

EFFECT OF GREEN INNOVATION IN ACHIEVING CORPORATE SUSTAINABILITY GOALS IN NORTH CENTRAL NIGERIA

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Abstract

This study examined the effect of Green Innovation on the achievement of Corporate Sustainability Goals (CSGs) in manufacturing SMEs in North Central Nigeria. Specifically, it assessed the influence of Green Product Innovation and Green Process Innovation on the attainment of CSGs. The study adopted a survey research design. The population consisted of 130,862 registered SMEs in North Central Nigeria as reported by NBS-SMEDAN (2021). A sample of 400 manufacturing SMEs was drawn using simple random sampling. Data was collected using a structured questionnaire administered to owners and managers of the selected firms. The measurement scales for Green Innovation were adapted from Liao et al. (2022) and Wang et al. (2022), while Corporate Sustainability Goals were measured using a scale developed by Batool and Mohsin (2024). Data analysis was conducted using descriptive statistics, correlation analysis, and multiple regression analysis with the aid of SPSS. Findings revealed that Green Process Innovation had a positive and significant effect on Corporate Sustainability Goals, while Green Product Innovation showed a negative but significant effect. The study concluded that Green Process Innovation positively and significantly affects Corporate Sustainability Goals, while Green Product Innovation showed negatively but significantly affect Corporate Sustainability Goals. The study recommends that manufacturing SMEs in North Central Nigeria prioritise Green Process Innovation by embedding eco-friendly practices into their operations, aligning product development with process efficiency, and fostering a culture of continuous improvement to support sustainability performance.

Keywords: Green Innovation, Green Product Innovation, Green Process Innovation, Corporate Sustainability Goals, Manufacturing SMEs, North Central Nigeria.

INTRODUCTION

The pursuit of Corporate Sustainability Goals (CSGs) has become a defining imperative for businesses worldwide in an era of intensifying global environmental crises. Urge organisations to integrate environmental responsibility, social equity, and economic viability into their core strategies, these goals, aligned with the United Nations' Sustainable Development Goals (SDGs) (UNDP, 2021). At the heart of these efforts lies a pressing need to address the alarming trends of climate change, biodiversity loss, and resource depletion, which threaten the very foundations of global economic stability and human wellbeing (Abbas & Dogan, 2022). As a result, sustainability has transcended the realm of voluntary corporate social responsibility to become a critical driver of competitiveness and resilience in the 21st-century business landscape (Ahmed et al., 2022; Liu et al., 2024).

In the context of Nigeria as a developing economy, the urgency of achieving corporate sustainability goals is particularly acute. known for its agricultural potential and growing industrial activities, the North Central region of Nigeria faces a complex interplay of environmental challenges including deforestation, waste mismanagement, and energy inefficiency (Mabhandu, 2024). Yet, despite these challenges, opportunities for sustainable growth abound, especially through the lens of Green Innovation. As scholars argue, Green Innovation offers a transformative pathway for organisations to not only mitigate their environmental impacts but also enhance their economic performance and societal contributions (Wang et al., 2022; Novitasari & Tarigan, 2022).

Green Innovation can be broadly understood as the development and implementation of novel products, processes, and practices that minimise environmental harm while creating economic and social value

(Ruan et al., 2024). Its significance in advancing corporate sustainability goals has been widely recognised, with studies demonstrating its positive effects on reducing carbon emissions, promoting resource efficiency, and fostering long-term competitiveness (Liao et al., 2022; Jianchun, 2024). In particular, two core dimensions of Green Innovation Green Product Innovation and Green Process Innovation have emerged as critical levers for sustainability.

Green Product Innovation involves the design and development of environmentally friendly products that reduce resource consumption and pollution across their lifecycle (Wang et al., 2022; Liu et al., 2024). Examples include biodegradable packaging, energy-efficient appliances, and solar-powered technologies solutions that not only meet consumer demand for sustainability but also differentiate firms in competitive markets (Batoool & Mohsin, 2024). Meanwhile, Green Process Innovation focuses on enhancing operational processes to minimise waste, emissions, and energy use, often through cleaner production technologies, recycling systems, and circular economy practices (Liao et al., 2022; Jianchun, 2024). Both dimensions are instrumental in helping organisations achieve their corporate sustainability goals by integrating environmental considerations into the very fabric of their value creation activities.

However, the extent to which firms in North Central Nigeria are leveraging these dimensions of Green Innovation to realise corporate sustainability goals remains underexplored. This study seeks to bridge that gap by investigating the role of Green Product Innovation and Green Process Innovation in advancing sustainability objectives among corporate organisations in the region. By doing so, it aims to contribute to the growing body of knowledge on Green Innovation in emerging economies and offer practical insights for policymakers, business leaders, and development practitioners seeking to promote sustainable industrial growth in Nigeria.

