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Green Innovation and the Profitability of Manufacturing Firms: The Moderating Role of Intelligence Generation

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ABSTRACT

This paper investigated the moderating role of intelligence generation on the link amid green innovation as well as the profitability of manufacturing firms. The survey utilized a self-administered questionnaire approach, gathering a total of 267 completed responses for data analysis utilizing Smart PLS-SEM (version 4). The study noted the occurrence of a significant positive relationship amid environmental commitment as well as profitability. Secondly, there is a significant positive effect amid stakeholder engagement as well as profitability. However, the connection amid market forces as well as profitability is insignificant. Intelligence generation plays a significant positive moderation role in the relationship between market forces and profitability. Furthermore, intelligence generation plays a significant negative moderation role in the relationship between stakeholder engagement and profitability. Moreover, intelligence generation has an insignificant moderation outcome on the relationship between environmental commitment and profitability. This investigation provides insights into the value of integrating intelligence generation to strengthen the relationship between green innovation as well as profitability thereby highlighting their implications for theory, managers and business success.

Keywords: Green Innovation, Profitability, Intelligence Generation, Environmental Commitment, Stakeholder Engagement, Market Forces
JEL Classification: M

1. INTRODUCTION

Manufacturing companies that want to make money and stay in business must have proper practices in place (Akuma et al., 2024c). These practices include using information technology systems (Akuma et al., 2024b), fostering suitable organizational culture (Akuma et al., 2024a), and adopting green innovation practices (Chen et al., 2021). There is growing pressure on these companies to adopt sustainable practices as environmental issues and regulatory rules evolve. Green innovation has become essential for improving firms' long-term competitiveness and sustainability. Green innovation is about creating new products, processes, and practices that lessen environmental damage while keeping economic feasibility (Chen et al., 2021).

Yet, the influence of green innovation on profitability is still debated in academic and industry settings. Some research indicates that using green technologies can lead to cost savings and improved brand value, ultimately boosting profitability (Khan et al., 2022). Other studies suggest that high initial expenditures and uncertainty regarding the market acceptance of green products may negatively affect financial performance in the short run (Wang et al., 2023).

Recently, Ghana's manufacturing sector has been pushed to adopt more sustainable practices due to rising environmental concerns and stricter regulations. Green innovation (GI), which consists of introducing eco-friendly methods, products, and technologies, has received significant focus as a way to tackle these challenges and improve competitive positioning (Acheampong and Frimpong, 2021). Despite the push for sustainability, there is still a shortage of empirical data on the impact of GI on the profitability (P) of manufacturing companies in Ghana. Previous studies have indicated that while green innovation can improve brand image, reduce costs, and promote long-term profitability, its immediate financial effects are often unclear due to high initial investments and the difficulties in adopting new technologies (Boateng et al., 2023).

Although many studies have examined the direct relationship between GI and P, fewer have looked at how intelligence generation (IG) may act as a moderating factor. Intelligence generation refers to a company's ability to collect, analyze, and use market data to guide strategic choices. In relation to GI, IG can help firms understand market trends, customer preferences, and regulatory changes, allowing them to optimize their green strategies for better profitability. Companies with strong intelligence generation skills may be in a better position to use green innovation for a competitive edge, transforming environmental friendliness into financial benefits (Zhao et al., 2022).

For Ghanaian manufacturing firms, intelligence generation can help them grasp consumer preferences for eco-friendly products, predict regulatory updates, and adjust their strategies as needed. Firms skilled in intelligence generation might better navigate the challenges of green innovation, making sustainability efforts profitable (Gyasi et al., 2022). However, this moderating role of intelligence generation in the GI-profitability connection has not been thoroughly studied in Ghana's context.

Despite the theoretical significance of intelligence generation in this relationship, there is little empirical evidence available. This lack of research highlights the need for further exploration, especially in manufacturing firms where operational efficiency and environmental sustainability may conflict. With the emphasis on sustainability increasing in both global and local markets, understanding this dynamic is becoming increasingly important. The role of intelligence generation in affecting the profitability of green innovations in Ghana's manufacturing sector is important. This study seeks to address this issue by exploring how intelligence generation impacts the link between green innovation and profitability in manufacturing companies in Ghana. The findings from this research will help policymakers and business leaders formulate strategies that consider both environmental sustainability and financial success. Explicitly, the objectives of this investigation are:

- To assess the relationship between green innovation and profitability.
- To scrutinize the moderating role of intelligence generation on the link amid green innovation as well as profitability.

Subsequent sections of the paper will include literature summaries on green innovation practices, intelligence generation and profitability, followed by the presentation of the investigation's methodology. Analysis and results will be provided in subsequent sections, with the paper concluding by discussing the findings, their theoretical and practical implications.

2. LITERATURE REVIEW

2.1. Theoretical Foundation and Hypotheses

Green innovation, profitability as well as the moderating role of intelligence generation constitute a complex interplay within the domain of manufacturing industries. This literature review aims to synthesize existing theoretical frameworks and empirical literature to elucidate the relationships between these constructs.

2.2. Resource-based View (RBV) Theory

The RBV theory says that a company's competitive strength and success come from its internal resources that are valuable, rare, hard to copy, and cannot be replaced (VRIN) (Barney, 1991). In the area of green innovation in manufacturing, RBV helps explain how companies can use their special resources to create eco-friendly products and processes to gain an advantage in the market.

Green innovation fits with the RBV, which indicates that companies can get a competitive edge by using their distinct resources and skills (Barney, 1991). Green innovation acts as a valuable asset that companies can utilize to stand out, improve efficiency, and meet environmental rules. This shows that green innovation is a key strategy for gaining and keeping competitive advantage in industries where sustainability matters (Zhang et al., 2020).

Green innovation depends on a company's internal resources, such as specialized knowledge, research and development (R&D) skills, and talented workers. These resources allow firms to create innovations that lessen environmental harm while keeping or improving product quality and efficiency (Zhang and Zhou, 2022). According to the RBV framework, green innovation serves as an important resource that helps firms stand out from competitors and seize new market opportunities focused on sustainability (Chen et al., 2021). For instance, companies with strong R&D skills can develop technologies that cut waste, lower emissions, and boost energy efficiency. These advancements are VRIN resources that help firms follow environmental rules and also lower costs while attracting eco-aware customers (Gao and Zhang, 2023). Thus, green innovation helps achieve long-lasting competitive advantage by linking profit with environmental aims.

