



Effect of Green Logistics on the Organizational Sustainability of Manufacturing Firms in South-East Nigeria

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Abstract

The study examines the effect of Green Logistics on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria. The Researcher adopted a survey research design for the study. A structured questionnaire design with a 5-point Likert scale is used to collect primary data for the study. The data are analyzed using SPSS 28.0. The results reveal that Energy-efficient transportation has a significant effect on Organizational Sustainability as well as Sustainable packaging has a significant effect on the Organizational Sustainability. The study concludes that Green Logistics has a significant positive effect on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria. It also recommends that Manufacturing firms should prioritize the adoption of delivery routes through advanced logistics technology.

Keywords: Green Logistics, Manufacturing, Organizational Sustainability, delivery routes, logistics technology.

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I. Introduction

Green logistics which can be viewed as integrating the environmentally sustainable practices into logistics and supply chain management to minimize the ecological footprint of transportation, warehousing, packaging, and distribution activities is a topic of great interest. As global awareness of environmental issues grows, companies are increasingly adopting green logistics to address the environmental impacts associated with traditional logistics operations, which often contribute to high emissions, resource consumption, and waste. Green logistics practices include optimizing fuel efficiency, using eco-friendly packaging materials, reducing waste, adopting energy-efficient technologies, and implementing reverse logistics to recycle and reuse materials. The goal of green logistics is to create a sustainable balance between operational efficiency and environmental responsibility, aiming to reduce carbon footprints while maintaining or enhancing service quality and economic viability. This approach not only meets the expectations of eco-conscious consumers and regulatory standards but also offers companies potential cost savings through energy conservation and improved resource utilization. By integrating green logistics, organizations can proactively engage in environmental stewardship, building resilience and gaining competitive advantages in a marketplace that increasingly values sustainability.

Green logistics has become a cornerstone for achieving organizational sustainability, as companies worldwide seek to balance economic growth with environmental and social responsibilities, especially within the manufacturing sector, which is often a major contributor to environmental impacts due to its resource-intensive processes. As firms face increasing pressure from stakeholders and regulatory bodies to adopt eco-friendly practices, green logistics offers a pathway to reduce carbon footprints, improve resource efficiency, and manage waste effectively. This shift not only supports environmental stewardship but also aligns with long-term economic goals.

In Southeast Nigeria, where manufacturing firms play a critical role in economic development, there is an increasing need to adopt sustainable practices that reduce environmental degradation and optimize resource use. The report of the International Transport Forum (2019), shows that by 2050, the need for the transportation

of products would have tripled. For this reason, "greening" logistics is seriously required for making transportation and logistics processes more ecologically friendly, in order to combat growing demand and stop pollution and climate change. It is expected that by adopting green logistics, manufacturing firms in Southeast Nigeria can not only mitigate adverse ecological impacts but also gain competitive advantages, such as enhanced brand reputation, regulatory compliance, and operational efficiency.

This study attempts to address how green logistics initiatives can contribute to the organizational sustainability of manufacturing firms in this region by examining the interconnected benefits of environmental responsibility, cost management, and long-term economic viability.

1.1 Statement of the problem

Manufacturing firms in Southeast Nigeria face increasing pressure to align their operations with global sustainability standards, particularly in logistics, which is one of the most resource-intensive and environmentally impactful components of the supply chain. Despite the potential of green logistics to reduce environmental degradation, lower operational costs, and enhance reputational value, many firms in the region have been slow to adopt sustainable logistics practices, due to high implementation costs, limited regulatory incentives, lack of awareness, and infrastructure challenges. This study seeks to address this gap by examining how green logistics practices impact the organizational sustainability of manufacturing firms in Southeast Nigeria.

In doing this, the study tends to:

Examines the effect of energy-efficient transportation on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria, and

Evaluates the effect of sustainable packaging on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria.

