). This transparency fosters trust among stakeholders and indicates responsible management of resources, which can result in increased investor funding. When these funds are properly managed, they can be used to produce high-quality, eco-friendly products, leading to higher profits and improved firm value (Zhang, 2023). Furthermore, Xu et al. (2021) have shown that green accounting positively influences firm value by improving financial metrics like return on assets, demonstrating that sustainable practices not only benefit the environment but also contribute to long-term financial success. The environmen-

tal performance of a company describes the environmental management activity inside the company. Several studies have examined how environmental performance affects the value of a company. Sahetapy (2023) reported that environmental performance had a positive effect on company value. These results are opposite to those of Carandang and Ferrer (2020). They concluded that environmental performance did not affect company value. The inconsistency in these studies suggests the possibility of financial performance acting as a moderating variable between environmental performance and company value. Green accounting is vital for companies as it integrates environmental and social costs into financial reporting, signaling a commitment to sustainability and enhancing transparency.

This study investigates the impact of green intellectual capital, green accounting, and green innovation on firm value, with return on assets as a moderating role. The research hypotheses developed in this study are (see Figure 1):

$H_1$ : *Green intellectual capital has a positive effect on firm value.*

$H_2$ : *Green accounting has a positive effect on firm value.*

$H_3$ : *Green innovation has a positive effect on firm value.*

$H_4$ : *Return on asset has a positive effect on firm value.*

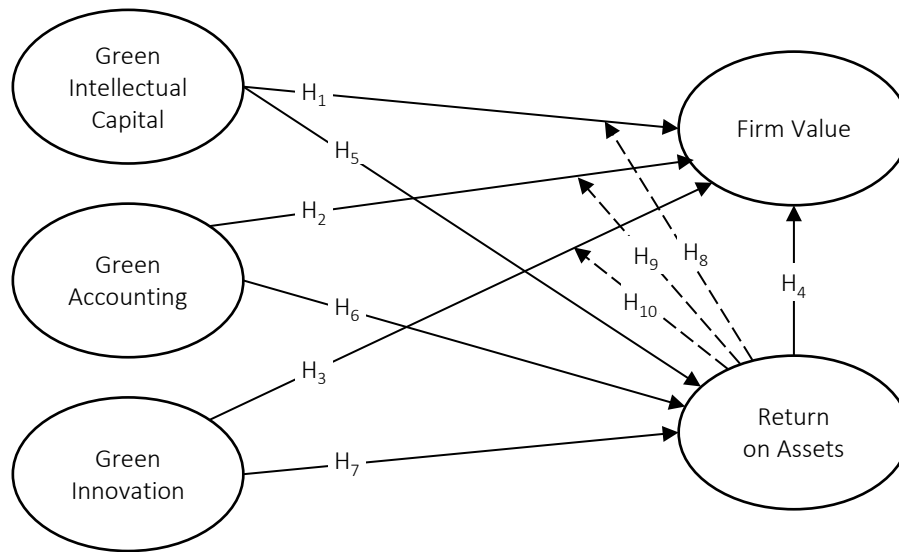
$H_5$ : *Green intellectual capital has a positive effect on ROA.*

$H_6$ : *Green accounting has a positive effect on ROA.*

$H_7$ : *Green innovation has a positive effect on ROA.*

$H_8$ : *ROA moderates the effect of green intellectual capital on firm value.*

$H_9$ : *ROA moderates the effect of green accounting on firm value.*



**Figure 1.** Research model

*H<sub>10</sub>: ROA moderates the effect of green innovation on firm value.*

companies are recognized for their commitment to sustainability, as well as their focus on environmental practices. A purposive sampling method was employed, with the selection criteria including:

## 2. METHOD

The study’s population consists of companies listed in the Sustainable and Responsible Investment (SRI-KEHATI) index and traded on the Indonesia Stock Exchange (IDX). These

- (a) companies listed in the SRI-KEHATI index and published in May and November, consistently receiving a proper assessment from 2015 to 2022;

