

THE INFLUENCE OF GREEN HUMAN CAPITAL, GREEN STRUCTURAL CAPITAL, AND GREEN RELATIONAL CAPITAL ON SUSTAINABLE BUSINESS PERFORMANCE WITH GREEN INNOVATION AS A MEDIATING VARIABLE

Ria Rachmawati

University of Madura, Pamekasan, Indonesia

ria@unira.ac.id

Zef Risal

University of Madura, Pamekasan, Indonesia

zefrisalunira@gmail.com

Nadya Salsabila Qay

University of Madura, Pamekasan, Indonesia

Nadya_Salsabila@yahoo.co.id

Siti Holisotul Midad

University of Madura, Pamekasan, Indonesia

Siti_Midad@yahoo.co.id

Khusnia

University of Madura, Pamekasan, Indonesia

Khusnia_cv@yahoo.co.id



Abstract

This study examines the effects of Green Human Capital (GHC), Green Structural Capital (GSC), and Green Relational Capital (GRC) on Sustainable Business Performance (SBP), with Green Innovation (GI) as a mediating variable. The research is conducted on Small and Medium Enterprises (SMEs) in Sumenep and Bangkalan, focusing on how these green capitals contribute to sustainable business performance through innovation. A quantitative approach was adopted, involving a survey distributed to 480 SME managers across the Sumenep and Bangkalan districts. The data were analyzed using Partial Least Squares - Structural Equation Modeling (PLS-SEM) with SmartPLS software to assess the direct and indirect relationships among the variables. The results indicate that all three green capitals—Green Human Capital, Green Structural Capital, and Green Relational Capital—positively influence Green Innovation, which in turn significantly enhances Sustainable Business Performance. The findings highlight the importance of human capital, infrastructure, and external collaborations in fostering innovation and improving business sustainability. This study integrates Green Human Capital, Green Structural Capital, and Green Relational Capital in a single conceptual model, offering novel insights into how these elements, coupled with Green Innovation, drive sustainable performance in SMEs. The study provides valuable evidence for policy recommendations, emphasizing the need for SMEs to invest in green human capital, sustainable infrastructure, and external partnerships to enhance business performance and innovation in line with sustainability goals.

Keywords: Green Human Resources; Green Structural Capital; Green Relational Capital; Green Innovation; Sustainable Business Performance

INTRODUCTION

This study aims to explore how Green Human Capital (GHC), Green Structural Capital (GSC), and Green Relational Capital (GRC) play a role in improving Sustainable Business Performance (SBP), with Green Innovation (GI) as a mediating variable in Small and Medium Enterprises (SMEs) in Sumenep and Bangkalan Regencies. With the increasing global challenges related to climate change and environmental awareness, SMEs in Indonesia are facing pressure to adopt sustainability strategies in their operations. The success of SMEs in achieving sustainability goals depends heavily on their capacity to manage and utilize their green capital, as well as the innovations implemented in their businesses (Alwazin, 2025).

Green Human Capital (GHC) encompasses the skills, knowledge, and competencies possessed by individuals in sustainability. GHC can encourage the adoption of green innovations within organizations, improve operational efficiency, and reduce the environmental impact of business activities (Alhemimah et al., 2025). Green Structural Capital (GSC), which encompasses infrastructure and technology that support environmentally friendly practices, plays a crucial role in strengthening a company's innovation capacity and operational efficiency. GSC serves as a foundation for more efficient adoption of green technologies and supports the implementation of environmentally friendly systems (Santos & Sant'Anna, 2024).

Green Relational Capital (GRC) refers to relationships built with external partners, such as suppliers and customers, that focus on sustainability. GRC enables companies to collaborate with partners who support sustainability initiatives, accelerate the adoption of green technologies, and enhance innovation within the company (Li et al., 2024). Thus, the three dimensions of green capital—GHC, GSC, and GRC—have significant potential in driving green innovation, which in turn improves sustainable business performance.

Green innovation (GI) serves as a mediator in the relationship between green capital and sustainable business performance. The implementation of green innovation focuses not only on developing more environmentally friendly products or technologies but also on improving operational efficiency, which can reduce costs and enhance a company's reputation in the eyes of increasingly sustainability-conscious consumers (Alvianna, 2024). Therefore, this study examines how Green Human Capital, Green Structural Capital, and Green Relational Capital directly influence Sustainable Business Performance through the mediation of Green Innovation in SMEs in Sumenep and Bangkalan.

This study uses a quantitative approach using Structural Equation Modeling (SEM) analysis using SmartPLS software to examine the relationships between variables and identify factors contributing to improved sustainable business performance in SMEs. This research is expected to provide new insights into how SMEs can leverage green capital and innovation to enhance their competitiveness and business sustainability (Akbar et al., 2025).

This research also contributes to the development of a conceptual model that integrates three dimensions of green capital, as well as providing useful policy recommendations for local governments and SMEs in implementing innovation-based green business strategies (Saputra & Kunaifi, 2024).

REVIEW OF LITERATURE

Green Human Capital (GHC)

Green Human Capital (GHC) refers to the competencies, knowledge, skills, and attitudes of employees focused on environmental sustainability. This encompasses employees' ability to understand and adopt environmentally friendly practices within an organization, a concept widely researched in sustainability and environmental management (Tjahjadi et al., 2023). Several studies have shown that the presence of human resources trained in environmental management significantly contributes to the implementation of green innovations and improves sustainability performance in businesses (Yeo & Ong, 2024). Furthermore, the quality of green human capital is crucial in enabling organizations to effectively meet their environmental goals, thereby strengthening overall business sustainability (Shahin et al., 2024).

