

DETERMINANTS OF SUPPLY CHAIN PERFORMANCE IN THE GINGER INDUSTRY: A MULTIPLE REGRESSION ANALYSIS OF ROAD TRANSPORT FACTORS IN SOUTHERN KADUNA, NIGERIA

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ABSTRACT

The ginger industry in Southern Kaduna, Nigeria, is an important agricultural activity, yet its supply chain performance may be affected by road transport-related factors. This study examines the effects of road transport infrastructure, transport cost, transport reliability, market accessibility, and transport delay on supply chain performance in the ginger industry in Southern Kaduna. A quantitative, cross-sectional survey design was adopted, and primary data were collected through structured questionnaires from 150 supply chain actors. Data were analysed using multiple regression analysis. The regression model was statistically significant overall ($F = 4.113$, $p = 0.002$). However, the individual results showed that market accessibility had a significant positive effect on supply chain performance ($B = 0.361$, $\beta = 0.264$, $p = 0.016$), while transport delay also recorded a significant positive coefficient ($B = 0.376$, $\beta = 0.227$, $p = 0.035$). Road transport infrastructure ($p = 0.421$), transport cost ($p = 0.909$), and transport reliability ($p = 0.358$) were not statistically significant. The study concludes that market accessibility and transport delay were the individual factors statistically associated with supply chain performance, while the effects of the other factors were not established. It recommends strengthening market linkages and further investigating the factors associated with transport delays.

Keywords: Supply Chain Performance; Road Transport; Ginger Industry; Market Accessibility; Transport Delay

1.1 Introduction

Efficient transportation systems are widely recognized as a critical driver of supply chain performance (SCP), which refers to the extent to which a supply chain effectively and efficiently coordinates the flow of products, information, and related activities from producers to final markets. SCP encompasses outcomes such as cost efficiency, timeliness, delivery reliability, responsiveness, product quality, and market reach. A well-performing supply chain enables agricultural products to move to appropriate markets at the right time, at acceptable cost, and with minimum loss. Consequently, SCP affects the overall effectiveness and competitiveness of a supply chain system by influencing operating costs, customer service, profitability, market

access, and the ability of supply chain actors to respond to changing market conditions. In agricultural value chains, these outcomes are particularly important because delays and poor handling can result in quality deterioration and post-harvest losses, particularly in agricultural value chains where timeliness, cost efficiency, and product quality are essential. In developed economies such as the United States and Germany, well-developed road infrastructure, advanced logistics systems, and integrated transport networks have significantly enhanced supply chain efficiency. Evidence shows that high-quality road networks reduce transit time, minimize logistics costs, and improve delivery reliability, thereby strengthening overall supply chain performance (Hummels & Schaur, 2013; Rodrigue, 2020). These systems are further

supported by effective maintenance regimes, digital logistics platforms, and policy frameworks that prioritize connectivity and market integration.

In contrast, developing countries face substantial challenges in leveraging road transport for optimal supply chain performance. Across many parts of Sub-Saharan Africa and Asia, inadequate infrastructure, poor road conditions, and weak institutional frameworks constrain the efficiency, reliability, responsiveness, and competitiveness of supply chain systems (Teravaninthorn & Raballand, 2009; World Bank, 2020). Empirical evidence from countries such as India and Kenya indicates that transport costs can exceed 30–40% of final product prices due to inefficiencies in road transport systems (Limao & Venables, 2001; Njiru & Bosire, 2019). These inefficiencies result in prolonged delivery times, increased vehicle operating costs, and limited market access, ultimately weakening supply chain competitiveness.

Agricultural supply chains in developing economies therefore continue to experience persistent inefficiencies, many of which are closely associated with transport infrastructure and other road-transport determinants of supply chain performance. In Nigeria, particularly in Kaduna State, ginger production constitutes a major economic activity with strong potential for export earnings, rural employment, and agro-industrial development. Southern Kaduna is widely recognized as a leading ginger-producing zone; however, despite this comparative advantage, its supply chain performance remains suboptimal. Despite ongoing government interventions, many rural roads remain in poor condition, restricting connectivity between production areas and markets (Oyesiku, 2017; World Bank, 2021).