II. Review of Related Literature

2.1 Conceptual Review

2.1.1 Green Logistics

The term "green logistics" (GL) is defined as practices and strategies related to supply chain management that can reduce the environmental and energy imprint of freight distribution. Nowakowska-Grunt, (2008), asserted that GL emphasizes handling of material, management of waste, as well as packaging and transport. Generally, Green logistics consists of all activities related to the eco-efficient management of the forward and reverse flows of products and information between the point of origin and the point of consumption whose purpose is to meet or exceed customer demand. From a sustainable development point of view, Sibih&Eglese (2009) define green logistics as production and distribution of goods sustainably, taking account of environmental and social factors, green logistics activities include measuring the ecological impact of different distribution strategies, reducing the energy usage in logistics activities, reducing waste and managing its treatment. Green logistics can be regarded as efforts to examine ways of reducing these external factors and achieving a more sustainable balance between environmental, economic, and social objectives.

The practices of GL involve adopting energy-efficient technologies, optimising transportation routes, reducing waste and emissions, promoting recycling and reuse, and implementing environmentally friendly packaging and storage solutions (Potter and Robert, 2024). In any logistics system, transportation is an operation that can contribute most in terms of negative environmental impact (Wu and Dunn, 1995). Pazirandeh and Jafari (2013) asserted that most firms with concerns about sustainability in their strategic plans concentrate on greening their transportation. All efforts in the "green" logistics area are therefore focused on contributing to ensuring sustainability. Two reasons compel companies to green their logistics services. One is marketing demand and the second is environmental concern. These days most consumers prefer green products to purchase and even they are conscious of every kind of activity in the chain and wish it should be green so that this planet will become safer to live a longer life, (Kumar, 2015). A study conducted by Alan, McKinnon (2010), regarding the key drivers for green logistics, found that managing good relations is the major factor while developing alternative networks is the least factor for the adoption of green logistics by the companies. Based on the reduction targets and logistics requirements of nearly 2,800 of the top firms worldwide across various industries, it is estimated that the demand for green logistics in 2025 will amount to almost \$50 billion, or roughly 2 percent of the total logistics expenditure. It projects that by 2030, this demand would have grown to almost \$350 billion, or 15% of global logistics expenditures (Bertele, Pacca, and Weber, 2024).

2.1.2 Energy-efficient transportation

Energy efficiency in transportation is an important issue among an array of other issues related to transport policies. According to the report of Statista Research Department, (2025), transportation is now noted to be the second-largest source of global greenhouse gas emissions, with mobility

from land, air, and sea pumping out more than eight billion metric tons of carbon dioxide equivalent (GtCO₂ e) into the atmosphere each year. Emissions from this sector have nearly doubled since 1990 and are expected to continue rising in the coming years unless effective policy measures are implemented. Reaching long-term energy efficiency and CO₂ reduction goals in the transport sector requires a transition at the system level from the present environmentally non-sustainable situation to a future, more inherently sustainable situation (Su, Wang, Cao and Yin, 2020). A blueprint for that future system, however, does not exist. Energy-efficient transportation systems, therefore, represent a vital mechanism for reducing environmental degradation while meeting mobility demands. Studies emphasize that improving energy efficiency in transportation can significantly decrease fuel consumption and emissions. Moomaw, Burgherr, Heath, Lenzen, Nyboer and Verbruggen, (2011) suggest that transitioning to energy-efficient vehicles and infrastructure could reduce global GHG emissions by up to 20% by 2050.

Not only do Energy Efficiency measures reduce fuel consumption, they also help tackle other transport-related problems. Organizing and operating urban transport efficiently reduces costs (for energy), and also lowers congestion, noise emissions, local air pollution, accident risks, and global greenhouse gas emissions. López&Monzón (2011) observed that there is potential to achieve greater Energy Efficiency for individual vehicles (vehicle efficiency) and trips (travel efficiency), as well as the whole transport system (system efficiency). Energy-efficient transportation faces numerous barriers such as high costs of new technologies which constitutes significant hurdles (Barrett, Holguin-Veras and Kallaios, 2022). Additionally, consumer adoption of energy-efficient vehicles is often slow due to concerns over performance and limited charging infrastructure (Hardman, Chandan, Tal and Turrentine, 2017). Energy-efficient transportation is an essential component of sustainable development, offering economic, environmental, and societal benefits. While challenges such as high costs and infrastructural limitations persist, innovations in electrification, smart systems, and alternative fuels show promise. A combination of strong policies, public awareness, and technological advancements will be critical to achieving the global transition toward energy-efficient transportation systems.