From an RBV angle, green innovation is a key skill that companies build, which lets them adjust to regulatory and market demands for sustainability. Companies with solid internal resources—like skilled workers, advanced technology, and a strong organizational culture—are in a better place to apply green innovations. These innovations, integrated into a company's processes and value chain, are tough for competitors to copy, leading to a competitive edge. By utilizing unique capabilities, green innovation helps maintain profitability and market leadership, as it's challenging for rivals to undermine a firm's unique position (Li et al., 2022; Chen et al., 2021; Zhang et al., 2020).

Green innovation lets manufacturing firms turn sustainability into a competitive advantage, aligning with RBV ideas. By excelling in green product innovation, companies attract eco-friendly customers, explore new markets, and set higher prices (Zhang and Zhou, 2022). Moreover, reducing resource use and waste cuts operational costs, boosting profits (Li et al., 2022). Green innovation also helps firms comply with environmental regulations, avoiding fines and gaining access to government incentives (Gao and Zhang, 2023). This mix of efficiency and regulatory compliance improves their market position, promoting a sustainable competitive advantage over the long term.

2.3. Dynamic Capability Theory

DCT points out that a company can adapt, combine, and change its resources to deal with fast-changing situations (Teece, 2007). In manufacturing, having robust dynamic capabilities helps companies keep making money by managing changes well, creating innovations, and improving their operations (Li et al., 2022). This review looks at how dynamic capabilities, like sensing, seizing, and reconfiguring, help companies respond to market changes, new technologies, and global issues. These abilities are crucial for keeping or boosting profits in tough and changing markets because they help companies stay flexible and creative amid change.

Companies with dynamic capabilities are in a better spot to innovate due to technological advancements. The ability to include new technologies in their processes makes their work more efficient, lowers expenses, and raises product quality. For example, companies using automation and digital production tech have seen big savings, faster production times, and fewer defects, which boosts profitability (Gao and Zhang, 2023).

Dynamic capabilities let manufacturing firms keep flexibility in how they operate. This flexibility allows companies to change their production levels, supply chains, and product lines in reaction to demand changes. For example, when economic conditions decline or consumer tastes shift, firms with dynamic capabilities can alter their operations to create lower-cost or more popular products, keeping profits steady despite difficulties (Li et al., 2022).

By consistently building and changing their resources, firms can gain a lasting competitive edge. Manufacturing companies that focus on developing dynamic capabilities can set themselves apart in the market by offering innovative products and services that align with changing customer needs. This uniqueness not only builds customer loyalty but also enables companies to charge higher prices, thus enhancing profit margins (Chen et al., 2021).

Dynamic capabilities also help firms manage risks and uncertainties better. Manufacturing companies deal with many issues like supply chain disruptions, regulatory changes, and environmental challenges. Companies with strong dynamic capabilities are more resilient and ready to tackle these problems, reducing impacts on profitability. For instance, during the COVID-19 pandemic, companies with adaptable supply chain strategies quickly adjusted to shortages and logistics issues, maintaining their profits (Gao and Zhang, 2023).

Even though the connection between dynamic capabilities and profits is clear, manufacturing firms often struggle to develop these abilities. One major issue is the heavy investment needed for technology and training. Dynamic capabilities depend on modern technologies like AI, big data, and advanced manufacturing systems, which need significant capital (Li et al., 2022). Additionally, building the necessary skills among employees to operate and manage these technologies is difficult for firms lacking the right expertise or resources.

Another hurdle is the cultural and organizational change needed to fully accept dynamic capabilities. Manufacturing firms must create a culture of innovation, learning, and adaptability to gain full benefits from dynamic capabilities. This often means adjustments in leadership, organization, and communication methods (Chen et al., 2021). Firms that hesitate to make these cultural changes may find it hard to tap into the full profit potential of dynamic capabilities.

2.4. Market Orientation Theory

Intelligence generation in manufacturing companies comes from market orientation theory. This theory suggests that companies that consistently gather, share, and respond to market information can better meet customer needs and improve performance (Narver and Slater, 1990). In the manufacturing sector, generating intelligence means understanding customer needs, the competitive environment, and observing changes in technology and regulations that could affect production and product development (Sheng et al., 2020).

Market Orientation has three main parts: customer focus, competitor focus, and coordination among departments (Narver and Slater, 1990). Customer focus is about knowing and reacting to customer needs, competitor focus looks at studying competitors' moves, and department coordination makes sure all areas work together to satisfy market demands (Kohli and Jaworski, 1990).

Intelligence generation requires collecting and analyzing data on market trends, customer choices, and competitor behaviors (Grewal and Tansuhaj, 2001). This process is essential for developing a firm's market orientation by aligning strategies with actual market conditions. Research by Liu and Wang (2021) shows that using advanced data analytics and market research tools helps manufacturing firms better understand customer preferences and new trends. This deeper understanding enables them to predict market changes and adjust their strategies accordingly, strengthening their market orientation and improving responsiveness to market shifts.

The use of big data analytics and AI has changed how firms collect and analyze market information. Zhang et al. (2023) mention that AI-based analytics help companies derive valuable insights from extensive data, encouraging a proactive market orientation. Furthermore, digital platforms and social media create new ways for companies to gather intelligence. Patel and Kumar (2022) point out that social media analytics allow firms to receive immediate customer feedback and track competitors more efficiently. This increased capability promotes a flexible market orientation,

enabling firms to swiftly adapt to changing market landscapes and maintain their competitive edge.

2.5. Green Innovation and Profitability

Many studies show that green innovation helps manufacturing companies make more money. Green innovation can save costs by using resources better and cutting down waste, making firms more competitive and improving their reputation (Lee et al., 2021). For example, Kumar et al. (2022) found that companies that put money into green technologies had higher profits because they had lower running costs and more customers liked eco-friendly products.

Green innovation means using sustainable methods to lessen environmental harm, and it often includes better energy use, effective waste management, and creating products that are better for the environment (Bocken et al., 2020). In Ghana, manufacturing companies are starting to use green innovations to become more competitive and profitable.

