Strengthening Green Intellectual Capital for Corporate Sustainable Performance through Green Innovation

Syahidun
67122010003@student.mercubuana.ac.id

Mafizatun Nurhayati
mafizatun.nurhayati@mercubuana.ac.id

Abstract

Green Intellectual Capital (GCI) is a concept that examines the impact of intellectual resources on Corporate Sustainable Performance (CSP). A Structural Equation Modeling-Partial Least Squares (SEM-PLS) analysis of 121 workers at Pertamina Boyolali Fuel Terminal in Central Java, Indonesia revealed that GCI and Green Organizational Culture (GOC) have a direct impact on CSP. The analysis showed that GOC does not affect CSP directly, but GCI does, mediating the effect of GOC on CSP. To promote sustainability, organizations should prioritize continuous innovation, implement strategies for environmental and social responsibility, invest in renewable energy sources, focus on developing green technology and infrastructure, create sustainable ecosystems and promote a culture of sustainability. By doing this, organizations can achieve their sustainability goals.

Keywords: *Green Customer Capital, Green Innovation, Green Intellectual Capital, Green Organizational Capital, Corporate Sustainable Performance.*

1. Introduction

Indonesia ranks 87th on the 2021 Global Innovation Index (GII). The Continuous Improvement (CI) movement helps organizations respond to change and increase the sustainability of their operations (Cillo et.al., 2019; Abbas, 2020). Green human capital is essential for a sustainable and environmentally conscious business model, and can enhance corporate performance by promoting sustainability. Green intellectual capital has also been identified as a key factor for improved corporate sustainability, enabling organizations to be agile and make quick decisions (Kale et.al., 2019). This agility needs access to the right information and processes to make timely decisions and act on solutions (Shahzad et al., 2019). Investing in green human capital gives businesses the potential to become more competitive and positively contribute to environmental goals (Abbas, 2020). By investing in green human capital, organizations can access the right information and processes to make timely decisions and act on solutions, as well as increase their competitive edge and positively contribute to environmental goals. Moreover, green intellectual capital can provide the agility needed to rapidly respond to change, make quick decisions, and enhance corporate performance.

Shahzad et.al. (2019, 2020) identified that absorption capacity and the sharing of knowledge have demonstrating a beneficial outcome on a firm's sustainability outcomes, as well as green innovation's environmental component. Abbas and Sagsan (2019) proposed that corporate sustainability is advanced

through the beneficial impact of innovation. Also, ITS Techno Science has benchmarked and assessed the utilization of resources by Pertamina (Persero) Operations Unit Marketing Fuel Terminal on six different levels: (1) Energy efficiency, (2) Managing Toxic Hazardous Waste (B3), (3) Managing Recycle Reuse (3R) Non-B3 Waste, (4) Managing Air Pollution, (5) Water Management, and (6) Managing Pollution Loads. In addition to achieving higher performance and a more sustainable future, GIC has been involved in many businesses for decades.

Organizations are increasingly recognizing the value of investing in intangible assets such as knowledge, ideas, and relationships to remain successful (Yusoff et al., 2019). Studies have concluded that Green Human and Structural Capital are positively correlated with business success (Susandya et al., 2019), while Green Relational Capital has a minimal correlation. Josephine et al. (2020) identified a significant impact from human and relational capital on business sustainability, but found no effect from Green Structural Capital. The researcher is investigating the potential impact of "green" capital investments on corporate sustainability and business success to identify companies taking steps towards greater environmental responsibility.

Theory and Hypothesis Basis

Companies must continually increase their knowledge, innovate existing products, and create environmentally friendly solutions in order to stay competitive. As unsustainable consumption is a major factor (Xie et.al., 2019; Li et.al., 2019), companies must recognize this trend and make changes to remain successful in order to be seen as responsible corporations.

