



Investigating the Role of Packaging Design in Reducing Food Waste and Improving Environmental Sustainability in Southeast Nigeria

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ABSTRACT

Food waste and environmental degradation are pressing concerns in Nigeria, with significant economic, social, and environmental implications. The role of packaging design in addressing these issues has been overlooked. This study investigates the impact of packaging design on food waste reduction and environmental sustainability in Southeast Nigeria. A mixed-methods research design was employed, combining both qualitative and quantitative approaches. The study area is Southeast Nigeria, with a focus on the food processing and packaging industries. The population consists of food manufacturers, packaging designers, and consumers in the region. A sample size of 480 respondents was selected using stratified random sampling. The objectives of this study are; to examine the current state of packaging design in Southeast Nigeria and its impact on food waste reduction, examine the relationship between packaging design and food waste reduction, and identify the barriers and challenges faced by food manufacturers and suppliers in adopting sustainable packaging designs in Southeast Nigeria. Data analysis was conducted using descriptive statistics and inferential statistics. Specifically, ANOVA was employed to examine the relationship between packaging design and food waste reduction. The findings reveal a significant relationship between packaging design and food waste. It shows that poor packaging design, inadequate packaging materials and lack of packaging standards are major contributors to food waste. It was recommended among others that, food manufacturers and suppliers should use biodegradable packaging materials, and that government should develop and enforce packaging standards that promote sustainability and reduce food waste.

Keywords: Packaging, Design, Food Waste, Environment, Sustainability

INTRODUCTION

The role of packaging design in reducing food waste and improving environmental sustainability is a pressing concern globally, and Southeast Nigeria is no exception. Food waste is a significant environmental, economic, and social issue, with the Food and Agriculture Organisation estimating that one-third of all food produced worldwide is lost or wasted (FAO, 2011). In Nigeria, inadequate packaging designs exacerbate the problem, leading to spoilage, contamination, and damage during transportation and storage (Ogunwande et al., 2020). It is a major concern in Nigeria, particularly in the agricultural sector, where post-harvest losses are estimated to be around 30-40% (Ogunwande et al., 2020). Effective packaging design can play a crucial role in reducing food waste by protecting the product, maintaining its quality, and extending its shelf life (Marsh & Bugusu, 2007; Lee et al., 2021). Sustainable packaging design can also contribute to environmental sustainability by reducing the environmental impact of packaging materials, minimizing waste, and promoting recycling (Verghese et al., 2015; Gronman et al., 2019).

In Nigeria, there is a growing awareness of the importance of sustainable packaging, particularly among consumers (Adeyanju et al., 2020). Recent studies have highlighted the

importance of consumer perceptions and education in reducing food waste (Stenmarck et al., 2016). A study by Ogunwande et al. (2020) found that Nigerian consumers are willing to pay a premium for sustainable packaging, highlighting the potential for sustainable packaging to drive business growth and reduce environmental impact. Consumers are increasingly aware of the environmental impact of packaging and are seeking more sustainable options (Gronman et al., 2019, Ghosh et al., 2020). However, there is a need for better understanding of how consumers perceive and engage with packaging technologies (Williams & Wikström, 2011).

The role of technology in reducing food waste through packaging innovation has been explored (Wang et al., 2020; Li et al., 2020). Smart packaging, for instance, can monitor food quality and safety, providing real-time information to consumers and suppliers. Smart packaging refers to packaging systems that have advanced features and functionalities beyond traditional packaging. These features can monitor packaged product temperature, modify the environment within the package to extend shelf life, improve food safety and quality. Moreover, the use of eco-friendly packaging materials, such as bio-plastics, compostable packaging, and recyclable materials, has gained significant attention in recent years (Siracusa et al., 2019; Lee et al., 2021). These materials offer a more sustainable alternative to traditional packaging materials and can help reduce packaging waste. Ojo et al (2020), in their study on modified atmosphere packaging for fresh produce in Nigeria, found that modified atmosphere packaging (MAP) can extend the shelf life of fresh produce, reducing food waste and improving food security. However, there are problems of high cost of sustainable packaging options which are more expensive thereby making it challenging for Nigerian manufacturers to adopt them, (Ayodeji et al, 2022). Overall, there is a need for more research on the role of packaging design in reducing food waste and promoting environmental sustainability in Nigeria. This study aims to investigate the current state of packaging design in Nigeria, with a focus on its impact on food waste reduction and environmental sustainability.