2.1.3 Sustainable packaging

Sustainable packaging is a relatively new concept that has attracted much attention in recent years. Indeed, it is a key issue to be considered to fulfill the Sustainable Development Goals. Sustainable packaging incorporates materials and designs aimed at reducing environmental harm throughout its life cycle. It adheres to the principles of the circular economy, emphasizing recyclability, reusability, and material biodegradability. Green packaging, also known as eco-friendly packaging or sustainable packaging, is an emerging area of interest for scholars, researchers, and practitioners around the world. Marques, de Paula and Soares (2022) highlight that sustainable packaging is not just about minimizing resource consumption but also about maintaining product safety and quality, contributing to waste reduction, and reducing the ecological footprint of companies. They advocate for a framework that aligns packaging design with sustainability at all life-cycle stages.

Packaging is one of the activities in the logistics system which can be viewed as the technology of enclosing or protecting products for distribution, sale, storage, and use. Packaging also refers to the process of design, evaluation, and of packages. Both products' loaded packages and logistics packages consume a large amount of resources and produce large amounts of solid waste. Thus, the impact of packaging on the environment is very large. Therefore, green packaging which can also be called ecological package or environmentally friendly package has been offered in green logistics. Eco friendly packaging is produced from sustainable materials that degrade rapidly and do not harm the environment (Honeycutt, 2022). Zhang and Zhao (2012) define a green package as an environmentally friendly package that natural plants make and that can be recycled or degraded, reused, and does not harm humans and pollute the environment during the product life cycle. Packaging is under intense public scrutiny and is regarded as a source of waste and pollution. Therefore, packaging producers are increasingly required to make packaging more sustainable. Most guidelines on packaging sustainability agree on a general definition of sustainable packaging. It has to provide optimal product protection, be safe for human health, and be cyclic while having the smallest possible ecological footprint, Pauer, Wohner, Krauter and Tacker, (2019).

2.1.4 Organizational Sustainability

Sustainability in the workplace involves integrating sustainable development principles, including social equality, economic efficiency, and environmental awareness, into the day-to-day operations of organizations (Varsei, Soosay, Fahimnia, and Sarkis, 2014). Organizational sustainability denotes everything about integrating the goals of sustainable development, for example, societal fairness, economic efficacy, and eco-friendly exposures, into the operating atmosphere of industries (Varsei et al., 2014). Organizational sustainability, on the other hand, is referred to as "adopting organizational strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining, and enhancing the human and natural resources that will be needed in the future". Elkington (2013) and Dyllick and Hockerts (2002)

highlighted in three circles measurements of sustainability like profit, planet, and people, representing economic, environmental, and social sustainability, respectively. With the "triple bottom line" (TBL) concept, Engert, Rauter, and Baumgartner, (2016) emphasized that organizations are striving for sustainability by producing better goods and services, meeting consumer demands and needs, and optimizing profitability while consistently addressing social and ecological concerns. However, according to Hunt, (2011), organizational sustainability is a multidimensional process based on efficiency and effectiveness that focuses on results, knowledge, capacity building, networks of partners, and products and services. This means that an organization's operations and production, strategy, and management have to keep incorporating and integrating sustainability issues (Rodríguez-Olalla and Avilés-Palacios, 2017; Lozano, 2018). Changes in organizational sustainability considerations occur often throughout time. In the manufacturing sector, sustainability means the essence of goods or services that are environmentally friendly, while the means for achieving them vary in their purpose. Sustainability can vary, like in the manufacturing industry, from that of the services sector.