1.1 Green Intellectual Capital

Intellectual capital (IC) is composed of intangible assets, human resources, organizational capabilities, customer relationships, intellectual property rights and other strategic data (Stewart, 2020: 79). It can be used to create wealth for stakeholders (Bontis, in Ulum, 2020: 80; Youndt et. al., in Ulum, 2020: 80). Knowledge is composed of three components: human capital (skills, abilities and expertise of employees), structural capital (intangible assets such as patents or copyrights), and relational capital (customers' loyalty and reputation among other stakeholders). The International Federation of Accountants (IFAC) classifies IC into three categories: Organizational (Structural) Capital (tangible and intangible assets), Relational/Social Capital (relationships with customers, suppliers and partners) and Human Capital (skills and abilities of employees). All these elements form an organization’s Intellectual Capital.

Green Human Resources Management (GHRM) practices are essential for improving Green Performance Improvement Potential (GPIP). Green recruitment/selection, rewards, training/development, and technological advancements create a more sustainable workforce and strengthen partnerships with stakeholders. Benefits include improved productivity, reduced material use, energy costs, and enhanced brand perception. Additionally, GHRM strategies contribute towards employee engagement and trust, helping organizations meet environmental objectives and achieve long-term sustainability goals. Malik et al. (2020) and Jirakraisiri et al. (2021) found that green intellectual capital (human, organizational, and relational capital) enhances GPIP and provides a competitive advantage. Companies should invest in GHRM

practices and green intellectual capital to remain competitive and achieve long-term sustainability.

1.1.1 Green Human Capital

The value of human capital for business sustainability is indisputable (Gross-Gołacka et al., 2020; Mousa & Othman, 2020), thus appropriate structures should be created to effectively incorporate green human resource management practices. Companies can introduce initiatives like recognition programs or bonuses for eco-friendly behavior, educational seminars and workshops on sustainable development, financial incentives for reducing energy expenditure or increasing recycling, and technological solutions like carbon offsetting software or AI algorithms for waste disposal.

1.1.2 Green Organizational Capital

Organizations can improve their environmental sustainability and green innovation by implementing an environmental management accounting system, employee training programs, and setting goals related to reducing emissions, water consumption, waste reduction, energy efficiency, and resource efficiency. These practices have been shown to positively affect environmentally sustainable development through lowering pollution levels and Greenhouse Gas (GHG) emissions (Asiaei et al., 2022; Shahzad et al., 2020). Additionally, green innovation is encouraged when organizations continue to strive for improvement instead of simply meeting regulatory requirements. This can lead to greater long-term gains in terms of the environment as well as economic benefits due to the advancement of research and technology. Organizations should prioritize these efforts if they want to reduce their environmental impact.

1.1.3 Green Customer Capital

Engaging with green suppliers is a key strategy for green entrants to diversify and innovate. Knowledge sourcing and co-creation can enhance innovation performance, allowing for efficient processing of market trends and customer preferences, leading to faster realization of product ideas and improved efficiency (Cheng, 2020). Thus, the benefits of engaging with suppliers when striving for sustainability innovations should not be overlooked.

1.2 Corporate Sustainable Performance (CSP)

The use of environmentally friendly natural resources in industrial sectors has been empirically observed in the last decade due to manufacturing expansion (Abbas & Sagsan, 2019). The Triple Bottom Line (TBL) approach, adopted by Global Reporting Initiative (GRI), focuses on economic, social, and environmental criteria to measure performance, incentivizing companies to pursue sustainable practices through legal, ethical, and commercial factors (Abbas & Sagan, 2019). Governments have implemented legislation to ensure companies meet standards, but additional measures must be taken: companies should invest in green technologies and research initiatives, and regular audits should be conducted to hold all parties accountable.

Corporate Sustainable Performance (CSP) is a multifaceted concept that takes into account three aspects: environmental sustainability (reducing waste/CO2, producing green products), economic sustainability (cost effectiveness, energy efficiency, cost utilization) and social sustainability (communication, equal opportunities, community health). Green intellectual capital

can be leveraged to bolster sustainable performance through green innovation and corporate social responsibility plans. (Shahzad et al., 2019; Abbas, 2020). Q. Zhang & Ma (2021) conducted a study on two environmental management dimensions—EMB & EMD—and their influence on economic performance. They found a reverse U-shaped correlation between EMB and economic performance, in addition to a positive relationship between EMD & economic performance, with green innovation acting as a mediator variable. In addition, the study concluded that environmental leadership moderated the impact of both factors on green innovation.

