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THE ROLE OF GREEN INNOVATION IN DRIVING SUSTAINABILITY PERFORMANCE WITHIN THE MANUFACTURING SECTOR IN KENYA

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ABSTRACT: *This study investigated the influence of green innovation on sustainability performance among manufacturing firms based in Nairobi County, Kenya. Data was collected from 351 respondents and analysed through multiple regression model in SPSS version 26. The results showed that both management innovation ($\beta=0.345$, $p<0.001$) and product innovation ($\beta=0.177$, $p<0.001$ are significant positive drivers of sustainability performance in the manufacturing sector in Kenya. However, process innovation ($\beta=-0.084$, $p=0.016$) had an unexpected negative effect. In addition, the model's low R^2 value ($R^2 = 0.274$, adjusted $R^2 = 0.259$) suggests that other factors not included in the study also play a significant role in the sustainability performance of the sector. The study concludes that green innovation is crucial in sustainability performance in manufacturing firms and recommends that the firms prioritize management and product innovation to enhance their sustainability efforts.*

KEYWORDS: Green Innovation, Sustainability Performance, Product Innovation, Process Innovation, Management Innovation, Manufacturing sector.

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INTRODUCTION

The global push for sustainability has increased pressure on manufacturing firms to adopt practices that balance economic growth with social equity and environmental protection (Nkemjika, 2024). In Kenya, the manufacturing sector is a key pillar of economic development, as outlined in the Vision 2030. The sector, however, faces challenges related to environmental degradation and harm to the society. A study by Nzomo& Muchemi (2019), found that green innovation strategies; which include product, process, and management innovation; are strategic tools for enhancing sustainability performance of manufacturing firms in Kenya. However, the specific influence of different green innovation dimensions on sustainability performance within the Kenyan manufacturing context, is not well understood. This study sought to fill these gaps by empirically investigating the specific effects of different types of green innovation on sustainability performance in the Kenyan manufacturing sector, using the Institutional and the Resource-Based View (RBV) theoretical frameworks. By doing so, it sought to provide evidence-based recommendations for firms, policymakers, and researchers to foster a more sustainable and responsible industrial setting.

Study Objectives and Hypotheses

The main objective of the study was to explore the effect of green innovation on sustainability performance of manufacturing firms in Nairobi County, Kenya. The specific objectives were to:

- Determine the effect of product innovation on sustainability performance.
- Determine the effect of process innovation on sustainability performance.
- Determine the effect of management innovation on sustainability performance.

Grounded on the above objectives, the following null hypotheses were framed:

- H_{01}: Product innovation has no significant effect on sustainability performance.
- H_{02}: Process innovation has no significant effect on sustainability performance.
- H_{03}: Management innovation has no significant effect on sustainability performance.

Statement of the Problem

The manufacturing sector in Kenya a fundamental pillar of the nation's economic growth. However, the sector faces serious sustainability challenges. Many firms in the sector operate in ways that create negative impacts on the economy, society, and the environment. While green innovation has been found to be a potential solution, the existing literature has concentrated on developed nations, leaving a critical research gap in developing economies like Kenya. In addition, the effectiveness of different dimensions of green innovation-product, process and management- on sustainability performance, particularly within the Kenyan manufacturing context, is not well understood. This study sought to fill these gaps by empirically investigating the effects of the specific different types of green innovation on sustainability performance within the Kenyan manufacturing sector.

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LITERATURE REVIEW AND THEORETICAL UNDERPINNING

Concept Definitions and Perspectives

Sustainability Challenges in the Kenyan Context

Economically, Kenya's manufacturing sector faces complex sustainability challenges. This is largely driven by the prioritization of short-term economic gains over long-term environmental and social benefits. Intense market competition and the high initial costs of adopting green technologies often deter firms from investing in sustainable innovations, despite their potential for long-term cost savings, opportunities for new markets and enhanced brand reputation (Awino, 2025; Omamo, 2012).

The social dimension of sustainability is also inadequate. Many manufacturing firms in Kenya operate under poor working conditions, with inadequate safety standards and limited community engagement. These issues not only compromise employee welfare; they also erode the sector's social license to operate, increasing the risk of regulatory and reputational consequences (Omamo, 2012).

Environmental degradation remains the most visible challenge. The sector is characterized by high levels of industrial waste, air and water pollution, excessive energy consumption, and reliance on non-renewable resources. For instance, the textile industry alone contributes approximately 56% of Kenya's total industrial pollution, underscoring the urgency of reform (Awino, 2025). Inefficient waste management and water-intensive production processes further exacerbate the environmental footprint of manufacturing activities.

Sustainability Performance

Firm sustainability encompasses economic value, environmental protection and social protection, and is often measured using the **Triple Bottom Line (TBL)** framework (Liu, *et al.,* 2018). The TBL posits that a firm's success should not be evaluated solely on financial profit, but should also incorporate its social and environmental impact. This study adopted the TBL perspective, and measured sustainability performance in terms of economic, social and environmental performance, as follows:

- **Economic Performance:** This dimension goes beyond traditional financial metrics. It includes a firm's ability to create long-term economic value while considering sustainability factors, for example, increased sales from green products, cost savings from energy efficiency, customer retention and enhanced market share due to a positive environmental reputation.

- **Social Performance:** This dimension evaluates the firm's impact on its employees, customers, and the communities within which it operates. The metrics include employee well-being and satisfaction; community development initiatives, labor practices, and the firm's contribution to social equity and corporate social responsibility.

- **Environmental Performance:** This dimension assesses a firm's impact on the natural environment. It is often measured through indicators like reduced carbon emissions, waste minimization, efficient resource consumption, pollution prevention, and the use of eco-friendly materials.