2.2 Theoretical Review

2.2.1 Triple Bottom Line (TBL) Framework

Elkington (1998) introduced the TBL framework, emphasizing the balance between economic, environmental, and social performance in business operations. This framework supports green logistics by integrating sustainability into supply chain strategies. For example, companies aim to reduce greenhouse gas emissions in logistics while maintaining profitability and societal welfare. To achieve sustainable development, the triple bottom line theory places a strong emphasis on striking a balance between social, environmental, and economic performance. According to this notion, businesses should work to balance these three aspects of sustainability throughout all aspects of their operations, including their logistics strategies (Svensson, 2018). The triple bottom line theory is a useful tool for evaluating sustainable business practices and green logistics.

2.2.2 Institutional Theory

Institutional theory posits that organizations adopt environmentally sustainable practices due to regulatory, normative, and cultural pressures (DiMaggio & Powell, 1983). Institutional theory focuses on the variety of institutions that are responsible for external and internal pressures on the organisation as well as the corresponding organisational responses that have been established within each business. Institutional theory is well adapted to explain the factors related to organizational supply because of the nature of green logistics management practice. Governments enforcing green logistics regulations and consumer demand for eco-friendly products drive firms to incorporate sustainability. The concepts of sustainability, as measured in the three dimensions of social, economic, and environmental, are primarily associated with the triple bottom line approach and their varied expectations. Institutional theory posits that organizations are influenced by their external environment, including the norms, values, and expectations of their stakeholders (Lok, 2019).

2.3 Empirical Review

Ziolkowska and Ziolkowski (2015) conducted a study to investigate energy efficiency in the European Union's (EU)-27 transport sector using a dynamic dematerialization framework. The study evaluates whether the sector has achieved sustainable energy consumption patterns and how energy efficiency improvements align with broader environmental and economic goals. The study utilized annual data spanning from the early 1990s to 2012 across the EU-27 countries. The results revealed that the transport sector in the EU-27 achieved moderate improvements in energy efficiency over the study period.

Lameck and David (2016) carried out a study on 10 multinational organizations in Kenya, specifically focusing on the following departments; procurement, human resources, environment specialists, and administrators, where the study picked at least four senior officers from each and explored the effect of green logistics practices on performance of supply chains in multinational organizations. The authors employed both qualitative and quantitative research design and worked with both descriptive and exploratory information as well as secondary data. Questionnaire was the main tool used to collect primary data for this study. This resulted to great significance of the study and a replication of the findings in the Kenyan context. The study recommends similar studies to other national organizations so as to validate their outcomes with this study and, then a comparative analysis for future strategies in this area.

Llorca and Jamasb (2017) examined the energy efficiency improvements and rebound effects in the European road freight transport sector. The study explores whether advancements in energy efficiency leads to proportional reductions in fuel consumption or if a rebound effect offsets the expected gains. The study employed panel data econometric techniques. The results revealed that a considerable portion of energy efficiency gains was offset by increased freight activity, meaning that energy efficiency measures alone are insufficient to achieve proportional reductions in energy consumption.

Mometto (2022) investigated how sustainable packaging influences consumer choices in the Italian food industry. The study examines the extent to which packaging design, materials, and eco-friendly messaging affect

purchasing behaviour, consumer preferences, and brand perception in the Italian food market. A mixed-methods approach combining quantitative surveys and qualitative interviews was utilized in this study. The results revealed that sustainable packaging significantly influences consumer behaviour in the food industry.

Kapse, Mahajan, Hudnurkar, AmbekaramdHiremath, (2023) conducted a study to examine the influence of sustainable packaging aesthetics on consumer behaviour in the Indian context. The study analyzed the role of aesthetic elements in sustainable packaging on consumer preferences, and whether sustainable packaging fosters a positive emotional response and increases purchase intentions and provide actionable insights for businesses to design eco-friendly packaging that aligns with consumer expectations and environmental sustainability goals. The study employed a quantitative approach using a structured survey. The results revealed that consumers preferred packaging that visibly communicated sustainability, such as the use of natural colours, biodegradable materials, and minimalist designs.