Asadi et al., (2020) explored the impact of environmental and economic performance factors on green innovations in the hospitality industry by formulating a model that identified driving forces for such developments. This research can be advantageous to policymakers and hotel managers who desire to comprehend what motivates such original ideas to successfully put them into action. Barriers, capabilities, regulations, turbulence, sources of resources & knowledge, and size are key precursors for environmental innovation, which is related to an organization's sustainability performance. The culture, economic situation & context can moderate this relation; lower HDI countries tend to exhibit greater competitive advantage than higher HDI countries (Bitencourt et al., 2020).

1.3 Green Innovation (GI)

Green Innovation (GI) is empirically studied and found to involve systems, processes, products and practices to benefit the environment and corporate sustainability (Xie et al., 2019). Theoretically, GI provides more than just competitive advantage; it also ensures ecological benefits and social welfare (Cillo et al., 2019). It is described as an "achievement" that results in reduced natural degradation and increased market share due to knowledge gained (Li et al., 2019). Research has shown that GI plays an important role for organizations when it comes to creating value, achieving competitive advantage, and improving performance. It is also seen as a critical element for corporate sustainability to manage environmental problems (Diba and Xie, 2019). Unifying business issues with green innovation is identified as key for success in Asia, where population and economic growth are both high. Green innovation (product creativity, reusing, publicity) and business continuity (fiscal egress, environmental egress, social egress) have been found to have a considerable effect on each other. Green publicity has a major effect on environmental egress, product creativity on fiscal egress, and reusing on social egress. (Irfan et al., 2019; Kale et al., 2019; Tolliver et al., 2021; Li et al., 2020).

Green Supply Chain Integration (GSCI) has three dimensions - internal integration, customers, and green suppliers - which improve environmental performance, reduce costs, and facilitate green product and process innovation. The perceived justice construct of procedural fairness and distributive has a strong positive relationship with embeddedness, but no significant effect on direct knowledge sharing. Investment and knowledge sharing also have partial mediating effects on green innovation in sustainable supply chains, with knowledge sharing having a key role. Additionally, firm size has a positive effect on green innovation (Wong et.al., 2020; Zhou et.al., 2020).

The results of Y. Zhang, Sun, et.al. (2020) support the hypothesized relationship that necessary and sufficient conditions along each

dimension facilitate and enable green innovation, leading to competitive advantage through the mediation of environmental performance and corporate performance. Furthermore, their research provides self-assessment tools for organizations to develop strategies for preparing and implementing green innovations for optimal sustainability results. From the perspective of the green innovation process, four risks are classified in this study, namely, global green R&D risk, global green manufacturing risk, global green marketing risk, and global green service risk. Among the four stages of green innovation risk, green marketing risk is the highest, followed by green service risk, and green R&D risk and green manufacturing risk are the least. Global green service risk and green R&D risk can be mitigated primarily through risk diversification and risk reduction. Global green manufacturing risks and green marketing risks can be reduced mainly through risk diversification and secondary through risk reduction (Sun et al., 2020).

