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Investigating the Role of Supply Chain Traceability (SCT) on the Performance of Manufacturing Companies in Northern Nigeria.

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Abstract
In an increasingly competitive market, supply chain traceability (SCT) has emerge as critical factor influencing operational efficiency, regulatory compliance, and customer satisfaction. The main aim of this study is to investigate the role of Supply Chain Traceability (SCT) on the operational and environmental performance of manufacturing companies in Northern Nigeria. The study is quantitative which employed descriptive survey design. The population of the study is made up of 495 registered members of Manufacturers Association of Nigeria (MAN) across the 19 states of the Northern Nigeria including the Federal Capital Territory (FCT), Abuja. A cluster random sampling technique was used to select 239 respondents out which 196 (82%) were found valid for the analysis. The data of the study was collected using a 5 – Point Likert Scale Questionnaire and were analysed with the help of Smart PLS 4. From the result, it was found that, supply chain traceability has positive and significant on the environmental and operational performance of manufacturing companies in Northern Nigeria with (β=0.582, t=11.603, p= .000) and (β=0.681, t=15.649, p< .000) respectively. The study concluded that, supply chain traceability is a valuable strategy for the firm's competitive advantages. Thus, it is recommended that, manufacturing companies should implement tracking systems by using technologies to track products throughout the supply chain, and monitor supplier practices to ensure compliance with environmental and social standards. Future studies may investigate expand the study area to cover the whole country in order to expand the result and for comparative analysis.

Keywords: S*upply chain traceability, environmental performance, operational performance, manufacturing companies, Northern Nigeria.*

1. Introduction

At first, supply chain traceability (SCT) was thought to be a tool for identifying food damage problems (Dabbene et al., 2014). As time gone on, traceability has gained attention from the public and authorities in other enterprises. For example, in the past, failed product efforts could be ascribed to functional areas in product design, manufacturing, and even faulty labelling, with little to no impact on the offenders' financial outcomes and reputations. Today, traceability allows for the identification and blaming of specific organisations for product failures, which is crucial because items safety problems will have severe monetary consequences on a word-wide basis (Liao et al., 2020). Traceability, which signifies the ability to

recognise and verify the elements and patterns of events along the supply chain, is one technique of monitoring supply chain operations, which has received little attention in the literature. Traceability implements to both tracking and tracing, which detect the origin and characteristics of an item and record its historical shifts in connection with the supply chain; tracking environmental performance along the supply chain; and tracking the techniques used to make products. Traceability encompasses, among other things, tracing the origins of acquired goods (Cousins et al., 2019). Recalls can have major indirect costs because they can divert attention from the main goals and missions of different companies in the supply chain, even though the direct costs may ultimately fall on a specific producer within the supply chain (Ni et. al., 2014). SCT is elevated from a simple procedure to a crucial and essential strategic requirement for each participant of any supply chain due to the potential for reputational harm, whether justified or not, as well as lost productivity and revenue due to product failure (Morana, 2016). Therefore, it is crucial for any business to develop a thorough traceability system in order to retain tight control over its goods from an economic, operational, and risk management perspective (Cousins et al., 2019).

Organizations' efforts to increase performance can be hampered without supply chain traceability, and it may even send the wrong signals to their clients. Tracking and tracing items with a complicated supply network necessitates managerial judgments about their supply chain in order to increase processing efficiency and risk management. It was discover that strengthening traceability provides firms with various benefits, including increased operational efficiency. They conclude that traceability improves the efficacy of existing operational procedures aimed at reducing spoiled inventory, reducing stock-outs, and shortening lead times. In terms of environmental implications, supply chain traceability enhances the quality of reporting to external stakeholders, lowering both reporting costs and the risks of potential environmental legal expenses, penalties, and fines (Meinlschmidt et al., 2018).

