HOW DOES THE GREEN COMPETITIVE ADVANTAGE OF BUILDING A SUSTAINABLE PALM OIL INDUSTRY? THE ROLE OF GREEN INNOVATIONS AS A MEDIATION

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Abstract

This study aims to analyze how green intellectual capital (GIC), green organization culture (GOC), and green information technology and system (GIT) impact corporate sustainability (CS) through green competitive advantage (GCA) with green innovation (GI) as an intervening variable. This study used a partial least squares structural equation model (PLS-SEM) model to test the conceptual model using SmartPLS version 3 on a sample of 220 employees in the palm oil industry of PT Astra Agro Lestari Tbk. The result shows that GIC, GOC, and GIT have an effect on GI and GCA, and further, GCA has proven to affect CS. Therefore, the Oil Palm Corporate that can create GI will get GCA and CS. Thus, it will increase the image of the company. Furthermore, applying GIC, GOC, and GIT will improve the application of GI, thereby reducing carbon emissions and the impact of environmental damage due to the company's business processes. Therefore, companies with GI continuously will improve the quality of green and have GCA. The relevant article also proclaimed comparable research conclusions. GI contributes positively to developing a competitive advantage for the company (Maziriri & Maramura, 2022).

Keywords: Green Intellectual Capital, Green Organizational Culture, Green Information Technology & System, Green Innovation, Green Competitive Advantage, Corporate Sustainability

Authors' individual contribution: Conceptualization — H.H.; Methodology — H.H. and L.C.N.; Validation — H.H. and L.C.N.; Formal Analysis — H.H. and L.C.N.; Investigation — H.H. and L.C.N.; Resources — H.H. and L.C.N.; Data Curation — H.H.; Writing — Original Draft — H.H.; Writing — Review & Editing — H.H. and L.C.N.; Visualization — H.H.; Supervision — L.C.N.; Project Administration — H.H. and L.C.N.

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1. INTRODUCTION

The increasing growth of the palm oil industry is directly proportional to the increase in pollution produced by business processes. Increasing carbon emissions impact global warming, which concerns the international and local communities. The most significant emissions are from the industrial sector at 37%, the transportation sector at 27%, and the electricity and heat-producing industry at 27% (Climate Transparency, 2020).

Activities in the palm oil industry are one of the factors that affect greenhouse gas (GHG). In efforts to reduce the impact of global warming on

the climate, mitigation needs to be done to reduce carbon dioxide (CO_2) significantly. The Indonesian government is concerned about this problem and is committed to efforts to reduce GHG emissions by 29% with its actions and 41% with international assistance until 2030. The palm oil industry is a plantation commodity with competitive competitiveness in international trade. Indonesia is the world's largest producer of crude palm oil (CPO), with a market share of 55.7% of global CPO production. Malaysia is the second country with a share of 28.9% in 2018 (U.S. Department of Agriculture [USDA], 2018). The palm oil industry has a vital role in the CPO trade, which is expected to implement green innovation (GI) and become a business process with a green competitive advantage (GCA) to achieve corporate sustainability (CS). The European Union (EU) establishes an environmental policy for industrial palm oil products. Environmental pressures and business competition have pushed the palm oil industry to implement various ecological policies and certify CPO products. The sustainable palm oil industry needs to carry out voluntary environmental certifications such as the Roundtable on Sustainable Palm Oil (RSPO), the International Standard for Carbon Certification (ISCC), and the Sustainable Agriculture Network (SAN). Indonesia Sustainable Palm Oil (ISPO) is a mandatory certification. ISPO-certified CPO has increased the export value of palm oil.

The cause of the highest emission in the palm oil business process is palm oil mill effluent (POME) which comes from the mill process. Using urea and nitrogen-phosphorous-potassium (NPK) fertilizers causes methane (CH_4) emissions in the atmosphere. Using fossil fuels in transportation, heavy equipment, and generators causes CO_2 emissions. These emissions are the focus of the assessment to obtain ISCC certification. One of the valuable business investments is green intellectual capital (GIC) because it is a center for the internal improvement of human resources (HR) toward understanding environmental issues (Yusoff et al., 2019) and plays a vital role in implementing and developing an environmentally friendly organizational culture. Green organization culture (GOC) can be built and managed properly through HR manager facilities (Tahir et al., 2019). GI is a product and process that leads to environmental improvement (Grazzi et al., 2019). The implementation of green information technology and system (GIT) practices helps organizations achieve environmental goals (Loeser et al., 2017). Organizations and companies that implement GI will produce environmental innovations through the use of technology for sustainable development (Leyva-de la Hiz et al., 2019).

This study is written in five parts. First, starting with the introduction, followed by a literature review and hypothesis development in Section 2. The research method is described in Section 3, followed by the results and discussion in Section 4. Finally, Section 5 explained the theoretical and managerial implications, as well as the study's limitations, following the author's suggestion for further research.

2. LITERATURE REVIEW

2.1. Theoretical background

2.1.1. Green intellectual capital

According to Josephine et al. (2020), GIC consists of green human capital (GHC), green structural capital (GSC), and green relational capital (GRC). GIC describes the company's intangible assets, including knowledge, skills, experience, and updates regarding environmental sustainability. According to Agostini et al. (2017), GIC is a strategic asset in terms of human capital, innovation capital, and relation capital, resulting in higher radical and incremental performance.