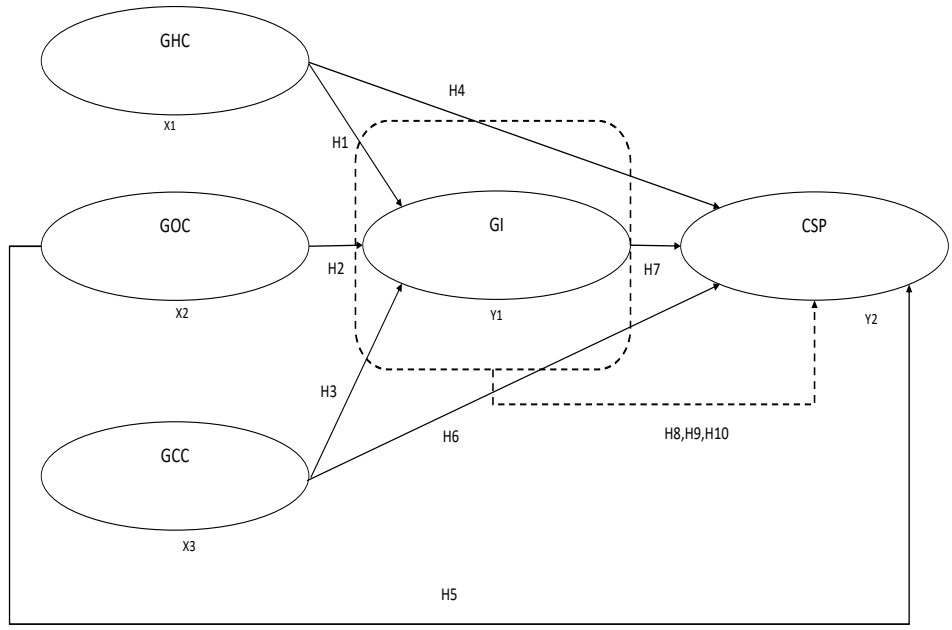
Green process and product innovation can effectively improve a company's economic performance, with environmental performance and market competitiveness as important mediating variables. Green process innovation can positively promote green product innovation and technological innovation, with the path from green product innovation to economic performance being more important than from green process innovation to economic performance (Wang et.al., 2021). Corporate environmental disclosure can also have a positive effect on green innovation, further improving a company's financing conditions (Y. Zhang, Xing, et.al., 2020). Therefore, if companies want to improve their economic performance, they should focus on green process and product innovations.

2. Research

Fuel Terminal BBM is an operating unit with operational business processes, such as receiving, storing, and distributing fuel oil (BBM). Quantitative methods were used with PLS SEM as data processing. In addition to workforce safety, the company has consistently implemented programs to promote efficient use of resources, reduce waste, protect biodiversity, and empower communities; all of which are instrumental in preserving the environment. The Ministry of Environment and Forestry (KLHK) evaluated the company's performance in environmental management against the benchmark distribution oil and gas groups in 2020. The assessment criteria include: Environmental Management Performance Summary Document (DRKPL), Environmental Management System (SML), Energy efficiency, Emission reduction, 3R B3 waste, 3R non-B3 solid waste, Water efficiency, Biodiversity, and Community empowerment.

Figure 1 presents a research model explaining the impact of green intellectual capital (GIC) on corporate sustainable performance (CSP). GIC includes environment-related knowledge, skills, attitudes, and values and is beneficial for improved innovation processes, leading to enhanced CSP scores. This study postulates a mediating effect between green innovation and CSP, with GIC resources necessary for the development of successful sustainable initiatives and better performance. Organizations should therefore strive to enhance GIC utilization for greater efficiency in tackling sustainability issues to improve CSP.

Figure 1. Research Model



2.1 The relationship between GHC and GI

The relationship between GHC and GI has been especially beneficial for developing countries; for instance, Abbas and Sagsan (2019) found a positive correlation between them and innovation in external markets. However, other researchers have reported mixed results (Abbas and Sagsan, 2019). By understanding how to best use these resources together, governments can better achieve growth while promoting sustainable development. Therefore, the following hypothesis is proposed:

H1: GHC has a positive and significant effect on the company's GI.

2.2 The relationship between GOC and GI

Research has shown that investment in green and eco-friendly resources for development and innovation by top management, in combination with organizational learning and corporate strategy, is seen to help achieve GI goals (Pe´rez-Lun˜o et al., 2019; Davenport et al., 2019). GOC has been shown to contribute to CSP (Shahzad et al., 2019). Furthermore, knowledge sharing - both explicit and tacit - has been identified to significantly influence innovative abilities (Ganguly et al., 2019). Additionally, the practice of learning by doing has been positively linked to GIs (Abbas and Sagsan, 2019). It is evident from the literature that learning by doing is an important factor for achieving GI. Top management's investment in green and eco-friendly resources for development and innovation, with the help of employees' knowledge and competence, is seen to be the cause of the relationship between GHC and GI (Pe´rez-Lun˜o et al., 2019). It is essential to combine corporate strategy with GOC strategy to achieve GI goals, which is further emphasized through organizational learning (Davenport et al., 2019). Therefore, the following hypothesis is proposed:

H2: GOC has a positive and significant effect on company GI.

