EFFECT OF SUSTAINABLE ENTREPRENEURSHIP PRACTICES ON PERFORMANCE OF SMALL AND MEDIUM ENTERPRISES IN THE NORTH CENTRAL REGION OF NIGERIA.

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Abstract
This study investigates the effect of green products innovation and green production innovation on the performance of small and medium-sized enterprises (SMEs) in the North Central region of Nigeria, where environmental sustainability is increasingly critical for business success. Utilizing a quantitative research design, data were collected from approximately 300 SMEs across various sectors, focusing on their adoption of eco-friendly practices, products, and production strategies. The findings reveal a significant positive relationship between the integration of green products innovation and effective green production innovation efforts with enhanced performance metrics, including profitability, market competitiveness, and operational efficiency. Furthermore, the research highlights the unique challenges faced by SMEs in adopting these practices, such as limited resources and inadequate knowledge of sustainable production techniques. Ultimately, this study underscores the importance of sustainable entrepreneurship practices for driving economic growth and sustainability in the region, providing actionable insights for policymakers and business leaders to promote environmentally responsible practices among SMEs.
Keywords: *Green products Innovation, Green production Innovation, Small and Medium Enterprises (SMEs), and Performance*

INTRODUCTION

In recent years, the global emphasis on sustainability has led to a significant transformation in business practices, particularly within small and medium-sized enterprises (SMEs). This shift is largely driven by increasing environmental concerns, consumer awareness, and the urgent need for sustainable practices to combat climate change and resource depletion (Schaltegger & Wagner, 2011). As businesses face mounting pressure to adopt eco-friendly measures, the concept of sustainable entrepreneurship practices has emerged as a vital strategy for achieving competitive advantage in various sectors. Sustainable entrepreneurship practices involve the development and management of environmentally sustainable products and practices, which not only mitigate negative environmental impacts but also align with consumer expectations for sustainability (Hsu et al., 2013).

This study focuses on the effect of sustainable entrepreneurship practices specifically green products innovation and green production innovation on the performance of SMEs in North Central Nigeria, a region characterized by both potential and challenges. The North Central region of Nigeria, often referred to as the "Middle Belt," is known for its rich agricultural resources and diverse cultural heritage. This area includes states such as Benue, Kogi, Kwara, Nasarawa, Niger, and Plateau, which are predominantly agrarian and endowed with significant mineral resources (Ogunfowora, 2018).

Despite its economic potential, SMEs in this region face numerous challenges that hinder their growth and performance. These challenges include inadequate access to finance, poor infrastructure, regulatory constraints, and socio-political tensions that exacerbate local economic instability (Afolabi & Adebayo, 2020; Nwankwo & Okwu, 2020). Nevertheless, there is a growing recognition of the role that sustainable practices can play in enhancing the resilience and performance of SMEs. By integrating sustainable entrepreneurship practices into their operations, these enterprises can not only improve their market competitiveness but also contribute positively to environmental sustainability.

The ongoing evolution of consumer preferences towards sustainability underscores the importance of adopting sustainable entrepreneurship practices within SMEs. As consumers increasingly seek products

that minimize environmental harm---such as biodegradable packaging or energy-efficient appliances---SMEs have an opportunity to innovate and differentiate themselves in the marketplace (Nuryakin & Maryati, 2020). Government incentives aimed at promoting green initiatives further encourage SMEs to invest in sustainable product development (Nuryakin et al., 2022). This period marks a critical juncture for SMEs in North Central Nigeria as they adapt to changing market dynamics driven by sustainability trends.

Statement of the Problem

The increasing awareness of environmental sustainability has spurred a growing interest in green products innovation and green production innovation among consumers and businesses alike. In North Central Nigeria, small and medium-sized enterprises (SMEs) face significant challenges in adopting eco-friendly practices and products due to limited resources, inadequate knowledge, and the perception that implementing green initiatives may be costly or detrimental to their profitability. Despite the potential benefits of green products---such as improved brand reputation, customer loyalty, and compliance with regulatory standards---many SMEs struggle to effectively integrate these practices into their operations. Furthermore, the role of green production innovation in promoting these eco-friendly products remains underexplored, limiting SMEs' ability to communicate their sustainability efforts effectively to consumers.

While existing literature emphasizes the importance of sustainability in business practices (Ahmad et al., 2024; Roh et al., 2022; Wang et al., 2021), there is a notable lack of research focused specifically on the impact of both green products innovation and green production innovation on SME performance in the Nigerian context, particularly in the North Central region. Most studies tend to concentrate on larger corporations or industries outside the scope of SMEs, leaving a significant gap in understanding how these smaller enterprises can leverage sustainable practices to enhance their performance. Additionally, unique socio-economic and cultural factors in North Central Nigeria may influence the adoption and effectiveness of green products innovation and production strategies, but this has not been adequately addressed in the literature. Therefore, this study seeks to fill this gap by providing empirical evidence on the relationship between sustainable entrepreneurship practices---including green product innovation adoption and green production innovation and SME performance in North Central Nigeria. By assessing how these environmentally friendly initiatives influence profitability, market competitiveness, and overall business growth, this research aims to contribute valuable insights for local businesses and policymakers. Ultimately, understanding the dynamics of sustainable entrepreneurship practices will not only enhance academic knowledge but also promote practical applications that can drive economic growth and environmental stewardship in the region.