2.1.2. Green organizational culture

Organizational culture is an essential factor in the suitability of diverse HR. HR will find work satisfaction, tend to stay in it, and have a high probability of getting a positive performance evaluation. In addition, organizational culture is a factor that positively affects employee commitment (Robbins & Coulter, 2018). Effective organizational culture plays an important role in employee productivity (Abane et al., 2022). Denison and Ko (2016) state that assessing organizational culture and evaluating organizational strengths and limitations are based on the following four dimensions:

1) involvement in work;
2) consistency;
3) adaptability;
4) mission.

2.1.3. Green information technology and system

Green information technology and system is a data collection system or statistical software that provides regulatory bodies for allocating resources to various sectors so that the use of GIT becomes a suitable mechanism and can be ascertained and utilized (Janssen et al., 2018). Technology adoption needs to be carried out by sustainable companies because it produces five perceived characteristics: relative advantage, compatibility, complexity, trialability, and observability (Shanmugam, 2021). According to Imasiku et al. (2019), GIT is a procedure for implementing environmentally friendly practices that promote resource efficiency by using computer systems to reduce energy consumption and environmental impact. GIT has become a global attraction for various environmentally conscious stakeholders. Restrictions on energy consumption, carbon footprint, and waste are the main issues in planning industrial activities. Dalvi-Esfahani et al. (2020) stated the importance of GIT in managing environmental resources and making policies to promote green technology to reduce high mass carbon emissions worldwide. Based on the statement of Loeser et al. (2017), green information system (green IS) strategies mediate the relationship between environmental adaptation and the application of green IT practices and green IS practices, which in turn, lead to organizational benefits in the form of cost reductions, corporate prestige increase, and green innovation capabilities. Therefore, the dimensions of green IT are assessed based on green IT practices and green IS practices.

2.1.4. Green innovation

Green innovation consists of new or better products (goods or services) and processes (including organizational change, production, and marketing) significantly different from the products or processes previously offered or used, leading to environmental improvements. Environmental improvement can be the primary goal of the innovation or the result of other innovation goals. Environmental improvement of innovation can occur during the production or supply of goods or services or the after-sales use of goods or services by end users (Grazzi et al., 2019). GI can be categorized into green product innovation product and green process innovation (Liao, 2016). GI focuses on operations and processes that affect competitive advantage; the focus of GI is on products and customers and eco-efficiency, which has a positive effect on GCA (Sellitto et al., 2020). Environmental innovation affects environmental performance, and responsible leadership has a positive effect on incremental environmental innovation (Liao & Zhang, 2020).

2.1.5. Green competitive advantage

A focused strategy is an indicator of GCA, which can identify market segments so that they can compete effectively (Nawangsari et al., 2022). Fundamental thinking related to environmental issues is needed in implementing sustainable development schemes in the manufacturing industry. In addition, intellectual capital as an intangible asset in the industry can build a competitive advantage in a knowledge-based economy (Chaudhry et al., 2016). GCA consists of two dimensions, namely:

1) low-cost advantage, namely the ability of an organization to implement product innovation and environmental processes to gain a competitive advantage at low costs;

2) differentiation advantage, which is a concept of environmental protection.

Consumer demand for environmentally friendly products increased CS by saving and reducing energy consumption. Through environmental innovation, companies improve environmental performance, promote a green image, and meet consumer demands, further helping companies to open up new market opportunities and increase competitive advantage in corporate differentiation (Liao, 2016).

2.1.6. Corporate sustainability

Corporate sustainability is an organization that embodies environmental, social, and economic values through the interaction of norms so that it always supports the development of human life and other creatures on Earth. For example, companies generate social benefits while regenerating the environment sustainably to be financially aligned (Upward & Jones, 2016). Better environmental management benefits a better life in society and the world and contributes to the sustainability of development goals (Wang et al., 2022). The company's strategy for business sustainability is an important concept by increasing the satisfaction of business service users (Nawangsari et al., 2022).

2.2. Hypothesis development

2.2.1. The effect of GIC on GI and GCA

Green intellectual capital is an effective business investment because it is the key to improving internal resources toward understanding environmental issues (Yusoff et al., 2019). The knowledge possessed by employees is fundamental to sustaining the company in the era of rapidly developing technology and provides greater motivation for employees to apply green knowledge to innovate green. GHC investment is a fundamental need to differentiate GI significantly. With a high GHC level of a company, the company will get substantially higher success in carrying out green innovations (Singh et al., 2020). In pioneering innovation, knowledge, skills, and experiences related to the environment require a strategic relationship (GRC) between the company and other collaborators that must be embedded in the company (Wang & Juo, 2021). Companies will be interested in implementing eco-innovation practices in dealing with the environmental awareness of stakeholders (Fernando et al., 2019).

GIC guides GI and ensures a competitive advantage for firms (Mehmood & Hanaysha, 2022). There is a significant relationship between GIC and green performance, with this relationship being partially measured by the GI variable (Marco-Lajara et al., 2022). GI serves as a full mediator between GIC's two components, GRC and GSC, and a partial mediator between GHC dan business sustainability (Li et al., 2023). GI has a direct effect on sustainability business (Shabana, 2023). Agricultural companies' sustainable competitive advantage requires efficient green HR management (Obeidat et al., 2020). Thus, hypotheses related to understanding GIC are:

H1: Green intellectual capital positively influences green innovation.

H2: Green intellectual capital positively influences green competitive advantage.