The pursuit of Corporate Sustainability Goals (CSGs) has become a global priority, urging organisations to integrate environmental, social, and economic objectives into their strategies. Yet, in North Central Nigeria, there is a limited understanding of how companies are translating these goals into action, particularly through innovative approaches. While Green Innovation is widely recognised as a critical driver for achieving sustainability—enabling firms to reduce environmental impacts while enhancing competitiveness—empirical evidence on how this plays out within the unique business context of North Central Nigeria remains scarce (Mabhandu, 2024; Wang et al., 2022; Liao et al., 2022). Specifically, the roles of Green Product Innovation, which focuses on developing environmentally friendly products, and Green Process Innovation, which emphasises operational efficiency and waste reduction, are yet to be fully examined in relation to achieving CSGs in the region (Liu et al., 2024; Batoool & Mohsin, 2024).

Many existing studies have been carried out in this area, they predominantly focus on contexts such as China, Indonesia, and Zimbabwe, with varying sectoral and methodological emphases ranging from solar energy (Mabhandu, 2024), knowledge management (Wang et al., 2022), and patent-based metrics (Liao et al., 2022) to ESG disclosures (Ruan et al., 2024), CSR frameworks (Novitasari & Tarigan, 2022), and mining operations (Jianchun, 2024). These studies often neglect the diverse corporate realities of North Central Nigeria, such as the prevalence of small and medium enterprises, informal sectors, and the agricultural economy. In light of these gaps, this study seeks to examine the effect of Green Innovation in achieving Corporate Sustainability Goals in North Central Nigeria, focusing on the specific contributions of Green Product Innovation and Green Process Innovation.

The general objective of this study is to examine the effect of Green Innovation on the achievement of Corporate Sustainability Goals in North Central Nigeria. Specifically, the study seeks to:

- i. Assess the effect of Green Product Innovation on the achievement of Corporate Sustainability Goals in North Central Nigeria.
- ii. Examine the effect of Green Process Innovation on the achievement of Corporate Sustainability Goals in North Central Nigeria.

LITERATURE REVIEW

Corporate Sustainability Goals

Corporate Sustainability Goals (CSGs) is defined as an organisation's commitment to align its operations with long-term environmental, social, and economic priorities. The achievement of CSGs reflects a firm's ability to balance profitability with accountability to stakeholders and the planet, recognising that long-term success depends on addressing both market demands and global sustainability imperatives (Liao et al., 2022; Liu et al., 2024). Globally, these goals are often shaped by frameworks such as the United Nations Sustainable Development Goals (SDGs), which emphasise reducing carbon emissions, conserving resources, promoting social well-being, and fostering ethical governance (UNDP, 2021; Wang et al., 2022).

While the specific targets of CSGs may differ across industries and regions, the common thread lies in embedding sustainability into the core of corporate strategy whether through eco-friendly products, cleaner processes, or responsible supply chains (Mabhanda, 2024; Ruan et al., 2024). This study defines Corporate Sustainability Goals as the strategic objectives set by organisations to integrate environmental protection, social responsibility, and economic performance into their operations, ensuring long-term value creation for stakeholders while safeguarding future generations.

Green Innovation

Green Innovation refers to the creation and implementation of products, processes, and practices that minimise environmental harm while delivering economic and social value. It involves the development of new technologies, improvements in production methods, and rethinking business models to reduce carbon emissions, conserve resources, and promote sustainable consumption (Wang et al., 2022; Liao et al., 2022). As argued by Ruan et al. (2024), Green Innovation is central to corporate sustainability, as it enables firms to adapt to environmental regulations, enhance efficiency, and meet stakeholder expectations for environmental responsibility. Within this broad concept, two key dimensions are often distinguished: Green Product Innovation, which focuses on developing eco-friendly products, and Green Process Innovation, which involves optimising operations to reduce waste, energy use, and emissions (Liu et al., 2024; Batool and Mohsin, 2024).

Scholars highlight that Green Innovation is a strategic response to global sustainability challenges, offering organisations a pathway to reduce environmental impact while enhancing competitiveness (Novitasari and Tarigan, 2022; Jianchun, 2024). Mabhanda (2024) shows how Green Innovation has driven progress in renewable energy sectors, while Liao et al. (2022) demonstrate its positive effects on corporate sustainability outcomes in China. However, much of the existing literature is focused on Asian economies or specific sectors, with limited attention to the diverse contexts of African economies like Nigeria. For this study, Green Innovation is defined as the development and application of new or improved products and processes that reduce environmental harm, improve resource efficiency, and contribute to the achievement of Corporate Sustainability Goals.