2.3 The relationship between GCC and GI

Sharing and collection are two fundamental components of knowledge management that can be facilitated through meetings, discussions, social networking, and collaboration (Attia & Salama, 2018). Through interactive conversations between colleagues, employees have the opportunity to acquire new skills and information as well as share their own experiences (Abbas & Sagsan, 2019; Shahzad et al., 2019). Therefore, introducing a platform that is easily accessible for users to find information related to work tasks or projects will help foster creativity and efficiency in the workplace (Abbas & Sagsan, 2019; Shahzad et al., 2019). Understanding how Global Communication Channels (GCC) can be used effectively to facilitate this process of sharing/collecting knowledge is key in encouraging innovative thinking within businesses. Thus, the following hypothesis is proposed:

H3 : GCC has a positive and effective influence on the company's GI.

2.4 The relationship between GI and CSP

Process innovation (continuous improvement of existing processes) and product innovation (creating new products/services) can both contribute to sustainability goals. Benefits of green initiatives (GI) extend beyond environmental improvements, such as cost savings, improved efficiency and increased customer loyalty (Fernando et al., 2019). Thus, GI should be a priority for organizations looking to reduce environmental impact (Xie et al., 2019). Based on the above arguments, the following hypotheses are proposed: H4: GI has a positive and significant influence on CSP

2.5 Relationship between GHC on CSP by GI mediation

Recent research has emphasized the importance of Human Capital (HC) for corporate sustainability (Shahzad et al., 2019). Studies have identified that HC has a direct and positive effect on sustainable company performance, such as increasing profits while reducing environmental impacts (Abbas and Sagsan, 2019). Furthermore, research suggests that the environment - a dimension of sustainability performance - also exerts a positive influence on Green Intensity (GI), or the use of renewable energy sources in production processes (Shahzad et al., 2020). As companies continue to embrace advanced and digital manufacturing technologies, operational efficiency is improved which further enhances corporate innovation capabilities. For example, unmanned automated systems can reduce manual labor hours while improving product quality at lower costs; this then provides opportunities for businesses to develop new products with greater market appeal (Gillani et al., 2020). Ultimately, these advancements create an environment where corporations can sustainably operate in order to maximize their long-term success. Based on the discussion above, the hypothesis is proposed:

H5: GHC has a positive and significant effect on CSP.

H6. GI mediates the relationship between GHC and CSP.

2.6 The relationship between GOC and CSP with GI mediation

GOC assists organizations in developing their continuous improvement to compete in uncertain environmental changes and create competitive opportunities successfully (Ashrafi et. al., 2019). It is a knowledge-based proactive

approach that progresses from agility to reactivity-based production (Kale et. al., 2019). The results of organizational capital illustrate that combining innovative and environmentally-friendly thinking in practice is the only way to achieve CSP (Ashrafi et. al., 2019). Therefore, this study argues that agile organizational capital has the potential to influence environmentally-friendly organizational strategies to ensure sustainable performance is attained. Furthermore, pro-environmental organizational capital will be more innovative. Thus the proposed hypothesis:

H7: GOC has a positive and significant influence on CSP

H8: GI mediates the relationship between GOC and CSP

2.7 Relationship between GCC and CSP mediated by GI

Organizations that prioritize environmentally friendly practices and resource-efficiency can meet their goals of avoiding environmental degradation (Fernando et al., 2019). Such organizations implement changes to reduce negative impact on the environment, minimize industrial waste, recycle resources, and minimize pollution levels, ultimately promoting corporate sustainability (Fernando et al., 2019). These measures create a positive image of an organization in public eyes and help attract customers who prefer green products or services. Businesses should invest time and resources into research and implementation of ecofriendly solutions to ensure sustainable growth and protect our planet's future prospects.Thus the proposed hypothesis:

H9: GCC has a positive and significant influence on CSP

H10: GI mediates the relationship between GCC and CSP

3. Research Methods

In 2019, a research paper by Shahzad et al. examined the potential environmental pollution in the fuel terminal sector. A survey method, using questionnaires and a cross-sectional approach through Google-form, was employed to test the hypothesis that organizational leaders consider sustainability from green intellectual capital and green innovation. The source of innovation is knowledge that leads to sustainable performance, and 121 respondent data was collected from Pertamina fuel terminal workers. The study aimed to explore the implications of this knowledge and the potential environmental pollution in the fuel terminal sector.