Objectives of the Problem

The main objective of the study is to examine the effects of sustainable entrepreneurship practices on the performance of SMEs in the North-Central region of Nigeria while the specific objectives of the study are;

- **i.** to evaluate the effect of green product innovation on performance of SMEs in the in the North-Central region of Nigeria.
- **ii.** to examine the effect of green production innovation on performance of SMEs in the in the North-Central region of Nigeria.

LITERATURE REVIEW

Conceptual Framework

Green Product Innovation

Enyi et al. (2024), define green product innovation as products that are intentionally designed to minimize environmental impact throughout their entire life cycle, which includes stages of production, usage, and disposal. This definition emphasizes a holistic approach to sustainability, indicating that the ecological implications of a product must be considered at every phase, from sourcing materials to the final disposal. By integrating sustainable materials and processes, companies can significantly reduce their carbon

footprints and contribute to a circular economy, where resources are reused and recycled rather than discarded.

Nasir et al. (2024), characterizes green products innovation as environmentally friendly, focusing on production processes that conserve resources and minimize pollution. This approach is critical as it not only addresses the materials used in products but also scrutinizes manufacturing practices that can lead to environmental degradation. For a product to be genuinely considered "green," it must be produced through processes that prioritize ecological integrity and sustainability, ensuring that resource use does not compromise the environment.

Rasheed et al. (2024), posits that green products innovation should yield environmental benefits, such as reduced energy consumption and lower emissions, while still meeting consumer needs. This definition highlights the challenge of balancing environmental performance with consumer demand, suggesting that for green products innovationto succeed in the marketplace, they must not only be sustainable but also competitive in functionality, quality, and price. This balance is essential for encouraging widespread adoption of green products innovationamong consumers.

Asante et al. (2024), defines green products innovation as those made from renewable resources and designed to be biodegradable or recyclable. This definition underscores the importance of using materials that can naturally decompose or be repurposed, thereby reducing waste and the strain on landfills. The focus on renewable resources aligns with the broader goal of achieving sustainability in product design and consumption.

Kiranantawat and Ahmad (2023), expands the definition of green products innovation to include their contributions to sustainable development, emphasizing the need to minimize environmental harm while promoting social equity. This broader perspective acknowledges that environmental sustainability is intertwined with social issues, suggesting that green products innovationcan play a significant role in achieving social justice and economic equality, in addition to providing ecological benefits.

Majali et al. (2022), describe green products innovation as those certified by recognized environmental standards, ensuring compliance with specific sustainability criteria. Certification acts as a crucial mechanism for validating environmental claims and providing consumers with reliable information, enabling them to make informed purchasing decisions based on established benchmarks of sustainability. According to Nuryakin (2022), green products innovation are marketed with an emphasis on their environmental benefits, reflecting an increasing consumer awareness of sustainability issues. This production strategy not only highlights the ecological advantages of these products but also responds to a growing demand for environmentally responsible options among consumers.

In this study, green product is defined as a product designed, manufactured, and marketed with a focus on minimizing its environmental impact throughout its entire lifecycle, from production to disposal. This includes utilizing sustainable materials, reducing energy consumption, and ensuring that the product is recyclable or biodegradable. Green products innovation aim to meet consumer needs while promoting ecological balance and resource conservation. They often incorporate features that enhance environmental performance, such as energy efficiency, reduced emissions, and lower waste generation. As awareness of environmental issues grows, green products innovation increasingly appeal to consumers who prioritize sustainability, making them an integral part of the shift towards more responsible consumption and production practices.

Green production innovation

According to LibGuides (2023), green production innovation involves the development and implementation of environmentally friendly production processes and technologies designed to reduce resource consumption, minimize waste, and lower emissions throughout the manufacturing lifecycle. By enhancing operational efficiency and integrating eco-friendly practices, this innovation aligns with

broader sustainability goals. It is characterized by the adoption of advanced technologies and methods that promote renewable resource use, reduce environmental impact, and ensure compliance with regulatory standards, ultimately contributing to improved corporate performance and a positive public image for businesses).

Green production innovation refers to the development and implementation of new processes, technologies, and practices aimed at reducing the environmental impact of manufacturing and production activities. This encompasses a range of strategies, including the adoption of energy-efficient technologies that optimize resource use and lower energy consumption. Waste minimization strategies play a crucial role, focusing on reducing waste generation at source and improving recycling and recovery practices. Sustainable resource use involves sourcing materials responsibly, ensuring that they are renewable or recycled whenever possible. Additionally, integrating renewable energy sources, such as solar or wind power, helps to lower carbon emissions and ecological footprints associated with production. By emphasizing life cycle thinking, green production innovation promotes sustainability from raw material extraction to product disposal. This approach not only benefits the environment but also enhances economic performance by reducing costs and improving efficiency. Overall, green production innovation represents a holistic strategy for creating a more sustainable manufacturing sector (Schiederig et al., 2012).