2.2.2. The effect of GOC on GI and GCA

Effective organizational culture plays an important role in employee productivity. Organizational culture, mission, involvement, and consistency are crucial for employee performance. Building resilience in the dynamics of organizational culture is carried out to foster employee productivity through a reward-based system (Abane et al., 2022). Managers and leaders are advised to develop a solid organizational culture to grow the total capacity of the workforce and the organization (Phatiranage, 2019) HR managers and workers play an essential role in developing and implementing an environmentally friendly organizational culture. HR provide a system for building a green corporate culture (Tahir et al., 2019). GOC as a facilitator positively mediates the connection between green human resources management practices and ecological capacity (Roscoe et al., 2019).

GOC affects performance and competitive advantage (Wang, 2019). The role of organizational culture in improving business performance and productivity will result in business excellence in the organization (Pathiranage, 2019). Social capital is

one of the unique resources owned by organizations that are useful for competitive advantage. Moreover, GOC through GI has a positive and significant effect on green competitiveness, profit, and organizational performance (Chandra et al., 2021). Organizational culture as a source of sustainable competitive advantage has been widely studied by several previous researchers (Fareed et al., 2016). For this reason, it is hypothesized that GOC will positively affect efforts to execute GI and give the company GCA. Thus, hypotheses related to understanding GIC are:

H3: Green organization culture positively influences green innovation.

H4: Green organization culture positively influences green competitive advantage.

2.2.3. The effect of GIT on GI and GCA

Green IT is a technology that facilitates environmentally friendly. Leyva-de la Hiz et al. (2019) state that organizations and companies implementing GI will produce environmental innovation using technology for sustainable development. The results of Chen and Chen's (2017) research show that resources and abilities positively influence the adoption of GI.

Social and technological factors have a positive effect on sustainable competitive advantage through the role of harmonization strategies (Haseeb et al., 2019a). The widespread application of information technology in various business sectors will improve business performance and result in higher education institutions using information and communication technology to stimulate business operations, provide services, and further improve administrative programs (da Silva et al., 2019). The company's competitive advantage influences business performance. IT applications have a positive influence on competitive advantage (Widyanti & Mahfudz, 2020). Thus, hypotheses related to understanding GIT are:

H5: Green information technology and system positively influences green innovation.

H6: Green information technology and system positively influences green competitive advantage.

2.2.4. The effect of GI on GCA

According to Sellitto et al. (2020), GI that focuses on operational processes does not directly facilitate competitive advantage. Instead, GI positively affects factors that support competitive advantages, such as products and eco-efficiency. Furthermore, if companies want to gain a competitive advantage, they must produce more investment in GI activities (Gürlek & Tuna, 2017). GI was positively related to enterprises' competitive advantage through the mediating role of organizational learning (Tu & Wu, 2021). With increasingly stringent environmental regulations and increasing demands for sustainability, GI is essential in achieving a competitive advantage. Chatzoglou and Chatzoudes (2018) found that higher innovation in products and business processes will lead to a better competitive advantage. Thus, the formulated hypotheses are as follows:

H7: Green innovation positively influences green competitive advantage.

2.2.5. The effect mediating of GI on GCA

Green human capital is the entity that underlies GI behavior in agronomic companies. Therefore, agricultural companies need workers who can contribute knowledge, experience, and environmental management skills to carry out GI (Almada & Borges, 2018). GI strategy has a significant positive effect on new business performance (Zhang et al., 2022). GI also positively affects the company's environmental performance (Liao & Zhang, 2020). Intellectual capital plays an important role in sustainable competitive advantage. Singh et al. (2020) argues that companies with higher levels of GHC will have more significant success in GI. GIC is an effective business investment because it is the key to improving internal resources toward understanding environmental issues (Yusoff et al., 2019). The palm oil industry must manage environmental and social issues to achieve competitive, sustainable development. Thus, the formulated hypotheses are as follows:

H8: Green innovation positively mediating between green intellectual capital and green competitive advantage.

H9: Green innovation positively mediating between green organization culture and green competitive advantage.

H10: Green innovation positively mediates between green information technology and system and green competitive advantage.

2.2.6. Sampling and data collection

In the modern industrial era, with a highly competitive environment, sustainable company performance is needed to achieve successful company performance (Mahdi et al., 2019). Sustainability has become the main goal of every organization (Fauzi et al., 2018). Businesses that focus on increasing social responsibility, values, and beliefs, IT organizational resources, and the success of IT implementation will be successful in achieving sustainable business performance (Almada & Borges, 2018) Sustainable performance plays a vital role in business sustainability. Thus, the formulated hypothesis are as follows:

