

Supply Chain Traceability in Shaping Product Sustainability Perceptions: An Empirical Investigation of Consumer Market in Calabar Cross River State

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Abstract: *The purpose of this study was to examine the influence of supply chain traceability and product sustainability perception in the Calabar, Cross River State consumer market. The study population was 384 and are made up of consumers, retailers and wholesalers in Calabar. The major instrument for data collection was the questionnaire. The proxies for supply chain traceability were on-pack digital verification and independent trust badge verification. The instrument was administered to every member of the population, out of which 370 copies of the questionnaire were completed and returned in usable form. Data collected was analysed using percentage analysis, and hypotheses formulated were tested using multiple regression analysis. Findings from the study revealed that there is a significant positive influence of supply chain traceability dimensions (on-pack digital verification, independent trust badge verification) on product sustainability perception. Based on the findings, it was concluded that Supply chain traceability influence product sustainability perception in the Calabar, Cross River State consumer market. Consequently, it is recommended that manufacturers, companies should strategically limited or get rid of greenwashing suspicions by being transparent in their branding, and install a scannable on pack infrastructure, and a verifiable third party badge on their offerings. These will create a positive product sustainable perception.*

Keywords: Supply chain traceability, on-pack digital verification, independent trust badge verification, and product sustainability perception.

1. INTRODUCTION

The increase in food safety, environmental degradation, and ethical production practice concerns has led to the global demand for sustainable brands. The quality of an offering does not determine patronage alone; prospective and actual consumers patronise brands from an identified source, the production effects on the environment, and the processes of production. Supply chain traceability in an agri-food sector is enhanced by transparency in operations (Essien et al., 2024). Munro et al., (2023) stated that while purchasing a sustainable brand in an outlet, actual shoppers face trust issues. These trust issues originate from a questionable source of brands. The ability to trace a brand from production to commercialisation and final consumption is a vital approach to product sustainability. According to Kafetzopoulos et al. (2024), reliable information regarding the origin of an offering and environmental performance forms the effectiveness of a traceability system. Caputo and Reardon (2025) opined that firms are encouraged to provide reliable information on their brand sustainability attributes. The technology explosion has led to the advent of modern technology that involves advanced mechanisms that provide sustainability information. These mechanisms encompass the following: On-pack digital verification which proves supply chain traceability by showing the literal path from raw material to shelf and exposes ethical practices in the operation. Latišenko (2026) asserts that independent trust-badge certification, which is a verified third-party logo, acts as a tool for supply chain traceability that influences patronage. These elements play vital roles in enhancing transparency, strengthen credibility, and influence consumers' perceptions regarding the sustainability of products. Nguyen and Nguyen (2025) identified that effective supply chain traceability depends on the information available to consumers throughout the supply process to consumption. The technology explosion has led to the advent of modern technology that involves advanced mechanisms that provide sustainability information.

Consumers' assessment on products produced, distributed, and consumed in a manner that minimises environmental harm supports long-term ecological balance. Agriculture thrives and plays a vital part in food exports in Nigeria. Regarding the sustainability of the environment, agricultural products are subjected to scrutiny (Du Plooy, 2025). Consumer markets are filled with greenwashing risks and reduced supply chain traceability (Marbun 2025). The reputation of Nigeria has been marred by environmental concerns such as water pollution and biodiversity degradation. In the words of Wooliscroft and Ganglmair-Wooliscroft., (2025), sustainability does center on manufacturer to consumer, but resides in the entire system of production, distribution and consumption.

Statement of the Problem

Supply chain traceability has become one of the determinants of consumer purchase behaviour in Nigeria. Inadequate supply chain traceability has hampered purchase decisions on sustainable brands in Calabar, Cross River State consumer markets. Firms have adopted sustainability-related labels and claims based on the environmental awareness received by consumers. Despite benefits

the of sustainability claims in Nigeria, lack of traceability of supply chains has created a significant gap between sustainability communication and consumer confidence in sustainable products. Hegde et al. (2025) revealed that unreliable claims affect consumers' decisions. Keaney et al. (2026) identified that the vague claims in consumer markets affect the product sustainability perception. These validate that the supply chain traceability process is essential in business operations in Calabar, Cross River State.

