Green Operations and Organisational Sustainability in Selected Manufacturing Firms in Akwa Ibom State

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Abstract
Purpose: *This study focused on Green Operation and Organizational Sustainability in selected manufacturing firms, a study of selected Manufacturing firms in Akwa Ibom State. The main objective of this study was to examine the effect of green operations on organizational sustainability in selected manufacturing firms.* ***Methodology:*** *The research adopted a survey design, with a sample size of 139 respondents. Primary data was collected through structured questionnaires,* ***Findings:*** *Multiple regression analysis revealed that environmental responsibility significantly affects organizational sustainability (p = 0.000). Energy efficiency also showed a significant positive effect (p = 0.000). Waste recycling exhibited a positive effect on sustainability (p = 0.231), all less than 0.05 level of significant.* ***Originality/Value:*** *This study concludes that environmental responsibility, energy efficiency and Waste recycling are vital for sustainability, with energy efficiency offering immediate benefits and environmental responsibility as a long-term investment. Waste recycling enhances sustainability through resource efficiency. Recommendations include prioritizing energy efficiency, viewing environmental initiatives as long-term investments, expanding waste recycling programs, and fostering a culture of sustainability through enhanced employee engagement.*

Key Words: *Green Operation, Organizational Sustainability, environmental responsibility, Energy efficiency and Waste recycling.*

1. Introduction

In recent years, the concepts of green operations and organisational sustainability have garnered significant attention in the context of manufacturing firms. The pressing need for environmental consciousness and the collective effort to mitigate the adverse impacts of industrial activities on the environment have led to a growing emphasis on Green operations within manufacturing firms worldwide. Concurrently, the notion of organisational sustainability has become increasingly crucial, reflecting a collective responsibility for the economic, environmental, and social impacts of business practices. Perotti and Colicchia, (2023) describes Green operation as a holistic approach that aims to minimize waste and pollution across the entire operational ecosystem, including production, logistics, and facilities management.

Green operation generally refers to the implementation of sustainable and environmentally-friendly practices within business operations. This can include reducing energy consumption, minimizing waste, using eco-friendly materials, and adopting renewable energy sources to minimize the environmental impact of the organisation's activities. The goal of Green operation is to promote ecologically responsible and resource-efficient processes while maintaining or improving operational effectiveness. It encompasses various aspects such as incorporating

sustainability principles into supply chain management, production processes, service delivery, and facilities management. The concept of Green operation is rooted in the idea of balancing economic goals with environmental stewardship and social responsibility. The literature on this topic has been rich and insightful, with numerous prominent authors contributing exceptionally to the understanding of how organisations can integrate Green operations into their overarching sustainability strategies (Peng, 2024).
Moreover, the implications of Green operations for organisational sustainability have been a subject of comprehensive exploration. Researchers such as Khan and Gupta (2021) highlight the interconnectedness between environmental stewardship and corporate performance, underscoring that proactive ecological strategies can yield cost savings, enhanced brand reputation, and regulatory compliance, thus directly contributing to organisational sustainability.

The manufacturing sector faced critical challenges in achieving Green operations and ensuring organisational sustainability. Balancing environmental responsibility with operational efficiency posed complex issues that demanded strategic solutions to minimise ecological impact while maintaining itscompetitive advantage and long-term viability for manufacturing firms. This was a pressing challenge in integrating Green operations and sustainable practices within the organisational framework. The lack of emphasis on environmental responsibility and sustainability within manufacturing processes has led to significant environmental impact on lack of energy efficiency, lack of waste recycling, lack of regulatory non-compliance and lack of operational inefficiencies (lack of employees involvement). These issues hindered the long-term environmental, economic, and social sustainability of manufacturing firms in the region. Addressing these challenges was crucial for fostering a culture of corporate responsibility and promoting the sustainable development of the manufacturing sector in Akwa Ibom State.

The main objectives of the study was to examine the effect of Green operations on Organisational Sustainability in selected manufacturing firms in AkwaIbom State. The specific objectives include to:

i. Ascertain the effect of Environmental Responsibility on organisational sustainability in manufacturing firm.
ii. Assess the effect of Energy Efficiency on organisational sustainability in manufacturing firms.
iii. Examine the effect of Waste Recycling on organisational sustainability in manufacturing firms.

2 Review of Related Literature

2.1 Concepts of Green Operations

Green operation generally refers to the implementation of sustainable and environmentally-friendly practices within business operations. This can include reducing energy consumption, minimising waste, using eco-friendly materials, and adopting renewable energy sources to minimise the environmental impact of the organisation's activities. The goal of green operations is to promote ecologically responsible and resource-efficient processes while maintaining or improving operational effectiveness. It encompasses various aspects such as incorporating sustainability principles into supply chain management, production processes, service delivery, and facilities management. The concept of green operations is rooted in the idea of balancing economic goals with environmental stewardship and social responsibility.