Evidence shows that green innovation can help profitability in Ghanaian manufacturing firms. For example, research by Addai et al. (2022) showed that firms in Ghana that used green technologies saw better profits due to savings from lower energy costs and waste reduction. This research indicates that companies that invest in green innovation can have an edge by being more efficient and appealing to the market. However, it did not address an important aspect of green innovation, which is stakeholder engagement. Wiesmeth (2020) argues that getting input from stakeholders on green innovation practices can help firms perform better in sustainability.

Several studies indicate that green innovation can enhance profitability by lowering production costs, improving brand image, and addressing increasing demand for sustainable products (Chen et al., 2021; Zameer et al., 2022). For instance, companies that implement green manufacturing technologies can cut energy and material costs, leading to better profit margins (Wang et al., 2023). Furthermore, firms with strong green practices may find it easier to secure funding, as investors are more inclined to support environmentally responsible businesses. Additionally, firms that excel in green innovation often gain a competitive edge in markets where consumers favor sustainability, which can boost long-term profits (Nidumolu et al., 2020).

However, the financial perks of green innovation are not always guaranteed. Companies may encounter high initial costs for research and development and for introducing new technologies. Also, it may take time for the market to accept green products, and companies could face profit issues if the demand for eco-friendly products is lower than anticipated (Wang et al., 2023). These points show that while green innovation can improve profitability, its success largely depends on how well a company manages risks and uncertainties. Consequently, the following hypotheses have been proposed;

H_1: There is a statistically significant relationship amid green innovation as well as profitability.

- H_{1a}: There is a statistically significant relationship amid environmental commitment as well as profitability.
- H_{1b}: There is a statistically significant relationship amid stakeholder engagement as well as profitability.
- H_{1c}: There is a statistically significant relationship amid market forces as well as profitability.

2.6. The Moderating Role of Intelligence Generation

Generating intelligence is important for making green innovation profitable by allowing companies to make smart strategic choices. By collecting and examining market data like customer needs, rules, and competition, companies can better match their green innovations to what the market wants (Zhao et al., 2022; Li et al., 2022). This matching makes sure that green innovations are not just good for the environment but also make money, leading to higher profits (Zhang and Zhou, 2022). Companies that are good at generating intelligence can create eco-friendly products that appeal to buyers, increasing sales and market presence while lowering risks (Zhang et al., 2020).

Intelligence generation can influence how green innovation connects with profitability by helping companies predict and adjust to market changes. For instance, companies strong in intelligence gathering can quickly spot consumer interest in green products, allowing them to invest in innovations that fit market needs. In the same way, intelligence generation helps companies follow regulatory changes and adjust their green plans, ensuring they meet requirements while keeping costs low (Li et al., 2021). Also, it aids in identifying potential risks tied to green innovation, like supply chain issues or lack of resources, thus letting companies reduce those risks and improve profits (Song and Yu, 2021).

Although the links between green innovation, intelligence generation, and profitability are known, more research is still needed. Most studies have looked at how green innovation directly affects business performance, giving less focus to the role of intelligence generation in moderating this relationship (Khan et al., 2022). Additionally, most existing studies are based in developed countries, with fewer examining this link in developing regions, such as sub-Saharan Africa. More research is essential to confirm these findings, especially in areas where green innovation is just starting and where intelligence generation skills might be lacking (Acheampong and Frimpong, 2021). Consequently, the following hypotheses have been suggested and conceptual framework is presented in Figure 1;

H_2: There is a statistically significant moderation effect of intelligence generation on the relationship amid environmental commitment as well as profitability.

- H_{2a}: There is a statistically significant moderation effect of intelligence generation on the relationship amid stakeholder engagement as well as profitability.
- H_{2b}: There is a statistically significant moderation effect of intelligence generation on the relationship amid market forces as well as profitability.
- H_{2c}: There is a statistically significant moderation effect of intelligence generation on the relationship between regulatory and market forces as well as profitability.

3. METHODOLOGY AND DATA

3.1. Survey Instrument

The survey instrument was created by selecting a questionnaire from literature to assess the research model's constituent parts.

Using information from a survey sample, the study assessed the validity as well as reliability of the instrument and tested the proposed relations. The question types used to assess green innovation have been modified (Song and Yu, 2018; Muangmee et al., 2021). Additionally, the questions used for profitability were modified (Venkatraman and Ramanujam, 1986; Kaplan and Norton, 1992); the items utilized to assess intelligence generation were modified (Narver and Slater, 1990; Kohli et al., 1993). For the investigation, a 5-point Likert scale was used. It is worthy of note, that three academic faculties (marketing, finance and accounting) assessed the content validity of the initial survey.

3.2. Sampling and Data Collection

The cross-sectional survey scheme targeted 634 manufacturing firms registered with the Association of Ghana Industries (AGI) as of 2024 as its population. These firms were categorized based on their respective products. The study relied on the Krejcie and Morgan (1970) formula below to determine the minimum sample size.

$$S = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

Where:
S=The required sample size.
X^2=The table value of chi-square for 1 degree of freedom at the desired confidence level (3.841)
N=The population size
P=The population proportion assumed to be 0.5 since this would provide a maximum sample size
d=The degree of accuracy expressed as a proportion (0.05)

Using the Krejcie and Morgan (1970) formula for sample size, it was determined that for a target population of 634 registered manufacturing firms, at a 95% confidence level and a margin of error of 0.05, a minimum sample size of 242 is needed. To meet this goal, 285 questionnaires were sent out via Google Forms through simple random sampling. A total of 267 questionnaires were returned, resulting in a response rate of 93.6%. Each questionnaire was filled out by a manager from each firm involved. The manufacturing firms studied are well-known both nationally and internationally for their significant commitment to sustainable practices. Before the survey, a cover letter outlining the study's aims and the criteria for participation was given to the participants. The researchers first asked informally if the participants were interested in the study. Those who showed interest were then invited to complete the questionnaire on a voluntary basis.

3.3. Profile of Respondents

A total of 267 valid responses were gathered for the analysis. Among these, 64.5% (n = 172) were males and 35.5% (n = 95) were females, showing more male than female responses. The study followed age groups suggested by Yarlagadda et al. (2015): young adults (<31 years), middle-aged adults (31–50 years), and senior adults (>50 years).

The findings show that 39% (n = 104) of respondents were young adults, 53% (n = 142) were middle-aged adults, and 8% (n = 21) were senior adults, suggesting that middle-aged managers were the largest group. This means the respondents are experienced and mature, which may help them give valuable insights into green innovation and intelligence practices in their companies.