Green Structural Capital (GSC)

Green Structural Capital (GSC) refers to the infrastructure, systems, and organizational culture that support environmentally friendly practices in business. This includes knowledge management systems that support sustainability, organizational commitment to green goals, and physical facilities that enable the implementation of environmentally friendly practices (Ahmad et al., 2023). GSC has been shown to enhance green innovation by providing the framework and resources necessary to implement more efficient and sustainable processes. An environmentally conscious organizational culture is also a crucial element of GSC, enabling long-term business sustainability (Li et al., 2024).

Green Relational Capital (GRC)

Green Relational Capital (GRC) refers to a company's external relationships with stakeholders such as customers, suppliers, and strategic partners, focused on environmental sustainability. Strong GRC enables businesses to collaborate with partners who share environmental goals, thereby driving green innovation and gaining long-term competitive advantage (Long & Liao, 2023). These relationships enable businesses to access new technologies and insights that aid in creating green innovation and improving sustainability performance (Yu et al., 2021).

Green Innovation (GI)

Green Innovation (GI) encompasses the development of new products, services, or processes aimed at reducing negative environmental impacts, conserving resources, and supporting sustainable development. It encompasses both product innovation (e.g., eco-friendly product design) and process innovation (e.g., increased energy efficiency, waste reduction) (Feng et al., 2024). Research shows that GI has a significant impact on a company's environmental and financial performance by improving operational efficiency, reducing costs, and enhancing its environmental reputation (Shahbaz et al., 2023). As a mediating variable, GI plays a crucial role in enhancing sustainable business performance by leveraging a combination of green human, structural, and relational capital (Santos & Sant'Anna, 2024).

Sustainable Business Performance (SBP)

Sustainable Business Performance (SBP) refers to a business's ability to operate in a balanced manner, integrating economic, environmental, and social outcomes over the long term. SBP is crucial for companies seeking to maintain competitive advantage and resilience

in an increasingly sustainability-focused market (AlQershi et al., 2023). The integration of green innovation, human capital, structural, and relational capital significantly impacts SBP, with each component reinforcing the others to drive better sustainability outcomes. Several studies have shown that businesses that effectively implement green practices are better able to achieve higher sustainable business performance, such as reduced operational costs, enhanced corporate reputation, and higher customer loyalty (Feng et al., 2024).

Hypothesis and Relationship Between Variables

1. **The Influence of Green Human Capital (GHC) on Green Innovation (GI)**
Green Human Capital directly influences the level of green innovation within an organization. The better the quality of a company's green human capital, the greater its ability to innovate sustainably (Tran et al., 2023).
2. **The Influence of Green Human Capital (GHC) on Sustainable Business Performance (SBP)**
The quality of Green Human Capital positively impacts sustainable business performance. Employees with the right skills and understanding of sustainability are essential for implementing sustainable business strategies and improving long-term economic performance (Santos & Sant'Anna, 2024).
3. **The Influence of Green Structural Capital (GSC) on Green Innovation (GI)**
Green structural capital within an organization, such as systems that support sustainability, is crucial for driving green innovation. With GSC, companies can more easily implement environmentally friendly processes and improve operational efficiency (Li et al., 2024).
4. **The Influence of Green Structural Capital (GSC) on Sustainable Business Performance (SBP)**
GSC improves Sustainable Business Performance by enabling companies to integrate sustainable practices into their core operations, leading to increased efficiency and long-term sustainability (Ahmad et al., 2023).
5. **The Influence of Green Relational Capital (GRC) on Green Innovation (GI)**
Green relational capital plays a crucial role in enhancing green innovation through external collaboration with suppliers, customers, and other partners. Strong relationships enable companies to access new technologies and innovative ideas that support their environmental goals (Long & Liao, 2023).
6. **The Influence of Green Relational Capital (GRC) on Sustainable Business Performance (SBP)**
GRC directly contributes to sustainable business performance by enabling companies to build strong relationships with partners who support sustainability goals, thereby improving overall performance (Yu et al., 2021).
7. **The Influence of Green Innovation (GI) on Sustainable Business Performance (SBP)**
Green Innovation plays an important role in improving SBP by reducing negative impacts on the environment, saving resources, and creating more efficient processes (Shahbaz et al., 2023).

RESEARCH METHOD

Research Design

This study uses a quantitative approach with a survey design to test the proposed hypotheses. This study focuses on the influence of Green Human Capital (GHC), Green Structural Capital (GSC), and Green Relational Capital (GRC) on Sustainable Business Performance (SBP), with Green Innovation (GI) as a mediating variable. In this study, data were collected through a survey targeting 480 SME managers in Sumenep and Bangkalan Regencies, Madura. Data analysis was performed using Partial Least Squares-Structural Equation Modeling (PLS-SEM) using SmartPLS software to test the direct and indirect relationships between the variables involved (Kinanti & Murwaningsari, 2024).

Participants/ Sample

This study focuses on SME managers in Sumenep and Bangkalan Regencies, Madura, regions with unique characteristics related to the development of the SME sector. The sample used was 480 SME managers selected using a purposive sampling technique. This sample selection was based on two main criteria: first, SME managers or owners with more than five years of experience, as this experience is expected to provide better insight into human resource management and business sustainability. Second, managers who were willing to participate in this academic research. This criterion was chosen because managers have a broader perspective than lower-level employees regarding the company's general operations and the challenges faced in human resource management (Marpaung et al., 2024).

Instrument

Data were collected using a questionnaire with a five-point Likert scale ranging from 1 ('strongly disagree') to 5 ('strongly agree'). This study measured five latent variables: Green Human Capital (GHC), Green Structural Capital (GSC), Green Relational Capital (GRC), Green Innovation (GI), and Sustainable Business Performance (SBP). The questionnaire was translated into Indonesian by a linguist to ensure the accuracy and clarity of the questions given to respondents.