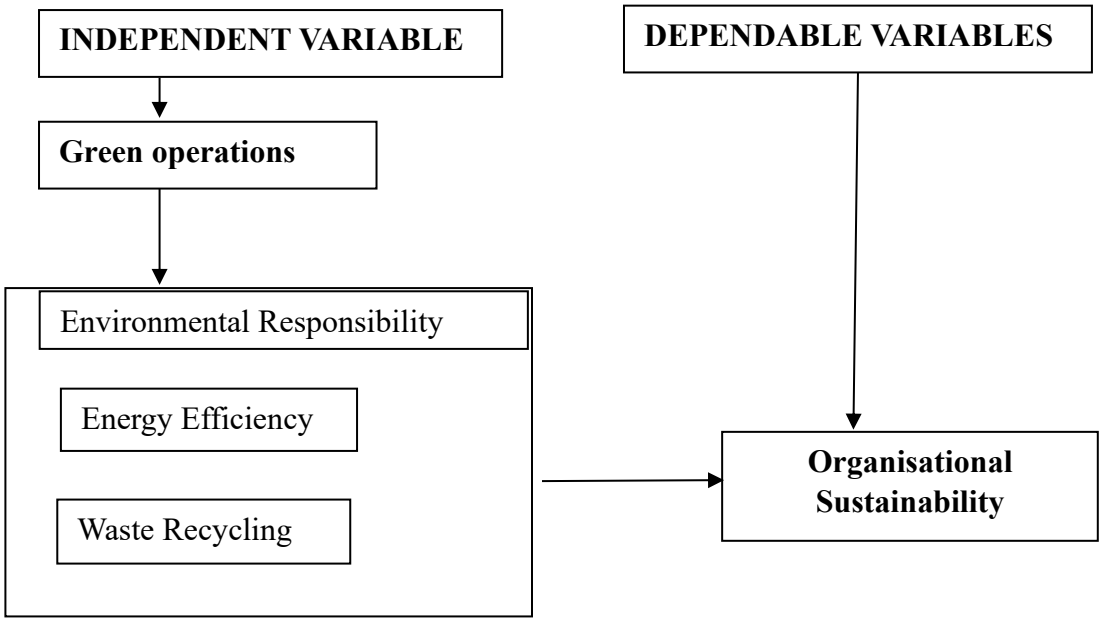

Figure 1: Model of Green operations and Organisational Sustainability

Lazar et al., (2021) explored the integration of sustainability in operations and supply chain management, emphasizing the importance of environmental considerations in decision-making processes. They indeed provided valuable insights into the integration of sustainability in operations and supply chain management.

Dimensions of Green operations

a. **Environmental Responsibility**: Environmental responsibility is a crucial dimension of Green operations, encompassing the commitment of businesses to minimize their ecological footprint and mitigate the impact of their activities on the environment. This entails adopting sustainable practices, reducing waste, conserving resources, and embracing renewable energy solutions to foster environmental stewardship. The Joshua et al, (2025) highlighted the increasing focus on environmental responsibility in the business sector, citing examples of companies that have implemented Green operational strategies to support environmental conservation and sustainability. Environmental responsibility focuses on minimizing the negative environmental effects of manufacturing operations, such as reducing carbon emissions, minimizing waste generation, and preserving natural resources.

b. **Energy efficiency:** Energy efficiency plays a pivotal role in green operations, encompassing the efforts of businesses to optimise energy use, minimise waste, and reduce their carbon footprint. Embracing energy-efficient technologies, implementing sustainable energy management practices, and prioritizing renewable energy sources are instrumental in fostering energy efficiency within organisations. This dimension emphasizes the efficient use of energy within manufacturing processes, including the adoption of renewable energy sources, energy-saving technologies, and proactive measures to reduce energy consumption (Turkova et al., 2023)

c. **Waste Recycling:** This dimension involves implementing strategies to reduce, reuse, and recycle waste materials generated during manufacturing processes, thereby minimizing environmental impact and promoting resource efficiency. Waste recycling

is a cornerstone of sustainable manufacturing and green operations, focusing on the systematic reprocessing of materials to reduce waste, conserve resources, and lower greenhouse gas emissions. Effective waste recycling practices include converting production scraps into reusable raw materials, recycling packaging, and repurposing by-products for other industrial applications (Udom & Ekpouko, 2024)

Organisational Sustainability

The term sustainability can be defined as "the development to meet the current needs of the people effectively without compromising the future needs of the next generations." The commitment to organisational sustainability is very important to develop awareness among employees about environmental issues and motivate employees to face the predictable challenges in a smooth way (Yuan & Li., 2022).