Antonius, Yunata, Sunda and Suharno (2023) examined the effect of green logistics (GL) and green human resource management (GHRM) on the performance of environmentally friendly manufacturing industries oriented toward sustainable development of organizations (SDO) through the role of sustainable production (SP) as a mediating variable. A quantitative approach was employed through a standardized questionnaire to obtain data from 110 manufacturing industries in Indonesia that implemented environmentally friendly practices. Advanced statistical techniques, such as structural equation modeling (SEM) and data analysis using Smart PLS (partial least square) version 4 were utilized to analyze the data collected. The results showed that the model supported the statistical significance of all seven hypotheses and confirmed the direct and mediating effects of GL, GHRM, and SP on SDO.

In the study of Nwaulune, Ajike and Bamidele (2023), an empirical investigation was carried out to ascertain the impact of green logistics practices on Social Sustainability of Fast-Moving Consumer Goods Firms in Lagos State, Nigeria. The study looked on the social sustainability and environmentally friendly logistics methods of a few selected FMCG companies in Lagos State, Nigeria. The authors used survey as their research design. 13,782 management workers from eight listed FMCG companies in Lagos State, Nigeria made up the study's population. The Taro Yamane formula was used to determine the sample size of 519. Survey respondents were chosen using a straightforward random sampling procedure. Data were gathered using a standardized, validated questionnaire, and the range of the Cronbach's alpha reliability coefficient for the components was 0.78 to 0.94. 96.7% of respondents responded. Descriptive and inferential (multiple and hierarchical regression) statistics were used to analyse the data. The findings revealed that green logistics practices had significant effect on social sustainability of selected FMCG firms in Lagos State, Nigeria. The study found that certain FMCG companies in Lagos State, Nigeria, benefited significantly from green logistics practises in terms of their social sustainability. In order to improve their long-term social sustainability performance, the study advised the management of FMCG enterprises in Lagos State, Nigeria, to take a holistic approach to sustainability and incorporate green logistical practises into their larger sustainability plan.

Sunusi, Umar, Muhammad, Zuhra, Zakiya, and Babangida (2024) examined the effect of green logistics practices on the operational performance of manufacturing industries in northern Nigeria using 495 registered members of Manufacturing Association of Nigeria (MAN). The study was quantitative in nature and they employed descriptive survey design. A systematic random sampling technique was employed to select 217 respondents, out of which 196 (82%) were found valid for the analysis. The data of the study were analysed with the help of SMART-PLS 4. It was established from the result that eco-design and green procurement have a positive and significant relationship with the operational performance of manufacturing industries. The result further showed that green production has a positive but insignificant relationship with operational performance. The study concluded that green logistics management practices (GLMP) are essential for sustainable futures. Sustainably, by leveraging GLMP through collaborative partnerships and innovations, the manufacturing industries will significantly reduce their environmental impact while driving economic growth and resilience.

Stephen, Daniel, Charles, and Moses (2024) conducted a study to determine the effect of green logistics practices on performance and mediating effect of environmental performance on this relationship in logistics companies in Kenya. The authors employed cross-sectional survey research design. A structured questionnaire was used to collect data from a sample of 300 firms which was analyzed using CB-SEM. The results established a significant positive relationship between green logistics practices and performance which was in line with the argument of the natural resource-based view whereas the mediating effect of environmental performance on the relationship between green logistics practices and firm performance was found to be non-significant. The study recommended that logistics firms should implement environment-friendly practices of green packaging, route optimization, fuel efficiency, carbon emission measurement and reverse logistics.