Green production innovation emphasizes the creation of eco-friendly products and services while maintaining economic viability. This approach is often driven by regulatory pressures that mandate stricter environmental standards, compelling businesses to adopt sustainable practices. Additionally, there is a growing consumer demand for sustainability, as customers increasingly prefer products that are environmentally friendly and ethically produced. Corporate social responsibility initiatives also play a significant role, motivating companies to integrate sustainability into their core operations to enhance their public image and stakeholder trust. By balancing ecological concerns with economic performance, green production innovation fosters a competitive advantage in the marketplace. This dual focus not only helps companies comply with regulations but also meets the expectations of socially conscious consumers. Ultimately, it aims to create a win-win scenario where both the planet and profits benefit from sustainable practices (Kemp & Pearson, 2007).

Chen et al., (2006) posits that green production innovation signifies a shift toward sustainable development by harmonizing industrial growth with environmental preservation. It encourages industries to adopt practices that minimize environmental impact and optimize resource use. By integrating sustainability into production processes, businesses can reduce waste and lower emissions. This alignment not only supports ecological health but also promotes economic viability. Ultimately, green production innovation seeks to create a sustainable framework where industrial activities coexist with the natural environment.

In this study green production innovation is about making products in a way that is better for the environment. It involves using new methods and technologies that reduce waste, save energy, and lower pollution. This means companies focus on creating things that are not only good for business but also good for the planet. For example, they might use renewable energy sources, recycle materials, or design products that are easier to reuse or recycle. The goal is to ensure that as we grow and produce more, we don't harm the Earth and help create a healthier future for everyone.

Small Medium Enterprises (SMEs)

Small and Medium Enterprise (SME) has been defined in different ways (often in terms of sales turnover, size, asset base or employment generation) and at different context (depending whether it is institutional or country based). Different countries advance their peculiar definitions grounded on the expected role of SME in that country. Therefore, many countries consider their levels of industrial development and other economic factors in defining SMEs (Tiwari & Swal-up, 2017).

A firm that is considered as small in economically advanced nations may become medium or large in other developing countries like Nigeria. In 2012 Small and Medium Enterprises Development Agency of Nigeria (SMEDAN) came up with a different definition of SMEs in Nigeria. The institution begins with the definition of cottage/micro firms. Cottage/micro firms are those with a labour size of not more ten workers, and the total cost of not more than five million Naira, excluding land but including working capital; Small scale firms are those enterprises with a labor size of between ten to forty nine workers, with a total cost of five million Naira, but not exceeding fifty million Naira excluding cost of land but including working capital; Medium scale are those enterprises with a labor size between fifty and one hundred and ninety nine, with a total cost of above fifty million Naira, but not exceeding five hundred million Naira, excluding cost of land but including working capital.

This study adapts definition of SMEDAN (2012) because it is an agency established and official recognized by the government. In this study therefore, Micro Enterprises are those enterprises with a total asset (excluding land and buildings, but including working capital) of less than five million Naira with a workforce not exceeding ten employees. Small Enterprises are those enterprises whose total assets (excluding land and building but including working capital) of above five million Naira but not exceeding fifty million with a total workforce of above ten, but not exceeding forty nine employees. Medium Enterprises are those enterprises with total assets (excluding land and buildings, but including working capital) of above fifty million Naira, but not exceeding five hundred million Naira with a total workforce of between fifty and one hundred and ninety-nine.

SMEs Performance

According to Tsiu, et al.(2024), SMEs performance refers to the effectiveness and efficiency with which small and medium-sized enterprises achieve their business objectives and goals, measured through various financial and non-financial indicators. This includes metrics such as profitability, revenue growth, market share, and operational efficiency, as well as qualitative factors such as customer satisfaction, employee engagement, and innovation capacity. Performance assessment may also encompass sustainability practices and their impact on environmental and social outcomes, reflecting the overall health and competitiveness of the enterprise within its industry. By evaluating these dimensions, stakeholders can gain insights into the operational success and strategic positioning of SMEs in the market. SMEs performance refers to the effectiveness with which small and medium-sized enterprises achieve their business objectives, evaluated through a combination of financial and non-financial indicators.

Financial metrics such as profitability, revenue growth, and return on investment provide quantitative measures of success, while non-financial factors like customer satisfaction, employee morale, and innovation capacity contribute to long-term sustainability. Additionally, operational efficiency, encompassing resource utilization and productivity, plays a critical role in performance assessment. In the context of green entrepreneurship, sustainability metrics, including waste reduction and energy efficiency, are also important, reflecting the commitment of SMEs to social responsibility. Overall, a comprehensive evaluation of SMEs performance highlights strengths and areas for improvement, guiding strategic development and enhancing competitiveness in the marketplace (Li, et al. 2024).

Rakshit, et al. (2024), posits that SMEs performance is a comprehensive assessment of how effectively small and medium-sized enterprises achieve their goals, incorporating both financial and non-financial metrics. Financial indicators such as profitability, revenue growth, and return on investment provide insights into economic health, while non-financial factors like customer satisfaction, employee engagement, and innovation capacity contribute to long-term sustainability and competitive advantage. Operational efficiency, focusing on resource utilization and productivity, is also critical. Additionally, in the context of green entrepreneurship, sustainability metrics like waste reduction and energy efficiency highlight an SME's commitment to social responsibility.