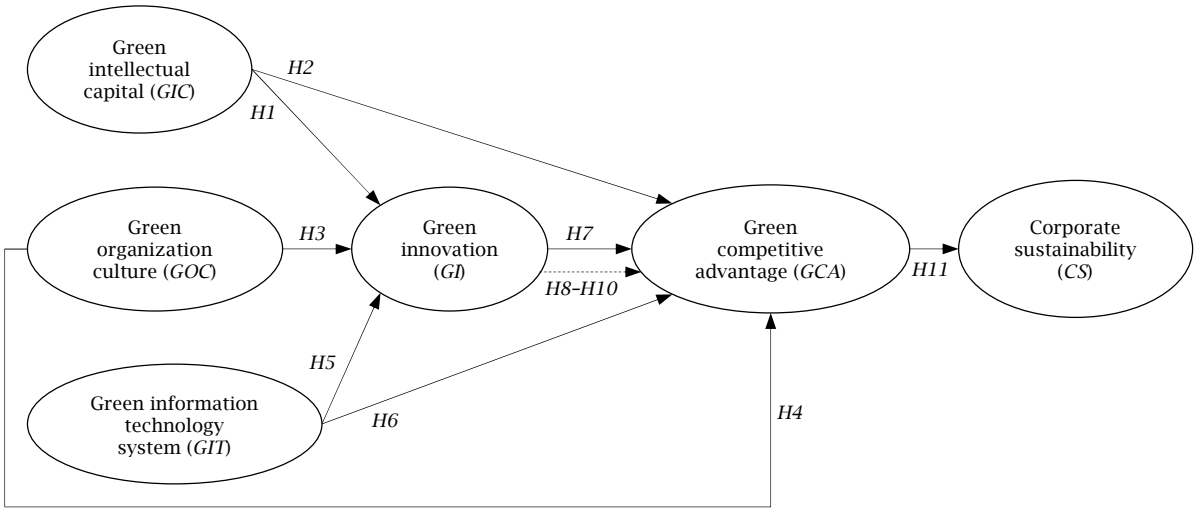
H11: Green competitive advantage positively influences corporate sustainability.

3. MATERIALS AND METHODS

3.1. Sampling and data collection

To achieve the research objectives, the Authors used a purposive sampling technique. Data collection progress in March 2022 through online questionnaires to PT Astra Agro Lestari Tbk employees (representing operational and functional sections related to environment and sustainability). Furthermore, the responses of 220 respondents were analyzed. Data analysis used statistics with the partial least squares structural equation model (PLS-SEM).

Figure 1. Research model



3.2. Research instruments and measurements

The design of the questionnaire is to evaluate the elements of the research model. Researchers compiled a questionnaire on the business process of the palm oil industry based on the conditions and environmental challenges currently facing the company. Through the author's significant experience in environmental management and policy in the palm oil industry, the questionnaire is hoped to meet the criteria. Employees are a resource as a reliable standard for implementing and assessing the validity of the questionnaire. Questionnaires were delivered to employees using a Likert scale with five points (1 — strongly disagree, 2 — disagree, 3 — disagree, 4 — agree, and 5 — completely agree) (Kriksciuniene et al., 2019). In addition, questions related to respondents' characteristics (gender, age, education, position, department, and length of work), as well as those associated with the geographic location were also included. We collected data from five departments related to environmental management and sustainability activities to limit common method bias in the study. Finally, we received 220 validated responses. The profile of the sample of respondents is presented in Table 1. The average percentage of the highest sample of respondents is that they have worked in the palm oil industry between 11–15 years.

3.3. Data analysis

This study uses PLS-SEM analysis to determine the relationship between variables (measurement model) and assess the connection between variables (structural model). We test the correlation among constructs in the theoretical model through a comprehensive multivariate statistical analysis approach (Hair et al., 2019). Data processing in this study also uses SmartPLS 3.3.3 software. Based on the PLS-SEM analysis literature, a two-step way is needed to evaluate the measurement and structural models (Hair et al., 2019). The first approach is to assess the measurement model by considering the reliability and validity of the reflective construct. Furthermore, the second approach evaluates the structural model by considering the path coefficients, R^2, f^2, and Q^2 (Hair et al., 2019).

Table 1. Characteristics of sample respondent (n = 220)

Sample characteristics	*Frequency*	*Percentage*
Gender		
Male	218	99.09%
Female	2	0.91%
Respondent age (years)		
< 25 years old	3	1.36%
25–34 years old	73	33.18%
35–44 years old	78	35.45%
45–55 years old	64	29.09%
> 55 years old	2	0.91%
Education		
Senior high school	92	41.82%
Associate degree	16	7.27%
Bachelor degree	110	50.00%
Master degree	2	0.91%
Work section		
Agronomy	171	77.73%
Engineering	14	6.36%
Mill	14	6.36%
Safety, healthy, and environment	14	6.36%
Sustainability	7	3.18%
Job		
Assistant	160	72.73%
Manager	60	27.27%
Length of work		
< 6 years	33	15.00%
6–10 years	37	16.82%
11–15 years	48	21.82%
16–20 years	20	9.09%
21–25 years	45	20.45%
> 25 years	37	16.82%
Geographic location		
Aceh	20	9.09%
Riau	51	23.18%
Jambi	15	6.82%
Central Kalimantan	33	15.00%
East Kalimantan	33	15.00%
South Kalimantan	26	11.82%
East Sulawesi	36	16.36%
Central Sulawesi	6	2.73%

4. RESEARCH RESULTS AND DISCUSSION

4.1. Results

The first phase is to assess the measurement model by analyzing the reliability of the measurement scale on each construct. Researchers perform individual item reliability checks and loading indicators with their respective constructs. Loading must be greater

than 0.708 (Hair et al., 2019). As shown in Table 2, all factor loadings items were more significant than 0.708, and Cronbach's of all of the constructs for the complete sample was more powerful than 0.70 (Hair et al., 2019). The individual reliability of each construct can be seen based on the composite reliability (CR) value; look that the possible scale has good reliability.

After analyzing the reliability, the stride furthermore is to review the convergent validity with the average value of the extracted variance (AVE), which must be greater than 0.5 (Hair et al., 2019). The AVE value for each variable in the measurement model is greater than 0.5, with a value of 0.589–0.646. For all reflective constructs, discriminant validity has been achieved (Hair et al., 2019). These results indicate that the measurement model is dependable. Furthermore, in assessing discriminant validity, we used the Fornell-Larcker criteria (Henseler et al., 2015).