About job roles, 16.7% (n = 45) were Chief Executive Officers (CEOs) or General Managers, 58.7% (n = 157) were senior managers, 12.5% (n = 33) were board members, and 12.1% (n = 32) were middle-level managers. This means that CEOs and senior managers together made up 75.6% (n = 202) of the respondents. These top-level workers, with their knowledge, can provide solid feedback on their green innovation practices.

4. DATA ANALYSIS

The statistical analysis was done using Smart PLS (version 4.0) software to look at the link between green innovation and profitability outcomes, with regulatory and market forces as moderating factors (Ringle et al., 2022). PLS-SEM was chosen because it can easily deal with different modeling issues compared to the strict rules of multivariate statistics (Boonlertvanich, 2019).

Hair et al. (2019) stated that measures for evaluating a concept in the structural model should be 0.70 for studies using validated concepts to ensure the reliability of the research items. This threshold indicates more than 50% of the variance of the indicator is explained. Since this study used validated constructs from earlier research, a reliability test was performed with the indicators, following a minimum reliability standard of 0.70.

4.1. Evaluation of Measurement Model

We appraised the measurement model utilizing PLS-SEM (version 4). Three modules made up the concept outline of this investigation namely; green innovation (environmental commitment, stakeholder engagement and market forces), profitability and intelligence generation (Figure 2).

To evaluate the measurement model, the construct reliability, convergent validity, and discriminant validity were checked (Hair et al., 2019; Hanafiah, 2020). To show reliability, Cronbach's alpha, composite reliability (rho_a), and composite reliability (rho_c) need to all be 0.7 or higher. Furthermore, to show convergent validity, the average variance extracted (AVE) must be greater than 0.5 (Ringle et al., 2022).

Table 1 shows that the items and constructs in this study had good levels of convergent validity and reliability for each construct used. The research used the heterotrait-monotrait (HTMT) ratio to check for discriminant validity (Henseler et al., 2015). For discriminant validity to be acceptable, each concept's HTMT ratio must be below 0.9 (Ringle et al., 2022). The HTMT results are shown in Table 2, which indicates that discriminant validity is acceptable. These limits were also set and verified by Akude et al. (2024).

4.2. Evaluation of the Structural Model

The structural model must be appraised to scrutinize the interrelationship amid green innovation as well as profitability with intelligence generation as the moderator. Consequently, the hypotheses of the investigation were tested.

4.3. Collinearity Assessment

Collinearity for hidden variables checked using variance inflated factor (VIF). Hair et al. (2017) say a VIF of 5 or more shows possible collinearity problems. Table 3 shows all VIF values are under 5, so no collinearity issues exist in the model. Thus, the model is free from common method bias (Kock, 2015).

The significance of the path coefficients ought to be appraised, together with the R-square (R^2) as well as Stone-Geisser criterion (Q^2) for green innovation and profitability in order to appraise the structural model (Hair et al., 2017). The R^2 values of 0.621 for profitability is regarded as medium scores in the behavioral sciences (Ali et al., 2018). This indicates that 62.1% of the three predictors is explained by the variance in profitability. It is worthwhile noting that the variance as explained was above the minimum threshold R^2 assessment of 25% (Hair et al., 2016).

According to Ali et al. (2018), the assessment of Q^2 ought to be greater than zero to show that a structural model is prognostic. In this situation, we observed a Q^2 assessment of 0.606 for profitability. These numbers demonstrate the model's good predictive capabilities.

The path coefficient revealed that, environmental commitment, stakeholder engagement, and market forces has a positive effect on profitability respectively. It is worthy of note that environmental commitment influenced profitability the most; followed by stakeholder engagement, and market forces.

4.4. Hypotheses Testing (Direct Effect)

As a conclusion of the direct effect, two of the three hypotheses were supported; environmental commitment to profitability ($\beta = 0.476$, $P < 0.01$), stakeholder engagement to profitability ($\beta = 0.242$, $P < 0.01$). However, market forces to profitability is insignificant ($\beta = 0.080$, $p = 0.368$); as can be demonstrated in Table 4.

The investigation also appraised the effect size (f^2), which is a measure of whether a certain exogenous construct significantly affects an outcome variable. Subject to Cohen's (1988) suggestion, the result of the investigation revealed that environmental commitment has a medium effect on profitability. Furthermore, stakeholder engagement has a small effect on profitability. However, market forces have no effect on profitability.

4.5. Moderation Effect

One of the current research hypothesis was to appraise the moderation role of intelligence generation on the link amid green innovation as well as profitability. Moderation refers to a state in which the connection between two concepts is not continuous, but hinge on the value of a third variable denoted to as a moderator (Hair et al., 2017).

In this regard the appraisal of the moderation effect was applied. It is worthy of note that intelligence generation has a positive significant moderation effect ($\beta = 0.302$, $p < 0.01$) on the relationship amid market forces and profitability. Furthermore, intelligence generation has a negative significant moderation effect ($\beta = -0.402$, $p < 0.01$) on the relationship amid stakeholder engagement and profitability. However, intelligence generation has a positive, but insignificant moderation effect ($\beta = 0.161$, $p = 0.017$) on the relationship amid environmental commitment and profitability (Table 5).

Subject to Cohen's (1988) suggestion, Table 5 further indicates that the moderation role of intelligence generation has a small effect on the relationship between market forces ($f^2 = 0.090$) and profitability. Furthermore, the moderation role of intelligence generation had a small effect on the relationship amid stakeholder engagement

Table 1: Cronbach alpha, Composite Reliability Rho_a and Composite Reliability rho_c

Constructs	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted
EC	0.839	0.891	0.924	0.858
P	0.877	0.887	0.924	0.802
RM	0.838	0.857	0.925	0.860
SE	0.838	0.861	0.925	0.860

EC: Environmental commitment, P: Profitability, RM: Market forces, SE: Stakeholder engagement

Table 2: Discriminant validity assessment (HTMT)

Constructs	EC	P	RM
P	0.796		
RM	0.779	0.660	
SE	0.838	0.728	0.852

EC: Environmental commitment, P: Profitability, RM: Market forces, SE: Stakeholder engagement

Table 3: Inner VIF

Constructs	VIF
EC -> P	2.267
RM -> P	2.299
SE -> P	2.550

EC: Environmental commitment, P: Profitability, RM: Market forces, SE: Stakeholder engagement, VIF: Variance inflated factor