Given this background, the main aim of this research is to '*Investigate the role of Supply Chain Traceability on the Environmental and Operational Performance of Manufacturing Companies in Northern Nigeria.* While the specific objectives are as follows:-

RO1: To evaluate the effect of supply chain traceability on environmental performance of manufacturing companies in Northern Nigeria.

RO2: To assess the impact of supply chain traceability on operational performance of manufacturing companies in Northern.

In view of the above stated objectives, the following hypothesis were formulated and tested:-

H_I^1 Supply Chain Traceability has a significant impact on the environmental performance of manufacturing companies in Northern Nigeria.

H_I^2 Supply Chain Traceability has a significant effect on operational performance of manufacturing companies in Northern Nigeria.

2. Literature Review

This section discusses relevant literature on the variables under review.

2.1 Supply Chain Traceability (SCT)

According to Liao et al. (2020) traceability is the ability to identify and verify the components and chronology of events surrounding products at all stages of the supply chain. Traceability encompasses the tracking of products from their raw materials through transformation into a consumer product and, ultimately,

distribution. Efficient SCT helps manufacturers track raw materials, work-in-process, finished goods and services, wherever they may reside in the supply chain. By measuring product and service history, traceability can benefit consumers, manufacturers, auditors, and other stakeholders involved in the supply chain process. This increases record accuracy, promotes supply chain transparency, and provides businesses with the ability to keep strict control over its own goods. SCT refers to the capacity to monitor a product batch and its history throughout all or part of the production chain, encompassing stages from harvest to transport, storage, processing, distribution, and sales, or within a specific step of the chain. (Kraisintu & Zhang, 2011).

Supply chain traceability (SCT) is the ability to identify and validate the components and chronology of events along the whole supply chain. It is a word used to describe the processes of tracking—finding the source and features of a certain product—and tracing—gathering product history pertaining to a product's displacement along the supply chain. Traceability encompasses various aspects such as monitoring the environmental impact of the supply chain and the manufacturing processes, ascertaining the origins of purchased products across the supply chain, identifying the sources of raw materials, and identifying the chemicals or elements present in purchased products (Cousins et al., 2019).

2.2 Manufacturing Performance

Manufacturing performance will show whether or not companies rely on needless hesitancy and inefficient procedures or whether they use their resources, capabilities, productions, and operations optimally to meet market demand and fulfil client orders. In the manufacturing sector, manufacturing performance refers to a set of objectives that are consistently met (Peng et al., 2011). According to Peng et al. (2011) it is also referred to as the real rate of achievement across the five performance aspects: cost, quality, delivery, flexibility, and innovation. It is therefore best understood as a reference point that includes a number of strategic industrial objectives. Essentially, earlier academics have used terms such as competitive considerations to refer to industrial performance, competitive capabilities, competitive performance, manufacturing goals, manufacturing success, manufacturing capability, strategic manufacturing capabilities, operational performance, among others (Madapusi & D'Souza, 2012). Despite having distinct semantics, all of these phrases refer to the same measurements and explanations of manufacturing performance (Abdulkarim et al., 2022).

2.2.1 Operational Performance

It is necessary for managers to find strategies that increase capacity and competitive advantage as firm competition heats up. Operational performance offers benefits in every way inside a firm. Better financial success, lower costs, and happier customers are all results of increased operational performance. Gaining and retaining a competitive edge is beneficial (Truong et al., 2014). Operational performance is the ability of a business to lower management expenses, improve the efficiency of raw material utilisation and distribution capacity, reduce order cycle time, and meet orders.

Operational performance is significant to businesses because it increases production efficiency, produces high-quality goods, and increases customer satisfaction, all of which boost sales and profits (Truong et al., 2014). Operational performance comprises the quantitative components of a company's operations, including dependability, manufacturing cycle a period of time and inventory turnover. This performance, in turn, drives company

performance indicators, particularly market share and client satisfaction. (Azim et al., 2015). Additionally, operational performance is the capacity of an enterprise to provide products or services to its customers in the most cost-effective manner while maintaining the quality of its products, services, and support (Ajayi & Babalola, 2021). Operational performance is considered one of the primary success factors of contemporary business organisations that are currently operating in a composite and competitive environment. By providing high-quality products or services to customers at competitive prices and meeting end-users' needs, a business can maintain a strong and positive operational performance and also achieve great success in the future. It is characterised by two specific components of supply chain management practice, which are end-user service and business efficiency (Althaqafi, 2021).