Empirical Review

Green Product Innovation and SMEs Performance

Enyi et al. (2024) explored the effects of green production innovation on the performance of small and medium enterprises (SMEs) in North Central Nigeria, focusing on green products, processes, use, and end-of-life management. The study was guided by Ecological Modernization Theory and Stakeholder Theory. A survey research design was adopted, covering Benue, Kogi, Kwara, Nasarawa, Niger, Plateau states, and the Federal Capital Territory. The population comprised 1,784 SMEs, with a scientifically derived sample size of 327 using Yamane's Formula. Data were collected through a structured questionnaire with a reliability index of 0.802. Statistical analysis revealed positive relationships between green production innovation dimensions and SME performance, particularly in agro-processing businesses. The findings underscore that adopting green products, processes, and end-of-life management can significantly enhance SME performance in the region. The study recommends that SMEs in North Central Nigeria integrate green production innovation practices to boost sustainability and competitiveness.

Rasheed et al. (2024) explored the role of green supply chain management, waste management, and green product innovation in enhancing "enviropreneurship performance" among SMEs in the United States. Using a deductive approach and Structural Equation Modeling to analyze survey data from 835 supply chain professionals, the study revealed that green practices positively influence entrepreneurial performance by reducing waste, strengthening stakeholder relationships, improving brand reputation, achieving cost savings, and ensuring regulatory compliance. Moreover, waste management and green product innovation were identified as mediators between green supply chain practices and business outcomes, underscoring their strategic importance. Grounded in the Resource-based View, the study introduced "enviropreneurship performance" as a pivotal concept, linking sustainability to entrepreneurship and providing a model for businesses to achieve competitive advantage through environmental advocacy. These findings offer actionable insights for fostering sustainable business practices while addressing areas for future research, such as industry-specific analyses and cultural influences on green entrepreneurship.

Nasir et al. (2024) examined the relationship between knowledge management practices and sustainable performance, focusing on the mediating role of green product innovation within Malaysia's SME sector. Using SmartPLS4 to analyze data collected via convenience sampling, the study conceptualized knowledge management as a formative construct comprising knowledge creation, acquisition, sharing, and application. The findings revealed that effective knowledge management positively influences sustainable performance, with green product innovation playing a crucial mediating role in this relationship. Additionally, green product innovation was shown to directly predict sustainable performance, emphasizing its importance as an enabler of greening perspectives. The study highlights the need for organizations to embed comprehensive knowledge management practices to enhance performance while fostering green product innovation as a critical intermediary. By integrating these elements, the research contributes to the growing body of knowledge on sustainability, providing actionable insights for SMEs to align innovative strategies with environmental goals for long-term performance.

Enyi et al. (2024), Rasheed et al. (2024), and Nasir et al. (2024) each contribute valuable insights into the relationship between green practices and SME performance, yet they exhibit notable variations in context and methodology that may affect the generalizability of their findings. Enyi et al. (2024) focus on SMEs in North Central Nigeria, utilizing a survey design to analyze how green production innovation impacts performance across various dimensions. While the study's structured approach and reliable sample size of 327 SMEs lend credibility to its findings, the specific regional focus may limit applicability to other contexts, especially given the unique economic and environmental challenges faced by Nigerian SMEs. In contrast, Rasheed et al. investigate green supply chain management and its impact on "enviropreneurship performance" among SMEs in the United States, employing a larger sample of 835 supply chain professionals.

Green production innovation and SMEs Performance

Amar et al. (2024) explored the strategies small and medium-sized enterprises (SMEs) in India can employ to engage in green production innovation effectively, highlighting both the opportunities and challenges within the sustainable market. Through an in-depth qualitative analysis of secondary data, the study emphasized the benefits of adopting green production innovation strategies, such as contributing to environmental conservation and resource management while capitalizing on a growing base of environmentally conscious consumers. Notably, the research cited a Nielsen report indicating that 83% of Indian consumers are willing to pay more for eco-friendly products, with 70% actively seeking sustainable options and 58% making purchases based on social or environmental impact. These trends underline the market potential for SMEs adopting green initiatives. However, the study stressed the importance of sincerity and evidence in green production innovation to build trust and credibility with customers. It also highlighted the role of certifications like Green Business Certification and Eco-friendly Product Certification in differentiating businesses in a competitive marketplace. This research offers valuable insights into the growing demand for green products innovation in India and the strategic approaches SMEs can adopt to achieve sustainable success.