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Green Innovation

Green innovation is defined as a procedure that incorporates the development, application, and implementation of new or improved products, processes, and management practices that contribute to environmental and social sustainability (Novitasari *et al*., 2022). Green innovation is not merely about incremental improvements but involves a fundamental re-evaluation of how a firm creates value in ways that minimize environmental harm and promotes the social well-being. This study adopted a multi-dimensional perspective, categorizing green innovation into three main types which form the basis of the study's hypotheses:

- **Product Innovation:** The development of new or improved goods and services that have a reduced environmental impact throughout their lifecycle. This include using eco-friendly materials or designing for recyclability. These innovations directly target the environmental footprint of a firm's output.
- **Process Innovation:** The introduction of new or significantly improved production and delivery methods that minimize environmental footprint. This involves adopting technologies that lead to reduced waste, enhanced energy and water efficiency, or more effective pollution prevention. These innovations focus on the internal operational efficiency of a firm.
- **Management Innovation:** The implementation of new organizational practices, structures, and management techniques that support environmental and social objectives. This includes implementing environmental management systems, promoting employee training on sustainability and fostering a culture of corporate social responsibility. Management innovation provides the strategic direction and organizational capacity for product and process innovation.

Theoretical Underpinning

The study was grounded in two theoretical frameworks, the Institutional Theory and Resource-Based View (RBV)

Institutional Theory was the key theory. This theory helps to explain how the external pressures, such as from government regulations and industry norms, compel firms to adopt green innovation practices. The theory suggests that an organization's actions are influenced by the social, political, and cultural pressures in its environment (DiMaggio & Powell, 2000). Firms adopt certain practices, such as green innovation, to gain legitimacy, conform to industry norms, and respond to various institutional pressures (e.g., from government regulations, industry associations like KAM, and customer demands). This theory helps to explain why firms in the Kenyan manufacturing sector might be driven to adopt green innovation practices to align with regulatory and social expectations.

The **RBV** was the subsidiary theory. This theory suggests that a firm's internal resources and capabilities are the primary drivers of its sustainable competitive advantage and performance (Barney, 1991). In the context of this study, the theory frames green innovation (product, process, and management innovation) as a strategic resource for achieving a competitive advantage. Green innovation is considered a valuable, rare, inimitable, and non-substitutable (VRIN) resource. By developing and leveraging these green innovation capabilities, firms can not only improve their environmental and social outcomes but also gain a competitive edge in

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the market, thereby enhancing their overall economic, social and environmental sustainability performance.

Empirical Literature Review and Hypotheses Development

Green Innovation and Sustainability Performance

Extant literature has extensively explored the relationship between innovation and firm sustainability development, with a growing consensus that green innovation is a key enabler of corporate sustainability (Liao et al., 2022). Asadi *et al*, (2020) established that Green Innovation has significant outcome on the sustainable performance of the hotel industry. Also, Yusuf, (2020), found that green innovation strategies positively influence sustainability performance firms in Nairobi, though implementation remains inconsistent due to infrastructural and regulatory gaps. Similarly, the study of Mdasha, *et al.,* (2024), found that in cement manufacturing firms, green production practices alone accounted for approximately 45% of performance variability. However, the effectiveness of adoption of green innovation is limited by infrastructural constraints and the absence of a coherent national framework guiding green distribution and disposal (Yusuf, 2020).

The effectiveness of different types of green innovation is, however, underexplored and not well understood especially within the specific context of Kenya. This calls for more context-specific studies, particularly in developing economies. This study addresses the gap by empirically testing the relationships within the Kenyan manufacturing sector, as highlighted below.

Green Product Innovation and Sustainability Performance

Previous global research has extensively explored the relationship between green innovation and firm sustainability performance (Liao *et al*., 2022). The findings reveal a growing consensus that green innovation is a key enabler of firm sustainability performance by influencing their social, environmental, and economic sustainability performance (Asadi et al., 2020). The findings of a systematic review of 90 studies by Ren and Mia (2025), highlight the multidimensional nature of Green Product Innovation and its role in achieving sustainability goals. Recent local studies, such as that by Githenduka& Fwaya (2024), have also reinforced the positive role of green product innovation in enhancing firm performance, aligning with the findings from developed economies. The evidence from both global and local studies reinforces the strategic importance of GPI.

Green Process Innovation and Sustainability Performance

Green Process Innovation is the introduction of new or significantly improved production and delivery methods that minimize environmental footprint, such as waste reduction, energy efficiency, and pollution prevention. While many studies find a positive association, some suggest that the initial costs and complexities of implementing new, greener processes may pose a challenge, particularly for firms in developing economies. Other studies also highlight the positive impact of green process innovation on financial and environmental outcomes, but often within specific contexts such as Chinese manufacturing industries (Khan *et al.,* 2023), where access to capital and advanced technology may be more readily available. The complexities in adopting these innovations, such as lack of supportive infrastructure, are a critical challenge in African manufacturing sectors (Musah *et al*., 2025).