Table 4: Hypotheses analysis

Constructs	Original sample (O)	f^2	T statistics (|O/STDEV|)	P-values	Decision
EC -> P	0.476	0.215	7.446	0.000	Supported
RM -> P	0.080	0.006	0.900	0.368	Not supported
SE -> P	0.242	0.049	3.237	0.001	Supported

EC: Environmental commitment, P: Profitability, RM: Market forces, SE: Stakeholder engagement

Table 5: Hypotheses testing (moderation effect)

Constructs	Original sample (O)	f^2	T statistics (|O/STDEV|)	P-values	Decision
IG×RM -> P	0.302	0.090	4.869	0.000	Supported
IG×SE -> P	−0.402	0.094	4.284	0.000	Supported
IG×EC -> P	0.161	0.015	2.395	0.017	Not supported

EC: Environmental commitment, P: Profitability, RM: Market forces, SE: Stakeholder engagement

Figure 1: Conceptual framework, (2024)

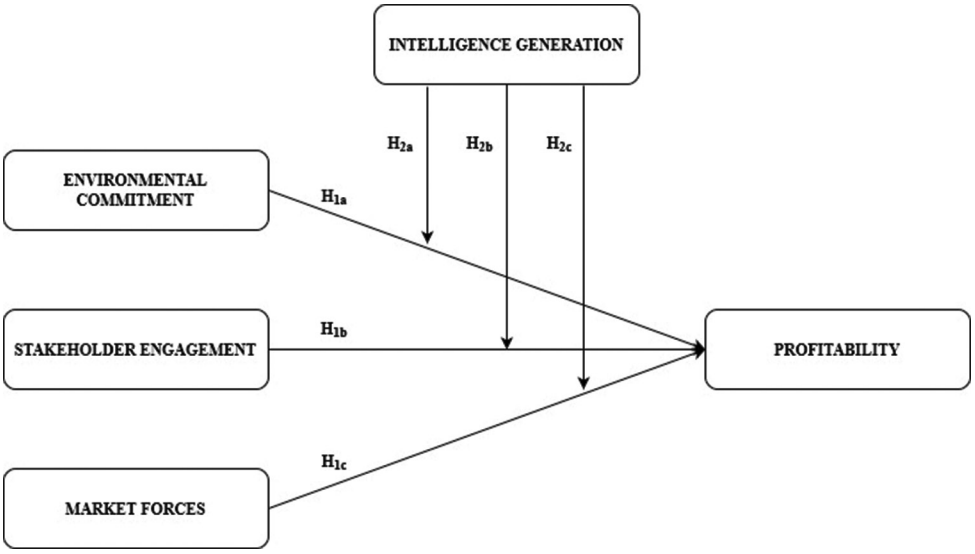
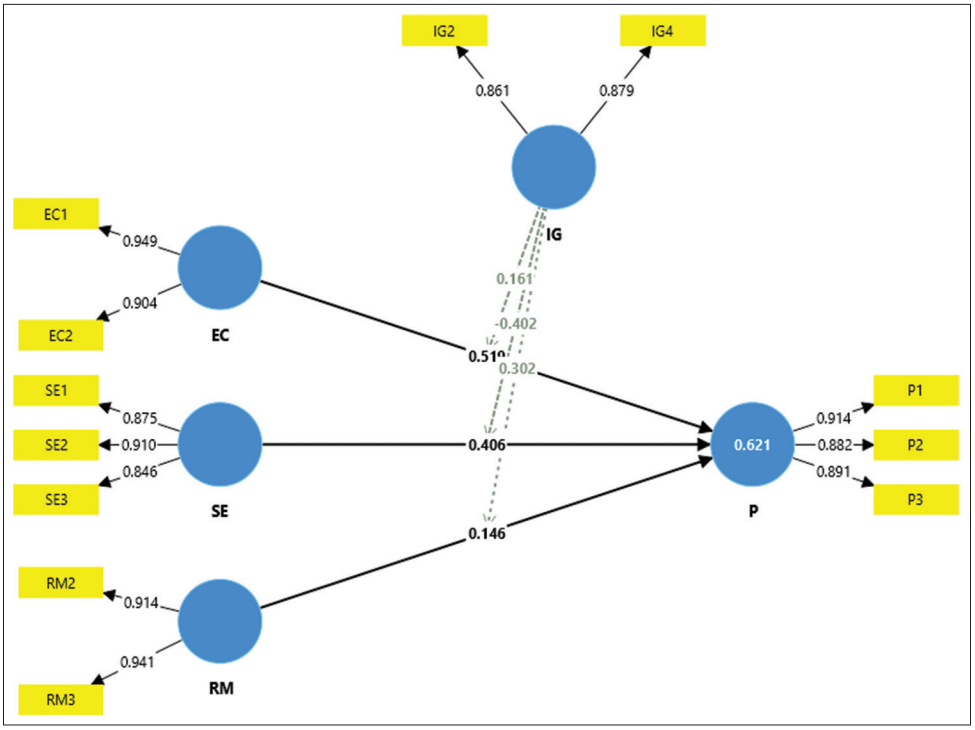


Figure 2: Measurement model



($f^2 = 0.094$), and profitability. However, the moderation role of intelligence generation had no effect on the relationship amid environmental commitment ($f^2 = 0.015$) and profitability.

5. DISCUSSION

Grounded on the RBV theory, dynamic capability theory as well as the market orientation theory, the investigation contrasts the moderating role of intelligence generation on the relationship between green innovation and as well as the profitability of manufacturing firms. Our results provide actual evidence for the crucial part that intelligence generation plays a critical role in moderating the relationship between green innovation and the profitability of manufacturing firms.

Overall, two of the three hypotheses related to the direct effect were supported (Table 4). The study noted the presence of a significant optimistic link amid environmental commitment and the profitability of manufacturing firms. Implicatively, the observed optimistic link between environmental commitment and profitability highlights a significant trend in contemporary business practices. Firms that adopt sustainable practices often realize cost savings, enhance operational efficiencies, and strengthen their market position, leading to increased profitability. Mechanisms such as reduced costs through energy efficiency,

regulatory benefits, market differentiation, and improved risk management explain this relationship. This finding underscores that environmental sustainability is not just a regulatory concern but a strategic advantage that can drive profitability.