Ismail (2022) conducted a study to explore the moderating role of technological absorptive capacity (TEOC) in the relationship between the green production innovation mix (GMX), enviropreneurial orientation (ENVO), and the sustainability (SUST) of small businesses. The research employed a cross-sectional design, analyzing data from 243 fast-moving consumer goods (FMCG) businesses, including food and beverages, cleaning products, office supplies, cosmetics, and toiletries. Structural equation modeling (SEM) and the PROCESS macro test were used for data analysis. The findings revealed that both GMX and ENVO significantly contribute to the sustainability of small businesses, highlighting their pivotal role in fostering sustainable practices. Furthermore, TEOC was identified as a significant moderator in the relationships between GMX, ENVO, and SUST. This indicates that the ability of businesses to absorb and utilize technology strengthens the positive impact of GMX and ENVO on sustainability outcomes. The study underscores the importance of integrating green production innovation strategies and enviropreneurial orientation while enhancing technological capabilities to achieve sustainable business performance. These insights are particularly valuable for FMCG industries aiming to align their business practices with environmental sustainability goals.

Theoretical Framework

This study is grounded in Innovation Theory, which posits that innovation is a critical driver of economic growth and competitive advantage for businesses. Developed by Joseph Schumpeter in the early 20th century, this theory emphasizes the role of innovative practices in transforming industries and enhancing organizational performance (Schumpeter, 1934). In the context of small and medium-sized enterprises (SMEs) in North Central Nigeria, the adoption of sustainable product practices---specifically green products innovation and green production innovation---can be viewed as a form of innovation that not only addresses environmental challenges but also enhances business performance. Green products innovation is defined as those designed to minimize environmental impact throughout their lifecycle from production to disposal (Majali et al., 2022). The adoption of such products represents a significant innovation for SMEs, allowing them to differentiate themselves in a competitive marketplace. By integrating eco-friendly materials and processes into their offerings, SMEs can meet the growing consumer demand for sustainable alternatives, thereby improving their market position and profitability (Ebrahimi & Mirbargkar, 2017).

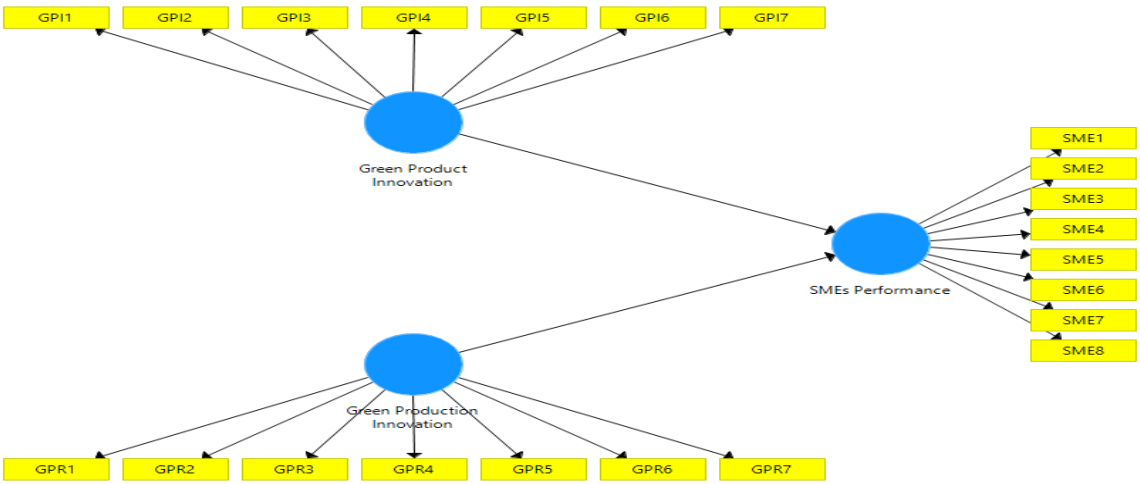
Innovation Theory supports this notion by suggesting that firms that embrace new technologies and practices are more likely to achieve superior performance outcomes. In this regard, SMEs that invest in green product development not only contribute to environmental sustainability but also enhance their operational efficiency and brand reputation. In addition to product innovation, green production innovation plays a crucial role in promoting sustainable practices among SMEs. Green production innovation encompasses strategies aimed at communicating the environmental benefits of products and fostering consumer awareness about sustainability (Peattie, 1995). This aspect of innovation is critical for

SMEs seeking to engage eco-conscious consumers who prioritize sustainability in their purchasing decisions. Effective green production innovation strategies can enhance brand loyalty and customer retention, ultimately contributing to improved financial performance (Dangelico & Vocalelli, 2017).

By leveraging innovative production techniques that highlight their commitment to sustainability, SMEs can differentiate themselves from competitors and create a strong value proposition that resonates with environmentally aware consumers. The relationship between sustainable product practices and SME performance is further supported by the mediating effects of innovation. Research indicates that green innovation acts as a mediator between sustainable practices and various performance outcomes, including financial success and market competitiveness (Weng et al., 2015). For SMEs in North Central Nigeria, aligning sustainable initiatives with business objectives can amplify positive impacts on performance metrics. This alignment enables SMEs to navigate environmental challenges while capitalizing on new market opportunities related to sustainability (Kravets et al., 2015). Thus, the integration of green products innovation and effective green production innovation strategies not only addresses pressing environmental concerns but also enhances the resilience and profitability of SMEs operating in a competitive landscape.