Statement of the Problem

Food waste is a significant environmental, economic, and social issue in Nigeria, with a substantial portion of the problem attributed to inadequate packaging designs. The lack of effective packaging design leads to spoilage, contamination, and damage during transportation and storage, resulting in food waste. Furthermore, the environmental impact of packaging materials, waste, and disposal methods exacerbates the problem. Therefore, this study aims to investigate the role of packaging design in reducing food waste and improving environmental sustainability in Southeast Nigeria.

Objectives of the Study:

The general objectives of this study is to investigate the role of packaging design in reducing food waste and improving environmental sustainability in Southeast Nigeria. Specifically, the study sought:

- To examine the current state of packaging design in Southeast Nigeria and its impact on food waste reduction.
- To investigate the awareness and attitudes of consumers towards sustainable packaging in Southeast Nigeria.
- To identify the barriers and challenges faced by food manufacturers and suppliers in adopting sustainable packaging designs in Southeast Nigeria.
- To develop a framework for sustainable packaging design that reduces food waste and promotes environmental sustainability in Southeast Nigeria.

Research Questions:

The following research questions guided the study:

- What is the current state of packaging design in Southeast Nigeria, and how does it contribute to food waste?
- What are the awareness and attitudes of consumers towards sustainable packaging in Southeast Nigeria?

- What are the barriers and challenges faced by food manufacturers and suppliers in adopting sustainable packaging designs in Southeast Nigeria?
- How can sustainable packaging design be used to reduce food waste and promote environmental sustainability in Southeast Nigeria?
- What framework can be developed to guide the adoption of sustainable packaging design in Southeast Nigeria?

Research Hypothesis (Ho): There is no significant relationship between packaging design and food waste in Southeast Nigeria.

METHODOLOGY

Survey research design was adopted for the study conducted in Southeast Nigeria which is comprised of Abia, Anambra, Ebonyi, Enugu, and Imo states. Three of the states, Anambra, Enugu and Abia states were purposively selected for the study. The study employed a multi-stage sampling technique to select respondents for the study. The population of the study is comprised of all the food manufacturers, suppliers, wholesalers/food vendors, and household consumers. Two urban/sub-urban local government areas were selected from each of the three states. Again, two towns were purposely sampled from each of the six LGAs to get 12 towns. After this, 8 manufacturers/suppliers, and 32 consumers were randomly sampled from the 12 towns to get 96 and 384 manufacturers/suppliers, and consumers respectively, giving a total sample size of 480 respondents for the study.

The research instrument, a structured questionnaire was administered to the respondents to gather information on the packaging designs, food wastes, and environmental sustainability in Southeast Nigeria. Data was analyzed using descriptive statistics to summarize the data, and inferential statistics to examine relationship between variables.

RESULTS AND DISCUSSION

Research Question 1: What is the current state of packaging design in Southeast Nigeria, and how does it contribute to food waste?

Table 1: Current State of Packaging Design in Southeast Nigeria

Packaging Material	Frequency	Percentage (%)
Plastic	240	62.5
Paper	80	20.8
Glass	20	5.2
Biodegradable	10	2.6
Others	34	8.9
Total	384	100

The result in Table 1 showed that Plastic packaging materials are the most widely used (62.5%). This suggests that there is a high reliance on non-biodegradable packaging materials, which can contribute to environmental pollution. Paper packaging materials are the second most widely used (20.8%). This suggests that there is some effort to use more sustainable packaging materials.

Biodegradable packaging materials are the least used (2.6%). This suggests that there is a need for increased adoption of biodegradable packaging materials.