Similarly, the relationship between stakeholder engagement as well as the profitability of manufacturing firms was positively significant. The positive link between stakeholder engagement and profitability highlights its strategic importance in modern business practices. Effective stakeholder management encompassing relationships with customers, suppliers, employees, and communities can enhance a firm's reputation, operational efficiency, and risk management, while also fostering innovation and new market opportunities. Mechanisms such as increased trust, operational synergies, and improved employee productivity contribute to this relationship.

However, the relationship between market forces and the profitability of manufacturing firms was positive, but not significant. This indicates that while market conditions may influence financial performance favorably, the effect is not consistently strong. This suggests that firms should focus more on internal strategies like operational efficiency, innovation, and stakeholder engagement rather than relying solely on market forces. Factors such as market volatility, external influences, measurement issues, and time lags might obscure the significance of market forces. This finding underscores the need for a comprehensive approach to business strategy.

The next hypothesis considered the moderation role of intelligence generation on the link amid green innovation as well as profitability (Table 5). The study noted the presence of a positive significant moderation effect of intelligence generation on the relationship amid market forces as well as profitability. This emphasizes the crucial role of strategic information in enhancing financial outcomes. Firms that effectively leverage market insights can make better decisions, gain a competitive edge, allocate resources efficiently, and manage risks more effectively. Intelligence generation aids in informed strategy formulation, opportunity identification, and improved responsiveness to market changes. This highlights the importance of investing in sophisticated intelligence capabilities to amplify the impact of market forces on profitability.

Moreover, the moderation role of intelligence generation on the relationship amid stakeholder engagement as well as profitability was negatively significant. This suggests that excessive or misaligned intelligence efforts may weaken the positive impact of stakeholder engagement. Manufacturing firms must balance resource allocation between intelligence generation and engagement strategies to avoid diminishing returns. Mechanisms behind this negative effect include information misalignment, strategic focus shift, and potential resource allocation issues. The result underscores the complexity of integrating intelligence with stakeholder engagement and highlights the need for a nuanced approach to ensure that intelligence efforts support rather than hinder stakeholder relationships, aligning with broader research on strategic information management.

However, this study finds that intelligence generation positively, but insignificantly moderate the relationship between environmental commitment and the profitability in manufacturing firms. The study finds that intelligence generation positively moderates the relationship between environmental commitment and profitability in manufacturing firms, though the effect is insignificant. Intelligence generation helps firms align environmental strategies with market demands, potentially improving decision-making and resource allocation. However, its moderation is limited in contexts like Ghana's manufacturing sector, where structural challenges, high costs, and inefficiencies may reduce its impact. Thus, while intelligence generation provides valuable insights, it may not be enough to significantly boost profitability without addressing broader operational and market challenges that dilute its effectiveness in driving financial performance.

6. CONCLUSION

The link between being environmentally responsible and making money indicates that sustainable methods can bring financial advantages to manufacturing companies, like lowering costs, better market presence, and improved risk handling. Adopting sustainable practices can help give a competitive advantage and support long-term profit.

Furthermore, the strong connection between working with stakeholders and profitability shows that good management of these relationships can enhance reputation, increase efficiency, reduce risks, and encourage innovation. Therefore, stakeholder engagement is crucial for achieving financial success and sustained profitability.

Additionally, the link between market conditions and profitability is positive but not clearly significant, showing the complicated way market factors affect manufacturing businesses. Although market conditions can affect profits, the impacts can differ. Companies should take a balanced approach, mixing responsiveness to the market with solid internal strategies.

Moreover, the role of intelligence generation positively affects the connection between market conditions and profitability, highlighting the need for effective management of strategic information for financial benefit. Companies skilled in using market intelligence can navigate market conditions better, take advantage of opportunities, and manage risks more effectively, leading to higher profits.

The negative effect of intelligence generation on stakeholder engagement and profitability suggests that poorly aligned or excessive intelligence efforts can damage relationships with stakeholders. Companies need to find a balance in intelligence generation to bolster, rather than disrupt, stakeholder engagement.

Though intelligence generation positively affects the relationship, its lack of significance signals the need for a deeper understanding of how companies can effectively use their informational resources to enhance profitability.

6.1. Theoretical Implications

Our study establishes a critical linkage amid green innovation as well as the profitability of manufacturing firms. Consequently, this study adds to the investigation on green innovation as well as profitability. Moreover, by analyzing the moderation role of intelligence generation on the connection amid green innovation as well as the profitability of manufacturing firms, this investigation significantly adds to the body of knowledge.

To make sure that the inquiry is pertinent and legitimate in the particular context of interest, the modified measurement of latent constructs in the study is essential. This can result in a more precise and detailed understanding of the connections between the different constructs and offer insightful information.

Furthermore, the conceptualization of the moderation role of intelligence generation on the link amid green innovation as well as the profitability of manufacturing firms offer a new direction for inquiry in order to increase knowledge of profitability while also empowering manufacturing firms to adopt green innovation strategies in an attempt to be competitive.

The RBV highlights that firms gain a competitive edge through unique resources. Green innovation, as a strategic resource, boosts long-term viability but requires effective intelligence generation to fully realize its profit potential. This expands RBV by emphasizing that the value of green innovations depends on a firm's ability to gather and utilize relevant market and operational information.

Dynamic capabilities theory highlights a firm's ability to adapt and reconfigure in changing environments. Intelligence generation serves as a dynamic capability, helping firms align green innovations with market demands, regulations, and trends. This moderating role indicates that firms with strong dynamic capabilities can better leverage green innovations for increased profitability, enhancing the theory's application in sustainability contexts.

6.2. Managerial Implications

The findings of this analysis have a lot of managerial implications;

Manufacturing companies need to put money into smart tools for generating intelligence, which include systems for collecting data, tools for researching markets, and platforms for analytics. These tools give immediate insights into trends about sustainability, rules, and what consumers want, allowing for well-informed decisions regarding green innovations. Focusing on investments in business intelligence (BI), predictive analytics, and large data processing will help connect green innovations with market chances and improve financial returns.

To make the most money, green innovations must meet market needs. Intelligence generation provides essential information about customer likes and the green approaches of competitors, assisting managers in adapting innovations to appeal to their intended markets. By knowing which features of green innovations customers appreciate, companies can shape product design and marketing plans, making sure efforts to increase profitability also drive sales and market share.