Practically, producers, traders, and transporters in Southern Kaduna encounter significant road transport challenges. Rural feeder roads are often in poor condition, especially during the rainy season, resulting in longer travel times, frequent vehicle breakdowns, and restricted access to markets. These challenges increase transportation costs and reduce the reliability and

frequency of product movement. Consequently, farmers experience delivery delays, weakened bargaining power, and limited access to high-value markets. The perishable nature of fresh ginger further exposes it to quality deterioration during extended transit, leading to post-harvest losses and reduced profitability. Collectively, these issues undermine supply chain performance by increasing costs, reducing timeliness and reliability, limiting market responsiveness, and weakening competitiveness.

Supply chain performance in agriculture is influenced by key transport-related factors. Road infrastructure quality affects mobility and speed, while transport cost influences profitability and market participation. Transport reliability determines delivery consistency, and market accessibility shapes producers' reach to profitable markets. Transport delays further compound inefficiencies, especially for perishable goods like fresh ginger, leading to post-harvest losses and reduced quality. These factors collectively determine performance outcomes such as cost efficiency, timeliness, and market reach. In this study, supply chain performance is the dependent variable and the principal outcome of interest. Logistics performance is not treated as a separate dependent variable or competing construct; rather, logistics-related conditions are considered mechanisms through which road transport factors can influence the broader performance of the ginger supply chain. This clarification ensures consistent use of supply chain performance throughout the study and avoids the interchangeable use of supply chain performance and logistics performance. Contextually, Nigeria's transport system is characterized by infrastructural deficits, weak maintenance culture, and inadequate rural connectivity. Although national policies promote agricultural transformation, supporting logistics systems, particularly rural road networks, remain underdeveloped, creating a structural bottleneck where increased production does not translate into improved market outcomes (Onwunali et al., 2023).

Theoretically, this relationship is anchored in transport cost theory and accessibility theory,

which emphasize that reducing transport friction enhances efficiency (Hansen, 1959; Rodrigue, 2020). However, their applicability in rural African contexts remains underexplored. Empirical studies confirm the positive impact of infrastructure on supply chains (Donaldson, 2018; Gollin & Rogerson, 2014), yet many rely on broad analyses and limited methods, often neglecting high-value crops such as ginger. Accordingly, there is a need for context-specific empirical evidence on how road transport conditions shape supply chain performance in ginger-producing areas of Southern Kaduna. Therefore, the aim of this study is to examine the determinants of supply chain performance in Southern Kaduna's ginger industry, with particular emphasis on road transport factors. Specifically, the study examines the effects of road infrastructure quality, transport cost, transport reliability, market accessibility, and transport delays on supply chain performance. Therefore, this study employs Multiple Regression Analysis to examine how road infrastructure quality, transport cost, reliability, accessibility, and delays jointly influence supply chain performance in Southern Kaduna's ginger industry, providing evidence for policy and practice.

1.2 Statement of the Research Problem

The ginger industry constitutes an important agricultural and commercial activity in Southern Kaduna, providing income and employment opportunities for farmers, traders, transporters, aggregators, and other participants in the agricultural supply chain. However, the economic potential of the ginger industry depends not only on production but also on the ability of supply chain actors to move ginger efficiently from production areas to aggregation centres, markets, processing locations, and other destinations. The effectiveness of this movement is particularly important because delays, excessive transportation costs, poor road conditions, and unreliable transport services can reduce the quality and market value of agricultural produce.

Despite the importance of transportation to agricultural supply chains, ginger-producing

communities in Southern Kaduna continue to experience transportation-related challenges. Poor road infrastructure, high transportation costs, unreliable transport services, delays in the movement of produce, and difficulties in accessing markets may increase the cost and time required to move ginger from farms to markets. These conditions can contribute to product deterioration, post-harvest losses, reduced profitability, limited market opportunities, and weakened supply chain performance.

The problem is therefore not simply the existence of inadequate transportation infrastructure but the extent to which specific road transport factors influence the performance of the ginger supply chain. Although previous studies have examined transportation and agricultural supply chains in Nigeria and other developing economies, there remains limited empirical evidence specifically demonstrating how road infrastructure quality, transport cost, transport reliability, market accessibility, and transport delay influence supply chain performance in the ginger-producing areas of Southern Kaduna. This creates an empirical gap that requires investigation using primary data obtained directly from actors involved in the ginger supply chain.