2.2.2 Environmental Performance

Environmental performance includes and focuses on reducing air emissions, wastewater, and solid wastes, as well as reducing consumption of hazardous/harmful/toxic materials, reducing the frequency of environmental accidents, and improving an enterprise's environmental situation. In general, environmental performance refers to lowering waste, pollution, and emissions while conserving resources or energy. Environmental performance in the manufacturing sector included minimising air and water emissions, waste, and hazardous chemicals. Measurement of supply chain environmental performance can include a company's ability to reduce air emissions, waste water, solid wastes, hazardous material consumption, and the frequency of environmental accidents (Geng et al., 2017).

3. Methodology

This section presents the methods, steps, and procedures that the study employed to obtain the necessary data for achieving the study's objectives. Table 1 presented the summary of the methodology followed.

Table 1: Summary of Methodology

S/N	Items	Description
1.	Research Design	Cross sectional research design
2.	Population	495 registered Members of Manufacturers Association of Nigeria (MAN) in the 19 States of Northern Nigeria including the Federal Capital Territory (FCT. Abuja) (MAN, 2024)
3.	Sample Size	239 respondents out of which 196 were retrieved and found valid for the analysis by (Krejcie & Morgan, 1970).
4.	Sampling Technique	Cluster random sampling technique
5.	Unit of analysis	CEOs, Managers and Heads of Departments
6.	Data Collection Instrument	A 5 point Likert scale questionnaire was adapted.

4. Results and Discussion

This section discusses and analyses the data obtained from the findings of the study.

4.1 Demographic Information of the Manufacturing Companies

Table 2 below presents the demographic information of the respondents.

Table 2: Demographic information of Respondents

Item		Frequency	Percentage
Company Life	Less than one year	47	24.0
	1-10 years	72	36.7
	11-20 years	32	16.3
	More than 20 years	45	23.0
	Total	**196**	**100**
Number of Employees	Less than 10	33	16.8
	10-50	69	35.2
	More than 50	93	47.4
	Not disclosed	1	.5
	Total	**196**	**100**
Status in the Business	MD/CEO	46	23.5
	Manager	53	27.0
	Unit Head	97	49.5
	Total	**196**	**100**

Source: Researcher's survey, 2025.

As presented in Table 2, this categorises respondents based on how long their company has been in operation. The results show that the highest percentage of respondents, 36.7% (72), are from companies that have been operational for 1-10 years. Companies operating for less than one year constitute 24% (47) of the respondents, while 16.3% (32) have been operating for 11-20 years. Companies with a long history of over 20 years account for 23% (45) of the total respondents. This distribution indicates a broad range of company longevity, with a slight concentration in the 1-10 years range, possibly indicating a younger, emerging market in the sector analyzed. With regards to the number of employees, which determines the size of the businesses, the largest group, 93 (47.4%), is made up of businesses with more than 50 employees, followed by 69 (35.2%) of businesses having between 10-50 employees, and 33 (16.8%) with fewer than 10 employees. The predominance of companies with more than 50 employees suggests a significant presence of medium- to large-sized enterprises. The data also reflects a nearly complete response rate, with only 1 (0.5%) respondent that failed to disclose the size of the employees. Lastly, status in the business provides an insight into the hierarchical positions of the respondents within their businesses. A significant portion, 97 (49.5%), hold the position of unit head, followed by managers at 53 (27%) and MD/CEOs making up 46 (23.5%) of the respondents. This distribution illustrates that most of the respondents occupy mid-level leadership positions, which could provide a balanced perspective between executive decision-making and on-the-ground management in the study.