Green Product Innovation

Green Product Innovation refers to the development of new or improved products that reduce environmental harm, conserve resources, and support sustainability across their lifecycle. It involves the use of eco-friendly materials, renewable energy sources, and design principles that minimise waste and emissions, ensuring that products meet both customer needs and environmental standards (Wang et al., 2022; Liu et al., 2024). As noted by Batool and Mohsin (2024), Green Product Innovation is not merely an incremental improvement but often requires a fundamental redesign of product features and functions to align with sustainability goals. These innovations are critical for businesses seeking to differentiate themselves in increasingly competitive markets, where consumers and regulators are placing growing emphasis on sustainability (Novitasari & Tarigan, 2022; Ruan et al., 2024).

Research shows that Green Product Innovation contributes to Corporate Sustainability Goals by enabling companies to reduce their carbon footprint, enhance energy efficiency, and promote circular economy practices (Liao et al., 2022; Mabhanda, 2024). While studies such as those by Jianchun (2024)

and Wang et al. (2022) demonstrate the strategic value of Green Product Innovation in sectors like mining, energy, and manufacturing, much of this research has been conducted in Asian contexts, leaving a gap in understanding its application in regions like North Central Nigeria. For this study, Green Product Innovation is defined as the design, development, and introduction of products that minimise environmental impact, reduce resource consumption, and contribute to the achievement of Corporate Sustainability Goals.

Green Process Innovation

Green Process Innovation refers to the improvement of operational practices, manufacturing methods, and organisational processes aimed at reducing environmental impact while maintaining or enhancing efficiency and productivity. It focuses on minimising waste, emissions, and energy consumption across the production cycle, often through the adoption of cleaner technologies, resource-efficient systems, and sustainable supply chain management (Wang et al., 2022; Liu et al., 2024). According to Batool and Mohsin (2024), Green Process Innovation plays a pivotal role in achieving sustainability by embedding eco-efficiency into the core of business operations, enabling firms to meet regulatory standards and stakeholder expectations. This dimension of Green Innovation is often seen as a strategic lever for enhancing competitiveness, reducing operational costs, and building long-term resilience (Liao et al., 2022; Ruan et al., 2024).

Scholars argue that Green Process Innovation is essential for achieving Corporate Sustainability Goals, as it enables organisations to decouple growth from environmental harm and align their activities with global sustainability frameworks such as the United Nations Sustainable Development Goals (SDGs) (UNDP, 2021). While studies such as those by Jianchun (2024) in the mining sector and Mabhandha (2024) in renewable energy highlight the benefits of Green Process Innovation in specific industries, much of the existing research is concentrated in Asian contexts, leaving a gap in understanding its application within the diverse business landscape of North Central Nigeria. For this study, Green Process Innovation is defined as the implementation of improved operational and production methods that reduce resource consumption, waste, and emissions, thereby contributing to the achievement of Corporate Sustainability Goals.

Green Innovation and Corporate Sustainability Goals

Ruan et al. (2024) studied the relationship between ESG information disclosure and Green Innovation in Chinese A-share listed companies using secondary data analysis and regression modelling. The study found that ESG disclosure fosters Green Innovation, particularly in non-heavy polluting industries and state-owned enterprises. Nevertheless, the study's focus on ESG disclosure, large Chinese firms, and the specific Chinese regulatory context limits its applicability to the more diverse and informal corporate sector in North Central Nigeria.

Mabhandha (2024) explored the role of Green Innovation in promoting sustainable economic development in Gweru, Zimbabwe. Using a qualitative interpretivist design, the study conducted in-depth interviews with 15 solar entrepreneurs and applied thematic analysis. It found that Green Innovation creates employment, reduces carbon emissions, and fosters climate change mitigation. However, the study is limited by its narrow focus on the solar sector in a single urban area, and it does not address broader Corporate Sustainability Goals or examine Green Process or Product Innovation in depth.

Wang et al. (2022) examined the relationship between Green Knowledge Management, Green Innovation, and Sustainable Development Goals (SDGs) in Chinese manufacturing and service firms. The study employed a quantitative survey-based design, analysing responses using structural equation modelling (SEM). While the study highlights the role of green culture in enabling Green Innovation, it focuses on knowledge management rather than specific Green Innovation types and is limited to Chinese firms, making generalisation to Nigeria's diverse business context problematic.