Apeksha and Sudha (2025) explored the influence of Green Logistics Management (GLM) on Sustainable Logistics Performance (SLP), emphasizing the pivotal role of Green Innovation (GI) in promoting sustainability and enhancing logistics efficiency (LE). The research evaluates the impact of GLM on SLP, examines GI's contribution to improving LE, and validates the relationship between green logistics practices and SLP. Survey-based data analysis employing reliable scales (AVE and Cronbach's alpha > 0.70) reveals that GI

significantly advances LE. The findings confirm that GLM positively influences SLP, underscoring the importance of integrating green practices into logistics operations. The study provides actionable insights for organizations and policymakers by addressing inconsistencies in green logistics practices and proposing strategies to enhance sustainability and operational efficiency. It presents a practical framework for improving environmental and business performance, offering valuable guidance for firms striving to achieve sustainable growth while meeting environmental objectives. The research contributes to advancing the logistics sector's sustainability and innovation-driven performance.

III. Methodology

To examine the effect of Green Logistics on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria, this study adopted a survey methodology. Eighteen firms were selected based on their expertise and track record in entrepreneurship especially in green logistics practices. From each firm, 14 specialists were randomly chosen, encompassing a broad range of employees with relevant insights into the subject matter. This provided a total population size of 252 participants, forming the basis for sample size determination.

Using Yamane's formula, $n = \frac{N+}{1+N(e)^2}$, where $N = 252$ (population size) and $e = 0.05$ (margin of error), the calculated sample size is approximately 157.

Data collection was facilitated using a structured questionnaire. The questionnaire included both yes-or-no questions and items measured on a 5-point Likert scale, with responses ranging from Strongly Agree (SA=5) to Strongly Disagree (D=1). This design provided a comprehensive means of capturing respondents' opinions and perspectives on green logistics practices and their influence on organizational sustainability.

3.1 Data presentation and analysis

The data for this study was collected through questionnaires administered to a sample of 18 firms in Nigeria. Out of 252 questionnaires distributed, 217 were returned, yielding a response rate of 86.1%. The returned questionnaires were deemed valid and were used for the analysis.

To provide a thorough understanding of the research, the study employs both statistical and economic analysis techniques. The statistical methods include exploratory data analysis to assess the demographic characteristics of the respondents and Chi-square tests to examine relationships between variables.

3.1.1 Demographic Data on the Respondents.

The demographic data are shown below along with their gender, marital status, age, level of education, and career category.

Table 1: Demographic Profile of the Respondents (n = 217)

Characteristics	Frequency	Percentage
Gender		
Male	139	64%
Female	78	36%
Marital Status		
Single	98	45%
Married	119	55%
Age (Years)		
20 -29 years old	47	22%
30-39 years old	71	33%
40-49 years old	39	18%
50-59 years old	27	12%
60 years and above	33	15%
Educational Qualification		
B.sc/HND	89	41%
Masters	53	24%
PhD	29	13%
Others	46	21%
Career category		
Managers	22	10%
Senior staff	33	15%
Contract Staff	87	40%
Junior staff	75	35%

As shown in Table 1, The demographic profile of the respondents (n=217) reveals a diverse group in terms of gender, marital status, age, educational qualification, and career category. In terms of gender, the

majority of respondents are male, accounting for 64% (139), while females make up 36% (78) of the sample. This distribution indicates a higher male representation among respondents. For marital status, a slightly larger proportion of respondents are married, constituting 55% (119), compared to 45% (98) who are single.

The age distribution shows that the largest group of respondents falls within the 30–39 age bracket, comprising 33% (71) of the sample. This is followed by 22% (47) aged 20–29, 18% (39) aged 40–49, 15% (33) aged 60 years and above, and 12% (27) aged 50–59. This indicates a relatively younger population with significant representation across other age groups.

In terms of educational qualification, the majority of respondents hold a B.Sc./HND, representing 41% (89) of the sample. Those with Master's degrees make up 24% (53), while 13% (29) possess a Ph.D., and 21% (46) fall under other categories of educational qualifications. The career category highlights that the largest group is contract staff, comprising 40% (87) of respondents, followed by junior staff at 35% (75), senior staff at 15% (33), and managers at 10% (22). This distribution suggests a workforce with a significant proportion in non-permanent or junior roles.