For many organisations, sustainability has become a key concern due to changes in the environment, regulations, and pressure from society toward social and environmental responsibility. Executives have put more emphasis on sustainability, and for many corporations, sustainability became an important part of organisational strategic goals (Uwa , 2022). The sustainability of society involves the business in the context of humans, which focuses on the fair distribution of opportunities among humans and related problems of education, health, income inequality, and level of poverty (Cuesta et al. 2022). The ultimate meaning of sustainability is that the success of any business is measured not just in terms of finance, such as profits and return on investments, but also in terms of social and environmental dimensions (Uwa, 2022).

Dimensions of Organisational Sustainability in Manufacturing Firms

i. **Economic Sustainability:** Economic sustainability focuses on ensuring long-term financial stability while integrating environmentally friendly practices into business operations. Manufacturing firms must adopt strategies that enhance operational efficiency, minimize costs, and maximize profitability while reducing environmental impact (El-Kassar & Singh, 2019).

ii. **Social Sustainability:** Social sustainability involves the fair treatment of employees, community engagement, and adherence to ethical labor practices. Manufacturing firms play a significant role in ensuring employee well-being, workplace safety, and diversity and inclusion in their operations (Sharma et al., 2021). Green operations require employee participation in sustainability initiatives, making training and awareness programs essential. Additionally, firms that actively engage with local communities by supporting environmental and social projects tend to enhance their corporate reputation and brand loyalty (Awan et al., 2022).

iii. **Environmental Sustainability:** Environmental sustainability aims to reduce the negative ecological footprint of manufacturing operations by adopting eco-friendly practices, such as renewable energy usage, pollution control, and waste minimization (Swarnakar et al., 2022). Manufacturing firms that integrate green operations—such as sustainable sourcing, resource conservation, and carbon footprint reduction—contribute to a healthier planet and comply with environmental regulations (Khan et al., 2022).

iv. **Innovation and Technology Adoption:** The integration of advanced technologies such as automation, artificial intelligence, and blockchain into manufacturing processes enhances sustainability efforts by improving resource efficiency and reducing waste (Bag & Pretorius, 2022). Innovations in green manufacturing, such as biodegradable materials and energy-efficient machinery, have enabled firms to align their operations with sustainability goals while maintaining productivity (Fernando et al., 2019).

Research highlights that firms that invest in sustainable technology are more likely to achieve long-term economic and environmental benefits (Dubey et al., 2024).

Green operations and Organisational Sustainability

a. Environmental Responsibility and Organisational Sustainability

Environmental Responsibility and Organisational Sustainability have become increasingly critical considerations for businesses and society as a whole. The approach emphasized the importance of minimising the environmental impact of business operations while simultaneously ensuring the long-term viability and prosperity of the organisation. Ullah et al., (2022) highlight the substantial link between corporate environmental responsibility and enhanced financial performance. The authors underscore how adopting environmentally responsible practices can lead to cost savings, improved resource efficiency, and heightened attractiveness to consumers who value sustainability.

b. Energy efficiency and Organisational Sustainability

Losada et al. (2024) emphasized the critical role of energy management in fostering organisational sustainability. The Study shows how implementing energy efficiency measures can lead to significant cost savings, reduced environmental impact, and improved overall organisational performance. Alzghoul et al., (2024) examine the direct correlation between energy efficiency initiatives and long-term organisational sustainability. The authors draw attention to the positive effects of energy-efficient practices on reducing greenhouse gas emissions, enhancing resource productivity, and ultimately contributing to the overarching sustainability goals of organisations.

c. Waste recycling and Organisational Sustainability

Waste recycling is a fundamental component of green operations, playing a critical role in enhancing organisational sustainability across multiple dimensions. Recycling initiatives reduce the environmental impact of manufacturing operations by minimizing waste sent to landfills, decreasing greenhouse gas emissions, and conserving natural resources (Khan et al., 2022). Additionally, waste recycling generates significant cost savings by recovering valuable materials and reducing the need for raw material procurement, contributing to improved financial performance (Jabbour et al., 2020). Moreover, recycling initiatives actively engage stakeholders, including employees, customers, and local communities, in sustainability efforts, fostering a culture of environmental responsibility and collaboration (Freeman et al., 2020).

2.2 Theoretical Framework

1. Natural Resource Dependency Theory by Lawrence and Charles (1975)

This theory was propounded by Lawrence W. Reed and Charles A. Newsom in 1975. This theory posits that organisations are dependent on natural resources and need to manage these dependencies to ensure long-term sustainability. It emphazed the need for sustainable resource management practices and strategies to reduce reliance on scarce resources.