These processes or mechanisms for supply chain traceability lack on-pack digital verification, geographic origin granularity, audited ecological metric disclosure and independent trust badge verification; these expose consumers to cognitive dissonance. Bram, V. W. (2026) stated that consumer's information to make informed sustainability decisions. The persistence of these traceability deficiencies has significant implications for product sustainability perceptions.

There is a structural gap in existing models. Traceability was treated as a single construct, without considering how each dimension independently influences supply chain traceability to product sustainability perception. To the best of the proposed researcher's knowledge, there is a structural and empirical gap in assessing how the proposed study's independent variable proxies drive product sustainability perception in Calabar, Cross River State, Nigeria; therefore, the researcher has set out to investigate the relationship between supply chain traceability and product sustainability perception in Calabar, Cross River State consumer market.

Objectives of the Study

The main objective of the study was to investigate the relationship between supply chain traceability and product sustainability perception in the Calabar, Cross River State consumer market. The specific objectives will be to:

- i. To examine the combined influence of on-pack digital verification, and independent trust badge verification on product sustainability perception in the Calabar consumer market.

Research Hypotheses

The following hypothesis was formulated in null form to guide this study:

H₀₁: There is no significant influence of on-pack digital verification, and independent trust badge verification on product sustainability perception in the Calabar consumer market.

2. Review of the Literature

Concept of Supply Chain Traceability

The essence of production is consumption, profitability and satisfaction. It is the task of macro-marketers to provide a system that gets the goods to the final consumer (Wooliscroft and Ganglmair-Wooliscroft., (2025). This system will be marred without a mechanism that aid in the tracking of product movement throughout the supply chain, the delivery lot time, and verifying the source of a brand. This measure enables prospective and actual consumers to access information on the state of the production and the environmental influence of the brand. A locally sourced and ethically produced brand is highly patronised in Calabar, and traceability will play an important role in building trust in brands' sustainability claims (Vincent, 2026). Supply traceability enables stakeholders to monitor sustainability performance from raw material sourcing to final consumption (Onuma, 2025).

Dimensions of Supply Chain Traceability

The following underpinnings provide a framework for supply chain traceability that influences product sustainability perception

i. On-Pack Digital Verification

The explosion of knowledge has led to the advanced invention that can hold information about a brand in QR codes, block chain-enabled labels, and other tech attributes stamped on product packaging that gives consumers free access to the information about the product source and supply chain information. The use of QR codes has gone beyond traditional package attributes (Barata, 2025). It involves a digital verification channel which provides transparency to information such as farm of origin, production methods, animal welfare standards and carbon footprint. This mechanism is not a marketing rhetoric, it enhances confidence on a brand Chen et al.,(2026),stated that the adoption of traceability mechanism has been mostly on premium dairy, seafood, honey products meant for exports. These traceability tools also aid in combating counterfeit products (Choudhury et al., 2025).

ii. Independent Trust Badge Verification

This tool acts as seal, certifications of approval from a third party organisation. It reveals that the product's supply chain has the approved standard of the external body. These verified statements can be in the form of carbon footprint measurements,

greenhouse gas emissions, water consumption, energy usage, and biodiversity protection indicators. This authentication builds transparency and credibility rather than claiming authentications from the producers of the product.

Overview of Marketing Product Sustainability Perception

This is how consumers perceive and interpret a sustainability claim or information provided by manufacturers of a brand. Sustainability perception influences consumer decisions on patronage if some factors of authenticity were not enshrined in the package. Products are not only being procured because of their price and quality but also because of their impact on environmental stewardship.

Consumer Market

This is a market that consists of individuals and households who procure brands for personal consumption. Calabar consumers are increasingly concerned about the sustainability of the products they purchase, particularly food and agricultural products.