Research Question 1:

Does energy-efficient transportation affect the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria?

Table 2: Response Rate for research hypothesis 1

Option	Frequency	Percentage
Yes	182	84%
No	35	16%
Total	217	100%

The above table shows that 84% of the total respondents are of the opinion that energy-efficient transportation has an effect on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria while 16% of the total respondents said energy-efficient transportation does not affect the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria.

Research Question 2:

Does sustainable packaging affect the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria?

Table 3: Response Rate for Research Hypothesis 2

Option	Frequency	Percentage
Yes	168	77%
No	49	23%
Total	217	100%

The above table shows that 77% of the total respondents are of the opinion that the opinion that sustainable packaging has an effect on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria while 23% of the total respondents said that sustainable packaging has no effect on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria.

Testing of hypotheses

At this point, the hypothesis formed is either to accept or reject them and as well as determine the extent of their reliability. In order to achieve this, we shall use the chi-square method which is the chi-square (X^2) test.

Hypothesis One

H₀₁: Energy-efficient transportation has no significant effect on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria

Test Statistic

X^2 = Chi-square

Formula = $X^2 = \sum (O - E)^2 / E$

O = observed frequency

E = expected frequency

Assumption:

The level of significance used is 5%, Which is 0.05.

Degree of freedom

The degree of freedom is given as $DF = (M-1) (N-1)$

Were

M = rows, N = columns

$DF = (2-1) (2-1) = 1$

Table 4: Chi-Square table for hypothesis 1

Chi-Square Tests						
	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	
Pearson Chi-Square	35.147 ^a	1	.000			
Continuity Correction^b	32.304	1	.000			
Likelihood Ratio	39.409	1	.000			
Fisher's Exact Test				.000	.000	
Linear-by-Linear Association	32.513	1	.000			
N of Valid Cases	217					

The value of 1 at 0.05 significant level is = 3.45. Using the chi-square table.

Thus: the critical value is given as $X^2 = 3.45$.

Since the calculated value of X^2 (35.147), is greater than the critical value (3.45), we reject the null hypothesis and accept the alternative hypothesis. We, therefore, conclude that Energy-efficient transportation has a significant effect on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria.

Hypothesis Two

H₀₂: Sustainable packaging has no significant effect on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria.

Test Statistic

$X^2 = \text{Chi-square}$

Formula = $X^2 = \sum (O - E)^2/E$

O = observed frequency

E = expected frequency

The level of significance used is 5%, Which is 0.05.

Degree of Freedom

The degree of freedom is given thus: $DF = (M-1) (N-1)$

Were

M = rows N = columns

$DF = (2-1) (2-1) = 1$

Table 5: Chi-Square table for Hypothesis 2

Chi-Square Tests						
	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	
Pearson Chi-Square	33.912 ^a	1	.000			
Continuity Correction ^b	24.319	1	.000			
Likelihood Ratio	36.164	1	.000			
Fisher's Exact Test				.000	.000	
Linear-by-Linear Association	23.931	1	.000			
N of Valid Cases	217					

The value of 1 at 0.05 significant level is = 3.45. Using the chi-square table.

Thus: the critical value is given as $X^2 = 3.45$.

Since the calculated value of X^2 (33.912), is greater than the critical value (3.45), we reject the null hypothesis and accept the alternative hypothesis. We, therefore, conclude that Sustainable packaging has a significant effect on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria.

IV. Discussion of Results

This study investigates the effects of effect of Green Logistics on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria, with data analyzed using chi-square tests. The demographic analysis provides insights into the respondents' profiles, which include a sample of 217 individuals. The demographic breakdown indicates that 64% (139) of the respondents are male, and 36% (78) are female. In terms of marital status, 55% (119) are married, and 45% (98) are single. The respondents span a wide range of ages, with the majority falling between 30–39 years (33%, 71). Educationally, 41% (89) hold a B.Sc./HND, while career-wise,

40% (87) are contract staff, followed by 35% (75) in junior roles. These demographic characteristics suggest that the study draws from a balanced and diverse workforce.