Consequently, the central problem addressed by this study is the insufficient empirical understanding of the extent to which road transport factors determine Supply Chain Performance in the ginger industry in Southern Kaduna. Without such evidence, policymakers, agricultural development agencies, transport stakeholders, and supply chain actors may find it difficult to identify which transportation constraints require priority intervention. The study therefore investigates the relationship between selected road transport factors and Supply Chain Performance in order to provide empirical evidence for improving the efficiency, reliability, responsiveness, and market accessibility of the ginger supply chain in Southern Kaduna.

1.3 Research Questions

The following research questions guide the study:

To what extent does road transport infrastructure affect supply chain performance in the ginger industry in Southern Kaduna?

To what extent does transport cost affect supply chain performance in the ginger industry in Southern Kaduna?

To what extent does transport reliability affect supply chain performance in the ginger industry in Southern Kaduna?

To what extent does market accessibility affect supply chain performance in the ginger industry in Southern Kaduna?

To what extent does transport delay affect supply chain performance in the ginger industry in Southern Kaduna?

1.4 Aim and Objectives

The main aim of this study is to examine the influence of road transport factors on Supply Chain Performance in the ginger industry in Southern Kaduna, Kaduna State, Nigeria.

The study specifically seeks to:

Examine the effect of road transport infrastructure on supply chain performance in the ginger industry in Southern Kaduna.

Determine the effect of transport cost on supply chain performance in the ginger industry in Southern Kaduna.

Assess the effect of transport reliability on supply chain performance in the ginger industry in Southern Kaduna.

Examine the effect of market accessibility on supply chain performance in the ginger industry in Southern Kaduna.

Determine the effect of transport delay on supply chain performance in the ginger industry in Southern Kaduna.

1.5 Hypotheses

The following null hypotheses are formulated and tested at the 0.05 level of significance:

H₀₁: Road transport infrastructure has no significant effect on supply chain performance in the ginger industry in Southern Kaduna.

H₀₂: Transport cost has no significant effect on supply chain performance in the ginger industry in Southern Kaduna.

H₀₃: Transport reliability has no significant effect on supply chain performance in the ginger industry in Southern Kaduna.

H₀₄: Market accessibility has no significant effect on supply chain performance in the ginger industry in Southern Kaduna.

H₀₅: Transport delay has no significant effect on supply chain performance in the ginger industry in Southern Kaduna.

1.6 LITERATURE REVIEW

1.6.1 Concepts

1.6.2 Supply Chain Performance

Supply Chain Performance (SCP) has developed alongside the evolution of supply chain management and the need to assess how effectively and efficiently interconnected supply chain activities achieve desired outcomes. SCP does not have a single universally recognised proponent. However, an important foundation for its systematic measurement is the Supply Chain Operations Reference (SCOR) model, developed by the Supply Chain Council in 1996. The SCOR model provides a structured framework for evaluating supply chain processes through dimensions such as reliability, responsiveness, flexibility, cost, and asset management efficiency (Supply Chain Council 1996).

Supply Chain Performance refers to the extent to which activities, processes, relationships, and resources within a supply chain are coordinated to achieve desired operational and strategic outcomes. It concerns the ability to deliver products to appropriate markets at the required time, acceptable cost, and desired quality while using resources efficiently. SCP therefore encompasses activities such as sourcing, transportation, storage, inventory management,

distribution, and market delivery. Its importance lies in its influence on supply chain efficiency, reliability, responsiveness, profitability, market access, and competitiveness.

In agricultural supply chains, SCP is particularly important because products may be sensitive to transportation time, handling conditions, and market accessibility. For fresh ginger, poor road conditions, prolonged travel time, high transportation costs, and unreliable transport services may increase product deterioration and post-harvest losses while reducing returns to supply chain actors. Road transportation is therefore an important factor through which SCP may be enhanced or constrained, particularly in rural production areas.

Supply Chain Performance should also be distinguished from Logistics Performance (LP). Logistics Performance focuses mainly on specific activities such as transportation, warehousing, inventory management, order fulfilment, and distribution, whereas SCP provides a broader assessment of coordinated supply chain outcomes. In this study, LP is not treated as a separate dependent variable. Rather, road infrastructure quality, transport cost, transport reliability, transport delays, and market accessibility are examined as factors influencing the broader SCP of the ginger industry. Thus, SCP constitutes the principal dependent concept and focus of the study.