Table 2. The result of the measurement model (Part 1)

Construct/item	*Loading*	*Cronbach' alpha*	*CR*	*AVE*
GIC		0.872	0.904	0.612
Employees have reliable performance in achieving company goals in the environmental field.	0.887			
The company has employees who are experts in the field of environment.	0.889			
The company has an organizational structure in the environmental field that has authority.	0.895			
The company has good synergy with the employee in environmental programs (e.g., environmental campaigns, plastic waste reduction, etc.).	0.906			
The company has good synergy with employees in environmental programs (e.g., environmental campaigns, plastic waste reduction, etc.).	0.938			
The company has partners with the government, stakeholders, alliances and others in environmental program activities (e.g., reduction of energy consumption and pollution).	0.937			
GOC		0.950	0.956	0.628
Employees have the authority to manage work related to environmental programs.	0.915			
The company values teamwork (group) to achieve common goals in environmental programs.	0.944			
The company continues to develop employee skills in the environmental field so that the company continues to have a competitive advantage.	0.897			
Employees nicely implement the values of corporate culture called *Sapta Budaya Planters*.	0.853			
Employees can agree on differences in work agreements related to the environment (e.g., the policy is not to carry out fertilization and chemical activities on river borders).	0.895			
Employees can collaborate with other employees in different fields to achieve common goals in environmental programs.	0.882			
The company meets the need to cope with future environmental changes.	0.885			
The company tries to satisfy customers (e.g., trying to reduce carbon emissions with CPO products).	0.892			
The company has carried out the process of developing environmental activities.	0.876			
The company has a clear strategy toward the goals and directions of an environmentally sound organization.	0.840			
The company gives freedom to employees to be able to participate in environmental programs.	0.874			
The company has targets related to the strategy to achieve an environmentally sound mission.	0.877			
Employees have the same perspective as the company in achieving environmental programs.	0.825			
GIT		0.860	0.896	0.589
The company applies environmentally friendly practices to IT services.	0.878			
The company applies environmentally friendly IT operational practices to reduce energy consumption.	0.899			
The company has practiced environmentally friendly IT to reduce e-waste.	0.760			
The company has implemented environmentally friendly information system (IS) practices to improve resource efficiency.	0.747			
The company has implemented environmental management using an IS base to track resource flows, waste, and emissions.	0.868			
The company has implemented environmental management that supports the technology IS to reduce the carbon footprint.	0.858			
GI		0.880	0.909	0.626
The company selects materials from products that cause the least pollution (emissions) in operational activities to produce CPO.	0.824			
The company has used ingredients from products that cause the least pollution (emissions) in its operations to produce CPO.	0.885			
The company has considered products that are easily recycled in producing CPO.	0.848			
The company has effectively reduced hazardous substances/hazardous waste in operational processes (e.g., installation of methane capture).	0.825			
The company has effectively reduced the consumption of water, electricity, and fuel (fossil fuel) in the operational process of the palm oil industry.	0.899			
The company has tried to reduce raw materials that cause pollution and emissions, such as fertilizers and fossil fuels.	0.849			

Table 2. The result of the measurement model (Part 2)

Construct/item	*Loading*	*Cronbach' alpha*	*CR*	*AVE*
GCA		0.922	0.936	0.646
The company has innovated environmentally friendly products to reduce pollution, which affects the company's competitive advantage at low costs.	0.842			
The company has innovated environmentally friendly processes to reduce pollution to affect the company's competitive advantage at low costs.	0.881			
The company innovates environmentally friendly products to face the environmental dynamism that affects the company's competitive advantage at low costs.	0.877			
The company innovates environmentally friendly processes to deal with the environmental dynamism that affects the company's competitive advantage at low costs.	0.825			
The company innovates environmentally friendly products to increase resource productivity and has a competitive advantage differentiation effect.	0.818			
The company innovates environmentally friendly processes to increase resource productivity to have a competitive advantage differentiation effect.	0.887			
The company innovates environmentally friendly products in response to changes in environmental dynamism, which affects the differentiation of the company's competitive advantage.	0.844			
The company innovates environmentally friendly processes in response to changes in environmental dynamism, which affects the differentiation of the company's competitive advantage.	0.816			
CS		0.931	0.942	0.645
The company has collaborated with various stakeholders to become a sustainable palm oil company.	0.863			
The company creates developments in other business areas to generate profitable profit opportunities.	0.932			
Companies make trade-off choices that lead to the re-allocation of resources in improving financial performance to create financial returns (e.g., initial public offering, IPO).	0.894			
The company works closely with all staff in the organization to improve the company's entire business network.	0.868			
The company has worked based on a corporate culture that reflects the company's norms and values based on corporate principles.	0.900			
The company has a consistent commitment to transparently reporting the company's performance to the public and all interested parties at large.	0.858			
The company make trade-off choices (consequences) that lead to the re-allocation of resources in improving financial performance to generate financial returns.	0.887			
The company has considered the impact of business operations on global warming by minimizing the generation of greenhouse gases.	0.921			
The company has carried out environmental efficiency programs on an ongoing basis (e.g., renewable energy: biodiesel, energy efficiency (turning off lights, air conditioning, etc.) and energy conservation (recycling materials, utilizing waste heat from boilers as a power source, reducing the use of plastics).	0.863			