By adopting green operations and sustainable practices, organisations can mitigate their reliance on finite natural resources, reduce their environmental impact, and contribute to long-term organisational sustainability. This can involve implementing energy-efficient processes, reducing waste and emissions, sourcing materials from sustainable suppliers, and investing in renewable energy sources. Ultimately, by integrating the principles of Natural Resource Dependency Theory into their operations, organisations can contribute to environmental preservation and ensure their own long-term survival and success (Gupta et al., 2021).

2. Triple Bottom Line (TBL) by John Elkington (1994)

This theory was propounded by John Elkington in 1994. The Triple Bottom Line framework expanded the traditional accounting framework of profit to include social and environmental dimensions. It emphasized the need for businesses to consider not only financial gains but also social and environmental impacts, aiming for sustainability across economic, social, and environmental realms.

The concept of the Triple Bottom Line (TBL) is integral to understanding how green operations and organisational sustainability are intertwined. TBL refers to a framework that measures an organisation's performance in three dimensions: social, environmental, and financial. By using this approach, businesses can assess their impact on people, the planet, and profits.

Furthermore, by embracing Green operations and prioritising sustainability, organisations contributed to the social and economic dimensions of the TBL. For example, sustainable practices often led to improved community relations, employee well-being, and long-term profitability.

2.3 Empirical Review

Marfo et al. (2024) examined the effect of green innovations on the environmental performance of the hotel industry in Ghana, focusing on the moderating role of green transformational leadership. The study utilized structural equation modeling to analyze data from 500 hotel staff. Findings indicated that both green innovation and transformational leadership positively and significantly influence environmental performance. Furthermore, green transformational leadership was found to significantly moderate the relationship between green innovation and environmental performance, highlighting leadership's crucial role in promoting sustainability.

Goni et al. (2023) investigated the impact of green innovation on environmental and organizational performance, with a focus on the moderating effects of human resource practices and management commitment. The study surveyed 320 employees from Pakistan's textile industry using a self-administered questionnaire. Employing structural equation modeling, the research revealed that both product and process innovations positively and significantly affect green innovation. In turn, green innovation significantly enhances environmental and organizational performance. Notably, while human resource practices did not show a significant moderating effect, management commitment positively moderated the relationship between green innovation and organizational performance.

Ameer et al. (2024) explored the relationship between organizational resilience, green innovation, and environmental performance in a study published in the Asia-Pacific Journal of Management Research and Innovation. The research highlighted that sustainable development goals have brought environmental performance into the global policy limelight. The study emphasized the importance of green innovation in enhancing environmental performance and suggested that organizational resilience plays a pivotal role in this relationship. Using a survey-based approach, the study collected data from **412 firms** across various industries, analyzing the relationship through Structural Equation Modeling (SEM). The results confirmed that organizational resilience significantly strengthens the impact of green innovation on environmental performance.

3. METHODOLOGY

3.1 Research Design

The research design adopted for this study was survey design, the population of these three manufacturing firms comprised 213 staff.

Table 1: Population Table

	Selected Manufacturing Companies	Population
1	Aquacare Premium water ltd	87
2	Panar Tissue Paper Company	76
3	Jubilee Stringe Industries	50
	Total	**213**

Source: Data from Field Survey, 2023

3.4 Sample Size Determination

In determining the samples size, Taro Yamane's formula was used.

$$n = \frac{N}{1+ N (e)^2}$$

Where; n = Samples Size
N = Population
e = level of significance

From the formula above, the sample size of this study is computed as:

$$n = \frac{213}{1+213 (0.05)^2}$$

$$n = \frac{213}{1+ 213 (0.0025)}$$

$$= \frac{213}{1.53} = 139.2$$

Therefore, the sample size of this study stood at 139, Stratified sampling techniques was used. For copies of questionnaire to be proportionally allotted to different cadre of employees in the study organisations, Bowley's formular for proportionate representation was used as follows:

$$nh = \frac{nNH}{N}$$

Where: n = sample size
NH = population of a strata
N = population

Therefore;

$$nh = \frac{139 \times 87}{213} = \frac{12,093}{213} = 57$$

$$nh = \frac{139 \times 76}{213} = \frac{10,564}{213} = 49$$

$$nh = \frac{139 \times 50}{213} = \frac{6,950}{213} = 33$$

$$nh = 57 + 49 + 33 = 139$$

Table 2: Sample Size Table

S/N	Selected Manufacturing Companies	Population	Sample Size
1	Aquacare Premium water ltd. Uyo	87	57
2	Panar Tissue Paper CompanyIkotEkpene	76	49
3	Jubilee Syringe Industries, Eket	50	33
	Total	**213**	**139**

Source: Data from Field Survey, 2024

Using strata sampling, the sample size of the study still stands 139 respondents of the three selected manufacturing firms in AkwaIbom State.