Methodology

This study will employ a quantitative research design to investigate the effect of green products innovation and green production innovation on the performance of SMEs in the North Central Region of Nigeria. The target population will consist of SMEs operating in diverse sectors, including manufacturing, agriculture, and services, within selected states in the region. A sample size of approximately 300 SMEs will be determined using a stratified random sampling technique to ensure representation across different industries and business sizes. Data will be collected using a structured questionnaire developed on a five-point Likert scale, which will assess various dimensions of green entrepreneurship, including innovation, sustainability practices, and perceived performance outcomes. The questionnaire will undergo a pre-test for reliability and validity before distribution. To analyze the data, Structural Equation Modeling with Partial Least Squares (SEM-PLS) will be utilized, which allows for the examination of complex relationships between variables and the testing of the hypothesized model. This methodological approach will provide insights into how sustainable entrepreneurship practices influence SME performance in the context of North Central Nigeria, facilitating evidence-based conclusions and recommendations.



Results and Discussion

Assessment of Measurement Model

Indicators' Loadings

The table of loadings presented reflects the strength and relevance of the individual items (indicators) in their respective constructs, namely green product innovation (GPI), SMEs Performance (SME), and green production innovation (GRI). These loadings, which result from a Partial Least Squares Structural

Equation Modeling (PLS-SEM) analysis, provide a crucial understanding of the relationship between the indicators and their latent variables.

Table 1; Loadings

GPI1	**0.834**		
GPI2	**0.713**		
GPI3	**0.821**		
GPI4	**0.818**		
GPI5	**0.806**		
GPI6	**0.805**		
GPI7	**0.795**		
GPR1		**0.892**	
GPR2		**0.849**	
GPR3		**0.840**	
GPR4		**0.791**	
GPR5		**0.734**	
GPR6		**0.853**	
GPR7		**0.842**	
SME1			**0.827**
SME2			**0.737**
SME3			**0.814**
SME4			**0.767**
SME5			**0.820**
SME6			**0.843**
SME7			**0.802**
SME8			**0.756**

Source: SEMPLS 2025

Green Product Innovation (GPI): The GPI values range from 0.713 to 0.834, indicating varying levels of effectiveness in green product innovation among the assessed items. GPI1 has the highest value at 0.834, suggesting it is the most effective or impactful indicator of green product innovation, while GPI2 has the lowest value at 0.713, indicating it may require further improvement or focus to enhance its effectiveness.

Green Production Innovation (GPR): The GPR values range from 0.734 to 0.892, showing a generally strong performance in green production practices. GPR1 stands out with a value of 0.892, indicating it is the most effective indicator in this category, while GPR5 has the lowest value at 0.734, which may suggest that there are opportunities for improvement in that specific area.

Small and Medium-Sized Enterprises (SME) Performance: The SME performance values range from 0.756 to 0.843, reflecting varying degrees of success among SMEs in implementing sustainable practices. SME6 has the highest performance score at 0.843, indicating strong overall performance related to sustainable practices, while SME4 has the lowest at 0.767, suggesting potential areas for development.

Table 1 highlights that while there are strong indicators of both green product innovation and green production, there is variability in their effectiveness across different items and SMEs. This suggests that targeted strategies may be necessary to enhance specific areas of green innovation and production to improve overall SME performance in sustainability initiatives.

Validity and Reliability

The results presented in Table 2 indicate the validity and reliability of the measurement models for green product innovation, SMEs Performance, and green production innovation. These metrics are crucial in assessing the consistency and quality of the constructs used in this study.

Table 2: Table 2: Validity and Reliability

	CRONBACH'S ALPHA	RHO_A	COMPOSITE RELIABILITY	AVERAGE VARIANCE EXTRACTED (AVE)
GREEN PRODUCT INNOVATION	**0.906**	**0.912**	**0.925**	**0.639**
GREEN PRODUCTION INNOVATION	**0.924**	**0.927**	**0.939**	**0.689**
SMES PERFORMANCE	**0.917**	**0.921**	**0.933**	**0.635**

Cronbach's Alpha measures internal consistency, with values above 0.7 generally indicating acceptable reliability. All constructs in the table exceed this threshold, with Green Production Innovation having the highest value at 0.924, followed closely by Green Product Innovation at 0.906 and SMEs Performance at 0.917. This suggests that the items within each construct are highly correlated and measure the same underlying concept effectively.

Similar to Cronbach's Alpha, Rho_A is another measure of internal consistency that can provide additional insights into the reliability of a construct. The values for all three constructs are also above 0.9, indicating excellent reliability. Green Production Innovation again leads with a value of 0.927, suggesting it has the strongest internal consistency among the constructs.

Composite Reliability assesses the overall reliability of a construct by considering both the individual item loadings and their error variances. All constructs demonstrate high composite reliability values, with Green Production Innovation at 0.939 being the highest, followed by Green Product Innovation at 0.925 and SMEs Performance at 0.933. Values above 0.7 indicate that the constructs reliably measure their respective concepts.

Convergent Validity

Average Variance Extracted (AVE) measures the amount of variance captured by a construct relative to the amount of variance due to measurement error. Values above 0.5 are considered acceptable, indicating that a construct explains more than half of its variance through its indicators. In this table, Green Production Innovation has an AVE of 0.689, which is strong, while Green Product Innovation and SMEs Performance have AVEs of 0.639 and 0.635 respectively, indicating they also meet the acceptable threshold but are slightly lower than Green Production Innovation.