For Hypothesis One, the analysis examined the effect of energy-efficient transportation on organizational sustainability. Using a significance level of 0.05, the critical chi-square value is 3.45. The calculated chi-square value of 35.147 is significantly higher than the critical value, leading to the rejection of the null hypothesis. This result confirms that energy-efficient transportation significantly impacts the sustainability of manufacturing firms. This finding aligns with current research that highlights the role of green transportation strategies in reducing carbon emissions, optimizing resource utilization, and fostering long-term organizational sustainability (Xue et al., 2023; Lin & Wang, 2021). Furthermore, the prominence of contract and junior staff among respondents underscores the practical application of such transportation systems in roles requiring logistical efficiency.

For Hypothesis Two, the analysis assessed the effect of sustainable packaging on organizational sustainability. Similarly, at a 0.05 significance level, the critical chi-square value is 3.45. The calculated chi-square value of 33.912 exceeds the critical value, leading to rejecting the null hypothesis. This outcome demonstrates that sustainable packaging has a significantly positive effects on the organizational sustainability. Research corroborates this conclusion, noting that sustainable packaging reduces environmental footprints, enhances brand reputation, and meets increasing consumer demands for eco-friendly practices (Yang, Li and Wu et al., 2022). The educational qualifications of respondents, with 41% holding B.Sc./HND and 24% possessing Master's degrees, reflect the growing awareness and implementation of sustainability-driven innovations in manufacturing processes.

In summary, the chi-square results highlight the importance of adopting energy-efficient transportation and sustainable packaging as critical components of organizational sustainability in manufacturing firms. These findings highlight actionable insights for industry stakeholders to incorporate eco-conscious strategies, further supported by demographic evidence and current research.

V. Conclusion

The study on the effect of green logistics on the organizational sustainability of manufacturing firms in Southeast Nigeria reveals critical insights into the relationship between environmentally conscious practices and long-term business viability. Energy-efficient transportation has been shown to significantly enhance organizational sustainability by reducing carbon footprints, optimizing fuel usage, and minimizing operational costs. This sustainable approach to logistics ensures that firms can maintain environmental compliance while achieving greater operational efficiency, contributing to both ecological and economic sustainability.

Similarly, sustainable packaging practices significantly affect organizational sustainability by decreasing waste, improving brand reputation, and aligning with global sustainability standards. The adoption of eco-friendly packaging materials and processes not only mitigates environmental impacts but also fosters consumer loyalty and opens access to eco-conscious markets, further securing the long-term growth and resilience of manufacturing firms.

Together, these findings underscore the importance of integrating green logistics strategies, such as energy-efficient transportation and sustainable packaging, into the core operations of manufacturing firms in Southeast Nigeria. Such practices serve as vital tools for achieving organizational sustainability in a competitive and environmentally sensitive global market. The study concluded that Green Logistics has a significant positive effect on the Organizational Sustainability of Manufacturing Firms in Southeast Nigeria.

VI. Recommendations

Based on the findings on the effect of green logistics on the organizational sustainability of manufacturing firms in Southeast Nigeria, the following recommendations are proposed:

- i. Manufacturing firms should prioritize the adoption of energy-efficient transportation systems. This includes investing in fuel-efficient vehicles, leveraging alternative energy sources such as electric or hybrid-powered fleets, and optimizing delivery routes through advanced logistics technology. These initiatives will help reduce fuel consumption, lower operational costs, and enhance environmental compliance, ultimately boosting organizational sustainability.
- ii. Firms should transition to sustainable packaging materials, such as biodegradable or recyclable materials, and design products with minimal packaging where possible. These practices will not only reduce environmental impact but also appeal to environmentally conscious consumers, enhancing the firm's reputation and market competitiveness.

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