The research employed Primary data were first time information obtained through the questionnaire that was administered to the respondents. Instrument for data collection was a structured questionnaire. The stratified sampling technique was employed in the administration of the research instrument for data collection. The reliability of the instrument was ascertained using the internal consistency method and test re-test method. After the return of the questionnaire by the respondents, the data were coded and analyzed using the Statistical Package for Social Science (SPSS) with interpretation made using frequency tables and percentages. In this case, the multiple regression analysis was used in measuring the extent to which Green operations in the selected manufacturing firms in Akwa Ibom State influenced Organisational Sustainability and the dependable variables.
To achieve the stated objectives of the study, as well as testing the study hypotheses, a multiple regression model was adopted as follows;

$$\boldsymbol{Y = \beta o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \mu \ldots\ldots \text{ eqn 1.}}$$

Where;
Y = Organisational Sustainability (dependent variable)
X = Green operations (explanatory/independent variable)
Explicitly, the equation was defined as:
Organisational Sustainability $= f$ (Green operations) + μ
Therefore, the broad model for this study was modified as;

$$\text{ORGS} = \boldsymbol{\beta_0 + \beta_1 ER + \beta_2 EE + \beta_3 WR + \beta_4 EI + \beta_5 RC + \mu \ldots\ldots\ldots \text{eqn 2.}}$$

Where; ORGS = Organisational Sustainability, ER = Environmental, Responsibility, EE = Energy Efficiency, WR = Waste Recycling, EI = Employee Involvement, RC = Regulatory Compliance, β_0 = Intercept or regression constant, $\beta_1, \beta_2 \beta_3$ = Regression coefficients, μ = Stochastic error term, The generally expected criterion for decisions is that H_O (null hypothesis) will be accepted if the P-value is greater than 5% significant level and to be rejected where the P-value is less than the 5% significant level, i.e., where P is greater than 5% we accept null hypothesis and where P is less than 5%, we reject null hypothesis and Alternative hypothesis will emerge.

4. DATA PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

4.1 *Data presentation*

The questionnaires were administered to the respondents identified and the summary was shown in table 3 below illustrates that out of the total respondents from three selected manufacturing firms in AkwaIbom State, 57 questionnaires, comprising 41%, were administered to Aquacare Premium Water Ltd. in Uyo, 49 questionnaires, representing 35%, were distributed to Panar Tissue Paper Company in IkotEkpene, and 33 questionnaires, making up 24%, were directed to Jubilee Syringe Industries in Eket. This adds up to a complete return of 139 questionnaires.

Table 3: Summary of questionnaire administered

Firms	Questionnaire Administered	Questionnaire Returned	Percentage (%)
Aquacare Premium water ltd. Uyo	57	57	41
Panar Tissue Paper Company IkotEkpene	49	49	35
Jubilee Syringe Industries, Eket	33	33	24
Total	139	139	100

Source: *Field Survey Data (2024)*

Data Analysis of respondents' responses

Table 4: Percentage analysis of respondents' responses regarding Environmental Responsibility and organizational sustainability

Questions	Agreed	Strongly Agreed	Disagreed	Strongly disagreed	Undecided	Total
Environmental Responsibility has effect on organizational sustainability in manufacturing firms	74 (52.8%)	29 (21.8%)	23 (16.2%)	8 (5.6%)	5 (3.5%)	139 (100%)
Do you believe that integrating environmental responsibility practices is essential for ensuring long-term organizational sustainability?	67 (48.6%)	38 (27.5%)	21 (14.8%)	6 (4.2%)	7 (4.9%)	139 (100%)
Do you agree that environmental responsibility initiatives positively impact organizational sustainability?	49 (35.2%)	40 (29.6%)	17 (12.0%)	5 (3.5%)	28 (19.7%)	139 (100%)

Source: *Field survey Data (2024)*

Table 4 above shows that; 74 respondents representing 52.8% of the respondents agreed that Environmental Responsibility has effect on organizational sustainability in manufacturing firms, 29 respondents representing 21.8% Strongly agreed, 23 respondents representing 16.2% were Disagreed, 8 respondents representing 5.6% Strongly disagreed while 5 respondents representing 3.5% Undecided.

Similarly, 67 respondents representing 48.6% of them also agreed to the assertion that integrating environmental responsibility practices is essential for ensuring long-term organizational sustainability, 38 respondents representing 27.5% Strongly agreed, 21 respondents representing 14.8% were Disagreed, 6 respondents representing 4.2% Strongly disagreed while 7 respondents representing 4.9% Undecided.