2.2 Theoretical Framework

The theoretical framework underpinning this research work is the Signaling Theory, Propounded by Michael Spence in the year 1973. The theory states that credible signals should be sent by organisations with superior information. The signals such as of on-pack digital verification, and independent trust badge verification on product over the limitations of “cheap talk” to alter consumer perception.

This theory breaks down marketing interaction network into; the signaller as the firm that have the detailed information of the product, the signal as the codes and badges sent by the firm to show quality, and the receiver as the actual or prospective consumer who interprets the codes as a form of perception. A firm that produces a fake brand can get official verification or badge on their brand. The applications of this codes and badges involves a strict scrutiny, and process. This shows that traceability is premium.

The Signaling Theory is pertinent to this study as it offers a theoretical framework to identify the specific traceability mechanisms that fail to operate as credible signals to the consumer. If the signals are unvouched for by the consumer, information asymmetry persists, leaving the consumer's sustainability perception unchanged.

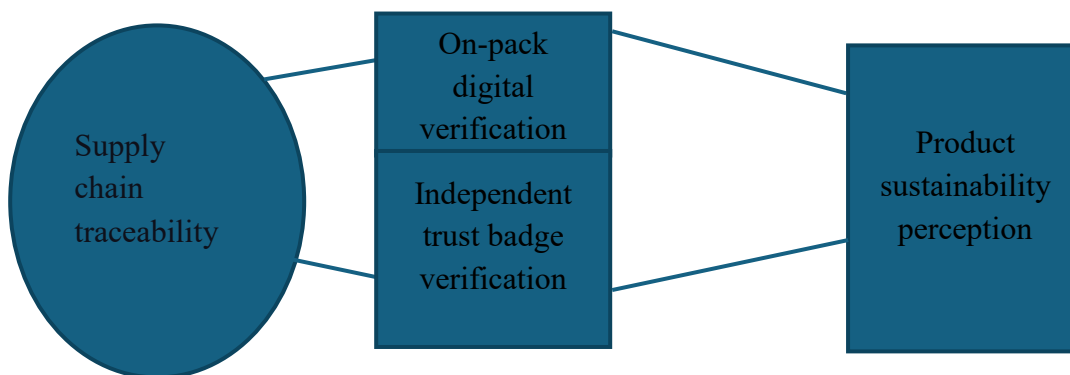
2.3 Empirical Framework

The summary of the reviewed study

SN	AUTHOR AND YEAR	TITLE	METHODOLOGY	FINDINGS	GAP IN STUDY
1.	Barata.,(2025)	Packaging communication and QR codes: a study on information, quality, involvement and purchase intention for the spice market.	Quantitative survey and statistical analysis was used.	It was identified that QR codes on packaging successfully bridge the information gap, increasing consumer involvement and purchase intentions by signaling product quality.	This study focuses generically on the spice market and lacks specific localized application to Nigeria's regulatory agribusiness landscape. The variables of the study differ with the proposed study variables.
2.	Bram.,(2026)	Certification confusion: the (mis)use of certifying marks in New Zealand.	Legal analysis, case law review was used.	The findings revealed that consumers in New Zealand face extreme certification confusion due to poorly regulated, overlapping, and certifying marks.	This study focuses on the legal and intellectual property challenges of trust marks. The dimensions of the independent variable, proxies differ.
3.	Caputo and Reardon (2025)	Hiding and revealing: a perspective on the paradox of information transparency in diverse agri-food value chain contexts.	Conceptual synthesis and viewpoint analysis was employed utilised	It was revealed that an information paradox where revealing too much backend supply chain data can overwhelm consumers.	The study was on a high-level theoretical framework that does not offer empirical consumer data. The structure, proxies, the variables differs.
4.	Du Plooy.,(2025)	Shaping the future of agri-food system in Aotearoa: Exploring	Interviews, narrative analysis, and value	It was shown that maps out deeply rooted on environmental and social	The study is primarily on supply-side stakeholder narratives and does not map how