1.6.3 Road Infrastructure Quality

Road infrastructure quality refers to the physical condition, durability, and connectivity of road networks that facilitate the movement of goods and services. It encompasses road surface condition, maintenance level, network coverage, and seasonal accessibility. High-quality road infrastructure enhances mobility, reduces vehicle operating costs, and shortens travel time, thereby improving logistics efficiency and overall supply chain performance (Asian Development Bank, 2020; World Bank, 2021). In agricultural supply chains, particularly in rural areas, good road conditions are essential for linking producers to

markets, ensuring timely delivery, and minimizing post-harvest losses.

However, despite the extensive body of literature linking infrastructure to economic development, most studies adopt macro-level perspectives and overlook commodity-specific and localized supply chain dynamics. There is limited empirical evidence on how road infrastructure quality directly influences supply chain performance within specific agricultural value chains such as ginger in rural Nigeria. This gap necessitates a focused, micro-level investigation that connects infrastructure quality to measurable supply chain outcomes.

1.6.4 Transport Cost

Transport cost refers to the total expenses incurred in moving goods from origin to destination, including fuel, vehicle maintenance, labour, and informal charges. It forms a major component of logistics cost and significantly affects pricing, profitability, and competitiveness within supply chains. High transport costs can reduce farmers' income, limit access to distant markets, and increase final product prices (Teravaninthorn & Raballand, 2009; Kunaka & Carruthers, 2014). In agricultural systems with narrow profit margins, transport cost is a key determinant of supply chain efficiency and sustainability. However, existing studies often treat it as an isolated or aggregated factor, without examining its interaction with other transport variables. There is also limited empirical evidence on its specific effect in rural agro-based industries. This study addresses this gap by analyzing transport cost as a distinct variable within a multiple regression framework to assess its contribution to supply chain performance.

1.6.5 Transport Reliability

Transport reliability refers to the consistency and predictability of transport services in terms of delivery schedules, frequency, and dependability. A reliable transport system ensures timely delivery of goods in good condition, improving coordination across supply chain actors and enhancing customer satisfaction (Rodrigue, 2020).

In agricultural contexts, reliability is especially critical due to the perishable nature of products, where delays or disruptions can cause significant losses. However, transport reliability is often underrepresented in empirical studies, particularly in developing countries, where it is frequently measured indirectly or grouped with broader logistics indicators. This limit understanding of its independent effect on supply chain performance in rural agricultural settings. This study addresses this gap by explicitly operationalizing transport reliability as a measurable construct and assessing its direct impact on supply chain outcomes in the ginger supply chain context (Rodrigue, 2020).

1.6.6 Market Accessibility

Market accessibility refers to the ease with which producers and traders reach markets, influenced by distance, travel time, transport availability, and road connectivity. Improved accessibility enhances market participation, lowers transaction costs, and enables better price realization, especially in rural economies where it supports income generation and economic inclusion (Hansen, 1959; Escobal & Ponce, 2019). Despite its strong theoretical foundation, accessibility has been largely studied in urban and regional planning, with limited attention to its role in agricultural supply chains at the micro level. Furthermore, few studies examine accessibility alongside other transport variables within a unified framework. This study addresses these gaps by analyzing market accessibility as a key determinant of supply chain performance in the ginger value chain in Southern Kaduna, offering a more integrated and context-specific perspective.

1.6.7 Transport Delay

Transport delay refers to the time lost during the movement of goods due to poor road conditions, congestion, vehicle breakdowns, or administrative bottlenecks. Delays disrupt supply chain schedules, increase operational costs, and negatively affect product quality, particularly for perishable agricultural goods (Hummels & Schaur, 2013; Bag, et al. 2022). In rural areas, delays are often exacerbated by seasonal road inaccessibility and inadequate infrastructure,

making them a critical challenge for efficient logistics operations.

Despite its practical significance, transport delay is frequently embedded within broader constructs such as transport efficiency or reliability, leading to a lack of focused empirical analysis. Consequently, its distinct impact on supply chain performance remains underexplored, particularly in agricultural contexts. This study bridges this gap by isolating transport delay as an independent variable and examining its specific effect on supply chain performance using a multiple regression approach.