Liao et al. (2022) investigated the impact of Green Innovation on corporate sustainable development in China, using a quantitative panel data analysis of listed firms from 2010 to 2018. Green Innovation was measured through green patent data, and results showed a positive effect on sustainability outcomes. However, the focus on formal patent data may overlook informal innovations prevalent in developing regions like Nigeria, and the study's scope is limited to Chinese listed firms.

The Triple Bottom Line (TBL) Theory

The Triple Bottom Line (TBL) Theory, introduced by John Elkington in 1998, emphasises that corporate success should be measured across three dimensions: economic performance (profit), environmental responsibility (planet), and social well-being (people). The theory assumes that long-term business sustainability requires balancing these three pillars, recognising that organisations have a responsibility not only to shareholders but also to a broader range of stakeholders including employees, customers, communities, and the environment. Scholars such as Cainelli et al. (2015) and Cheng et al. (2014) support the TBL framework, arguing that it provides a clear link between Green Innovation and corporate competitiveness, while Fernando et al. (2019) and Hendarjanti (2022) highlight its value in fostering eco-friendly practices and employee commitment. However, critics such as Bansal (2005) and Dyllick & Muff (2015) argue that the TBL approach can be broad, difficult to measure, and may lead to trade-offs between goals, particularly in complex and resource-constrained contexts.

Despite these limitations, the TBL Theory remains a relevant and robust foundation for this study, which examines the effect of Green Innovation through Green Product Innovation and Green Process Innovation on the achievement of Corporate Sustainability Goals in North Central Nigeria. The theory aligns with the study's objective to explore how businesses in the region can integrate environmental, social, and economic considerations into their operations, offering a useful lens for understanding the pathways through which Green Innovation drives sustainability outcomes in a developing economy context.

METHODOLOGY

The study adopted a survey research design. A sample of 400 manufacturing SMEs operating in North Central Nigeria was drawn from a population of 130,862 registered SMEs, as obtained from the NBS-SMEDAN report (2021). The study employed a structured questionnaire to collect primary data from owners and managers of these SMEs. A scale containing 10 items, adapted from the works of Liao et al. (2022) and Wang et al. (2022), was used to measure Green Product Innovation (5 items) and Green Process Innovation (5 items). To assess the achievement of Corporate Sustainability Goals, a scale containing 5 items, developed by Batool and Mohsin (2024), was adapted. All items were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

According to Singh and Masuku (2014), a provision for attrition should be made to account for unreturned questionnaires. Accordingly, 10% was added to the total number of questionnaires distributed, bringing the total to 440 copies of the questionnaire distributed to manufacturing SMEs in North Central Nigeria. Out of the 440 copies distributed, a total of 406 were completely filled and returned, giving a reasonable response rate of 92%. Hence, all further analyses were carried out using the 406 valid responses.

Responses collected were analysed using multiple regression analysis with the aid of SPSS. The model is specified as follows:

$$CSG = \beta_0 + \beta_1 GPI + \beta_2 GPR + e$$

Where:

CSG	=	Corporate	Sustainability	Goals
GPI	=	Green	Product	Innovation
GPR	=	Green	Process	Innovation
e	=	Error	term	(5% = 0.05)
β_0	=			Intercept
β_1, β_2 = Coefficients of independent variables				

RESULTS AND DISCUSSION

Table 1: Descriptive Statistics on Study Variables

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis		
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
GPI	146	1.40	5.00	3.9164	.89497	-.371	.201	-.660	.399
GPR	146	1.40	5.00	4.0356	.73707	-.509	.201	.028	.399
CSG	146	1.60	5.00	4.0804	.73596	-.666	.201	.077	.399
Valid (listwise)	N 146								

Source: SPSS Output, 2025

Table 1 indicates the behaviour of all the variables under study. The average value of Green Product Innovation (GPI) was 3.92, indicating that most responses were above undecided and leaned towards agreement. The minimum and maximum values for GPI were 1.40 and 5.00 respectively. The skewness value of -0.371 suggests a slight left-skew, but since it falls within the acceptable threshold of ± 1.96 , the variable is considered to follow a normal distribution. Similarly, Green Process Innovation (GPR) recorded a minimum and maximum of 1.40 and 5.00 respectively, with an average value of 4.04. The skewness value of -0.509 also indicates a normal distribution. Lastly, Corporate Sustainability Goals (CSG) had a minimum and maximum of 1.60 and 5.00 respectively, with an average value of 4.08. The skewness value of -0.666 suggests a normal distribution pattern, as it remains within the acceptable range. These descriptive results indicate that the responses are generally reliable and suitable for further inferential analysis such as regression.