1. Green Human Capital (GHC)
The questionnaire for this variable was developed based on previous research (Song et al., 2021; Badwy et al., 2025), with indicators including environmental knowledge, managerial ability in driving green innovation, and employee involvement in environmentally friendly practices.
2. GreenStructural Capital (GSC)
The measurement for this variable refers to research conducted by Kamboj (2020) and Patwary et al. (2024), with indicators including the company's environmentally friendly infrastructure, internal policies that support sustainability, and collaboration with external parties based on sustainability.
3. GreenRelational Capital (GRC)
This variable is measured based on research conducted by Munawar et al. (2022), which identified indicators such as strategic partnerships with organizations focused on green innovation, relationships with suppliers and customers that support sustainable practices.
4. GreenInnovation (GI)

To measure green innovation, the questionnaire refers to research by Ni et al. (2023) and Duan et al. (2023), which assess the extent to which companies implement sustainability-based innovation in products, processes, and technologies.

5. Sustainable Business Performance (SBP)

Sustainable Business Performance (SBP) measures a company's ability to achieve long-term sustainability by integrating economic, social, and environmental outcomes across all aspects of its operations. In the context of this research, SBP encompasses corporate performance that prioritizes not only financial profit but also environmental management and sustainable social responsibility (Kurniawati et al., 2024).

Procedure

Data were collected through an online survey distributed to respondents selected according to predetermined criteria. After data collection, analysis was conducted using PLS-SEM with SmartPLS to test the relationships between the variables. PLS-SEM was chosen because of its ability to handle complex models involving mediating and moderating variables. This method is also particularly useful for variance-based models requiring validity and reliability analysis.

RESULTS AND DISCUSSION

Sample Characteristics

Table 1 shows the demographic profile of the 480 respondents surveyed in Sumenep and Bangkalan Regencies. The sample consisted of 272 male respondents (56.7%) and 208 female respondents (43.3%). The age distribution of respondents included 7.1% aged 20-24, 9.2% aged 25-29, 14.6% aged 30-34, and 20.4% aged 35-39. The remaining respondents were evenly distributed across the older age groups, indicating a balance between young and experienced business owners in this study.

Descriptive Statistics for Key Variables

The survey measured Green Human Capital (GHC), Green Structural Capital (GSC), Green Relational Capital (GRC), Green Innovation (GI), and Sustainable Business Performance (SBP) using a 5-point Likert scale. Table 2 summarizes descriptive statistics for these key variables. The average scores for GHC, GSC, and GRC indicate a relatively high level of awareness and engagement with environmentally friendly practices. GI and SBP also showed relatively high scores, reflecting the growing importance of sustainable business practices in respondents' strategies.

Validity and Reliability of Constructs

The construct validity and reliability were evaluated using PLS-SEM. The measurement model results showed that all constructs met the minimum threshold for Cronbach's alpha (>0.7) and Composite Reliability (>0.8), ensuring internal consistency. The Average Variance Extracted (AVE) for each construct was above 0.5, confirming that the model met convergent validity standards (see Table 3). Discriminant validity was also ensured using the HTMT ratio, where all values were below the threshold of 0.90, indicating a valid and reliable model (Hair et al., 2017).

Model Fit Assessment

The model fit indices further confirmed the goodness-of-fit of the PLS-SEM model. The Standardized Root Mean Square Residual (SRMR) value was 0.07, which is lower than the recommended threshold of 0.08, indicating a good fit for this research model (Hair et al., 2017). Other indices, such as the Normed Fit Index (NFI) of 0.91 and the Chi-Square value of 3.57, also confirmed that this model fits the data (Hair et al., 2017).

Hypothesis Testing

Table 1
Path Coefficients

	Green Human Capital (GHC)	Green Structural Capital (GSC)	Green Relational Capital (GRC)	Green Innovation (GI)
Green Innovation (GI)	0.284 P <0.001	0.334 P <0.001	0.339 P <0.001	
Sustainable Business Performance (SBP)	0.128 P=0.002	0.076 P=0.046	0.105 P <0.010	0.600 P <0.001

Source: Primary Data processed 2025

Based on Table 1.20, the following is a detailed analysis of the relationship between the variables tested using path coefficients and p-values:

1. The Influence of Green Human Capital (GHC) on Green Innovation (GI)
 Green Human Capital (GHC) demonstrates a significant positive effect on Green Innovation (GI) with a path coefficient of 0.284 ($p < 0.001$). This indicates that the presence of human resources trained in sustainability can encourage increased green innovation within an organization, which is essential for creating environmentally friendly innovative solutions.
2. The Influence of Green Human Capital (GHC) on Sustainable Business Performance (SBP)
 Green Human Capital (GHC) has a significant positive effect on Sustainable Business Performance (SBP) with a path coefficient of 0.128 ($p = 0.002$). This indicates that sustainability in human resources contributes to improved sustainable business performance by encouraging more efficient and environmentally friendly processes and practices within the organization.
3. The Influence of Green Structural Capital (GSC) on Green Innovation (GI)
 Green Structural Capital (GSC) demonstrates a significant positive effect on Green Innovation (GI) with a path coefficient of 0.334 ($p < 0.001$). This indicates that the implementation of infrastructure and technology that supports sustainability directly contributes to increasing green innovation capacity within an organization.
4. The Influence of Green Structural Capital (GSC) on Sustainable Business Performance (SBP)