Equally, 49 respondents representing 35.2% of them also agreed to the assertion that environmental responsibility initiatives positively impact organizational sustainability, 40 respondents representing 29.6% Strongly agreed, 17 respondents representing 12.0% were Disagreed, 5 respondents representing 3.5% Strongly disagreed while 28 respondents representing 19.7% Undecided.

Table 5: Percentage analysis of respondents' responses regarding Energy Efficiency and organizational sustainability

Questions	Agreed	Strongly Agreed	Disagreed	Strongly disagreed	Undecided	Total
Energy Efficiency has effect on organizational sustainability in manufacturing firms	64 (45.8%)	57 (41.5%)	12 (8.5%)	0 (0%)	6 (4.2%)	139 (100%)
Do you strongly agree that investing in energy-efficient technologies and practices is essential for ensuring long-term organizational sustainability?	60 (43.0%)	44 (31.7%)	15 (10.6%)	4 (2.8%)	17 (12.0%)	139 (100%)
Energy efficiency initiatives have minimal influence on the overall sustainability objectives of organizations.	64 (45.8%)	38 (28.2%)	25 (17.6%)	8 (5.6%)	4 (2.8%)	139 (100%)

Source: *Field survey Data (2024)*

Table 5 above shows that; 64 respondents representing 45.8% of the respondents agreed that Energy Efficiency has effect on organizational sustainability in manufacturing firms, 57 respondents representing 41.5% Strongly agreed, 12 respondents representing 8.5% were Disagreed, 0 respondents representing 0% Strongly disagreed while 6 respondents representing 4.2% Undecided.

Similarly, 60 respondents representing 43.0% of them also agreed that investing in energy-efficient technologies and practices is essential for ensuring long-term organizational sustainability, 44 respondents representing 31.7% Strongly agreed, 15 respondents representing 10.6% were Disagreed, 4 respondents representing 2.8 % Strongly disagreed while 17 respondents representing 12.0% Undecided.

Equally, 64 respondents representing 45.8% of them also agreed that Energy efficiency initiatives have minimal influence on the overall sustainability objectives of organizations, 38 respondents representing 28.2% Strongly agreed, 25 respondents representing 17.6% were Disagreed, 8 respondents representing 5.6% Strongly disagreed while 4 respondents representing 2.8% Undecided.

Table 6: Percentage analysis of respondents' responses regarding Waste Recycling and organisational sustainability

Questions	Agreed	Strongly Agreed	Disagreed	Strongly disagreed	Undecided	Total
Waste Recycling has effect on organisational sustainability in manufacturing firms.	56 (40.8%)	39 (28.2%)	25 (17.6%)	8 (5.6%)	11 (7.7%)	139 (100%)
Waste recycling efforts have minimal impact on the overall sustainability goals of organisations?	59 (43.0%)	70 (50.0%)	2 (1.4%)	0 (0%)	8 (5.6%)	139 (100%)
Effective waste recycling programs contribute significantly to reducing environmental impact and promoting long-term organisational sustainability?	62 (45.1%)	61 (43.7%)	5 (3.5%)	0 (0%)	11 (7.7%)	139 (100%)

Source: *Field survey Data (2024)*

Table 6 above shows that; 56 respondents representing40.8% of the respondents agreed that Waste Recycling has no effect on organisational sustainability in manufacturing firms, 39respondents representing28.2% Strongly agreed, 25 respondents representing 17.6% were Disagreed, 8 respondents representing 5.6% Strongly disagreed while 11 respondents representing 7.7% Undecided.

Similarly, 59 respondents representing 43.0% of them also agreed that waste recycling efforts have minimal impact on the overall sustainability goals of organisations, 70 respondents representing 50.0% Strongly agreed, 2 respondents representing 1.4% were Disagreed, 0 respondents representing 0% Strongly disagreed while 8 respondents representing 5.6% Undecided.

Equally, 62 respondents representing 45.2% of them also agreed that effective waste recycling programs contribute significantly to reducing environmental impact and promoting long-term organisational sustainability, 61 respondents representing 43.7% Strongly agreed, 5 respondents representing 3.5% were Disagreed, 0 respondents representing 0% Strongly disagreed while 11 respondents representing 7.7% Undecided.