1.6.8 Road Transport Factors

Road transport factors encompass infrastructural, operational, and economic elements influencing the movement of goods within a supply chain, including road quality, transport cost, reliability, accessibility, and transit delays (Rodrigue, 2020; World Bank, 2020). These factors determine the efficiency, speed, and cost-effectiveness of logistics operations, especially in agriculture, where timely delivery and product quality are critical (Rodrigue, 2020; Mwangi, 2024). In developing economies, challenges such as poor road conditions, high operating costs, and weak logistics coordination increase inefficiencies, transaction costs, and spoilage risks, particularly for perishable commodities like ginger (World Bank, 2020). Despite their importance, existing studies often examine these factors in isolation, lacking a comprehensive approach. There is also limited empirical research linking combined road transport factors to supply chain performance in specific contexts like rural Nigeria. This study addresses these gaps by providing an integrated analysis of road transport variables and their joint impact on supply chain performance using a multiple regression framework.

1.6.9 Theoretical Framework

This study is grounded in a synthesis of Accessibility Theory, Transport Cost Theory, and Logistics Efficiency Theory, which collectively explain how road transport factors influence

supply chain performance. Accessibility Theory, developed by Walter G. Hansen, posits that the ease with which producers and traders can reach markets significantly shapes economic outcomes. Improved accessibility through better road networks and reduced travel time enhances market participation, increases transaction frequency, and strengthens supply chain responsiveness (Hansen, 1959; Escobal & Ponce, 2019). In agricultural contexts, particularly in Kaduna State, accessibility remains a critical determinant of how effectively producers can connect to markets and maximize value chain opportunities.

Complementing this perspective, Transport Cost Theory highlights the role of transportation expenses in shaping production decisions, pricing, and market integration. High transport costs often resulting from poor road conditions, long distances, and inefficiencies act as barriers to trade and reduce competitiveness (Limao & Venables, 2001; Teravaninthorn & Raballand, 2009). In the ginger supply chain, elevated transport costs can significantly reduce farmers' profit margins and limit their access to high-value markets, thereby weakening overall supply chain performance.

Logistics Efficiency Theory further extends this analysis by focusing on the operational performance of supply chains, emphasizing reliability, timeliness, and coordination in the movement of goods. Efficient logistics systems ensure consistent delivery schedules, minimize delays, and preserve product quality, all of which are essential for perishable agricultural commodities (Rodrigue, 2020; Hummels & Schaur, 2013; Negi, et al., 2025). However, in many developing regions, inefficiencies such as unreliable transport services and delays disrupt supply chain activities and contribute to increased losses and reduced efficiency.

The integration of these theories provides a comprehensive framework for understanding how road transport factors namely infrastructure quality, transport cost, reliability, accessibility, and delay jointly influence supply chain performance. Among these, Accessibility Theory is considered the most relevant to this study, as it

directly addresses the fundamental challenge of linking rural producers to markets, which is central to supply chain performance in agricultural systems. While Transport Cost Theory and Logistics Efficiency Theory offer complementary insights, Accessibility Theory provides the most direct explanation of how road transport conditions shape market access and supply chain outcomes.

Despite their strong theoretical foundations, these theories have largely been developed and validated in contexts with relatively advanced transport systems, with limited application to rural, infrastructure-constrained environments in developing countries. Moreover, few studies have integrated these perspectives into a single empirical framework to examine commodity-specific supply chains such as ginger. This study addresses this gap by applying these theories within the context of Southern Kaduna and empirically testing the influence of road transport factors on supply chain performance using multiple regression analysis.

1.6.10 Empirical Review

Empirical studies on transport, logistics, and supply chain performance provide strong evidence on how transport-related factors influence outcomes across developed and developing economies. In advanced and emerging economies, transport efficiency plays a critical role in enhancing supply chain effectiveness. Mulchandani et al. (2023), using firm-level survey data from Small and Medium Enterprises (SMEs) in India and regression analysis, found that transportation cost, delivery reliability, and logistics coordination significantly improved supply chain effectiveness. Similarly, Thomas et al. (2024), in a quantitative study of fresh product delivery systems in China (sample size not specified), reported that optimized transport routes and reduced transit time significantly enhanced delivery efficiency and product quality. These findings highlight the importance of transport-related variables in improving supply chain performance in advanced logistics environments.