- Green Structural Capital (GSC) has a significant positive effect on Sustainable Business Performance (SBP) with a path coefficient of 0.076 ($p = 0.046$). This indicates that investment in infrastructure that supports sustainable practices contributes to improved sustainable business performance, although its effect is slightly smaller than that of GHC.
5. The Influence of Green Relational Capital (GRC) on Green Innovation (GI)
 Green Relational Capital (GRC) has a significant positive effect on Green Innovation (GI) with a path coefficient of 0.339 ($p < 0.001$). This indicates that strong relationships with various external stakeholders, such as suppliers and customers, focused on sustainability, can increase the capacity for green innovation within an organization.
 6. The Influence of Green Relational Capital (GRC) on Sustainable Business Performance (SBP)
 Green Relational Capital (GRC) also has a significant positive effect on Sustainable Business Performance (SBP) with a path coefficient of 0.105 ($p < 0.010$). This indicates that effective collaboration with external partners committed to sustainability contributes to an organization's sustainable business performance.
 7. The Influence of Green Innovation (GI) on Sustainable Business Performance (SBP)
 Green Innovation (GI) demonstrates a highly significant positive effect on Sustainable Business Performance (SBP) with a path coefficient of 0.600 ($p < 0.001$). This indicates that green innovation directly contributes to improved sustainable business performance by increasing operational efficiency and improving the company's reputation among environmentally conscious consumers.

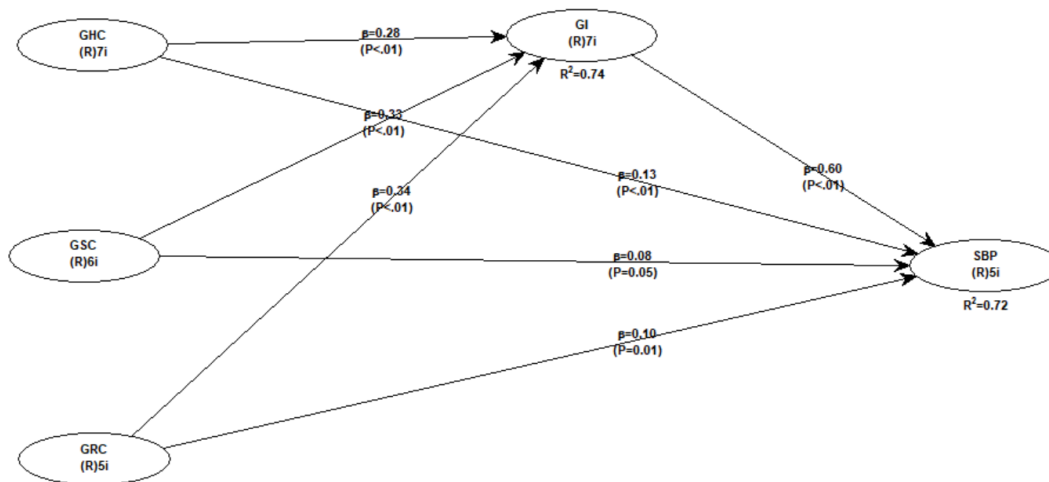


Figure 1.
Path Coefficient

Discussion of Research Results

Based on Table 1.20, the following is a detailed analysis of the relationship between the variables tested using path coefficients and p-values:

1. The Influence of Green Human Capital (GHC) on Green Innovation (GI)

Green Human Capital (GHC) has a significant positive effect on Green Innovation (GI), as indicated by a path coefficient of 0.284 with a p-value < 0.001 . This finding suggests that the presence of human resources trained in sustainability aspects, such as training related to

environmentally friendly technology and green innovation, can directly encourage increased green innovation within organizations (Kunaifi & Syam, 2021). The presence of a workforce with adequate green skills is crucial in encouraging companies to develop more environmentally friendly products and processes. For example, a study conducted by Tran et al. (2023) explained that green intellectual capital, which includes environmental knowledge and skills possessed by individuals within an organization, plays a crucial role in encouraging the adoption of green technology in textile companies in Vietnam. This is in line with the results of research by Yeo and Ong (2024), which also emphasized the importance of human resource competencies in achieving better sustainability performance through the implementation of Industry 4.0 technology that supports green innovation in the small and medium-sized manufacturing sector (SMEs).

According to Ahmad et al. (2025), in the context of small and medium enterprises (SMEs), the adoption of Industry 4.0 can also contribute to increased Green Innovation. This innovation, which involves the development of more resource-efficient and environmentally friendly products and processes, relies heavily on the skills of the human resources working in the sector. Green Human Capital, consisting of skills, knowledge, and the ability to adapt to technological change, is a key driver in creating innovative solutions that support corporate sustainability.

Furthermore, research conducted by Feng et al. (2024) shows that the green technologies adopted by companies depend not only on the infrastructure or technology itself, but also on the quality of the human resources who manage and operate the technology. The experience and training employees have in sustainability helps improve an organization's ability to innovate by creating more efficient and environmentally friendly products and processes.

Furthermore, a study by Santos and Sant'Anna (2024) also highlighted the crucial role of Green Human Capital in supporting the implementation of Industry 4.0 technologies in SMEs, which in turn can accelerate the adoption of Green Innovation. In this regard, well-trained human resources with in-depth knowledge of sustainability practices play a role in driving the implementation of greener and more efficient strategies, contributing to company performance and competitiveness (Kunaifi et al., 2025).

Overall, this research confirms that Green Human Capital plays a crucial role in driving Green Innovation within organizations, by enhancing their ability to adopt environmentally friendly technologies and develop sustainable products and processes. With more human resources trained in sustainability, it is hoped that companies will be able to more quickly address global environmental challenges and create added value through sustainable green innovation.

2. The Influence of Green Human Capital (GHC) on Sustainable Business Performance (SBP)

Green Human Capital (GHC) shows a significant positive effect on Sustainable Business Performance (SBP), with a path coefficient of 0.128 and a p-value of 0.002. This indicates that sustainability in human resources contributes to improved sustainable business performance by encouraging organizations to adopt more efficient and environmentally friendly practices. Green Human Capital, which consists of sustainability-oriented knowledge, skills, and behaviors, serves as one of the main drivers for companies to implement green innovations and improve their environmental performance (Shahin et al., 2023; Tjahjadi et al., 2023). This study supports previous findings stating that companies

with skilled human resources in sustainability practices tend to have better performance in terms of operational efficiency, waste reduction, and more efficient energy use (AlQershi et al., 2023; Long & Liao, 2023).