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Githenduka and Fwaya (2024) explored the adoption of green innovation in Nairobi's star-rated hotels. Their study revealed that green process, organizational, and technological innovations significantly improved sustainability performance. Interestingly, environmental commitment did not moderate this relationship, suggesting that direct innovation adoption has a stronger impact than attitudinal factors

Green Management Innovation and Sustainability Performance:

Green Management Innovation is the implementation of new organizational practices, structures, and management techniques that support environmental and social objectives. This includes implementing environmental management systems (like ISO 14001), promoting employee training on sustainability, and fostering a culture of corporate social responsibility. A recent meta-analysis by Dzage *et al.* (2024) and a study by Hasan, *et al.,* (2024) underscore the vital link between corporate social responsibility (CSR) initiatives and green innovation, noting that a strong management commitment is a primary driver for these activities. Hariadi et al. (2023) developed a sustainable product-service system performance model, showing that top management commitment and product stewardship practices significantly influence green product-service innovation, which in turn enhances sustainability performance. In addition, the study of Khan, (2023), provides a comprehensive framework for Green Management Innovation especially in developing countries. The study reiterate that leadership commitment is vital for in Green Innovation. When leadership actively supports green initiatives, Green Innovation is significantly enhanced

Conceptual Framework

The interrelationship between these dimensions is central to the TBL framework. While existing literature suggests a positive link between green innovation and sustainability performance Asadi *et al*., (2020), more context-specific studies, particularly in developing economies like Kenya are lacking. This study addresses this gap by empirically testing the relationships within the Kenyan manufacturing sector.

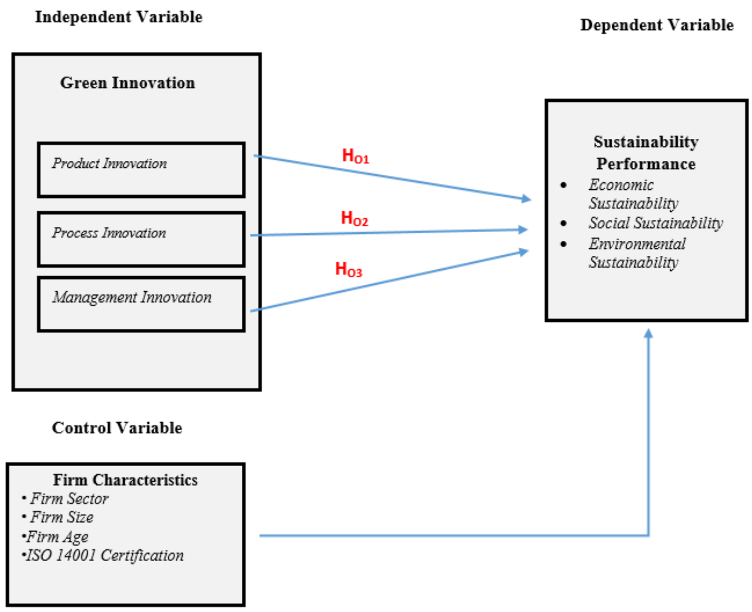

Figure 1: Conceptual Framework of the Study
Source: *Researcher, (2024)*

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METHODOLOGY

Research Philosophy and Approach

The research adopted a **positivist philosophy**, which assumes that social reality can be studied objectively and that knowledge is derived from observable phenomena. This philosophy is suitable for a quantitative study that seeks to establish causal relationships between variables. The study's approach was **deductive**, beginning with established theories (Resource-Based View and Institutional Theory) to formulate specific hypotheses, which were then tested using data collected from the field.

Research Design

The study employed a **descriptive and correlational research design**. This design was appropriate for describing the characteristics of the population and the relationships between the variables. The correlational aspect allowed for an examination of the nature and strength of the relationship between green innovation and sustainability performance, while the descriptive part provided a detailed account of the firm characteristics.

Study Location

The study was conducted in Nairobi County, Kenya. Nairobi county was selected for its significant concentration of manufacturing firms. According to the Kenya Association of Manufacturers (2023), approximately 80% of the country's manufacturing companies are located in this county. This made Nairobi an ideal and accessible setting for the research due to its rich industrial setting.

Target Population and Sampling Design

The **target population** comprised all 1,072 members of the Kenya Association of Manufacturers (KAM) in Nairobi County, as per the 2017/2018 directory. Based on this population, a sample size of 407 was determined using Yamane's (1967) formula. The sampling design involved a combination of stratified and systematic sampling procedures. The population of 1,072 firms was first stratified by sector to ensure a representative sample. Within each stratum, a systematic sampling procedure was used to select 407 managers from 407 firms. The response rate was 86.2%, with a final sample of 351 valid responses.

Data Collection and Measurement

Primary data were collected using a **structured online survey** administered between 23rd September 2024 and 23rd October 2024. The survey questionnaire, developed based on the conceptual framework, measured the study variables using a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Green Innovation was measured using multiple items for its three dimensions: product, process and management innovation. **Product Innovation** entailed (e.g., " Our firm has introduced new products with materials that are easily degradable"), **Process Innovation** (e.g., " Our firm has deliberately redesigned our processes to meet new environmental laws"), and **Management Innovation** (e.g., " Our leaders have frequently communicated with staff on green innovation issues ").

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Sustainability Performance was also measured using multiple items across its economic, social, and environmental dimensions (e.g., " Our firm has been more profitable than our competitors", "Our firm has obeyed the provisions of Public Health Act," and " Our firm has obeyed the environmental laws, e.g. NEMA laws ").

- **Firm Characteristics:** Firm sector, age, size, and ISO 14001 certification were included as control variables and were measured using nominal and ordinal scales.

A pilot study was undertaken on a sample of 43 KAM members in Mavoko constituency, Machakos County, to test the validity and reliability of the data collection tools before the main study.

Ethical Considerations

The research adhered strictly to all ethical guidelines throughout its execution. Prior to data collection, necessary approvals were obtained from the Kenya Association of Manufacturers (KAM), the School of Business at Moi University. A research permit was also issued by the National Commission for Science, Technology, and Innovation (NACOSTI). Participation in the study was entirely voluntary. Informed consent was secured from all respondents, who were clearly briefed on the study's objectives, expected time commitment, and the confidentiality of their responses. The survey was carefully designed to maintain participant anonymity, and all data were handled with the highest level of confidentiality to safeguard the identities of both individuals and their respective organizations. The research process was conducted responsibly, ensuring no harm was caused to any participant or institution involved.