4.2 Normality Test

To further test the normality of the data set, the Kolmogorov-Smirnov (K-S) test and Shapiro-Wilk (S-W) statistics for each variable were also computed. The use of normality tests for this study is consistent with other studies like (Akinola & Akinrinola, 2023; Olayemi & Adeboye, 2020; Sarihan, 2024). Table 3 shows the K-S and S-W statistics of all eight variables. Following the recommendation of Goodhue et. al. (2012) and Ghasemi and Zahediasl (2012) the values of the K-S and S-W statistics computed indicate that all the variables were statistically significant. This violates the assumption of K-S and S-W, which says that the p-value for each variable should be insignificant to indicate

normality of the data. Thus, this indicates that the data set is non-normally distributed, which further supports the use of SEM-PLS in this study.

Table 3: Kolmogorov-Smirnov and Shapiro-Wilk Statistics

Tests of Normality						
Constructs	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Operational_Performance	.117	196	.000	.958	196	.000
Environmental_Performance	.101	196	.000	.964	196	.000
Supply_chain_traceability	.140	196	.000	.972	196	.001

Source: Extracted for IBM SPSS Output, 2025.

Table 4: Descriptive Statistics of the Variables

Items of Variables	**Observation**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
SCT1	196	1	5	3.948	1.001
SCT2	196	1	5	3.830	0.889
SCT3	196	1	5	3.619	0.941
SCT4	196	1	5	3.505	0.970
OP1	196	1	5	3.892	1.047
OP2	196	1	5	3.896	0.933
OP3	196	1	5	4.052	1.039
OP4	196	1	5	3.845	0.962
EP1	196	1	5	3.694	0.941
EP2	196	1	5	3.674	0.967
EP3	196	1	5	3.865	0.934

Source: Smart-PLS Output 2025.

Based on the results in table 3 and 4 above, the majority of the respondents agreed that supply chain traceability have positive and significant relationship with the performance of manufacturing industries improve as shown by the means range 3.505 to 4.052. Based on the rule of thumb by Goodhue, et al., (2012), a mean value of ≥3.0 in a five-point scale is acceptable. Thus, indicates that the respondents to this study have averagely agreed that, supply chain traceability have significantly impacted the environmental and operational performance of manufacturing industries in the Northern Nigeria.

Table 5: Path Coefficient of Structural Equation Model

Hypothesised paths	***B***	***T***	***P***
Supply Chain Traceability -> Environmental Performance	0.582	11.603	0.000
Supply Chain Traceability -> Operational Performance	0.681	15.649	0.000