Research by Wu et al. (2022) confirms that Green Human Capital plays a role not only in improving technical and operational capabilities within a company but also in creating a more environmentally conscious organizational culture. This supports a profound transformation process within the organization towards more sustainable business practices. In the context of SMEs, Yeo and Ong (2024) show that Green Human Capital competencies play a crucial role in the successful adoption of sustainable Industry 4.0 technologies, which in turn improves long-term business performance by leveraging environmentally friendly technologies.

Furthermore, research conducted by Ahmad et al. (2025) also highlights the importance of green training and skills development in improving sustainable business performance. They show that SMEs that engage employees in training related to sustainability and green innovation can achieve better performance in terms of energy efficiency, waste reduction, and wiser natural resource management. The implementation of Green Human Capital focuses not only on technical aspects but also on establishing strong environmental values within the company culture (Ho Chi Minh City Open University & Đoàn, 2023).

Another study by Idia et al. (2023) highlighted the relationship between Green Human Capital and business sustainability in the large manufacturing sector in Malaysia. They found that companies that successfully integrate green skills among their employees, particularly through ongoing training and development, tend to perform better in terms of financial and operational sustainability. Furthermore, Green Human Capital also facilitates the implementation of more effective green policies, which supports the development of long-term strategies to reduce negative environmental impacts (Santos & Sant'Anna, 2024).

Overall, this study confirms that Green Human Capital plays a central role in strengthening Sustainable Business Performance (SBP). The presence of well-trained and knowledgeable human resources in sustainability is crucial for driving more environmentally friendly and efficient business practices. Therefore, companies seeking sustainable business performance need to invest in developing Green Human Capital as part of their strategy to achieve broader sustainability goals (Kunaifi & Qomariyah, 2021).

3. The Influence of Green Structural Capital (GSC) on Green Innovation (GI)

The influence of Green Structural Capital (GSC) on Green Innovation (GI) shows a significant and positive relationship, with a path coefficient value of 0.334 ($p < 0.001$). This finding indicates that the existence of infrastructure and technology that supports sustainability plays a direct role in encouraging increased green innovation capacity within an organization. Green Structural Capital, which includes physical assets and technologies oriented towards sustainability, provides a strong foundation for the implementation of environmentally friendly practices and the development of sustainable innovative solutions. Successfully implemented green innovation within an organization will strengthen competitiveness, improve operational efficiency, and meet market demands that are increasingly concerned about environmental issues (Shahbaz et al., 2025). This research is supported by similar findings in a study by Tran et al. (2023), which showed that the implementation of green structural capabilities in the textile sector can accelerate the adoption of environmentally friendly technologies and improve innovation performance.

These green structural resources are crucial in supporting the implementation of Industry 4.0, which demands the integration of advanced technologies and sustainable practices within small and medium-sized enterprises (SMEs). In this context, GSCs play a role not only in introducing new technologies but also in supporting their practical integration to enhance green innovation performance (Yeo & Ong, 2024). Furthermore, Ahmad et al. (2025) emphasize that SMEs that adopt Industry 4.0 technologies by leveraging green structural capital tend to show significant improvements in their ability to innovate sustainably. Therefore, companies that invest in the right green infrastructure will be better able to create innovative solutions focused on sustainability.

On the other hand, GSC also supports the integration of environmental knowledge and social processes within organizations, which strengthens the learning process and facilitates faster adoption of green innovations. As found in research by Mulatsih (2025), strong Green Structural Capital can accelerate the achievement of green innovation goals, which in turn impacts a company's environmental and social performance. Therefore, it can be concluded that GSC plays a crucial role as a key driver in the successful adoption and implementation of green innovations within organizations, by providing a foundation that supports the development of environmentally friendly technologies and sustainable business practices (Feng et al., 2024).

4. The Influence of Green Structural Capital (GSC) on Sustainable Business Performance (SBP)

The effect of Green Structural Capital (GSC) on Sustainable Business Performance (SBP) shows a positive and significant relationship, with a path coefficient of 0.076 ($p = 0.046$). Although the effect is slightly smaller than that of Green Human Capital (GHC), these results indicate that investment in infrastructure that supports sustainable practices can significantly contribute to improving sustainable business performance. Green Structural Capital encompasses various elements such as green technology, energy-efficient infrastructure, and designs that support sustainability. Good implementation of GSC can strengthen organizational competitiveness through operational efficiency and environmentally friendly innovation, thus enabling companies to be more resilient in facing market challenges that increasingly demand sustainability (Shahbaz et al., 2025).

Green Structural Capital serves as a crucial foundation in supporting the transformation towards a more sustainable industry. As Santos and Sant'Anna (2024) noted, Industry 4.0 technology integrated with green infrastructure provides a strong foundation for achieving sustainability goals in the small and medium-sized enterprises (SMEs) sector. This enables companies to reduce their environmental impact while improving operational performance. Research conducted by Yeo and Ong (2024) also shows that competency in implementing environmentally friendly technologies plays a crucial role in improving sustainability performance in SMEs, particularly in terms of resource efficiency and waste reduction (Kunaifi & Zhilalil Haq, 2025). The implementation of GSC that supports green technology enables companies to optimize production and operational processes for greater efficiency and sustainability.