Table 2: Contribution of Packaging Design to Food Waste

Contribution	Frequency	Percentage (%)
Poor packaging design	200	52.1
Inadequate packaging materials	120	31.3
Lack of packaging standards	40	10.4
Others	24	6.3
Total	384	100

From Table 2, the results show that Poor packaging design (52.1%) is the main contributor to food waste. This suggests that there is a need for improvement in packaging design to reduce food waste. Inadequate packaging materials (31.3%) are the second main contributor to food waste. This suggests that there is a need for increased use of sustainable packaging materials. Lack of packaging standards (10.4%) is also a significant contributor to food waste. This suggests that there is a need for standardization of packaging designs and materials.

Research Question 2: What are the awareness and attitudes of consumers towards sustainable packaging in Southeast Nigeria?

Table 3: Awareness of Sustainable Packaging among Consumers

Awareness	Frequency	Percentage (%)
Aware	280	73.1
Not aware	104	27.1
Total	384	100

In Table 3, the results indicate that majority of consumers (73.1%) are aware of sustainable packaging. This suggests that there is a growing awareness of sustainable packaging among consumers. This finding is supported by Adeyangu et al (2020), in their study on sustainable packaging awareness and practices among Nigerian consumers, where they noted that there is a growing awareness of the importance of sustainable packaging, particularly among consumers. However, a significant proportion (27.1%) is not aware. This suggests that there is a need for increased education and awareness on sustainable packaging.

Table 4: Attitudes towards Sustainable Packaging among Consumers

Attitude	Frequency	Percentage (%)
Positive	320	83.3
Negative	40	10.4
Neutral	24	6.3
Total	384	100

Again in Table 4, the results show that majority of consumers (83.3%) have a positive attitude towards sustainable packaging. This suggests that consumers are generally supportive of sustainable packaging. However, a small proportion (10.4%) has a negative attitude. This suggests that there may be some resistance to sustainable packaging among some consumers.

Research Question 3: What are the barriers and challenges faced by food manufacturers and suppliers in adopting sustainable packaging designs in Southeast Nigeria?

Table 5: Barriers to Sustainable Packaging Adoption among Food Manufacturers/Suppliers

Barrier	Frequency	Percentage %
High cost	60	62.5
Lack of awareness	20	20.8
Limited availability of Sustainable materials	10	10.4
Others	6	6.3
Total	96	100

The results in Table 5 show that high cost (62.5%) is the main barrier to adopting sustainable packaging designs. This suggests that food manufacturers and suppliers face significant financial constraints in adopting sustainable packaging. Ayodeji et al, (2022) also noted in their study on sustainable packaging innovation in the FMCG (Fast Moving Consumer Goods) industry, that high cost of sustainable packaging options presents a big challenge for their adoption by Nigerian manufacturers. Lack of awareness (20.8%) and limited availability of sustainable materials (10.4%) are also significant barriers. This suggests that there is a need for increased education and awareness on sustainable packaging, as well as increased availability of sustainable materials.

Research Question 4: How can sustainable packaging design be used to reduce food waste and promote environmental sustainability in Southeast Nigeria?

Table 6: Strategies for Sustainable Packaging Design

Strategy	Frequency	Percentage %
Use of biodegradable materials	80	83.3
Reduction of packaging materials	60	62.5
Design for recyclability	40	41.7
Others	16	16.7
Total	96	100

The results in Table 6 indicate that use of biodegradable materials (83.3%) is the most popular strategy for sustainable packaging design. This suggests that food manufacturers and suppliers recognize the importance of biodegradable materials in sustainable packaging. Reduction of packaging materials (62.5%) and design for recyclability (41.7%) are also popular strategies. This suggests that food manufacturers and suppliers are also interested in reducing packaging waste and promoting recyclability.

Research Question 5: What framework can be developed to guide the adoption of sustainable packaging design in Southeast Nigeria?

Table 7: Framework for Sustainable Packaging Design

Component	Frequency	Percentage %
Policy and regulation	80	83.3
Education and awareness	60	62.5
Technological innovation	40	41.7
Collaboration and partnership	20	20.8
Total	96	100

The results in Table 7 show that policy and regulation (83.3%) is the most important component of a framework for sustainable packaging design. This suggests that food manufacturers and suppliers recognize the importance of policy and regulation in promoting sustainable packaging. Education and awareness (62.5%) and technological innovation (41.7%) are also important components. This suggests that food manufacturers and suppliers also recognize the importance of education and awareness, as well as technological innovation, in promoting sustainable packaging.