Data Analysis

The data analysis incorporated both descriptive and inferential statistical techniques. Frequency and percentage distributions were used to summarize key firm characteristics, including sector, size, age, and ISO 14001 certification status. Additionally, measures of central tendency and dispersion-specifically the mean, standard deviation and standard error-were computed to assess levels of green innovation and sustainability across the sampled firms.

Data Analysis

The data analysis included the following:

(i). **Descriptive Statistics:** Frequency and percentage distributions were used to summarize firm characteristics (firm sector, size, age, and ISO 14001 certification). Mean, standard error, and standard deviation were calculated for the green innovation and sustainability performance variables.

(ii). **Reliability and Validity Analysis:** Cronbach's Alpha was used to assess the internal consistency of the multi-item scales (Cronbach, 2004)

(iii). **Factor Analysis:** Both Exploratory (EFA) and Confirmatory (CFA) factor analysis were employed to validate the constructs of green innovation and sustainability performance. These techniques helped ensure the reliability and structural integrity of the measurement models used in the study.

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(iv). **Multiple Regression Analysis:** A multiple regression model was employed to examine the predictive power of the independent variables (green innovation dimensions and firm characteristics) on the dependent variable (sustainability performance).

The regression model was specified as follows:

$Y = \beta 0 + (\beta 1X1) + (\beta 2X2) + (\beta 3X3) + (\beta 4X4) + (\beta 5X5) + (\beta 6X6) + (\beta 7X7) + \varepsilon 1$

Where:

Y = Sustainability Performance

X1 = Firm Sector

X2 = Firm Size

X3 = Firm Age

X4 = ISO 14001 Certification

X5 = Product Innovation

X6 = Process Innovation

X7 = Management Innovation

β 0 = Constant

β 1−7 = Regression Coefficients

ε = Error Term

RESULTS/ FINDINGS

Firm Characteristics and Descriptive Statistics

The majority of the firms surveyed (34.8%) were in the "Chemical, Pharmaceuticals, Medical Equipment, Motor Vehicle, Metal & Electronics" sector. Most firms (36.5%) had fewer than 50 employees, and a significant portion (30.8%) were 11-15 years old. Over half of the firms (55.6%) had ISO 14001 certification. The mean scores for green innovation and sustainability performance were 3.813 and 3.870 respectively, on a 5-point Likert scale, indicating a largely positive perception among respondents.

Table 1: Firm Characteristics

Factor	Category	Frequency	Percentage
Firm Sector	Service & Consultancy	12	3.4%
	Mining, Construction, Plastics & Rubber	79	22.5%

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Factor	Category	Frequency	Percentage
	Chemical, Pharmaceuticals, Medical Equipment, Motor Vehicle, Metal & Electronics	122	34.8%
	Food & Fresh Produce	55	15.7%
	Textile, Apparel & Leather	57	16.2%
	Timber, Wood & Paper	26	7.4%
	Total	**351**	**100.00%**
Size	Below 50 Employees	128	36.5%
	50-100 Employees	65	18.5%
	101-150 Employees	54	15.4%
	151-200 Employees	62	17.7%
	Above 200 Employees	42	12.0%
	Total	**351**	**100.00%**
Age	Below 10 yrs	93	26.5%
	11-15 years	108	30.8%
	16-20 yrs	78	22.2%
	Above 20 yrs	72	20.5%
	Total	**351**	**100.00%**
ISO 14001 Certification	Yes	195	55.6%
	No	156	44.4%
	Total	**351**	**100.00%**

Source: *Research Data (2024)*

Reliability and Validity

The **Cronbach's Alpha** for the green innovation scale was 0.623 and for the sustainability performance scale was 0.749. While the former is slightly below the conventional threshold of 0.7, it was still considered acceptable for exploratory research as guided by Pallant (2010), who recommends a value of at least 0.5. The **Kaiser-Meyer-Olkin (KMO)** measure for sustainability performance was 0.740, which is above the recommended value of 0.5, indicating that the data is suitable for factor analysis. The **Bartlett's Test of Sphericity** was also significant ($p<0.001$), supporting the suitability of the data for a factor solution.

Factor Analysis Results

Exploratory Factor Analysis (EFA)

(a). **EFA Results for Sustainability Performance:**

The EFA analysis for the sustainability performance extracted three components with eigenvalues greater than 1: social, environmental and economic. These components together explained **57.5%** of the total variance; with social (24.2%) contributing greatly to the total variance. **Bartlett's Test of Sphericity** produced a Chi-Square value of 3224.020 with 120

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degrees of freedom ($p < .001$). This indicated that the correlation matrix was large enough and suitable for factor analysis. The **Kaiser-Meyer-Olkin (KMO)** Measure of Sampling Adequacy was **0.730.** This indicated good sampling adequacy. The Rotated Component Matrix additionally confirmed that all items loaded noticeably onto their proposed constructs, supporting the hypothesized three-factor structure of sustainability performance. The **Rotated Component Matrix** shows a clear and clean factor structure, with each item loading strongly on a single component, as shown in table 2 below.