Furthermore, research by Ahmad et al. (2025) shows that companies with strong GSC are better prepared to adapt to increasingly sustainability-oriented market demands. This aligns with the findings of a study by Feng et al. (2024), which emphasized the importance of utilizing green technology in driving innovation that can contribute to environmental

sustainability. Investment in GSC has an impact that is not limited to better environmental management but can also improve a company's image, which in turn positively impacts its reputation and customer trust in the company's commitment to sustainability (Shahbaz et al., 2025; Ahmad et al., 2025).

5. The Influence of Green Relational Capital (GRC) on Green Innovation (GI)

Green Relational Capital (GRC) shows a significant positive effect on Green Innovation (GI) with a path coefficient of 0.339 and a p-value <0.001. Strong relationships between companies and various external stakeholders, such as suppliers and customers, who focus on sustainability, play a crucial role in enhancing the organization's green innovation capacity. External stakeholders who support sustainability practices and share knowledge and resources with the company will accelerate the adoption and implementation of environmentally friendly technologies. Consistent with these findings, research by Tran et al. (2023) states that social relationships and collaboration based on green knowledge can encourage companies to be more proactive in developing and implementing sustainable green innovations. Established relationships with sustainability-focused suppliers can create a more efficient and environmentally friendly supply chain, which in turn drives improved corporate innovative performance in a green context (Wu et al., 2022).

Furthermore, Yeo and Ong (2024) revealed that strong external relationships with environmentally conscious suppliers and business partners can accelerate the adoption of sustainability-focused Industry 4.0 technologies. In this context, Green Relational Capital facilitates the flow of information and technology between companies and external stakeholders, enabling organizations to access the latest green innovations and collaborate on developing environmentally friendly solutions. This leads to increased operational efficiency and reduced environmental impact, supporting the achievement of long-term sustainability goals within the organization (Santos & Sant'Anna, 2024).

Research by Ahmad et al. (2025) also emphasized the importance of Green Relational Capital in enhancing green innovation capabilities in the SME sector. They found that strong relationships with suppliers who prioritize sustainable practices play a significant role in driving the adoption of green technologies and accelerating innovation in more environmentally friendly products and processes. This is consistent with the findings reported by de Andrade et al. (2025), who stated that Green Relational Capital serves as a key driver in accelerating the adoption of green practices in the SME sector, ultimately contributing to improved environmental and operational performance.

The importance of relationships with external stakeholders in facilitating green innovation is also supported by research by Li et al. (2022), which shows that external relationship capabilities within the context of green relationships can strengthen an organization's ability to develop more environmentally friendly products. Engagement in these sustainability-focused relational networks creates opportunities for sharing knowledge, resources, and technologies necessary for more effective green innovation (Shahbaz et al., 2025).

Overall, the results of this study indicate that Green Relational Capital plays a crucial role in accelerating the green innovation process within organizations. Strong collaboration with external stakeholders who support sustainability and share green knowledge will enhance an organization's capacity to develop and implement environmentally friendly innovations, which in turn contributes to sustainable business performance.

6. The Influence of Green Relational Capital (GRC) on Sustainable Business Performance (SBP)

Green Relational Capital (GRC) has a significant positive effect on Sustainable Business Performance (SBP) with a path coefficient of 0.105 ($p < 0.010$). This indicates that strong relationships with external partners committed to sustainability, such as sustainability-focused suppliers and customers, can improve sustainable business performance. Good collaboration with external stakeholders enables organizations to obtain the resources, knowledge, and technology needed to implement environmentally friendly practices in their business operations. This concept aligns with research conducted by Wu et al. (2022), which emphasizes the importance of external relationships in improving operational and environmental performance through the implementation of effective green management.

Relationships with environmentally conscious external partners will facilitate the flow of information and technology, which can accelerate the adoption of green innovations. As explained by Tran et al. (2023), strong external relationships within the context of Green Relational Capital play a crucial role in enhancing an organization's capacity to innovate, particularly in the development of environmentally friendly technologies (*Green Economy and Sustainable Development*, 2022). This finding is also supported by research conducted by Long and Liao (2023), which states that external stakeholders, such as suppliers and business partners engaged in environmentally friendly activities, can provide a company with a competitive advantage in terms of sustainability and operational efficiency.

Furthermore, strong relationships with external partners can help companies more easily obtain external support in the form of policies, technology, or even skilled human resources. According to Yeo and Ong (2024), collaborating with external partners who share sustainability values can enhance an organization's ability to adopt and implement sustainability-focused Industry 4.0 technologies, contributing to its sustainable performance. This is further supported by research by Ahmad et al. (2025), which found that companies with strong relationships with environmentally conscious suppliers and customers have a greater ability to achieve sustainable business success.

Santos and Sant'Anna (2024) also emphasize the importance of Green Relational Capital in improving business sustainability in SMEs. They explain that companies that are able to build strong relationships with external partners committed to sustainability can accelerate the development and adoption of green practices, which in turn contributes to achieving sustainable business performance. This indicates that GRC is not only crucial for improving operational performance but also serves as a catalyst for implementing more effective sustainability strategies in the SME context.

Overall, this research shows that Green Relational Capital plays a significant role in driving sustainable business performance. Collaboration with external partners who support sustainability can accelerate the adoption of green innovations, improve operational efficiency, and provide long-term competitive advantage. Therefore, building and maintaining strong relationships with external stakeholders who care about sustainability issues is crucial for companies seeking to achieve sustainable performance.

7. The Influence of Green Innovation (GI) on Sustainable Business Performance (SBP)

Green Innovation (GI) has a highly significant positive effect on Sustainable Business Performance (SBP), with a path coefficient of 0.600 ($p < 0.001$). These results indicate that the implementation of green innovation can directly contribute to improving sustainable

business performance. Green innovation, which includes the development and implementation of environmentally friendly products, processes, and technologies, can increase operational efficiency, reduce waste, and improve a company's reputation in the eyes of consumers who are increasingly concerned about sustainability issues. This research aligns with the findings of Tran et al. (2023), which show that green innovation integrated with green intellectual capital can strengthen a company's operational and environmental performance, creating a sustainable competitive advantage.