**Table 1.** Operationalization of variables

Variable	Indicator
Dependent Variable: Y <sub>1</sub> : Firm Value (Price to Book Value) Brooks and Oikonomou (2018)	$\frac{\text{Market price per share}}{\text{Book value per share}}$
Independent Variables: X <sub>1</sub> : Green intellectual capital (GIC) Benevene et al. (2021) and Bombiak (2021)	Green intellectual capital index (GICI) = dummy score 1 if it is disclosed, score 0 if it is not disclosed
X <sub>2</sub> : Green accounting (GA) Astuti et al. (2022c)	Sustainability reporting by the Global Reporting Index (GRI) $\frac{\text{Number of items disclosed}}{\text{Total items (82 items)}} \cdot 100\%$ score 5 if it is more than 5 paragraphs, score 4 if it is 4-5 paragraphs, score 3 if it is 2-3 paragraphs, score 1 if it is 1 sentence, score 0 if no disclosure
X <sub>3</sub> : Green innovation (GI) Yu et al. (2022)	The dimensions used in the content analysis are: (1) Green Process Innovation consisting of 3 indicators; (2) Green Product Innovation consisting of 3 indicators, or with a total of 6 indicators $\frac{\text{Number of items disclosed}}{\text{Total items}} \cdot 100\%$ score 1 if it is in 1 sentence, score 0 if no disclosure
Moderating Variable X <sub>4</sub> : Financial Performance (ROA) Astuti et al. (2022b)	$\frac{\text{Net income}}{\text{Total Assets}}$

- (b) companies that have published annual and sustainability reports containing complete data for the relevant variables within the same period; and
- (c) companies that report their financials in rupiah.

The final analysis included data from 88 companies within the SRI-KEHATI index. Warp PLS was utilized as the data analysis technique. Table 1 details the indicators and variable measurements.

### 3. RESULTS

Table 2 shows that during the research period from 2015 to 2022, green intellectual capital, green accounting, green innovation, size, and leverage exhibited standard deviation values lower than their respective averages, indicating variability in the data. Specifically, green intellectual capital had a minimum value of 0.67 and a maximum value of 1.00, with an average of 0.88 and a standard deviation of 0.08.

The relatively low standard deviation compared to the average suggests that the data varied, with the average value being close to the maximum, indicating that companies within the SRI-KEHATI index report green intellectual capital at near-

maximum levels. Green accounting had a minimum value of 1.10 and a maximum value of 2.94, with an average of 1.97 and a standard deviation of 0.26. Again, the standard deviation is smaller than the average, reflecting variability in the data. The average value of green accounting is 1.97, close to the maximum, suggesting that companies in the SRI-KEHATI index report green accounting at high levels. For green innovation, the minimum value was 0.38 and the maximum value 1.00, with an average of 0.83 and a standard deviation of 0.16. The standard deviation, being lower than the average, indicates data variability. The average value of 0.83, near the maximum, suggests that the companies in the SRI-KEHATI index report green innovation at near-maximum levels.

Table 3 presents model fit and quality indices, which evaluate the overall performance of a model. The Average Path Coefficient (APC) is 0.027, indicating a model fit as it is within the acceptable limit ( $\leq 0.05$ ). Average R-Squared (ARS) and Average Adjusted R-Squared (AARS), with values of 0.003 and 0.021, respectively, also indicate model fit since they are within the limit of  $\leq 0.05$ . Average Block VIF (AVIF) and Average Full Collinearity VIF (AFVIF) values are 1.472 and 1.661, respectively, both considered ideal as they are below the threshold of 3.3. Tenenhaus Gof (Gof) is 0.518, which falls below the “large” criterion ( $\geq 0.63$ ), indicating a smaller goodness of fit. Other indica-

**Table 2.** Descriptive statistics

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Green Intellectual Capital	88	0.67	1.00	0.88	0.08
Green Accounting	88	1.10	2.94	1.97	0.26
Green Innovation	88	0.38	1.00	0.83	0.16
Firm Performance	88	0.55	82.44	5.48	13.59
Return on Assets	88	0.02	4.32	0.80	1.21

**Table 3.** Model fit and quality indices

Criterion	Value	Admission limits	Conclusion
Average Path Coefficient (APC)	0.027	$\leq 0.05$	Model Fit
Average R-Squared (ARS)	0.003	$\leq 0.05$	Model Fit
Average Adjusted R-Squared (AARS)	0.021	$\leq 0.05$	Model Fit
Average Block VIF (AVIF)	1.472	Ideal if $\leq 3.3$	Ideal
Average Full Collinearity VIF (AFVIF)	1.661	Ideal if $\leq 3.3$	Ideal
Tenenhaus Gof (Gof)	0.518	Large if $\geq 0.63$	Big
Sympson’s Paradox Ratio (SPR)	0.759	Acceptable if $\geq 0.7$	Acceptable
R-squared Contribution Ratio (RSCR)	0.782	Acceptable if $\geq 0.9$	Unacceptable
Statistical Suppression Ratio (SSR)	0.930	Acceptable if $\geq 0.7$	Acceptable
Nonlinear Bivariate Causality Direction Ratio (NLBCDR)	0.938	Acceptable if $\geq 0.7$	Acceptable