		stakeholder values, narratives and relationships	mapping was employed.	values held by New Zealand agri-food stakeholders, emphasizing collaborative relationships	these values are digitally verified via traceability systems for the end consumer
5.	Kafetzopoulos et al.,(2024)	Managing the traceability system for food supply chain performance	Empirical quantitative survey was employed.	It was found that effective management of traceability systems drastically improves internal food safety operational logistics.	The study treats traceability as an internal operational and performance metric.
6.	Keaney et al. (2026)	Prevalence of sustainability claims on package.	Empirical content analysis was adopted.	The findings revealed that a massive boom and high prevalence of sustainability labels on retail shelves, increasing the risk of unverified greenwashing.	The study offers a descriptive look at what claims currently exist on shelves. Variables differ.
7.	Latišenko (2026)	Designing packaging and brand identity for a wellness supplement line.	Applied design project and creative brand development case study was employed	It was identified that clean, transparent packaging design and clear brand identity drastically improve consumer trust in wellness markets	The study was on a localized, applied design study that offers zero theoretical insights into systemic supply chain data verification. The proxies differ.
8.	Marbun.,(2025)	The commodification of culture in global tourism: balancing authenticity, sustainability, and ethical practices amidst disruption.	Qualitative seminar review was adopted	It was shown that global market disruptions threaten cultural authenticity, highlighting an urgent need for verified ethical.	The study focuses conceptually on the macro tourism sector which is different from the proposed study.
9.	Munro, Kapitan, and Wooliscroft (2023)	A systematic review of energy systems: The role of policymaking in sustainable transitions. Renewable and Sustainable Energy.	Systematic literature review was adopted	It was found that a persistent "attitude-behaviour gap" where New Zealand supermarket shoppers say they care about sustainability but do not buy eco-friendly goods due to structural retail hurdles.	The study differ because it conceptualizes the supermarket environment barriers but fails to explore if real-time data transparency and traceability could actively close this behavioural gap.
10.	Nguyen and Nguyen.,(2025)	How do transparency and traceability enhance purchasing behaviour via consumer trust? Insights for food supply chains.	Quantitative survey modeling was used.	It was identified that backend traceability directly builds consumer trust, which subsequently drives positive purchasing behaviors.	This study is on a broad global supply chain study that does not account for the highly localized, and unique "Clean Green" brand expectations of Nigeria consumers. Proxies differ
11.	Onuma.,(2025)	Multi-tier supplier visibility and ethical sourcing: leveraging block chain for transparency in complex global supply chains.	Conceptual and systemic review was used.	The finding revealed that Block chain technology is highly effective at providing multi-tier supplier visibility and proving ethical sourcing practices	The study focuses on large-scale, complex international enterprise supply chains, missing the specific nuances of Nigeria's local, direct-to-consumer

Source: Researchers compilation (2026)

Independent Variable**Dependent Variable**

Source: Researcher's compilation, 2026

Figure 1: Research model showing the relationship between independent variable proxies and the dependent variable.

3. Methodology

Research Design

Cross-sectional survey design was employed for this study, and data was collected from a diverse sample of consumer encountered in four major market, and selected malls in Calabar Cross River State in a single instance and within a brief period. This research design was appropriate for the study since it enabled the researcher to obtain a snapshot of the population's behaviour at a particular instant, facilitating the analysis of the link between the study's variables.

Population of the Study

The population of the study is unknown, and the target population of the study comprises consumers encountered in the four major markets, and malls in Calabar metropolis. These consumers/customers were regarded as most appropriate due to their direct involvement in purchase practices and product sustainability perception.

Sample Size Determination

The Cochran formula was used to determine the sample size which is ideal for infinite population.

$$n = \frac{Z^2 * p * (1-p)}{e^2} \text{ where } n = \text{sample size for infinite population}$$

Z= Z score corresponding to desired confidence level (1.96 for 95% confidence)

P= estimated proportion (0.5 for maximum variability)

e= margin of error (0.05 for 5%)

$$\text{Substituting the values: } n = \frac{1.96^2 * 0.5 * (1-0.5)}{0.05^2}$$

$$n = \frac{3.8416 * 0.25}{0.0025}$$

$$n = \frac{0.9606}{0.0025}$$

$$n = 384$$

Therefore, the sample size is 384. This figure forms the target population for the study.