More deeply, GI plays a key role in improving resource efficiency, reducing costs, and enhancing market competitiveness. For example, Yeo and Ong (2024) found that the implementation of sustainability-focused Industry 4.0 technologies can strengthen business performance in the context of MSMEs. Green innovation enables companies to optimize production processes, increase energy efficiency, and minimize their carbon footprint. This impacts not only operational costs but also the company's reputation, which is increasingly important in attracting environmentally conscious consumers. Thus, companies that effectively implement GI can create sustainable added value, ultimately driving better business performance.

The results of this study also support previous research showing that green innovation has a strong direct impact on sustainable business performance in the manufacturing sector. Ahmad et al. (2025) highlighted that MSMEs that adopt green innovation practices in their operations tend to perform better, both in terms of cost efficiency and customer satisfaction. By implementing more environmentally friendly innovations, companies can improve their operational sustainability and strengthen relationships with customers who increasingly prioritize sustainability in their consumption choices (Kunaifi et al., 2024).

Furthermore, Santos and Sant'Anna (2024) added that the relationship between GI and SBP is strongly influenced by collaboration with external partners who share similar values regarding sustainability. Partners focused on green innovation, such as suppliers providing environmentally friendly materials, can enhance a company's ability to implement GI in their supply chain, which in turn positively impacts sustainable business performance. This relationship is further strengthened by the active role of external stakeholders who support and commit to sustainability initiatives.

Overall, the impact of green innovation on sustainable business performance is very clear in this study. The implementation of green innovation not only improves operational efficiency but also contributes to the company's long-term sustainability by enhancing its reputation with consumers and improving financial performance. Therefore, companies seeking to strengthen sustainable business performance should pay attention to the development and implementation of green innovation in every aspect of their operations (Adediran Ulrich, 2025).

CONCLUSION

Based on the research results, it can be concluded that the management of Green Human Capital (GHC), Green Structural Capital (GSC), Green Relational Capital (GRC), and Green Innovation (GI) has a significant role in improving Sustainable Business Performance (SBP) within an organization. Green Human Capital has been shown to have a significant positive influence on Green Innovation and Sustainable Business Performance, where the skills and knowledge possessed by human resources in the sustainability aspect

encourage green innovation that has an impact on improving sustainable business performance. Green Structural Capital, which includes infrastructure and technology that supports sustainability, also contributes to increasing the company's innovation capacity and operational efficiency, thereby strengthening the company's competitiveness and resilience to more environmentally friendly market demands. Green Relational Capital, or strong relationships with external partners committed to sustainability, has been shown to accelerate the adoption of green technology and improve operational performance and innovation within the company. Finally, Green Innovation shows a very significant influence on sustainable business performance, where the implementation of green innovation helps companies increase efficiency, reduce environmental impact, and improve their reputation in the eyes of consumers. Overall, this study emphasizes the importance of integrating sustainability into corporate strategy through the development of trained human resources, the implementation of environmentally friendly technologies, and collaboration with external partners to achieve sustainable business performance.

Acknowledgment

The entire author team would like to express their gratitude to all parties who have supported this research, especially the funders: Directorate of Research, Technology, and Community Service, Ministry of Education, Culture, Research and Technology. According to the Research Program Implementation Contract. Number: Based on the Decree No. 0070/C3/AL.04/2025 and the agreement/contract numbers 128/C3/DT.05.00/PL/2025; 036/LL7/DT.05.00/PL/2025; 156/E.02/UNIRA-LPPM/VI/2025.

REFERENCES

- Adediran Ulrich, B. O. (2025). The Influence of Green Innovation on Corporate Financial Performance. *International Journal of Scientific and Research Publications*, 15(7), 205–216. <https://doi.org/10.29322/IJSRP.15.07.2025.p16319>
- Akbar, K., Bilal, M., & Sherazi, S. K. H. (2025). The Relationship Between Green HRM and Environmental Performance in SMEs. *ACADEMIA International Journal for Social Sciences*, 4(3), 4345–4359. <https://doi.org/10.63056/ACAD.004.03.0707>
- Alwazin, A. (2025). Politik Emas Hijau: Aktor, Agensi, Dan Perdagangan Tembakau Di Madura. *Cerdika: Jurnal Ilmiah Indonesia*, 5(9), 2680–2690. <https://doi.org/10.59141/cerdika.v5i9.2837>
- Ahmad, MF, Fauzi, MA, Mustapha, MR, Muhamad Tamyez, PF, Sadun, AS, So, IG, et al. (2025). Industry 4.0 in small and medium enterprises: A state-of-the-art science mapping review. *Industrial Robots: The International Journal of Robotics Research and Applications*, 52(1), 46–57. <https://doi.org/10.1108/IR-03-2024-0115>
- AlQershi NA, Saufi RBA, Yaziz MFBA, Ramayah T, Muhammad NMN, Yusoff MNH Bin. The relationship between green entrepreneurship, human capital and business sustainability in Malaysian large manufacturing firms: An empirical study. *Technol Forecast Soc Change* [Internet]. 2023;192:122529. Available from: <https://www.sciencedirect.com/science/article/pii/S0040162523002147>
- Feng Q, Usman M, Saqib N, Mentel U. Modeling the contribution of green technologies, renewable energy, economic complexity, and human capital in environmental sustainability: Evidence from BRICS countries. *Gondwana Res* [Internet].