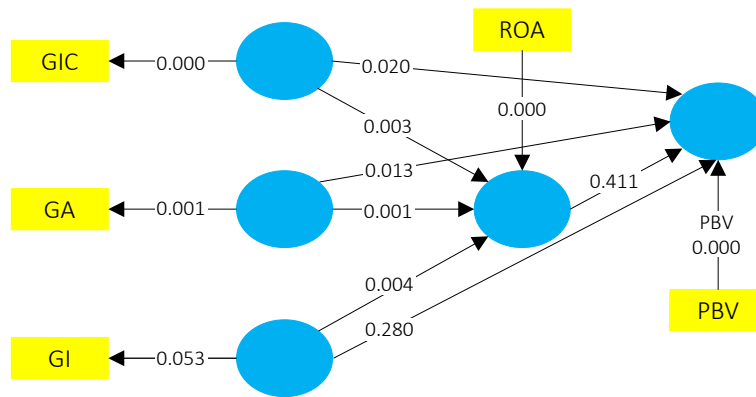


Figure 2. Structural model

tors, such as Sympson’s Paradox Ratio (SPR) and Statistical Suppression Ratio (SSR), are acceptable, while the *R*-squared Contribution Ratio (RSCR) is slightly below the acceptable limit, being marked as “unacceptable” with a value of 0.782. Overall, the model shows a good fit, with most indices falling within acceptable or ideal ranges, though the RSCR falls short of the recommended threshold.

Figure 2 illustrates the structural relationships between key variables, which are green intellectual capital (GIC), green accounting (GA), green innovation (GI), return on assets (ROA), and price to book value (PBV).

Tables 4 and 5 show the output results of the fit indices model of direct and indirect relationships

between independent variables and dependent variables.

The results of direct testing in Table 4 inform that green intellectual capital and green accounting have a significant positive relationship to price book value with *P* values <0.05. However, green innovation and return on assets do not affect price book value with *P* values >0.05. Other results of this study in direct testing found that green intellectual capital, green accounting, and green innovation have a positive effect on return on assets with *P* values <0.05.

The results of the indirect relationship test in Table 5 found that return on assets is a moderating variable that strengthens the relationship between

Table 4. Direct effect test

Hypothesis	Path Coefficient	T Statistic	P Values	Conclusion
$H_1$	GIC → PBV	2.086	0.020	Accepted
$H_2$	GA → PBV	2.857	0.003	Accepted
$H_3$	GI → PBV	0.583	0.280	Rejected
$H_4$	ROA → PBV	0.227	0.411	Rejected
$H_5$	GIC → ROA	2.516	0.013	Accepted
$H_6$	GA → ROA	2.879	0.001	Accepted
$H_7$	GI → ROA	0.881	0.004	Accepted

Note: GIC = green intellectual capital; GA = green accounting; GI = green innovation; ROA = return on assets; PBV = price to book value.

Table 5. Indirect effect test

Hypothesis	Path Coefficient	T Statistics	P Values	Conclusion
$H_8$	GIC → ROA → PBV	0.121	0.002	Accepted
$H_9$	GA → ROA → PBV	1.072	0.001	Accepted
$H_{10}$	GI → ROA → PBV	1.156	0.125	Rejected

Note: GIC = green intellectual capital; GA = green accounting; GI = green innovation; ROA = return on assets; PBV = price to book value.



green intellectual capital and green accounting on price book value with  $P$  values  $<0.05$ . In contrast, the study also found that return on assets did not moderate the relationship between green innovation and price book value with  $P$  values  $>0.05$ .

## 4. DISCUSSION

The findings revealed that green intellectual capital has a significant positive impact on firm value. This outcome supports the knowledge-based view theory, which emphasizes that intangible assets, such as knowledge and expertise, are essential drivers of competitive advantage. In this context, green intellectual capital represents the knowledge and innovations focused on environmental sustainability, which enable companies to differentiate themselves in the marketplace (Malik et al., 2020). By developing human resources with expertise in environmental practices and green technologies, companies are able to improve their resource efficiency, reduce waste, and ultimately enhance their firm value. This finding aligns with the literature that highlights the role of green intellectual capital in improving a company's competitive position and long-term profitability (Benevene et al., 2021).