Source: Extracted from SMART-PLS Output 2025

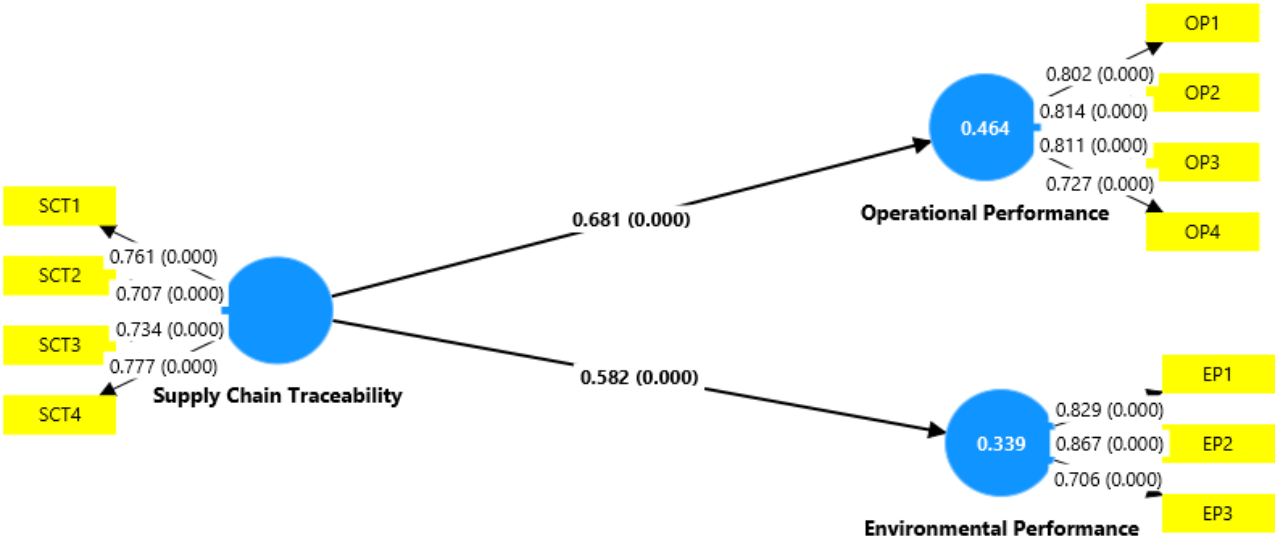

Figure 1: Bootstrapping Result: Extracted from SMART-PLS Output 2025

4.3 Hypothesis Testing

The path coefficient estimation or hypothetical relations using bootstrapping procedure was performed to observe the significance of the relationships in the inner path of the structural model (see figure 1). As a rule of thumb, the path coefficient value must be at least 0.1 to account for a particular effect in the model (Hair et al., 2017). Table 6 below shows the path coefficient assessment results for the hypothesized relationships in the structural model.

Table 6 Hypotheses Testing of Direct Effects

Hypothesised paths	B	t-statistics	p-values	Decision
SCT->EP	0.582	11.603	0.000	Significant and supported
SCT->OP	0.681	15.649	0.000	Significant and supported

Source: Extracted from SMART-PLS Output 2025

4.3.1 *Hypothesis one (H_1): Relationship between supply chain traceability and environmental performance of manufacturing industries.*

The first hypothesis one (H_1) "Supply chain traceability has significant effect on environmental performance of manufacturing industries. The results presented in Table 6 and depicted in figure 1 shows that β=0.582; t=11.603; p<0.000. Furthermore, by having P-value <0.05, it means that the results reached statistically significant. Thus, it can be concluded that, supply traceability has significant effects on the environmental performance of manufacturing industries. Hence, hypothesis one (H_1) is hereby accepted.

4.3.2 *Hypothesis two (H_2): Relationship between supply chain traceability and operational performance of manufacturing industries.*

The first hypothesis two (H_2) "Supply chain traceability has significant effect on operational performance of manufacturing industries. The results presented in Table 6 and depicted in figure 1 shows that β=0.681; t=15.649; p<0.000. Furthermore, by having P-value <0.05, it means that the results reached statistically significant. Thus, it can be concluded that, supply traceability has significant effects on the operational performance of manufacturing

industries. Hence, hypothesis two (H_2) is hereby accepted.

Discussion of Findings

Based on the results from the analysis and the reviewed of empirical studies, the findings of hypothesis are align with the study by (Kros et al., 2019), (Liao et al., 2020) among others. The results support the hypothesis that supply chain traceability positively influences both environmental and operational performance. The benefits are more pronounced in firms that integrate traceability into broader supply chain management strategies, such as quality control, sustainability reporting, and supplier relationship management. SCT allows manufacturers to pinpoint the source of quality issues in raw materials or components. For a Northern Nigerian manufacturer, this could mean quickly identifying a batch of spoiled agricultural inputs or substandard imported materials, allowing for targeted disposal or return, thus reducing overall waste. It also enables the take-back of products for recycling or remanufacturing. For instance, A manufacturer in Kwara could track its products to facilitate proper end-of-life recycling, reducing lead pollution.

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