Table2: Rotated Component Matrix for Sustainability Performance

Code	Item Description	Component		
		Component 1: Social Performance	Component 2: Environmental Performance	Component 3: Economic Performance
Soc.2	Our firm has provided equal opportunity for all without discrimination	.822		
Soc.7	Our firm has obeyed the provisions of Public Health Act	.816		
Soc.5	Our firm has engaged in fair labour practices	.791		
Soc.6	The social welfare scheme of our employees has greatly improved	.776		
Soc.1	Our firm has considered the interests of all stakeholders in investment decisions	.673		
Soc.8	Work-related accidents & illnesses in our firm has greatly reduced	.653		
Soc.3	Our firm has regularly funded & participated in local CSR activities	.451		
Env.2	Our firm has obeyed the environmental laws, e.g. NEMA laws		.938	
Env.4	Our firm has undertaken regular voluntary measures to restore the environment		.914	
Env.6	Our firm has a policy on environmental conservation		.906	
Env.3	Our firm has conducted periodic environmental impacts audits of its activities		.596	
Econ.4	Our firm has reduced the cost of inputs for similar level of output			.776
Econ.6	Our firm's overall financial performance has improved better than our competitors			.772
Econ.2	Our firm has increased its market share greater than our competitors			.647
Econ.3	Our firm's total sales have gradually improved			.605
Econ.1	Our firm has been more profitable than our competitors			.533

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Code	Item Description	Component		
		Component 1: Social Performance	Component 2: Environmental Performance	Component 3: Economic Performance
	Eigen Values	2.748	1.178	1.136
	% of Variance	24.2	18.8	14.5%
	Cumulative %	24.2%	43.2%	57.5%
	Kaiser-Meyer-Olkin measure of sampling adequacy = 0.730 Bartlett's test for Sphericity: Approx. Chi-Square =3224.020; df =120; Sig<.=.001			
	Extraction Method: *Principal Component Analysis.* ***Rotation Method****: Varimax with Kaiser Normalization.* *Rotation converged in 4 iterations.*			

Note: Factor loadings for items are presented. Loadings below .40 are suppressed for clarity.

Source: *Research Data (2024)*

(b) Exploratory Factor Analysis (EFA) for Green Innovation

The EFA analysis for the green innovation extracted three components: process, product and management innovation. These jointly accounted for **51.47%** of the total variance. This result provides strong empirical support for the study's conceptual framework, which posits that green innovation is a multi-dimensional construct with three distinct components. The **Kaiser-Meyer-Olkin (KMO)** measure was **0.640**, which was above the recommended value of 0.5, indicating that the data was suitable for factor analysis. The **Bartlett's Test of Sphericity** was also highly significant ($p < .001$), supporting the factorization of the correlation matrix. The **Rotated Component Matrix,** highlighted in Table 3 below, shows a clear and clean factor structure, with each item loading strongly on a single component.

Table 3: EFA Report for Green Innovation Scale

Code	Item	Component 1: Product Innovation	Component 2: Management Innovation	Component 3: Process Innovation
PRD4	Our firm has introduced new products with materials that are easily degradable	0.723		
PRD 3	Our products have been made deliberately from safe materials that do not harm the health of consumers	0.662		
PRD 5	Our firm has redesigned its products to meet new health & environmental laws	0.658		

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Code	Item	Component 1: Product Innovation	Component 2: Management Innovation	Component 3: Process Innovation
PRD 2	Our firm has developed new products that consume less materials to produce	0.657		
MG 4	Our leaders have frequently collected & shared information on green innovation		0.768	
MG 5	Our leaders have frequently communicated with staff on green innovation issues		0.745	
MG 3	Our customer service relations management system has greatly improved		0.725	
PRC 5	Our firm has deliberately redesigned our processes to meet new environmental laws			0.829
PRC 3	Our firm has introduced cleaner renewable energy e.g. solar energy			0.703
PRC 1	Our firm has used processes that reduce the emission of hazardous substances			0.428
	Cumulative %	18.45%	36.63%	51.47%
	Kaiser-Meyer-Olkin measure of sampling adequacy = .640 **Bartlett's test for Sphericity**: Approx. Chi-Square =425.266; df =45; Sig<.=.001			
	Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 4 iterations.			

Note: Factor loadings for items are presented. Loadings below .40 are suppressed for clarity.

Source: *Research Data (2024)*

Confirmatory Factor Analysis (CFA)

(a) Confirmatory Factor Analysis (CFA) for Sustainability Performance

A CFA was conducted to further authenticate the EFA validity and reliability results, and to refine the multidimensional structure of the constructs.

The sustainability performance construct had a three-factor structure (Environmental, Social, and Economic Performance) The fit indices results for the model indicated a good fit for the data. The **Root Mean Square Error of Approximation (RMSEA)** was 0.069, falling within

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the recommended maximum threshold of 0.08. The **Standardized Root Mean Square Residual (SRMR)** was 0.069, which also fell below the cut-off value of 0.08. The **Comparative Fit Index (CFI)** and **Tucker-Lewis Index (TLI)** were 0.947 and 0.934 respectively, both exceeding the 0.90 threshold. The chi^2/df ratio was 2.6, which was within the acceptable range of <5.0. These results confirm that the three-dimensional model of sustainability performance provided an excellent fit for the data, validating its use as the dependent variable in the regression analysis.