4.2. Structural model

In evaluating the presence or absence of multicollinearity in the regression model, it is necessary to look at the tolerance value and the variance inflation factor (VIF) value. Optimally the VIF value shows < 3 (Hair et al., 2019). However, the VIF value in this study is below the specified limit, so there is no collinearity problem (see Table 3). Next, test the structural model. Tests evaluate indicators' significance with path coefficients using a bootstrap procedure with 5,000 iterations (Wong, 2019). The next step is hypothesis testing. In assessing the structure of the model, it is necessary to consider the coefficient of determination (R^2) of the endogenous construct, the size of the path coefficient, the effect size (f^2), and the cross-validated redundancy (Q^2) (Hair et al., 2019). This assessment is carried out before testing the hypothesis. R^2 measures 0.75, 0.50, and 0.25 for all endogenous structures, which are considered substantial, moderate, and weak. The result shows that R^2 for GI is 0.368, R^2 for GCA is 0.524, and R^2 for CS is 0.478. Each exogenous variable affects the endogenous variable with moderate criteria.

Table 3. Discriminant validity

Fornell-Larckel criterion						
	GIC	***GOC***	***GIT***	***GI***	***GCA***	***CS***
GIC	***0.782***					
GOC	0.437	***0.792***				
GIT	0.543	0.475	***0.768***			
GI	0.431	0.456	0.574	***0.791***		
GCA	0.508	0.520	0.605	0.616	***0.804***	
CS	0.660	0.538	0.622	0.668	0.691	***0.803***

Note: The square root of AVEs is shown diagonally in italic.

To determine the effect size in each path model through the calculation of the effect size value based on Cohen's (1988) criteria, namely: smaller when effect size $f^2 = 0.02$, moderated when $f^2 = 0.15$, and high when $f^2 = 0.35$. GCA (0.914) has a great influence on CS. Companies that have a GCA will be able to compete in the future and become sustainable companies. Under green innovation's influence, constructions with a medium effect size are GIT (0.175). In contrast, GIC (0.014) and GOC (0.052) have weak effect sizes. On the effect of green competitive advantage, all effect sizes are weak in GIC (0.032), GOC (0.052), and GIT (0.069). Then, GI also has a weak effect measure on GCA (0.135).

In the final stage, perform a predictive relevance test using the Q^2 Stone-Geisser model. The purpose of predictive relevance testing is to evaluate the structural model in this study (Hair et al., 2019). Relevance predictive results (Q^2) show a value > 0 (see Table 4), meaning that the variable model is good (true). Exogenous variables as explanatory variables capable of predicting endogenous variables. Table 5 presents the results of one-way hypothesis testing. The use of one-way hypothesis testing because the coefficient has a positive or negative assumption sign. GIC has a positive effect on GI (β = 0.133, t = 2.184) and GCA (β = 0.163, t = 2.525); therefore, *H1* and *H2* are accepted. GOC has a positive effect on GI (β = 0.206, t = 2.629) and GCA (β = 0.118, t = 2.553), thus supporting *H3* and *H4*. GIT also has a significant effect on GI (β = 0.401, t = 5.677) and GCA (β = 0.240, t = 3.309); thus, *H5* and *H6* are accepted. GI has a positive effect on GCA (β = 0.319, t = 5.001); therefore, *H7* is accepted. GCA is positively influenced by three exogenous variables, namely GIC (β = 0.042 t = 3.309), GOC (β = 0.066, t = 2.255), and GIT (β = 0.128, t = 3.701) through the mediation of the GI variable, therefore *H8, H9* and *H10* are accepted. In the end, GCA also positively affects CS (β = 0.691, t = 18.398) so that *H11* is accepted (see Figure 2).

Table 4. Structural model evaluation

Relationships	*β*	*t value*	*Confidence interval (95%)*	*Variance explained (R^2)*	*R^2 adj.*	*Predictive relevance (Q^2)*	*Effect size (f^2)*	*Confidence interval (95%)*	*VIF*
GIC → GI	0.133	2.184*	[0.033; 0.227]	0.382	0.373	0.233	0.014	[0.043; 0.240]	1.507
GIC → GCA	0.163	2.525**	[0.061; 0.272]	0.524	0.515	0.332	0.032	[0.065; 0.278]	1.529
GOC → GI	0.206	2.629**	[0.076; 0.342]				0.052	[0.065; 0.323]	1.372
GOC → GCA	0.188	2.553**	[0.065; 0.309]				0.052	[0.055; 0.296]	1.444
GIT → GI	0.401	5.677***	[0.280; 0.518]				0.175	[0.273; 0.511]	1.575
GIT → GCA	0.240	3.309***	[0.115; 0.364]				0.069	[0.110; 0.346]	1.850
GI → GCA	0.319	5.001***	[0.217; 0.424]				0.135	[0.219; 0.424]	1.618
GIC → GI → GCA	0.042	1.920*							
GOC → GI → GCA	0.660	2.255*							
GIT → GI → GCA	0.128	3.701***							
GCA → CS	0.691	18.398***	[0.626; 0.745]	0.478	0.475	0.303	0.914	[0.620; 0.743]	1.000