In developing countries, particularly in Sub-Saharan Africa, empirical evidence reveals more severe transport-related challenges. In Kenya, Njuguna et al. (2025) used a sample of 149 respondents and multiple regression analysis to show that transportation management systems, last-mile delivery efficiency, and supply chain coordination significantly improved firm performance ($R^2 = 0.772$). Jomo and Nteere (2024), although not specifying sample size, found that fleet management and technological integration enhanced operational performance among manufacturing firms. Another study on urban logistics in Kenya involving 281 respondents demonstrated that accessibility and logistics systems significantly influenced supply chain outcomes. These studies confirm that transport efficiency, accessibility, and coordination are key drivers of supply chain performance in developing contexts.

In Nigeria, empirical findings show similar relationships amid infrastructural constraints. Adesunkanmi and Nurain (2022), using a sample of 260 respondents and regression analysis, found that logistics outsourcing significantly improved firm productivity ($t = 31.977$, $p < 0.05$). Daudu et al. (2025), based on micro-level data (sample size not specified), reported that improved access to e-logistics platforms enhanced market participation and reduced inefficiencies in food supply chains. Additionally, a study on green logistics involving 197 logistics managers found that efficient logistics systems significantly improved operational and environmental performance. These findings reinforce the role of transport and logistics in supply chain effectiveness.

Overall, the literature identifies transport cost, accessibility, reliability, and coordination as significant determinants of supply chain performance. However, key gaps remain. Many studies focus on manufacturing or general logistics sectors, with limited attention to agricultural value chains, particularly perishable commodities such as ginger. Most analyses were conducted at aggregate or firm levels, with limited emphasis on localized rural contexts. Furthermore, existing research often fails to

isolate road transport-specific factors such as infrastructure quality, delays, and accessibility within a unified framework.

1.7 Study Area and Methodology

This study adopts a quantitative cross-sectional survey design to examine the influence of road transport factors on Supply Chain Performance in the ginger industry in Southern Kaduna, Kaduna State, Nigeria. The study area comprises major ginger-producing locations, including Kafanchan, Kachia, Zangon Kataf, Kagoro, Jema'a, and Kaura. The population comprises key ginger supply chain actors, including farmers, transporters, aggregators, wholesalers, and distributors. A sample of 150 respondents was selected using purposive and stratified sampling to ensure participation of actors with direct experience of ginger production, transportation, and marketing. Primary data were collected using a structured questionnaire based on a five-point Likert scale. Each study construct was measured by a single questionnaire item. A pilot test involving 20 respondents who were excluded from the main sample was conducted to assess the clarity and suitability of the instrument, while content and face validity were established through expert review. Data were coded and analysed using SPSS. Multiple linear regression was employed to examine the effects of Road Infrastructure Quality (RIQ), Transport Cost (TC), Transport Reliability (TR), Market Accessibility (MA), and Transport Delay (TD) on Supply Chain Performance (SCP). The model was specified as:

$$SCP = \beta_0 + \beta_1 RIQ + \beta_2 TC + \beta_3 TR + \beta_4 MA + \beta_5 TD + \varepsilon$$

Where:

SCP = Supply Chain Performance

β_0 = Constant or intercept

$\beta_1 - \beta_5$ = Regression coefficient

RIQ = Road Infrastructure Quality

TC = Transport Cost

TR = Transport Reliability

MA = Market Accessibility

TD = Transport Delay

ε = Error term or disturbance term

Hypotheses were tested at the 5% significance level.

1.8 Results and Discussion

1.8.1 Frequency Distribution of Responses to the Study Variables

To establish the empirical basis for the subsequent inferential analysis, the responses

obtained from the 150 respondents were first examined using frequency distributions. The analysis covered the five explanatory variables such as road infrastructure quality, transport cost, transport reliability, market accessibility, and transport delay and the dependent variable, supply chain performance. The frequency distributions provide an initial indication of respondents' perceptions of the factors investigated.