The green innovation construct also had a three-factor structure (management, process, and product innovation). The results of the model fit indices were robust, suggesting an excellent fit of the data. The **Root Mean Square Error of Approximation (RMSEA)** was 0.016, which is well within the recommended maximum threshold of 0.08. The **Standardized Root Mean Square Residual (SRMR)** was 0.037, also within the 0.08 cut-off. The **Comparative Fit Index (CFI)** and **Tucker-Lewis Index (TLI)** were 0.994 and 0.991 respectively, both exceeding the 0.90 threshold. The chi^2/df ratio was 1.1, which is within the acceptable range of <5.0. These results confirmed that the three-dimensional model of green innovation is a valid and reliable representation of the construct in this study. The results are depicted in the table below

Table 9: Model fit Indices

Construct	Model Fit (CFI/ TLI / RMSEA SRMR/)	Validated Dimensions	Discriminant Validity (HTMT)	Implications
Sustainability Performance	0.947 / 0.934 / 0.069/ 0.069	Economic, Social, Environmental	Low inter-factor correlations	Validated sustainability dimensions; supports theoretical framework and policy relevance
Green Innovation	0.994 / 0.991 / 0.016/0.037	Product, Process, Management Innovation	Low to moderate HTMT ratios	Strong measurement model; applicable in innovation strategy research

Source: *Research Data (2024)*

Regression Analysis

Multiple regression analysis was conducted using the stepwise method in four models to test the hypothesized model. The results of the model analysis are in table 4 below.

Table 4: Multiple Regression Results

		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model	Variable	β	Std. Error	β	t	Sig.	Tolerance	VIF
	(Constant)	3.851	.118		32.767	.000		
	Firm Sector	.000	.020	.001	.012	.990	.987	1.013
	Firm Size	-.010	.018	-.030	-.556	.578	.995	1.005
	Firm Age	-.013	.023	-.029	-.542	.588	.998	1.002

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Model	Variable	Unstandardized Coefficients β	Unstandardized Coefficients Std. Error	Standardized Coefficients β	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
	ISO 14001 Certification	.050	.051	.053	.987	.324	.989	1.011
2	(Constant)	3.037	.176		17.218	.000		
	Firm Sector	-.005	.019	-.013	-.257	.797	.985	1.015
	Firm Size	-.015	.017	-.045	-.878	.381	.993	1.007
	Firm Age	-.007	.022	-.017	-.328	.743	.996	1.004
	ISO 14001 Certification	.058	.048	.062	1.204	.229	.989	1.011
	Product Innovation	.208	.035	.307	5.976	.000	.993	1.007
3	(Constant)	2.892	.219		13.217	.000		
	Firm Sector	-.002	.019	-.005	-.102	.919	.967	1.035
	Firm Size	-.014	.017	-.043	-.838	.402	.992	1.008
	Firm Age	-.007	.022	-.017	-.338	.735	.996	1.004
	ISO 14001 Certification	.058	.048	.062	1.197	.232	.989	1.012
	Product Innovation	.204	.035	.301	5.853	.000	.985	1.015
	Process Innovation	.040	.036	.058	1.121	.263	.973	1.027
4	(Constant)	2.186	.212		10.325	.000		
	Firm Sector	-.011	.017	-.030	-.641	.522	.963	1.038
	Firm Size	-.017	.015	-.054	-1.159	.247	.991	1.009
	Firm Age	.007	.020	.016	.353	.724	.990	1.010
	ISO 14001 Certification	.044	.044	.047	1.010	.313	.987	1.013
	Product Innovation	.177	.032	.262	5.630	.000	.977	1.024
	Process Innovation	-.084	.035	-.123	-2.415	.016	.822	1.216
	Management Innovation	.345	.038	.457	9.043	.000	.827	1.210

Dependent Variable: Sustainability Performance

Source: *Research Data (2024)*

The model summary in table 5 below showed that the entire model explained 27.4% of the variance in sustainability performance ($R^2 = 0.274$, adjusted $R^2 = 0.259$). This suggests that while the included variables were significant in explaining sustainability performance, a substantial portion of the variance remained unexplained by the model. The outcomes of the various components are expounded below:

- **Product Innovation:** The regression coefficient for product innovation was positive and statistically significant ($\beta=0.177$, $p<0.001$), indicating that a one-unit increase in product innovation leads to a 0.177-unit increase in sustainability performance, holding other variables constant. In this regards, H_{01} was rejected.

- **Process Innovation:** Surprisingly, the coefficient for process innovation was negative and statistically significant ($\beta=-0.084$, $p=0.016$). This suggests that process innovation, as measured in this study, may have a negative effect on sustainability performance. This finding requires further investigation. In this regards, H_{02} was rejected.

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- **Management Innovation:** This had the strongest positive and statistically significant effect (β=0.345, p<0.001), suggesting it is the most impactful dimension of green innovation on sustainability performance. Hence, H_{03} was rejected.

- **Control Variables:** The control variables (Firm Sector, Size, Age, and ISO 14001 Certification) were not found to have a statistically significant effect on sustainability performance in the final model.

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	Df1	Df2	Sig. F Change	Durbin-Watson
1	.067[a]	.005	-.007	.46936	.005	.395	4	346	.812	
2	.313[b]	.098	.085	.44746	.093	35.709	1	345	.000	
3	.318[c]	.101	.086	.44729	.003	1.258	1	344	.263	
4	.524[d]	.274	.259	.40252	.173	81.772	1	343	.000	1.734

Source: *Research Data (2024)*

Table 6: Anova Results

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.348	4	.087	.395	.812[b]
	Residual	76.224	346	.220		
	Total	76.572	350			
2	Regression	7.497	5	1.499	7.489	.000[c]
	Residual	69.075	345	.200		
	Total	76.572	350			
3	Regression	7.749	6	1.292	6.455	.000[d]
	Residual	68.823	344	.200		
	Total	76.572	350			
4	Regression	20.998	7	3.000	18.514	.000[e]
	Residual	55.574	343	.162		
	Total	76.572	350			

Source: *Research Data (2024)*

DISCUSSION

The results of this study offer a summary viewpoint on the relationship between green innovation and sustainability performance. The results partially confirm and partially challenge existing literature. The strong positive influence of management innovation and product innovation confirms that firms which prioritize the two areas are in a better position to succeed in their sustainability goals. The unexpected negative relationship between process innovation

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and sustainability performance is a key finding that warrants deeper investigation. This may be attributed to a number of factors specific to the sub Saharan Africa and Kenyan context.