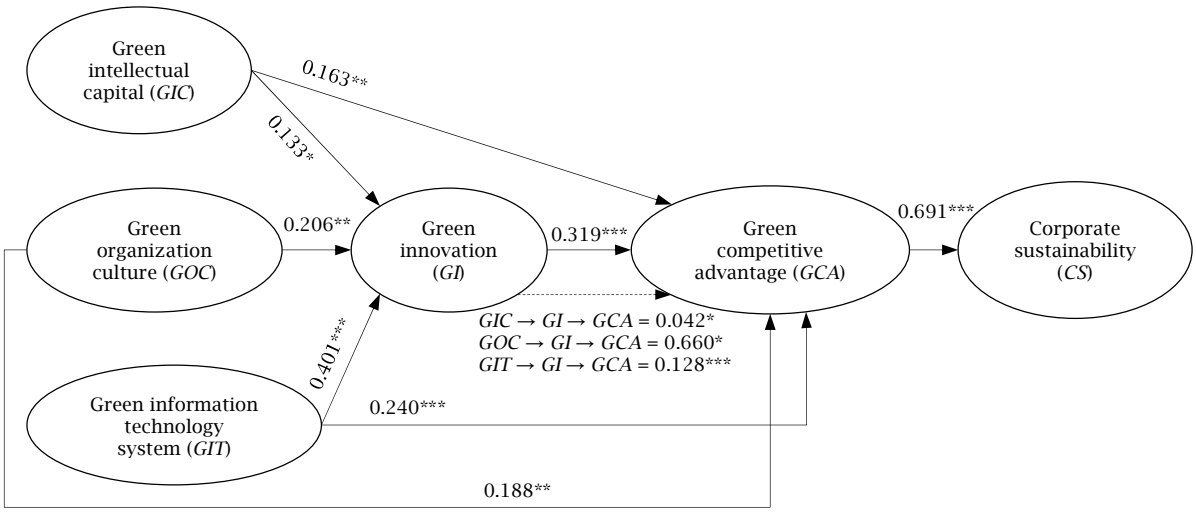
*Note: n = 5,000 subsample, * p < 0.05, ** p < 0.01, *** p < 0.001 (one tailed t-test).*

Table 5. The path analysis and t value of the structure model

Hypotheses	*β*	*t value*	*Confidence interval (95%)*	*Accepted*
H1: GIC → GI	0.133	2.184*	[0.033; 0.227]	Yes
H2: GIC → GCA	0.163	2.525**	[0.061; 0.272]	Yes
H3: GOC → GI	0.206	2.629**	[0.076; 0.342]	Yes
H4: GOC → GCA	0.188	2.553**	[0.065; 0.309]	Yes
H5: GIT → GI	0.401	5.677***	[0.280; 0.518]	Yes
H6: GIT → GCA	0.240	3.309***	[0.115; 0.364]	Yes
H7: GI → GCA	0.319	5.001***	[0.217; 0.424]	Yes
H8: GIC → GI → GCA	0.042	1.920*		Yes
H9: GOC → GI → GCA	0.660	2.255*		Yes
H10: GIT → GI → GCA	0.128	3.701***		Yes
H11: GCA → CS	0.691	18.398***	[0.626; 0.745]	Yes

*Note: n = 5,000 subsample, * p < 0.05, ** p < 0.01, *** p < 0.001 (one tailed t-test).*

Figure 2. Result model



*Note: n = 5,000 subsample, * p < 0.05, ** p < 0.01, *** p < 0.001 (one tailed t-test).*

4.3. Discussion

This study proves that integrating GIC, GOC, and GIT into one framework can influence employee behaviour, management, and support in creating GI and GCA. This integration model is strengthened by previous research (Gürlek & Tuna, 2017; Dalvi-Esfahani et al., 2020; Singh et al., 2020; Chandra et al., 2021; Giantari & Sukaatmadja, 2021; Wang & Juo, 2021). Furthermore, the GI applied in the business processes of the palm oil industry will increase GCA.

GI is positively related to a firm competitive advantage (Dai & Xue, 2022) and this process is mediated by organizational learning (Tu & Wu, 2021). If GI is applied, the company's GCA will tend to increase companies oriented towards achieving GCA must always be creative with innovative ideas in their business. Businesses committed to GCA always prioritize innovation in their business ventures. PT Astra Agro Lestari Tbk is one of the companies that can prove GI as a weapon to continue to exist in any condition and become a company with a sustainable GCA. Companies must invest in GI in business activities to get GCA (Gürlek & Tuna, 2017). GI strategy has significantly stimulated company performance, assisted companies in building a positive green image, and increased competitive advantage (Yang & Cui, 2022). The usage of a GI value chain not only reduces pollutant emissions but can also in cost rationalization (Abdulkadhim, 2023). Government environmental regulations can effectively promote the company of GI, and environmental investments play a mediating role (Chen et al., 2023). Business analysis and environmental orientation have an essential role in GI and GCA (Zhang et al., 2022). GI has succeeded in partially mediating the effect of environmental commitment to financial performance (Prasetyo et al., 2023).

A good influence of GIC on GI will increase the ability to innovate in environmentally friendly and sustainably. In the tight competition in the vegetable oil business, companies are required to be more innovative. Companies must be able to offer and produce a better product or process than their competitors. On the other hand, a black campaign related to palm oil requires companies to carry out environmentally friendly and sustainable practices. Wang and Juo (2021) stated that GIC allows companies to boost the company's green performance and green economics. The results of this study follow previous research by Singh et al. (2020), which states that if a company has a higher level of GHC which is part of GIC, it will be a more significant success in GI. GI is a mediator between GIC, GRC, and GSC. Furthermore, it is said that GI is also a mediator of GIC and business sustainability (Li et al., 2023). The significant positive influence between GOC and GI in oil palm plantation companies explains that companies can encourage employees to behave by following green culture values through GOC. GOC can provide confidence to organizations to carry out business management practices in an environmentally friendly and sustainable manner. In line with research by Gürlek and Tuna (2017), Chandra et al. (2021) show that GOC positively affects GI. Therefore, green corporate culture is an essential determinant of GI. GOC directly or indirectly affects organizational performance, with the mediating role of environmental performance and GI (Imran & Jingzu, 2022). GI will increase because it is supported by organizational innovation variables (Bataineh et al., 2023). Green product innovation can partially mediate the relationship between environmental commitment to financial performance (Prasetyo et al., 2023).