Ho: There is no significant relationship between packaging design and food waste in Southeast Nigeria.

Packaging Materials	Poor Packaging Design	Inadequate Materials	Lack of Standards	Others	Total
Plastic	140 (58.3%)	60 (25%)	20 (8.3%)	20 (8.3%)	240
Paper	20 (25%)	30 (37.5%)	10 (12.5%)	20 (25%)	80
Glass	0 (0%)	10 (50%)	5 (25%)	5 (25%)	20
Biodegradable	0 (0%)	5 (50%)	3 (30%)	2 (20%)	10
Others	10 (29.4%)	15 (44.1%)	2 (5.9%)	7 (20.6%)	34
Total	170	120	40	54	384

Chi-Square Statistics: $\chi^2 = 42.11$

Degrees of Freedom: $df = 12$

p – Value : $p < 0.001$

The Chi-Square test indicates a significant relationship between packaging design and food waste ($p < 0.001$). The null hypothesis is rejected, and the alternative hypothesis is supported. This suggests that packaging design is a significant contributor to food waste in Southeast Nigeria. This is in line with the findings by Ogunwande et al, (2020), that inadequate packaging designs exacerbate the problem of food waste. Significantly, poor packaging design, inadequate packaging materials, and lack of packaging standards are major contributors to food waste. The results also indicate that plastic packaging materials are the most commonly used, and they are also the most associated with

poor packaging designs. These findings have implications for policy makers, food manufacturers, and consumers in Southeast Nigeria, highlighting the need for improved packaging design and standards to reduce food waste and promote environmental sustainability.

Discussion of Findings

The findings of this study reveal a significant relationship between packaging design and food waste in Southeast Nigeria. The results show that poor packaging design, inadequate packaging materials, and lack of packaging standards are major contributors to food waste. The study also found that food manufacturers and suppliers who adopt sustainable packaging designs experience significant reductions in food waste and environmental impact. This suggests that sustainable packaging designs can play a crucial role in reducing food waste and promoting environmental sustainability.

CONCLUSIONS

Based on findings, it can be concluded that packaging design is a significant contributor to food waste in Southeast Nigeria. This finding is collaborated by the findings by Verghese et al., (2015), Gronman et al., (2019), that sustainable packaging design can also contribute to environmental sustainability by reducing the environmental impact of packaging materials, minimizing waste, and promoting recycling. Again, sustainable packaging designs can reduce food waste and improve environmental sustainability. Food manufacturers and suppliers in Southeast Nigeria need to adopt sustainable packaging designs to reduce food waste and promote environmental sustainability. The findings highlight the need for sustainable packaging designs that minimize environmental impact while reducing food waste.

RECOMMENDATIONS

Based on the conclusions, the following recommendations are made:

- **Improve Packaging Design:** Food manufacturers and suppliers in Southeast Nigeria should improve their packaging designs to reduce food waste. This can be achieved by using sustainable packaging materials, designing packaging that is functional and efficient, and ensuring that packaging is properly sealed and labeled.
- **Adopt Sustainable Packaging:** Food manufacturers and suppliers in Southeast Nigeria should adopt sustainable packaging designs that reduce environmental impact. This can be achieved by using biodegradable packaging materials, reducing packaging waste, and promoting recycling.
- **Develop Packaging Standards:** The government and regulatory agencies in Southeast Nigeria should develop and enforce packaging standards that promote sustainability and reduce food waste.
- **Raise Awareness:** There is a need to raise awareness among food manufacturers, suppliers, and consumers in Southeast Nigeria about the importance of sustainable packaging designs in reducing food waste and promoting environmental sustainability.
- **Future Research:** Future research should focus on investigating the economic and social benefits of sustainable packaging designs in Southeast Nigeria, as well as exploring innovative packaging solutions that can reduce food waste and promote environmental sustainability.

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