Globally, the results align with the studies of Asadi *et al*., (2020) and Novitasari *et al*., (2022), who also found positive impact of product innovation on firm sustainability performance. Recent meta-analyses and systematic reviews have also reinforced the foundational role of green management practices and corporate social responsibility in driving green innovation (Dzage *et al.,* 2024; Faruque, 2025).

The negative relationship observed for process innovation both contradicts and align with some global and local findings. For example, Nkemjika (2024) also found out that green process innovation had a negative impact on economic sustainability among Multinational companies in South-West Nigeria. On the contrary, Githenduka& Fwaya (2024) found that Green Process Innovation had significant positive impact on sustainability performance on rated hotels in Kenya. One possible explanation for the negative result could be that the costs and complexities associated with implementing new, greener processes in the short term may outweigh the immediate benefits. For example, Liu *et al.,* (2024) and Rennings, (2000) reiterate that environmental regulations are an expensive burden that governments impose on firms, and that firms must invest in unproductive activities to reduce pollution to the environment, which reduces their profitability. Another reason could be that firms have not yet fully optimized these processes. This is supported by recent literature that highlight the challenges faced by firms in developing economies like Kenya, high initial investments, a lack of supportive infrastructure, high costs of new technology, or a focus on short-term economic gains over long-term environmental benefits, as noted in recent literature (Awino, 2025; Musah *et al.,* 2025). Still more, literature highlighted additional barriers such as limited awareness of sustainability standards, weak enforcement of environmental regulations, and insufficient domestic production of natural inputs (e.g., cotton) hinder the adoption of green practices (Awino, 2025; Omamo, 2012).

The results for product and management innovation are comparable to studies in countries like Nigeria and South Africa, where green innovation is seen as a key factor for competitive advantage and sustainability improvement (Nkemjika, 2024).

Here in Kenya, the emphasis that innovation as a significant driver of sustainability performance is consistent with literature of Githenduka& Fwaya, (2025) and Githenduka& Fwaya, (2024). The study concluded that majority of star-rated hotels had embraced green innovation which contributed to sustainability performance in the hospitality industry.

Still more, this study's finding that firm characteristics are not significant predictors of sustainability performance may be a unique outcome, potentially indicating a widespread adoption of sustainability practices regardless of these factors among KAM members (Musah *et al.,* 2025). However, these factors were just control variables. Hence they did not affect the efficacy of the research.

The low R^2 value of the regression model (.274) is also a critical finding. It indicates that a large portion of the variance remains unexplained by the variables included in this study. This opens a gap for future research. Recent studies also point to the importance of institutional quality and innovation networks in promoting green growth in Africa (Teklie & Yağmur, 2024), suggesting that a broader framework may be necessary to fully capture the determinants of sustainability.

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IMPLICATION TO RESEARCH AND PRACTICE

The findings of this study offer valuable insights for managers, policymakers, industry stakeholders and researchers in Kenya and beyond, as outlined below.

Implications to Practice: For business leaders in the Kenyan manufacturing sector, the findings underscore the importance of strategically focusing on management and product innovation to achieve sustainability goals. Also, strengthening regulatory compliance mechanisms could serve as a catalyst for broader adoption of sustainable practices across the sector (Mdasha *et al.,* 2024). However, rather than viewing sustainability as a mere compliance issue, firms should also integrate it into their core strategies by developing new, eco-friendly products and fostering a culture of green management. The unexpected negative finding for process innovation suggests that firms must carefully plan and manage the implementation of new processes to mitigate potential short-term costs and complexities.

Implications to Policy: The study highlights the need for targeted policies and incentives that encourage and support management and product innovation. These appear to be the most effective levers for driving sustainability performance. Therefore, policy makers should create supportive policies and incentives that encourage firms to adopt green innovation, particularly in management and product development.

Implications to Research: The results of this study open several avenues for future research. First, the surprising negative relationship between process innovation and sustainability performance in the Kenyan context requires further investigation to uncover the specific causal factors. Second, the low R^2 value of the regression model points to the need for a more comprehensive model of sustainability performance.

CONCLUSION

The study concludes that green innovation is a significant predictor of sustainability performance in the Kenyan manufacturing sector. Specifically, management innovation and product innovation are crucial drivers. Therefore, firms aiming to enhance their sustainability performance should invest in green innovation, especially product and management innovation. The role of process innovation was, however, inconclusive and needs further investigation. In addition, the study further concludes that other factors not included in the study could influence sustainability outcomes of manufacturing firms in Kenya, needing further investigation.

FUTURE RESEARCH

Future research should explore deeper into the negative relationship between process innovation and sustainability performance to understand the underlying causes. A mixed-methods approach incorporating both qualitative and quantitative data could provide a richer understanding of this phenomenon. Future studies could also expand the research framework to include additional variables such as government support, market conditions, and organizational culture to better explain the variance in sustainability outcomes. Researchers could also explore the role of technology, capital investment, and human resource capabilities

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in the implementation of green processes. This would provide a more holistic understanding of the factors that influence sustainable performance of manufacturing firms in developing economies.