The application of GIT will have a positive influence on GI. Palm oil industry operational activities include responsible waste management and recycling processes. Various pressures from stakeholders and industry demands force companies to transform to meet environmental requirements and policies (Fahad et al., 2022). Implementation of sustainable environmental management and environmental risk mitigation using renewable energy sources. Preservation of the environment by reducing energy consumption, carbon footprint, and waste through better environmentally friendly ideas, initiatives, and policies. The digitization program in operational activities is part of implementing GIT. Implementing green IT policies and procedures will increase the efficiency of computing resources in limiting energy consumption and the environmental impact of using computer systems (Batool et al., 2019). IT can be a solution for sustainable business operations. For strategies that aim to improve sustainability, the company's management must consider its IT resources (Gholami et al., 2016).

This study's results align with several previous studies which showed a positive and significant effect between GIC and GCA. Yusoff et al. (2019) state that GSC, GRC, and environmental leadership significantly positively affect GCA. Intellectual capital and entrepreneurial strategy significantly grant competitive advantage (Anwar, 2018). Pro-environmental systems achieve a GCA (Iraldo et al., 2017).

The effect of GOC on GCA is fully accepted, which shows that if the GOC is strong, the company's GCA will be superior. With the increasingly fierce competition in the palm oil industry, companies must be able to define and provide for consumer needs. This condition encourages companies to have strategies for implementing good environmental activities. A strong GOC will help employees to understand the company's environmental strategy. GOC has eco-innovation that has a positive and significant effect on GCA through green strategy (Giantari & Sukaatmadja, 2021). GI acts as a full mediation on the effect of GOC on GCA (Gürlek & Tuna, 2017). Managers with an organizational culture aligned with environmental preservation can implement environmental protection policies, increasing the organization's GI.

There is a positive effect between GIT and GCA in the oil palm plantation company PT Astra Agro Lestari Tbk. Thus, if the GIT is good, the company's GCA will be good. IT implementation and IT organizational resources have a positive and significant impact on sustainable competitive advantage (Haseeb et al., 2019b). Companies adopt IT to achieve organizational business goals and competitive advantage (Anthony et al., 2019). IT systems are crucial for companies to produce effective and efficient business transactions. Fast information access provides better customer service by reducing the company's manual documents, increasing coordination and communication, increasing company productivity, and saving time (Gorane & Kant, 2016). In general, green IT practices positively impact environmental quality and emissions. Online and alternative transportation can

reduce energy and carbon dioxide (CO_2) (Gelenbe & Caseau, 2015). Telecommunications infrastructure drives green technology innovation. However, telecommunication infrastructure has a more significant impact on driving green technology innovation (Tang et al., 2021).

Lastly, found GI to impact GCA and GCA to affect CS positively. GI offers a competitive advantage and increases strategic business value in a competitive industry in a dynamic, ever-changing marketing environment (Maziriri, & Maramura, 2022). GI are developed in the industry to promote organizational sustainability by embracing sustainable development practices (Shahzad et al., 2021). GI can be a valuable corporate resource for building competitive advantage while contributing to sustainable development (Khanra et al., 2021). This study is in line with the research of Haseeb et al. (2019b), which states that sustainable competitive advantage has a positive and significant effect on sustainable business performance. Research by Nawangsari et al. (2022) proves that GSC and GRC impact business sustainability through competitive advantage. Competitive advantage is also demonstrated to affect business Sustainability by the research of Chaudhry et al. (2016). Innovation-oriented sustainability will improve competitiveness.

5. CONCLUSION

This study provides essential information. Integrating GIC, GOC, and GIT in the palm oil industry positively affects GI and GCA. The palm oil industry can build a sustainable competitive advantage through GI. The stronger the ability to use GI in the company, the higher the green competitiveness and the more sustainable the company will be.

The study in this research is helpful for oil palm plantation companies in managing and preserving the environment. Efforts to carry out GI effectively with the support of an excellent GOC and implementing GIT will ultimately gain a green and sustainable competitive advantage. The GI strategy is the right choice for most companies to deal with environmental problems (Wang et al., 2022). The limitations of this research are still limited to the independent variables, namely GIC, GOC, and GIT. The Authors hope the results will be more varied if the measurement of successful implementation of CS involves other variables such as green commitment, green identity, and corporate social responsibility in corporate environmental management activities. Environmental certification challenges, stakeholder influence, and local and global environmental pressures, especially carbon mitigation in the palm oil industry. In this study, the focus is still on the palm oil industry.

Accordingly, in the future can focus on longitudinal research to track the various factors and levels of advancement of the sustainable palm oil industry through different stages to conduct more dynamic research. The Authors hope that this study's results will benefit managers, researchers, practitioners, and policymakers in oil palm agribusiness companies and contribute to further research as a reference.

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