Similarly, green accounting was shown to have a significant positive effect on firm value. This result aligns with agency theory, which posits that transparency in financial reporting reduces information asymmetry between management (agents) and shareholders (principals), thus increasing investor confidence (Maama & Appiah, 2019). Green accounting integrates environmental costs into the financial reporting process, allowing companies to disclose their environmental initiatives and their impacts. This transparency not only improves the company's reputation among stakeholders but also signals responsible management, which attracts environmentally conscious investors (Ratmono et al., 2024). As a result, green accounting practices contribute to enhancing firm value, particularly for companies that are committed to sustainability and long-term profitability.

In contrast, the study found that green innovation did not have a direct significant effect on firm value. This finding suggests that while green inno-

vation is vital for improving operational efficiency and reducing environmental impacts, its financial benefits may not be immediately reflected in firm value due to the high initial costs of green technologies and longer payback periods (Xie et al., 2019). This supports the resource-based view theory, which emphasizes that investing in sustainable innovation is essential for long-term competitive advantage, but the short-term financial returns may be delayed. Green innovations, such as renewable energy technologies and energy-efficient products, require substantial upfront investments that may not yield immediate financial gains but are crucial for future profitability and sustainability (Schäfer et al., 2023).

The positive effects of green intellectual capital, green accounting, and green innovation on financial performance, as measured by ROA, indicate that sustainability practices contribute to operational efficiency and profitability. Firms that invest in green intellectual capital and green accounting practices experience improved financial outcomes, likely due to cost savings from better resource management and increased market appeal to environmentally conscious consumers (Astuti et al., 2022c). Although green innovation does not directly increase firm value in the short term, it significantly improves financial performance by enhancing operational efficiency, which can eventually lead to increased firm value (Xie et al., 2019).

Return on assets (ROA) was found to moderate the relationship between green intellectual capital and green accounting with firm value. This suggests that companies with stronger financial performance are better able to leverage their sustainability practices to create additional value. Firms with higher profitability can reinvest in green initiatives and further enhance their competitive positioning, thus increasing firm value over time (Benevene et al., 2021). However, the moderating effect of ROA on the relationship between green innovation and firm value was not significant, suggesting that financial performance may not immediately enhance the impact of green innovation on firm value. This outcome is consistent with the view that green innovation's financial benefits take longer to realize due to the need for market acceptance and technological maturation (Schäfer et al., 2023).

## CONCLUSION

The objective of this study is to examine the combined effects of green intellectual capital, green accounting, and green innovation on firm value and financial performance, with a particular focus on the moderating role of return on assets (ROA). The findings demonstrate that green intellectual capital and green accounting are critical factors that positively influence firm value, confirming the importance of intangible assets and transparent financial practices in enhancing both sustainability and corporate performance. Although green innovation did not have a direct significant impact on firm value, it was found to positively affect financial performance. This highlights the long-term value of green innovation in improving operational efficiency, even if its immediate financial benefits are less apparent. Firms that invest in environmentally sustainable technologies and processes position themselves for future success, as these innovations will eventually contribute to firm value as markets and technologies mature. The moderating role of ROA underscores the importance of financial performance in maximizing the benefits of green intellectual capital and green accounting. Firms with stronger financial performance are better equipped to leverage their sustainability initiatives to boost firm value. However, the absence of a significant moderating effect of ROA on green innovation suggests that financial returns from green innovation may take longer to materialize.

The research limitation was that the cross-sectional design captures a snapshot in time, but green innovation, in particular, may take longer to show its financial benefits. Future studies should include different industries and regions to improve the generalizability of the findings.

This analysis contributes to both theory and practice. Theoretically, it supports the knowledge-based view, resource-based view, and agency theory by showing how green intellectual capital and green accounting improve firm value. It also highlights the longer-term role of green innovation in improving financial performance. Practically, the study provides valuable insights for businesses and policymakers. It shows that investing in green intellectual capital and green accounting can boost both financial outcomes and firm value while emphasizing the importance of green innovation for long-term sustainability.

## AUTHOR CONTRIBUTIONS

Conceptualization: Tri Astuti.  
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 Formal analysis: Tri Astuti, Nurmala Ahmar.  
 Funding acquisition: Tri Astuti, Nurmala Ahmar.  
 Investigation: Tri Astuti, Nurmala Ahmar.  
 Methodology: Tri Astuti, Nurmala Ahmar.  
 Project administration: Tri Astuti.  
 Resources: Nurmala Ahmar.  
 Software: Tri Astuti.  
 Supervision: Tri Astuti.  
 Validation: Tri Astuti, Nurmala Ahmar.  
 Visualization: Nurmala Ahmar.  
 Writing – original draft: Tri Astuti.  
 Writing – review & editing: Nurmala Ahmar.

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