Descriptive statistics of variables

The descriptive statistics analysis was conducted on each of the dependent and independent variables in the study. The independent variables were Environmental Responsibility, Energy Efficiency, Waste Recycling, Employee Involvement and Regulatory Compliance while the dependent variable was organisational sustainability. The descriptive statistics result is as presented in table 4.2d below;

Table 7: Descriptive Statistics of variables

Variables	N	Mean	Std. Deviation	Skewness	Kurtosis
Environmental_Responsibility	139	6.1295	2.58152	.668	.023
Energy_Efficiency	139	5.7554	1.90286	.562	-.238
Waste_Recycling	139	5.7194	2.48773	1.403	1.717

Source: *Researcher's computation (2024)*

Table 7 shows that for the independent variables- Environmental Responsibility, Energy Efficiency, Waste Recycling, Employee Involvement and Regulatory Compliance, the mean values obtained for all the responses were 6.1295,5.7554, 5.7194, 5.5036 and 6.2086 respectively. This shows the average scores of all the responses regarding these variables. Furthermore, variability of the distribution, these variables were obtained from the standard deviation values of 2.58152, 1.90286 and 2.48773, respectively. This indicates high variability in the scores of the responses regarding these variables.
Furthermore, the distribution for these variables- Environmental Responsibility, Energy Efficiency and Waste Recycling, were shown to be positively skewed to the left with a skewness value of 0.668, 0.562 and 1.403 respectively. The kurtosis values were also obtained for Environmental Responsibility, Energy Efficiency, Waste Recycling, as 0.023, -0.238 and 1.717indicating that these variables were platykurtic.

Model evaluation

Table 8: Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.523[a]	.274	.247	.81504	2.393
a. Predictors: (Constant), Regulatory_compliance, Waste_Recycling, Energy_Efficiency, Employee_Involvement, Environmental_Responsibilty					
b. Dependent Variable: Organisational_Sustainability					

Source: *Researcher's computation (2024)*

The results in table 8 above reveals an Adjusted R-squared of 0.274. This implies that the independent variables- Environmental Responsibility, Energy Efficiency, Waste Recycling, Employee Involvementand Regulatory Compliance jointly accounts for approximately 27.4% of the variations in the dependent variable- Organisational_Sustainability. While other variables not included in the model accounts for approximately 72.6% of the variations.

Analysis of variance

Table 9: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	33.332	5	6.666	10.035	.000[b]
	Residual	88.351	133	.664		
	Total	121.683	138			
a. Dependent Variable: Organisational_Sustainability						
b. Predictors: (Constant), Environmental_Responsibilty, Energy_Efficiency and Waste_Recycling,						

Source: *Researcher's computation (2024)*

The results in table 9 shows the calculated F-statistic of 10.035 to the critical value obtained from the F-distribution with 5 and 133 degrees of freedom, which is approximately 2.461 at a significance level of 0.05. Since the calculated F-value exceeds the critical value and the p-value is very low ($p < .0001$), we conclude that there is sufficient evidence to reject the null hypothesis. Therefore, we can infer that the regression model, which includes predictors such as Waste_Recycling, Energy_Efficiency, and Environmental Responsibility, is statistically significant in explaining the variability in the dependent variable, Organisational_Sustainability.

Test of hypotheses

This analysis was conducted to test the relationship between the dependent variables and the independent variable in this study. In line with this, each hypothesis was tested based on the regression results obtained.

Table 10: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.232	.262		4.705	.000
	Environmental_Responsibilty	-.139	.030	-.381	-4.577	.000
	Energy_Efficiency	.265	.041	.537	6.488	.000
	Waste_Recycling	.321	.125	.291	2.574	.011

a. Dependent Variable: Organisational_Sustainability

Source: *Researcher's computation (2024)*

The T-statistics and p-values revealed in table 10 above were employed in the test of hypotheses stated in the previous section at 5% significance level.

Hypothesis one

H_1: Environmental responsibility has significant effect on organisational sustainability in manufacturing firms

The p-value for Environmental Responsibility is 0.000, which is less than 0.05. Therefore, we reject the null hypothesis for Environmental Responsibility. Therefore, based on this analysis, there is a statistically significant effect of environmental responsibility on organisational sustainability.

Hypothesis two

H_2: Energy Efficiencyhas effect on organisational sustainability in manufacturing firms

Since the p-value for Energy Efficiency is 0.000, which is less than the significance level of 0.05, we reject the null hypothesis. Therefore, based on this analysis, there is a statistically significant positive effect of Energy Efficiency on Organisational Sustainability.

Hypothesis three

H_A: Waste recycling has a significant positive effect on Organisational Sustainability ($\beta = 0.291$, $t = 2.574$, $p = 0.011$). Therefore, the null hypothesis, which states that waste recycling has no significant effect on organisational sustainability, is rejected in favor of the alternative hypothesis, stating that, waste recycling has a positive effect on organisational sustainability.

4.3 Discussion of findings

i. Environmental Responsibility and Organisational Sustainability:

The analysis reveals a significant negative effect of Environmental Responsibility on Organisational Sustainability. The coefficient (B) for Environmental Responsibility is -0.139, with a t-value of -4.603 and a p-value of 0.000, which is well below the significance level of 0.05. This suggests that as Environmental Responsibility increases by one-unit, Organisational Sustainability decreases by 0.139 units, holding Energy Efficiency constant.