Discriminant Validity

The Heterotrait-Monotrait (HTMT) ratio is a measure of discriminant validity, which assesses the extent to which a construct is truly distinct from other constructs by comparing the correlations between different constructs (heterotrait) with the correlations within the same construct (monotrait). A rule of thumb for HTMT is that values should be below 0.90 for concepts that are distinct from each other (Henseler, Ringle, & Sarstedt, 2015.

Table 3: HTMT

	Green Product Innovation	Green Production Innovation
Green Product Innovation		
Green Production Innovation	**0.931**	
SMEs Performance	0.874	0.882

Source: SEMPLS 2025

The HTMT value green product innovation and green production innovation is 0.931, indicating a very strong positive correlation. This suggests that organizations that excel in green product innovation are likely to also excel in green production innovation. The high correlation implies that these two constructs share significant overlap in their underlying dimensions, which may reflect a comprehensive approach to sustainability in product development and production processes.

The HTMT value of 0.874 indicates a strong positive relationship between green product innovation and SMEs performance. This suggests that improvements in green product innovation are associated with better performance outcomes for SMEs, highlighting the importance of sustainable practices in enhancing business success.

The HTMT value of 0.882 also reflects a strong positive correlation between green production innovation and SMEs performance. This indicates that as SMEs adopt more sustainable production practices, their overall performance tends to improve as well

Assessment of Structural Model

Hypotheses Test

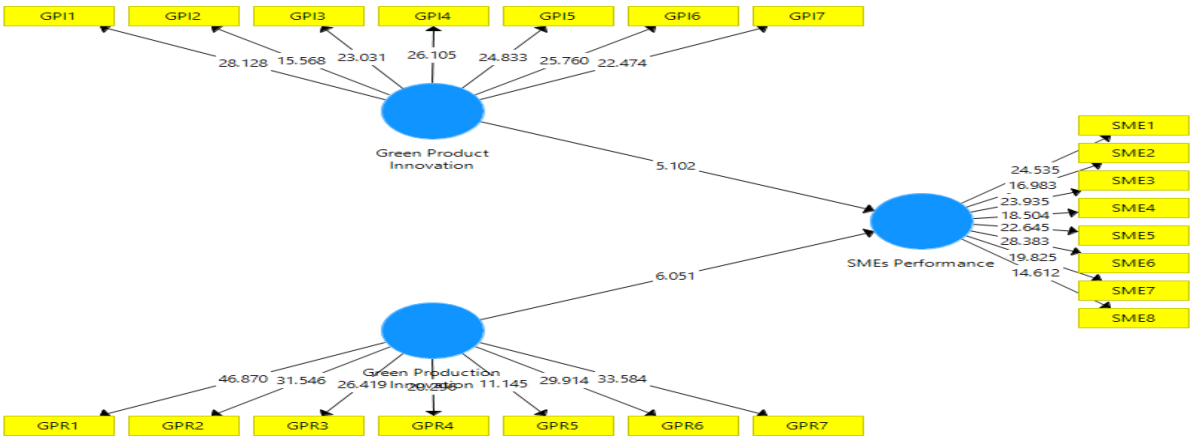
The table of path coefficients presented provides critical information regarding the relationships between the constructs in this study, namely green product innovation, green production innovation, and SMEs Performance. These relationships are assessed using the Original Sample (O) values, T Statistics, and P Values to determine the significance and strength of these pathways.

Table 4: Path Coefficient

	Original Sample (O)	T Statistics (|O/STDEV|)	P Values	Decisions
Green Product Innovation -> SME Performance	0.774	5.102	0.000	Rejected
Green Production Innovation -> SME Performance	0.076	6.051	0.000	Rejected

The original sample estimate (O) is 0.774, indicating a strong positive effect of green product innovation on SME performance. The T-statistic is 5.102, which is significantly higher than the common threshold of 1.96 for statistical significance in a two-tailed test, suggesting that this relationship is statistically significant. The p-value is 0.000, which is well below the conventional alpha level of 0.05, confirming that we can reject the null hypothesis. This indicates that there is a significant positive impact of green product innovation on the performance of SMEs.

The original sample estimate (O) here is 0.076, which suggests a very weak positive effect of green production innovation on SME performance. The T-statistic is 6.051, indicating that this relationship is also statistically significant. The p-value is again 0.000, allowing us to reject the null hypothesis. However, despite the statistical significance, the effect size (0.076) is considerably smaller than that of green product innovation, indicating that while green production innovation does have a positive effect on SME performance, it is much weaker compared to green product innovation.



Coefficient of Determinations

The R Square and Adjusted R Square values are key metrics in assessing the explanatory power of your model. In this study, these values indicate how well the independent variables (Green production innovation and green product innovation) explain the variation in the dependent variable (SMEs Performance).