4. Data

Analysis Data analysis was done using SmartPLS v.3.2.8 and PLS-SEM.

4.1 Analysis of the Outer Model

Measurement or model outer is a powerful tool for data analysis. It can be used to test the validity and reliability of models, measure relationships between observed variables, and identify key components of a construct or model. To do so, it utilizes various statistical techniques such as assessing internal consistency, convergence, and discriminant validity (Sarstedt et al., 2017). This allows researchers to detect anomalies in data sets which may indicate problems with the underlying construct or model. Furthermore, it can help determine if two factors are related and how strongly they are associated. Measurement or Model Outer is an invaluable tool that provides valuable insights into the quality of models being studied.

Table 1. Reliability and Validity of All Constructs

Latent constructs	Cronbach's Alpha (CA)	rho_A	Composite Reliability (CR)	Average Variance Extracted (AVE)
Corporate sustainable performance (CSP)	**0.905**	**0.911**	**0.923**	**0.573**
Green Customer capital (GCC)	**0.925**	**0.929**	**0.947**	**0.817**
Green human capital (GHC)	**0.817**	**0.828**	**0.872**	**0.578**
Green Innovation (GI)	**0.938**	**0.939**	**0.956**	**0.844**
Green organizational capital (GOC)	**0.879**	**0.879**	**0.917**	**0.733**

Cronbach's Alpha is a measure of internal consistency, which suggests that items on a scale are measuring the same concept. A score of 0.70 or higher indicates excellent reliability and therefore valid results when assessing this concept in research. Composite Reliability also measures internal consistency; it looks at whether or not all items in a construct are capturing the same underlying factor, with a score of 0.70 or higher indicating reliable data for assessment purposes. Average Variance Extracted (AVE) assesses convergent validity, which looks at how well different indicators measure similar constructs to one another. An AVE score greater than 0.50 demonstrates acceptable levels of convergent validity and thus reliable results when using constructs in research studies.

Table 2. Hypotheses Assessment

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values	Signifikansi
GCC -> CSP	0.249	0.243	0.097	2.567	**0.011**	Signifikan
GCC -> GI	0.279	0.282	0.118	2.371	**0.018**	Signifikan
GHC -> CSP	0.258	0.271	0.128	2.020	**0.044**	Signifikan
GHC -> GI	0.298	0.294	0.138	2.167	**0.031**	Signifikan
GI -> CSP	0.340	0.333	0.102	3.345	**0.001**	Signifikan
GOC -> CSP	0.087	0.085	0.138	0.633	**0.527**	Tidak Signifikan
GOC -> GI	0.258	0.260	0.121	2.128	**0.034**	Signifikan

The t test is a commonly used statistical technique to assess differences between two independent groups and determine the influence of one variable on another. To ensure accurate results, researchers should control for demographic and environmental variables, such as age, gender, location, and seasonality. By doing so, researchers can make valid conclusions and draw meaningful insights from their data.

Basis for Decision Making

Probability is a fundamental tool used in statistics to measure the likelihood of an event occurring. It is especially important in hypothesis testing, where its probability value is compared to alpha (the significance level). If the probability value is greater than 0.05, then it implies that the t statistic falls within -t table and t table; thus, we cannot reject H0. On the other hand, if the prob value is less than 0.05 then either t statistic > t table or t statistic < -t table; indicating that H0 must be rejected due to its lower probability value. It's also essential to note that critical values for alpha = 0.05 (1.96) and alpha = 0.10 (1.65) offer us more precise insight into how likely an event can occur based solely on its associated probability value alone.