Sampling Technique

Purposive sampling technique a non-probability sampling method was employed for this study. Respondents were selected based on the research objectives, rather than choosing them at random. The manageable population enabled the researcher to gain comprehensive insights without excluding any relevant people, hence, this technique was chosen.

Sources and Method of Data Collection

The researcher employed a 5-point Likert scale questionnaire titled "supply chain traceability and product sustainability perception in the Calabar, Cross River State consumer market". The instrument comprised two sections, namely, Section A (Personal Data) and Section B, which contained statements to measure the variables of the study.

Questionnaire reliability and data analytical method

The reliability status of the research questionnaire was confirmed through the Cronbach alpha method. Copies of the questionnaire were administered to 20 selected customers from the selected markets, and malls. These respondents were deliberately excluded

from the actual survey to guard against respondent biases in the actual survey. The data obtained during the survey were coded and entered into the Statistical Package for the Social Sciences (SPSS 27) for reliability testing. The instrument was subsequently deemed reliable and adopted for field administration because all its measurement scales produced Cronbach alpha coefficients not less than the benchmark of 0.7 (see Table 1).

Table 1: Questionnaire Reliability Statistics

S/N	Variables No. of item	Alpha	Coefficients
1	On-pack digital verification	3	.792
2	Independent trust badge verification	3	.799
3	Product sustainability perception	3	.764
Total			12

Source: Researchers' analysis via SPSS-27 (2026)

Method of Data Analysis

Data was collected with structured questionnaire, resulting in the collection of primary data for the research. The data was then analysed using descriptive statistics. The hypotheses were tested via a simple linear regression model.

4. Data presentation and Analysis

Three hundred eighty four copies of questionnaire were distributed, out of the distributed copies, three hundred and seventy copies were returned, properly filled, and useable. This shows that 97% was found relevant for this study. The feedback from respondents are as follows:

Table 2: Showing Respondents Profile

S/N	Sample Characteristic	Number of Respondents	Respondents (%)
1	Gender		
	Male	166	44.9
	Female	204	55.1
	Total	370	100.0
2	Age Distribution		
	18–25 years	92	24.9
	26–35 years	148	40.0
	36–45 years	85	23.0
	46 years and above	45	12.2
	Total	370	100.0
3	Educational Qualification		
	O'Level	30	8.1
	ND / NCE	55	14.9
	Bsc, B.Tec, B.ed/ HND	210	56.8
	Postgraduate Degree	75	20.3
	Total	370	100.0

Source: Researchers computation (2026)

The analysis presented in Table 2 reveals that male respondents comprised 44.9% of the sample, while female respondents accounted for 55.1%.

24.9% of the respondents are between the ages of 18 years to 25years, 40.0% accounted for respondents between 26 years to 35 years, 23.0% of the respondents are between 36 years to 45 years, and 12.2% of the respondents are between 46 years and above. A significant portion of the respondents, specifically 8.1% indicated that they have o-level educational qualification, 14.9%, indicated that they possessed ND/NCE qualifications. The proportion of individuals possessing BSc, B.Tec, B.Ed. / HND stood at 56.8%, whereas 20.3% respondents have MSc/MBA/PhD qualification.

Data Presentation and Interpretation

H₀₁: There is no significant influence of on-pack digital verification, and independent trust badge verification on product sustainability perception in the Calabar consumer market.

Table 3: Results of Multiple Regression analysis between on-pack digital verification, and independent trust badge verification on product sustainability perception in the Calabar consumer market.

Model Summary				
Model	R	R ²	Adjusted R ²	Std. Error of the Estimate
1	0.684 ^a	0.468	0.465	0.5214

a. Predictors: (Constant), on-pack digital verification, independent trust badge verification.