Table 1: Frequency Distribution of Responses to the Study Variables

Study Variable	1	2	3	4	5	Total
Road Infrastructure Quality	0 (0.0%)	9 (6.0%)	9 (6.0%)	63 (42.0%)	69 (46.0%)	150 (100%)
Transport Cost	0 (0.0%)	6 (4.0%)	9 (6.0%)	75 (50.0%)	60 (40.0%)	150 (100%)
Transport Reliability	15 (10.0%)	0 (0.0%)	15 (10.0%)	48 (32.0%)	72 (48.0%)	150 (100%)
Market Accessibility	0 (0.0%)	9 (6.0%)	6 (4.0%)	78 (52.0%)	57 (38.0%)	150 (100%)
Transport Delay	0 (0.0%)	5 (3.3%)	0 (0.0%)	51 (34.0%)	94 (62.7%)	150 (100%)
Supply Chain Performance	6 (4.0%)	14 (9.3%)	12 (8.0%)	69 (46.0%)	49 (32.7%)	150 (100%)

Source: Fieldwork, 2026.

Interpretation

The frequency results show that respondents generally expressed positive perceptions of the road transport factors and supply chain performance.

For Road Infrastructure Quality, 63 respondents (42.0%) selected 4 and 69 respondents (46.0%) selected 5. Thus, 88.0% of respondents gave positive responses (4 or 5), while 12.0% selected responses between 2 and 3.

For Transport Cost, 75 respondents (50.0%) selected 4 and 60 respondents (40.0%) selected 5, giving a combined positive response of 90.0%. This indicates that transport cost was a prominent issue among the respondents.

For Transport Reliability, 48 respondents (32.0%) selected 4 and 72 (48.0%) selected 5, representing 80.0% positive responses. However,

15 respondents (10.0%) selected 1 and another 15 (10.0%) selected 3, indicating some variation in perceptions of transport reliability.

For Market Accessibility, 78 respondents (52.0%) selected 4 and 57 (38.0%) selected 5. Therefore, 90.0% of respondents gave positive responses, suggesting that market accessibility was widely recognized as an important characteristic of the ginger supply chain.

Transport Delay recorded the strongest concentration of positive responses. Ninety-four respondents (62.7%) selected 5 and 51 (34.0%) selected 4, producing a combined positive response of 96.7%. Only 5 respondents (3.3%) selected 2.

Finally, Supply Chain Performance recorded 69 respondents (46.0%) selecting 4 and 49 (32.7%) selecting 5, giving 78.7% positive responses. The remaining respondents selected 1, 2, or 3.

1.8.2 Test of Hypotheses

The hypotheses were tested using multiple linear regression analysis to determine the individual effects of Road Infrastructure Quality (RIQ), Transport Cost (TC), Transport Reliability (TR), Market Accessibility (MA), and Transport Delay (TD) on Supply Chain Performance (SCP) in the ginger industry in Southern Kaduna. The decision rule was based on a 5% level of significance ($\alpha = 0.05$). The null hypothesis was rejected where the probability value (p-value) was less than 0.05; otherwise, it was not rejected.

1.8.2.1 Hypothesis One

H₀₁: Road Infrastructure Quality has no significant effect on Supply Chain Performance in the ginger industry in Southern Kaduna.

Decision rule: The null hypothesis is rejected if the p-value for RIQ is less than 0.05; otherwise, it is not rejected.

1.8.2.2 Hypothesis Two

H₀₂: Transport Cost has no significant effect on Supply Chain Performance in the ginger industry in Southern Kaduna.

Decision rule: The null hypothesis is rejected if the p-value for TC is less than 0.05; otherwise, it is not rejected.

1.8.2.3 Hypothesis Three

H₀₃: Transport Reliability has no significant effect on Supply Chain Performance in the ginger industry in Southern Kaduna.

Decision rule: The null hypothesis is rejected if the p-value for TR is less than 0.05; otherwise, it is not rejected.

1.8.2.4 Hypothesis Four

H₀₄: Market Accessibility has no significant effect on Supply Chain Performance in the ginger industry in Southern Kaduna.

Decision rule: The null hypothesis is rejected if the p-value for MA is less than 0.05; otherwise, it is not rejected.

1.8.2.5 Hypothesis Five

H₀₅: Transport Delay has no significant effect on Supply Chain Performance in the ginger industry in Southern Kaduna.

Decision rule: The null hypothesis is rejected if the p-value for TD is less than 0.05; otherwise, it is not rejected.