Green innovation should be part of a broader sustainability plan steered by intelligence generation. Managers should create teams from different departments like R&D, marketing, operations, and sustainability to ensure innovations are supported by data. This method promotes unified strategies that connect innovation with profits and environmental aims. Furthermore, intelligence generation helps identify effective green innovations, allowing for wise use of resources to maximize financial returns.

The changing rules around the environment require firms to keep up with laws and regulations. Intelligence generation supports managers in tracking shifts in regulations, facilitating the proactive development of green innovations that comply with existing and future requirements. This tactic lowers risks related to non-compliance and takes advantage of early compliance chances, guaranteeing long-term profitability by avoiding fines and adjusting strategies for upcoming regulations.

Intelligence generation can enhance engagement with stakeholders by offering data-driven insights to illustrate the worth of green innovations. This contributes to establishing a strong reputation for sustainability, which fosters customer loyalty and draws in investors who care about social responsibility. Moreover, keeping an eye on stakeholder opinions allows companies to adjust their green approaches to meet changing expectations, thus further reinforcing their market position and stakeholder ties.

Moreover, intelligence generation helps manage resource allocation for green innovations by delivering thorough insights. Managers should utilize this intelligence to assess financial risks and gains, prioritizing investments in high-impact sectors. This strategy reduces the risk of engaging in unprofitable green projects and helps pinpoint potentially profitable initiatives. Additionally, intelligence can help predict market changes and operational issues, allowing for quick strategic modifications.

Furthermore, intelligence generation enables firms to compare their green innovations with those of competitors and industry frontrunners. By keeping a constant watch on the best practices in the industry and market trends, managers can enhance their green innovation efforts, boosting efficiency and effectiveness over time. Benchmarking based on intelligence keeps firms competitive in a market that increasingly values sustainability, enabling them to adjust strategies to handle new challenges and seize new opportunities.

Managers ought to use intelligence generation to develop a long-term vision for green innovation that balances immediate profitability with future expansion. Intelligence helps reveal patterns in sustainability, consumer habits, and technology, which allows companies to align innovations with long-term market changes. This forward-thinking approach ensures that green innovations remain profitable now and prepare the firm for continued growth as environmental issues become more significant.

6.3. Limitations and Recommendations for Future Research

The study looks at some industries in Ghana's manufacturing sector, which might make it hard to apply the findings everywhere.

The effects of green innovation can differ a lot among sub-sectors. Future research should explore more industries for better understanding of how green innovation and intelligence affect profits.

Furthermore, the analysis might focus too much on immediate profits and miss the long-term financial effects of green innovation. Many environmental efforts need time to show benefits. Future studies should use a longer timeframe to see how green innovation impacts profits over time and if intelligence generation continues to play a key role.

Moreover, intelligence generation includes various aspects like data analysis, competitive insight, and market research, which makes it tricky to measure and understand its effects on green innovation. Future research should clarify the different types of intelligence activities and how they fit into decision-making to find out which ones' best boost profits from green innovation.

Furthermore, the study might not fully look at outside factors like government policies, trade issues, and global market conditions that can influence green innovation and profits. Future research should include these external factors, such as regulations and international norms, to see how they affect profits and how intelligence generation assists companies in dealing with these elements.

The study may not consider the differences between small, medium, and large firms in applying green innovation and intelligence. Future research should look at how company size, structure, and resources affect the success of green innovation. Understanding if smaller firms, with less funding, have different profit results than larger firms could offer useful insights.

REFERENCES

Acheampong, A.O., Frimpong, S. (2021), Green innovation and sustainability performance of manufacturing firms in sub-Saharan Africa: The role of dynamic capabilities. Journal of Cleaner Production, 293, 126337.

Addai, I., Appiah, E., Boakye, K. (2022), Green innovation and profitability in Ghanaian manufacturing firms: The role of market intelligence. Journal of Sustainable Business Practices, 14(2), 95-110.

Akude, D.N., Agyapong, G.K.Q., Iqbal, B.A. (2024), Service quality perception and behavioural purchase intention in hotels: A measurement invariance of composite (micom) approach. International Journal of Professional Business Review, 9(7), 8.

Akuma, J.K., Akude, D.N., Kwaning, E.A., Asiama, K.A. (2024a), Green marketing practices and financial performance of manufacturing firms: The moderating role of organizational culture. Multidisciplinary Reviews, 8(1), 2025017.

Akuma, J.K., Idun, A.A.A., Tackie, G., Kwaning, E.A., Asiama, K.A. (2024b), Management accounting practices and financial performance of manufacturing firms: Moderating role of information technology integration. American Journal of Industrial and Business Management, 14(5), 800-824.

Akuma, J.K., Tackie, G., Idun, A.A.A., Kwaning, E.A. (2024c), Management accounting practices and sustainability performance of manufacturing firms in Ghana. American Journal of Industrial and Business Management, 14, 214-241.

Ali, F., Rasoolimanesh, S.M., Sarstedt, M., Ringle, C.M., Ryu, K. (2018), An assessment of the use of partial least squares structural equation modeling (PLS-SEM) in hospitality research. International Journal of Contemporary Hospitality Management, 30(1), 514-538.

Barney, J. (1991), Firm resources and sustained competitive advantage. Journal of Management, 17(1), 99-120.

Boateng, D., Kwakye, K., Nyame, A. (2023), Green innovation and financial performance: Evidence from Ghanaian manufacturing firms. African Journal of Business Management, 17(4), 128-139.

Bocken, N.M.P., de Pauw, I., Bakker, C., Van Der Grinten, B. (2020), Product design and business model strategies for a circular economy. Journal of Industrial Ecology, 24(3), 441-453.

Boonlertvanich, K. (2019), Service quality, satisfaction, trust, and loyalty: The moderating role of main-bank and wealth status. International Journal of Bank Marketing, 37(1), 278-302.

Chen, W., Zhang, X., Li, J. (2021), The impact of green innovation on corporate performance: Evidence from Chinese manufacturing firms. Journal of Cleaner Production, 285, 124838.

Chen, Y., Wang, Z., Shen, J. (2021), Green innovation and firm performance: The moderating role of environmental regulation and industry competition. Journal of Cleaner Production, 282, 124379.

Gao, H., Zhang, Y. (2023), Green innovation and firm competitiveness: Evidence from Chinese manufacturing firms. Journal of Business Research, 145, 123-136.