ANOVA					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	87.640	2	43.820	161.221	.000 ^b
Residual	99.754	367	0.271		
Total	187.394	369			

a. Dependent Variable: Product sustainability perception

b. Predictors: (Constant), on-pack digital verification, independent trust badge verification

Coefficients ^a					
1 Model	Unstandardized Coefficients B	Std. Error	Standardized coefficient Beta	t-value	Sig.
(Constant)	1.120	0.145	—	7.724	.000
On-Pack Digital Verification	0.412	0.038	0.441	10.842	.000
Independent Trust Badge	0.328	0.041	0.326	8.000	.000

a. Dependent Variable: Product sustainability perception

Source: Field Survey Result (2026).

Results of the multiple regression analysis show that the on-pack digital verification and independent trust badge verification jointly accounted for approximately 68% of the variation in product sustainability perceptions in Calabar, Cross River State consumer market with a regression coefficient of $R^2 = 0.684$. $R^2 = 0.468$, shows that 46.8% of the total variance in product sustainability perception among consumers in Calabar is explained by on-pack digital verification and independent trust badge verification. The remaining 53.2% of variance is attributed to error. In addition F-value =161.221 and P-value < 0.000 on the ANOVA shows that on-pack digital verification and independent trust badge verification jointly and significantly predicted the changes in product sustainability perception in Calabar, Cross River State consumer market. To determine the relative importance of each proxies on product sustainability perception, the coefficients are provided on the table. The on-pack digital verification increases product sustainability perception by 0.412 points on $t=10.842$, $p=0.000$ and independent trust badge verification with 0.328 points on $t=8.000$, $p=0.000$ increases product sustainability perception. Based on the values presented on the table $0.441 > 0.326$, On-pack digital verification functions as the primary predictor influencing Calabar's consumer behavior.

The proposed multiple regression equation is:

$$Y = a_0 + \beta_1 X_1 + \beta_2 X_2 + \dots e$$

$$PSP = a_0 + \beta_1 Odv + \beta_2 Itd \dots e$$

Thus, the resulting multiple regression model is presented as:

$$PSP = 1.120 + 0.328 Odv + 0.412 Itd$$

Considering the result of a significant P-value = 0.000 in the ANOVA and coefficient, it is Concluded that On-pack digital verification and independent trust badge verification have a joint significant positive influence on the product sustainability perception in Calabar, Cross River State consumer market

Discussion of findings

The empirical results showed a strong positive impact of the predictor factors; on-pack digital verification and independent trust badge verification on the product sustainability perception in Calabar, Cross River State consumer market. The result from the analysis revealed that null hypothesis is rejected and the alternative hypothesis is accepted. This suggests that verifiable indicators, and endorsement label influences sustainability perception. This outcome aligns with the research of Barata (2025); Bram (2026); and Keaney et al. (2026) who, across difference geographical area, confirmed that a significant relationship exist between supply chain traceability and product sustainability perception

5. Conclusion and business implications

Based on the findings of the study, it was concluded that there is a positive significant influence of supply chain traceability and product sustainability perception among shoppers in Calabar, Cross River State.

Recommendation

The findings of this study showed a positive influence of supply chain traceability on product sustainability perception. Since consumers, shopping centers and marketing outlets in Calabar market rely heavily on third party endorsement and verifiable indicators to validate corporate ecological claims, Manufacturers, companies should strategically limited or get rid of greenwashing suspicions by being transparent in their branding, and install a scannable on pack infrastructure, and a verifiable third party badge on their offerings. These will create a positive product sustainable perception.

Suggestion for further studies

This study focused on supply chain traceability and product sustainability perception in the Calabar, Cross River State consumer market. To address the identified limitations, future studies should be cross-regional comparison by increasing the geographical scope of the study, technological readiness in rural areas for the acceptance of on-pack digital codes, and sector-specific analysis by focusing on agri produces rather than consumer market.

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