This finding is counterintuitive, as it might be expected that higher environmental responsibility would enhance organisational sustainability. However, several possible explanations could account for this result. For instance, the costs associated with implementing environmentally responsible practices might outweigh the immediate benefits, leading to short-term reductions in overall sustainability. Organisations may face higher operational costs, reduced efficiency, or lower profitability as they invest in green technologies or adhere to stricter environmental regulations. Additionally, the negative impact could reflect a transitional phase where the benefits of environmental responsibility are not yet realized in the short term. Research by Joshua et al., (2025) highlights that the financial burden of sustainability initiatives can strain resources, especially in the early stages of implementation.

ii. Energy Efficiency and Organisational Sustainability

Conversely, the analysis shows a significant positive effect of Energy Efficiency on Organisational Sustainability. The coefficient (B) for Energy Efficiency is 0.265, with a t-value of 6.488 and a p-value of 0.000, also below the significance level of 0.05. This indicates that for each one-unit increase in Energy Efficiency, Organisational Sustainability increases by 0.265 units, holding Environmental Responsibility constant.

This result aligns with expectations, as energy-efficient practices typically lead to cost savings, improved operational efficiency, and reduced environmental impact. By lowering energy consumption, organisations can decrease their utility costs and carbon footprint, contributing to both financial and environmental sustainability. The positive effect of Energy Efficiency on Organisational Sustainability underscores the importance of adopting energy-efficient technologies and practices as a strategic priority for organisations aiming to enhance their sustainability performance. Studies such as those by Pham et al. (2021) have shown consistent evidence that energy efficiency is a critical driver of improved sustainability outcomes in various industries.

iii. Waste Recycling and Organisational Sustainability

The analysis revealed that waste recycling has a significant positive effect on organisational sustainability ($\beta = 0.291$, $p = 0.011$). This finding suggests that waste recycling initiatives contribute meaningfully to the sustainability of manufacturing firms. Waste recycling reduces environmental footprint and promotes resource efficiency, which are critical components of sustainable practices. This result aligns with the study by Udobia, (2023), which found that waste management practices significantly enhance corporate sustainability performance in manufacturing industries. However, unlike Okon (2024), who noted that the integration of advanced recycling technologies was essential for maximizing sustainability benefits, this study did not delve into the technological aspects of waste recycling. Future research should explore how specific technologies in waste recycling can further enhance sustainability outcomes.

Overall Implications and Identified Gap

The contrasting effects of Environmental Responsibility, Energy Efficiency and waste recycling, on Organisational Sustainability highlight the complexity of sustainability efforts within organisations. While energy efficiency improvements seem to provide immediate and clear benefits to organisational sustainability, the pathway for environmental responsibility

appears more nuanced and may require a longer-term perspective to fully realize its potential benefits. Organisations should consider these dynamics when designing and implementing their sustainability strategies, balancing the need for immediate gains in energy efficiency with longer-term investments in environmental responsibility that may pay off in future sustainability performance. Research by Putra (2024) emphasizes that a balanced approach, integrating both short-term and long-term sustainability initiatives, is crucial for achieving comprehensive sustainability goals.

5 CONCLUSION

This study examined the impact of various Green operation practices on organisational sustainability within selected manufacturing firms. Specifically, it focused on environmental responsibility, energy efficiency, waste recycling, employee involvement, and regulatory compliance.

The multiple regression analysis shows that p-value for Environmental Responsibility is 0.000, which is less than 0.05 revealing that Environmental responsibility had significant negative effect on organizational sustainability, suggesting that increase effort may incur short-term costs that potentially decrease sustainability.

Since the p-value for Energy Efficiency is 0.000, which is less than the significance level of 0.05, Energy Efficiency demonstrated a significant positive effect on sustainability indicating that improvements will contribute positively to sustainability outcomes.

Waste Recyclingwas was $p = 0.011$ identified as a significant positive contributor to sustainability enhancing environmental performance.

This study concludes that energy efficiency and regulatory compliance are crucial for organizational sustainability. While energy efficiency provides immediate benefits, environmental responsibility, despite its initial costs, is a long-term investment. Waste recycling enhances sustainability by improving resource efficiency, whereas the role of employee involvement requires further exploration. The recommendations suggest that manufacturing firms should invest in energy-efficient technologies, integrate environmental responsibility strategically, and enhance waste recycling initiatives. Future research should examine the long-term effects of environmental responsibility, explore the indirect impact of employee involvement, and investigate the role of advanced technologies in waste management. The study contributes to knowledge by highlighting the distinct impacts of sustainability practices and emphasizing a strategic approach rather than assuming uniform benefits across all initiatives.

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