Decision:

The results of the t-test suggest that the GCC variable has a strong, positive effect on CSP (t stat value of 2.567 > 1.96). All other hypotheses (excluding GOC on CSP) have positive and statistically significant effects (t values > 1.96). Therefore, there appears to be a structural equation demonstrating how these variables are related in terms of their effects on each other - namely that an increase in GCC leads to an increase in CSP, while other factors may contribute positively to this relationship. Thus the structural equation is:

GI = 0.298*GHC + 0.258*GOC + 0.279*GCC + e

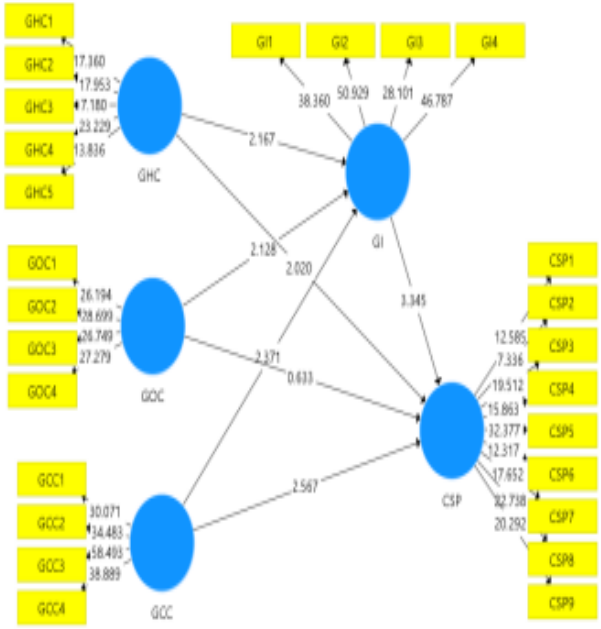
CSP = 0.258*GHC + 0.087*GOC + 0.249*GCC + 0.340*GI +e

Table 3. R Square

	R Square	R Square Adjusted
CSP	0.654	0.642
GI	0.538	0.526

The coefficient of determination (R square Adjusted) is a statistical measure used to indicate how well the independent variables explain the variation in the dependent variable. An adjusted R2 value close to 1 indicates that the independent variables have a strong influence on the dependent variable, while an adjusted R2 value close to 0 indicates weak influence. In this case, an adjusted R2 value of $$0.526$$ for GI variance means that 52.6% of this variance can be explained by changes in GHC, GOC and GCC. Similarly, when considering CSP equation, it has an adjusted R2 value of $$0.642$$ indicating that 64.2% of its variance can be attributed to these four factors — GHC, GOC ,GCC and GI . This emphasises how important it is for decision makers to take into account external factors like these when making decisions as they may significantly affect performance outcomes.

Figure 2: Structural Model of Bootstrapping



5. Conclusion

The role of Green Innovation (GI) as a mediator between Green Human Capital (GHC) and Corporate Sustainable Performance (CSP) is supported, with positive, significant effects on environmental, economic and social aspects being observed. Abbas and Sagsan (2019) and Shahzad et. al. (2019) demonstrate partial mediation of the relationship between GHC and CSP by GI. The importance of utilizing resources efficiently while preserving the environment is recognized. Continuous innovation and improvement in green energy initiatives, such as renewable energy sources, is essential for achieving sustainability. Secundo et. al. (2020) and Setiyowati et. al. (2022) describe that supporting the national energy transition through renewable energy and engaging local communities to promote sustainable social and economic progress is an effective approach. This study provides valuable insights into the interrelatedness between GI, GHC, and CSP that can inform corporate decision-making. In order to gain a more comprehensive understanding of the effects of green innovation on corporate sustainability performance, future research should explore the relationship in various contexts and industries. Additionally, researchers should investigate other forms of green human capital investments, such as training, development, incentives, and rewards, and assess their cumulative impacts over an extended period of time. This type of inquiry would provide valuable insight into the efficacy and potential advantages of investing in green human capital initiatives.

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