REFERENCES

Asadi, S., Pourhashemi, S. O., Nilashi, M., Abdullah, R., Samad, S., Yadegaridehkordi, E., Aljojo, N., & Razali, N. S. (2020). Investigating influence of Green Innovation on sustainability performance: A case on Malaysian hotel industry. *Journal of Cleaner Production*, *258*, 120860. https://doi.org/10.1016/j.jclepro.2020.120860

Awino, D. (2025). Challenges and opportunities for green transitions adoption in Kenya's textile manufacturing industry. *Frontiers in Sustainability*. https://www.frontiersin.org/articles/10.3389/frsus.2025.1527365/pdf

Kenya Association of Manufacturers, (2023). Association's website

Musah, M., Osei, M. J., Donkor, J., & Obeng, E. (2025). The effect of information and communication technology on environmentally sustainable development in Sub-Saharan Africa: The role of green innovation and industrial structure. *Information Technology for Development*, *41*(1).

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Cronbach, L. J. (2004). My current thoughts on coefficient alpha and successor procedures (CSE Report 643). *Center for Research on Evaluation Standards and Student Testing* (CRESST).

DiMaggio, P. & Powell, W. (2000). 'The Iron Cage Revisited: Isomorphism in Organizational Fields'. *American Sociological Review*. 48. 147-160. 10.2307/2095101.

Dzage, E.J., Hussain, M. R., Dapaah, P. O., & Mustapha Y. (2024). Corporate social responsibility, sustainable environmental practices and green innovation; perspectives from the Ghanaian manufacturing industry *International Journal of Corporate Social Responsibility* 9:4 https://doi.org/10.1186/s40991-024-00090-2

Faruque, B. (2025). Green Organizational Development for Sustainable Organizational Transformation and Improved Environmental Efficiency: A Literature Review-Based Approach. *Journal of Applied Management and Entrepreneurship*, *9*(1). https://www.theseus.fi/bitstream/handle/10024/881900/Faruque_Bushra.pdf

Githenduka, M.W., Fwaya, E.V.O. & Nthenge, A. (2025). The Relationship Between Green Innovation Adoption and Sustainability Performance in Nairobi's Star-Rated Hotels. *African Journal of Hospitality, Tourism and Leisure*, 14(1):171-177. DOI: https://doi.org/10.46222/ajhtl.19770720.597

Githenduka, M. W., & Fwaya, E. V. O. (2024). Exploring the relationship between green innovation adoption and sustainability performance in Nairobi's star-rated hotels. *International Journal of Tourism and Hotel Management, 6*(2), 138–144. https://doi.org/10.22271/27069583.2024.v6.i2b.115

Hariadi, B., et al. (2023). Impact of green practices through green product and service innovation on sustainability performance. *Journal of Industrial and Production Engineering*. https://doi.org/10.1080/19397038.2023.2205873

Hasan, M. B., Verma, R., Sharma, D., & Alaqel, A. (2024). The synergistic effect of corporate social responsibility and ESG disclosure on green innovation: evidence from least developed countries. *Cogent Business & Management*, *11*(1). https://doi.org/10.1080/23311975.2024.2396051

Khan, S.; Rehman, S.&Nasir, A. (2023). Investigating the factors affecting Green Innovation

Liao Y, Qiu X, Wu A, Sun Q, Shen H and Li P (2022). Assessing the Impact of Green Innovation on Corporate Sustainable Development. Front. *Energy Res.* 9:800848. doi: 10.3389/fenrg.2021.800848

Liu, M.; Liu, L.; Feng, A. (2024). The Impact of Green Innovation on Corporate Performance: An Analysis Based on Substantive and Strategic Green Innovations. *Sustainability.*16, 2588. https://doi.org/10.3390/ su16062588

Liu, S., & Yan, M.-R. (2018). Corporate Sustainability and Green Innovation in an Emerging Economy-An Empirical Study in China. *Sustainability*, *10*(11), 3998. https://doi.org/10.3390/su10113998

Mdasha, Z., Kariuki, P., & Wanjohi, P. (2024). Environmental Regulations Compliance and Performance of Large Manufacturing Firms in Kenya. *AJOEI Journal*. https://ajoeijournal.org/sys/index.php/ajoei/article/download/553/667/

Novitasari, Maya, and Zeplin Jiwa Husada Tarigan. (2022). The Role of Green Innovation in the Effect of Corporate Social Responsibility on Firm Performance. *Economies* 10: 117. https://doi.org/ 10.3390/economies10050117

Nzomo, J. K., & Muchemi A. W. (2019). Green innovation strategies, organizational competences and firm's performance in the context of manufacturing sector: A theoretical review. *The Strategic Journal of Business & Change Management, 6 (2), 615 – 639.*

Pallant, J. (2010). *SPSS survival manual: A step by step guide to data analysis using SPSS* (4th ed.). Allen & Unwin.

Omamo, J. O. (2012). Factors Affecting Adoption of Green Technology by Firms in Kenya. *University of Nairobi.* https://erepository.uonbi.ac.ke/handle/11295/8188

Ren, X., & Mia, M. A. (2025). The determinants of green innovations in manufacturing industries: a systematic literature review. *Future Business Journal*, 11(1). https://doi.org/10.1186/s43093-025-00461-6

Rennings, K. (2000). Redefining innovation. Eco-innovation research and the contribution from ecological economics. *Ecol. Econ*., 32, 319–332.

Teklie, D. K., & Yağmur, M. H. (2024). The Role of Green Innovation, Renewable Energy, and Institutional Quality in Promoting Green Growth: Evidence from African Countries. *Sustainability*, *16*(14), 6166. https://doi.org/10.3390/su16146166

Yamane, T. (1967). *Statistics: An introductory analysis* (2nd ed.). Harper & Row.

Yusuf, R. (2020). Effect of Green Distribution on the Performance of Manufacturing Firms in Kenya. IOSR *Journal of Business and Management*. https://www.iosrjournals.org/iosr-jbm/papers/Vol22-issue4/Series-4/A2204040107.pdf

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