Table 5: R square

	R Square	**R Square Adjusted**
SME Performance	0.711	0.709

R Square (0.711) value indicates that approximately 71.1% of the variance in SME performance can be explained by the independent variables included in the model (in this case, Green Product Innovation and Green Production Innovation). This is a relatively high value, suggesting that the model has a strong explanatory power and that these factors significantly contribute to understanding variations in SME performance.

The adjusted R square value accounts for the number of predictors in the model and adjusts the R square value accordingly. An adjusted R square of 0.709 indicates that when considering the number of independent variables, approximately 70.9% of the variance in SME performance is still explained. This slight decrease from the R square value suggests that while the model remains robust, some variability may not be fully accounted for by the predictors included.

Both R Square and Adjusted R Square values indicate a strong relationship between the independent variables (Green Product Innovation and Green Production Innovation) and SME performance. The model effectively explains a significant portion of the variance in performance outcomes, highlighting the importance of these sustainable practices for enhancing business success among SMEs in North Central Nigeria. This suggests that further investments in green innovations could lead to improved performance metrics, making a compelling case for SMEs to adopt sustainable strategies.

Effect Size

The f Square values, also known as effect sizes, indicate the extent to which each independent variable contributes to the explained variance in the dependent variable, which in this case is SMEs Performance. The f Square values help in assessing the impact of removing an independent variable from the model.

Table 6: f Square

	SME Performance
Green Product Innovation	0.149
Green Production Innovation	0.98

The f-square values presented in the table indicate the effect sizes of two independent variables—Green Product Innovation and Green Production Innovation—on the dependent variable, SME Performance.

Green Product Innovation ($f^2 = 0.149$): This value suggests a small to medium effect size according to Cohen's conventions, where values of 0.02, 0.15, and 0.35 are typically interpreted as small, medium, and large effect sizes, respectively. An f^2 of 0.149 indicates that green product innovation has a meaningful impact on SME performance, although it is not as strong as it could be. This suggests that while improvements in green product innovation can positively influence performance metrics for SMEs, there may be other factors at play that also significantly affect performance.

Green Production Innovation ($f^2 = 0.98$): This value indicates a very large effect size, suggesting that green production innovation has a substantial impact on SME performance. An f^2 of 0.98 implies that this variable explains a significant portion of the variance in SME performance outcomes. This strong effect size indicates that enhancing green production practices can lead to considerable improvements in how SMEs perform, highlighting its critical role in driving business success.

Multicollinearity test

The Variance Inflation Factor (VIF) is a measure used to detect multicollinearity in a regression model. Multicollinearity occurs when two or more independent variables are highly correlated, which can distort the estimated coefficients and compromise the statistical significance of the variables. VIF values above 10 are typically considered indicative of high multicollinearity, while values between 5 and 10 suggest moderate multicollinearity (Hair et al., 2017).

In Table 7, the VIF values for both Green product innovation and Green production innovationare 2.25. These values are well below the threshold of 10, indicating that there is no significant multicollinearity among the independent variables in the model. This suggests that Green product innovation and Green production innovation are sufficiently distinct from each other and do not exhibit problematic levels of correlation that would affect the stability and interpretability of the regression coefficients.

Table 7: Inner VIF

	SMEs Performance
Green product innovation	2.25
Green production innovation	2.25

The low VIF values indicate that the estimation of the effects of Green product innovation and Green production innovationon SMEs Performance is reliable. The absence of multicollinearity enhances the confidence in the results obtained from the regression analysis, ensuring that the relationships between the variables are accurately represented.

CONCLUSION AND RECOMMENDATIONS

This study sought to analyze the impact of green product innovation and green production innovation on performance of SMEs in the North Central, Nigeria. By employing a quantitative survey design and utilizing Partial Least Squares Structural Equation Modeling (PLS-SEM) for data analysis, the study provided comprehensive insights into the relationships between these sustainable entrepreneurship practices and SME performance.

The findings revealed a significant positive impact of green production innovation on SME performance. The high path coefficient and large effect size for both green product innovation and green production innovation underscore their critical role in fostering a conducive business environment.

Based on the findings of this study, here are the recommendations:

1. SMEs should invest in training programs focused on green product and production innovations. This can help business owners and employees understand sustainable practices, the benefits of eco-friendly products, and how to implement these innovations effectively. Workshops, seminars, and partnerships with educational institutions can facilitate knowledge transfer and skill development.
2. Policymakers should develop and promote incentives for SMEs that adopt green innovations. This could include financial subsidies, tax breaks, or grants aimed at reducing the initial costs associated with transitioning to sustainable practices. By providing a supportive regulatory framework, governments can encourage more SMEs to engage in green product and production innovations.
3. Encouraging collaboration among SMEs can lead to shared resources, knowledge, and best practices in green innovation. Establishing networks or associations focused on sustainability can facilitate partnerships that enable smaller enterprises to pool resources for research and development of eco-friendly products, thus enhancing their competitiveness in the market.
4. SMEs should develop targeted marketing strategies that emphasize the environmental benefits of their green products. Utilizing eco-labeling, transparent communication about sustainability efforts, and engaging storytelling can help attract environmentally conscious consumers. By effectively marketing their commitment to sustainability, SMEs can enhance brand loyalty and differentiate themselves in a competitive marketplace.

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