Grewal, R., Tansuhaj, P. (2001), Building organizational capabilities for managing economic crises: A market-oriented perspective. Journal of Marketing, 65(2), 80-94.

Gyasi, P.K., Asare, E.N., Adusei, M. (2022), Intelligence generation and its role in enhancing firm performance through green innovation: Insights from Ghana. Sustainability, 14(6), 3528.

Hair, J., Risher, J., Sarstedt, M., Ringle, C. (2019), When to use and how to report the results of PLSSEM. European Business Review, 31(1), 2-24.

Hair, J.F. Jr., Hult, G.T.M., Ringle, C., Sarstedt, M. (2016), A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). United States: Sage Publications.

Hair, J.F., Sarstedt, M., Ringle, C.M., Gudergan, S. (2017), Advanced Issues in Partial Least Squares Structural Equation Modeling. Available from: https://nls.ldls.org.uk/welcome.html?ark:/81055/vdc100044101027.0(000001

Hanafiah, M.H. (2020), Formative vs. reflective measurement model: Guidelines for structural equation modeling research. International Journal of Analysis and Applications, 18(5), 876-889.

Henseler, J., Ringle, C.M., Sarstedt, M. (2015), A new criterion for assessing discriminant validity in variance-based structural equation modeling. Journal of the Academy of Marketing Science, 43(1), 115-135.

Kaplan, R.S., Norton, D.P. (1992), The balanced scorecard-measures that drive performance. Harvard Business Review, 70(1), 71-79.

Khan, H., Xue, J., Rizwan, M. (2022), Green innovation and financial performance: The moderating role of market orientation in manufacturing firms. Sustainability, 14(4), 2205.

Kock, N. (2015), Common method bias in PLS-SEM: A full collinearity assessment approach. International Journal of e-Collaboration, 11(4), 1-10.

Kohli, A.K., Jaworski, B.J. (1990), Market orientation: The construct, research propositions, and managerial implications. Journal of Marketing, 54(2), 1-18.

Kohli, A.K., Jaworski, B.J., Kumar, A. (1993), MARKOR: A measure of market orientation. Journal of Marketing Research, 30(4), 467-477.

Krejcie, R.V., Morgan, D.W. (1970), Determining sample size for research activities. Educational and Psychological Measurement, 30(3), 607-610.

Kumar, S., Jain, A., Reddy, A. (2022), Green innovation and firm profitability: The moderating effect of environmental regulations and market orientation. Environmental Science and Policy, 132, 108-118.
Lee, K., Chang, D., Lee, H. (2021), The role of green innovation in improving firm performance: Evidence from the manufacturing industry. Business Strategy and the Environment, 30(2), 940-955.
Li, X., Zhu, Y., Li, Y. (2022), The impact of dynamic capabilities on firm performance: The role of innovation and market orientation. Sustainability, 14(12), 7475.
Liu, H., Wang, S. (2021), Data analytics and market orientation: The moderating role of competitive dynamics. Industrial Marketing Management, 95, 127-138.
Muangmee, C., Dacko-Pikiewicz, Z., Meekaewkunchorn, N., Kassakorn, N., Khalid, B. (2021), Green entrepreneurial orientation and green innovation in small and medium-sized enterprises (SMEs). Social Sciences, 10(4), 136.
Narver, J.C., Slater, S.F. (1990), The effect of a market orientation on business profitability. Journal of Marketing, 54(4), 20-35.
Nidumolu, R., Prahalad, C.K., Rangaswami, M.R. (2020), Why sustainability is now the key driver of innovation. Harvard Business Review, 87(9), 56-64.
Patel, S., Kumar, R. (2022), Social media analytics and its impact on market orientation in the manufacturing industry. Journal of Strategic Marketing, 30(3), 210-226.
Ringle, C.M., Wende, S., Becker, J.M. (2022), SmartPLS 4. Oststeinbek: SmartPLS GmbH. Available from: https://www.smartpls.com
Sheng, H., Yang, Q., Zhu, M. (2020), Market intelligence, marketing capability, and innovation performance in Chinese manufacturing firms. Journal of Business Research, 112, 246-256.
Song, H., Yu, H. (2021), Exploring the moderating effect of intelligence generation on the relationship between green innovation and firm performance. Journal of Cleaner Production, 312, 127604.
Song, W., Yu, H. (2018), Green innovation strategy and green innovation: The roles of green creativity and green organizational identity. Corporate Social Responsibility and Environmental Management, 25(2), 135-150.
Teece, D.J. (2007), Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. Strategic Management Journal, 28(13), 1319-1350.
Venkatraman, N., Ramanujam, V. (1986), Measurement of business performance in strategy research: A comparison of approaches. Academy of Management Review, 11(4), 801-814.
Wang, Q., Li, W., Yu, H. (2023), Challenges of green innovation: Insights from Chinese firms. Journal of Business Research, 159, 113071.
Yarlagadda, A., Murthy, J.V.R., Prasad, M.K. (2015), A novel method for human age group classification based on correlation fractal dimension of facial edges. Journal of King Saud University-Computer and Information Sciences, 27(4), 468-476.
Zameer, R., Tariq, S., Noreen, S., Sadaqat, M., Azeem, F. (2022), Role of transcriptomics and artificial intelligence approaches for the selection of bioactive compounds. In: Drug Design Using Machine Learning. United States: John Wiley and Sons, Inc. p283-317.
Zhang, J., Zhao, H., Zheng, W. (2023), Artificial intelligence in market intelligence generation: A review and future research agenda. Journal of Business Analytics, 8(1), 55-70.
Zhang, L., Zhou, Y. (2022), Green innovation, market orientation, and firm performance: The moderating role of environmental dynamism. Technological Forecasting and Social Change, 174, 121276.
Zhang, Y., Liu, S., Wei, Z. (2020), Dynamic capabilities and firm profitability: The role of market demand and regulatory changes. Business Strategy and the Environment, 29(4), 1846-1857.
Zhang, Y., Liu, S., Wei, Z. (2020), Green innovation and firm profitability: The role of market demand and environmental regulation. Business Strategy and the Environment, 29(4), 1846-1857.
Zhao, X., Sun, S., Wang, Y. (2022), How intelligence generation moderates the relationship between green innovation and firm performance. Sustainability, 14(10), 5910.