Table 2: Correlations

		GPI	GPR
GPI	Pearson Correlation	1	
	Sig. (2-tailed)		
	N	146	
GPR	Pearson Correlation	.891**	1
	Sig. (2-tailed)	.000	
	N	146	146

Source: SPSS Output, 2025

Table 2 shows that Green Product Innovation (GPI) has a strong positive relationship with Green Process Innovation (GPR), with a correlation coefficient of 0.891, which is statistically significant at the 5% level of significance ($p = 0.000$). This indicates that firms that adopt Green Product Innovation practices are also likely to implement Green Process Innovation practices, highlighting a strong association between the two dimensions of Green Innovation. All the variables under study satisfy multicollinearity assumptions, as none of the independent variables is excessively correlated with each other beyond the acceptable threshold (typically $r > 0.90$). This suggests that Green Product Innovation and Green Process Innovation, while related, are sufficiently distinct constructs and can be included in the same regression model without multicollinearity concerns.

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.701 ^a	.492	.485	.52833	1.941

a. Predictors: (Constant), GPR, GPI

b. Dependent Variable: CSG

Table 4: Analyses of Variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	38.621	2	19.310	69.181	.000 ^b
	Residual	39.916	143	.279		
	Total	78.536	145			

a. Dependent Variable: CSG

b. Predictors: (Constant), GPR, GPI

Table 5: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.211	.249		4.866	.000
	GPI	-.367	.108	-.447	-3.407	.001
	GPR	1.068	.131	1.069	8.153	.000

a. Dependent Variable: CSG

The results, as shown in Tables 3, 4, and 5, reveal an R-square value of 0.492, which signifies that approximately 49.2% of the variation in Corporate Sustainability Goals (CSG) of manufacturing SMEs in North Central Nigeria can be explained by the combination of Green Product Innovation (GPI) and Green Process Innovation (GPR). The remaining 50.8% of the variation could be explained by other factors not included in this study. The F-statistic stood at 69.181, while the probability of the F-statistic was found to be significant at the 5% level ($p = 0.000 < 0.05$), indicating that the model is fit to measure the relationship between the variables under study.

The regression equation, $CSG = 1.211 - 0.367GPI + 1.068GPR$, indicates a negative effect of Green Product Innovation on Corporate Sustainability Goals, signifying that, in the context of the sampled SMEs, product-based green initiatives alone may not sufficiently drive sustainability outcomes. The probability of the t-statistic for GPI was 0.001, which is less than 0.05, indicating that the effect is statistically significant. Hence, the study rejects the null hypothesis and accepts the alternative hypothesis, which states that Green Product Innovation has a significant effect on Corporate Sustainability Goals in manufacturing SMEs in North Central Nigeria. This finding, however, contrasts with the conclusions of Liu et al. (2024), who reported a positive relationship between Green Product Innovation and sustainability in Chinese firms.

In contrast, the regression line shows that Green Process Innovation (GPR) has a positive effect on Corporate Sustainability Goals, suggesting that eco-friendly improvements in production processes significantly enhance sustainability outcomes for SMEs. The t-statistic for GPR stood at 8.153, which is less than 0.05, confirming the statistical significance of this effect. Consequently, the study accepts the alternative hypothesis that Green Process Innovation has a significant effect on Corporate Sustainability Goals in manufacturing SMEs in North Central Nigeria. This finding aligns with the conclusions of Batool and Mohsin (2024) and Wang et al. (2022), who reported positive effects of Green Process Innovation on corporate sustainability outcomes.

CONCLUSION AND RECOMMENDATIONS

This study examined how green product innovation and green process innovation affect the achievement of corporate sustainability goals in manufacturing SMEs in North Central Nigeria. Based on the research findings, the study concludes that Green Innovation is a crucial determinant of an SME's ability to meet its sustainability objectives. The study finds that while Green Process Innovation significantly enhances Corporate Sustainability Goals, Green Product Innovation, when not effectively integrated with process improvements, may not deliver the desired impact. This suggests that while introducing environmentally friendly products is important, it must be accompanied by operational improvements to fully realise sustainability benefits.

The study, therefore, recommends that SMEs should prioritise the integration of Green Process Innovation within their production systems, ensuring that processes are optimised to reduce waste, energy consumption, and emissions. In addition, SMEs should adopt a holistic approach to Green Innovation, ensuring that product development and process improvements are aligned to support sustainability goals. This can be achieved by fostering a culture of continuous improvement, investing in employee training on eco-friendly practices, and promoting the use of renewable resources. Furthermore, SMEs should establish mechanisms for monitoring and evaluating the impact of Green Innovation initiatives, using the insights gained to inform strategic decisions and enhance overall sustainability performance.

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