- 2024;132:168–81. Available from:
<https://www.sciencedirect.com/science/article/pii/S1342937X24001035>
- Green Economy and Sustainable Development*. (2022). MDPI.
<https://doi.org/10.3390/books978-3-0365-3222-6>
- Ho Chi Minh City Open University, & Đoàn, B. S. (2023). Green human resource management, Green intellectual capital and Green innovation: A case of SMEs in Ho Chi Minh city. *Science & Technology Development Journal - Economics - Law and Management*. <https://doi.org/10.32508/stdjelm.v7i2.1197>
- Hansen AK, Lasse C, and Lassen AH. Technology isn't enough for Industry 4.0: on SMEs and barriers to digital transformation. *Int J Prod Res [Internet]*. :1–21. Available from:
<https://doi.org/10.1080/00207543.2024.2305800>
- Ida Bagus Ngurah, I Wayan Widnyana IWS. The Effect Of Structural Capital, Social Capital, And Reputational Capital On Financial Performance And Business Sustainability. *Glob Res Rev Bus Econ [GRRBE] [Internet]*. 2023;9(5):19-34. Available from:
https://grrbe.in/Vol-9-issue-05/GRRBE_C_090501903402047.pdf
- Isbahi, M. B., Zuana, M. M. M., & Toha, M. (2024). The Multi-Social Relation of the Cattle Industry in the Plaosan Subdistrict Animal Market of Magetan Regency. *Malacca: Journal of Management and Business Development*, 1(1), 31–46.
<https://doi.org/10.69965/malacca.v1i1.51>
- Jamwal A, Palit N, Kumari S, Agrawal R, Sharma M. A decision framework for SMEs to address sustainability issues with Industry 4.0 technologies. *Ann Oper Res [Internet]*. 2025; Available from: <https://doi.org/10.1007/s10479-025-06560-5>
- Kinanti, S. A., & Murwaningsari, E. (2024). Pengaruh Green Human Capital, Green Structural Capital Dan Green Relational Capital Terhadap Kinerja Perusahaan. *Jurnal Ekonomi Trisakti*, 4(1), 245–252. <https://doi.org/10.25105/jet.v4i1.18851>
- Kunaifi, A., Djamaluddin, B., Fauzia, I. Y., Ritonga, I., Nurhayati, N., Syam, N., Widiastuti, T., & Ahsan, M. (2024). Islamic Entrepreneurship Identity In The Indonesian Hijrah Community. *Multifinance*, 2(1), 60–72. <https://doi.org/10.61397/mfc.v2i1.140>
- Kunaifi, A., Djamaluddin, B., Fauzia, I. Y., Syam, N., & Widiastuti, T. (2025). Conservative-Political Global Islamic Economy Movement, Face of Entrepreneurship Constructivism of The Indonesian Hijra Community. *IQTISHODUNA: Jurnal Ekonomi Islam*, 14(2), 531–550.
- Kunaifi, A., & Qomariyah, L. (2021). Developing Company Images Through Spiritual Public Relations Facing Covid-19 Outbreak. *Jurnal Iqtisaduna*, 1(1), 13.
<https://doi.org/10.24252/iqtisaduna.v1i1.15808>
- Kunaifi, A., & Syam, N. (2021). Business Communication in Developing the Halal Tourism Industry. *Indonesian Interdisciplinary Journal of Sharia Economics (IIJSE)*, 4(1), 1–17. <https://doi.org/10.31538/ijse.v4i1.1305>
- Kunaifi, A., & Zhilalil Haq, F. (2025). Is Fintech Financing Failing the Faithful? Online Lending, Debt Culture, and Islamic Economic Principles. *EKSYPAR: Ekonomi Syariah dan Bisnis Islam*, 12(1), 21–33. <https://doi.org/10.54956/eksyar.v12i01.672>
- Marpaung, E. I., Setiana, S., & Wijaya, A.-. (2024). Green Innovation, Sustainable Competitive Advantage Dan Sustainability Performance. *Jurnal Akuntansi, Keuangan, Pajak Dan Informasi (JAKPI)*, 4(2), 72–89. <https://doi.org/10.32509/jakpi.v4i2.4627>

- Saputra, T. A., & Kunaifi, A. (2024). *Islamic Economic Politics And Policy For The Use Of Artificial Intelligence In The Defense Sector*. 7(3).
- Santos A de M, Sant'Anna MO. Industry 4.0 technologies for sustainability within small and medium enterprises: A systematic literature review and future directions. *J Clean Prod* [Internet]. 2024;467:143023. Available from: <https://www.sciencedirect.com/science/article/pii/S0959652624024727>
- Thuy LX, and Quang T. Relational Capital and Performance of International Joint Ventures in Vietnam. *Asia Pacific Bus Rev* [Internet]. 2005 Sep 1;11(3):389–410. Available from: <https://doi.org/10.1080/13602380500068532>
- Toha, M., Zuana, M. M. M., & Isbahi, M. B. (2024). Acculturation of Mataraman Local Wisdom with Islamic Values: Implications for Social and Economic Development. *Danadyaksa: Post Modern Economy Journal*, 2(1), 33–47. <https://doi.org/10.69965/danadyaksa.v2i1.143>
- Tran TD, Huan DM, Phan TTH, Do HL. RETRACTED ARTICLE: The impact of green intellectual capital on Green Innovation in Vietnamese textile and garment enterprises: mediating role of environmental knowledge and moderating impact of green social behavior and learning outcomes. *Environ Sci Pollut Res* [Internet]. 2023;30(30):74952–65. Available from: <https://doi.org/10.1007/s11356-023-27523-y>
- Yeo Hui Ying, Ong Choon Hee. Industry 4.0 Competencies and Sustainable Manufacturing Performance in the Context of Manufacturing SMEs: A Systematic Literature Review. *SAGE Open* [Internet]. 2024 Jul 1;14(3):21582440241271264. Available from: <https://doi.org/10.1177/21582440241271263>