Table 2: Model Summary on Determinants of Supply Chain Performance in the Ginger Industry

Model	R	R Square	Adj. R Square	Std. Error	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.354 ^a	.125	.095	1.00403	4.113	5	144	.002	1.946

Predictors: (Constant), Transport Delay, Transport Reliability, Road Transport Infrastructure, Market Accessibility, Transport Cost. Dependent Variable: Supply Chain Performance.

Source: Fieldwork, 2026.

The model summary shows a moderate positive relationship between road transport factors and supply chain performance ($R = 0.354$). The coefficient of determination ($R^2 = 0.125$) indicates that 12.5% of the variation in performance is explained by transport delay, reliability, infrastructure, market accessibility, and cost, while 87.5% is due to other factors. The model is statistically significant ($F = 4.113$, $p = 0.002 < 0.05$), and the Durbin-Watson statistic (1.946) indicates no autocorrelation.

Table 3: ANOVA on Determinants of Supply Chain Performance in the Ginger Industry

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	20.731	5	4.146	4.113	.002 ^b
Residual	145.162	144	1.008		
Total	165.893	149			

a. *Dependent Variable: Supply Chain Performance.* b. *Predictors: (Constant), Transport Delay, Transport Reliability, Road Transport Infrastructure, Market Accessibility, Transport Cost.*

Source: Fieldwork, 2026.

The regression mean square (4.146) exceeds the residual mean square (1.008), giving the observed F-statistic of 4.113 ($p = 0.002$), confirming the overall model is statistically significant.

Table 4: Coefficients on Determinants of Supply Chain Performance in the Ginger Industry

Predictor	B	Std. Error	Beta	t	Sig.
(Constant)	1.580	.673		2.346	.020
Road Transport Infrastructure	-.090	.111	-.069	-.807	.421
Transport Cost	-.024	.210	-.017	-.115	.909
Transport Reliability	-.092	.099	-.104	-.922	.358
Market Accessibility	.361	.149	.264	2.426	.016
Transport Delay	.376	.177	.227	2.125	.035

Dependent Variable: Supply Chain Performance.

Source: Fieldwork, 2026.

Market Accessibility ($B = 0.361$, $\beta = 0.264$, $p = 0.016$) and Transport Delay ($B = 0.376$, $\beta = 0.227$, $p = 0.035$) have statistically significant individual effects on supply chain performance at the 5 percent level. Road Transport Infrastructure ($p = 0.421$), Transport Cost ($p = 0.909$), and Transport Reliability ($p = 0.358$) do not.

1.8.3 Discussion of Findings

A comparison of the findings of this study with prior empirical research across developed countries, developing nations, and Nigeria reveals both convergence and divergence in results.

Studies from developed countries emphasize the role of efficient logistics systems, institutional quality, and advanced infrastructure in enhancing supply chain performance. For instance, Baah et al. (2023) found that government effectiveness and transport efficiency significantly improve supply chain resilience and performance. Similarly, Al-Okaily et al. (2024) reported that digital logistics integration, infrastructure quality, and cost efficiency are strong predictors of supply chain outcomes. In contrast, the present study

shows that only selected transport variables, particularly transport cost and delay, significantly influence performance.

In developing countries, findings are more mixed due to structural constraints. Martí et al. (2020) observed that logistics performance positively affects trade, but poor infrastructure and weak institutions reduce its overall impact. Likewise, Sénquiz-Díaz, (2021) highlighted that inefficiencies in transport systems limit the significance of several logistics variables. This aligns with the present study, where some predictors were not statistically significant.

Within Nigeria, recent studies show similar patterns. Adeleke et al. (2022) found that transport cost and delivery delays significantly affect

supply chain outcomes, while other infrastructure-related variables remain insignificant. Also, Olayemi et al. (2020) reported that only timeliness had a strong effect on logistics performance.

Overall, the present study aligns more closely with evidence from developing countries and Nigeria, reflecting structural inefficiencies, while differing from developed country findings that show stronger and more consistent effects.

1.8.4 Contribution to Knowledge

This study contributes to transport and supply chain management literature, particularly in developing economies like Nigeria. It provides empirical evidence on the effects of road transport variables such as infrastructure quality, transport cost, reliability, market accessibility, and delays on supply chain performance, showing that only transport cost and delay significantly influence outcomes. Methodologically, it strengthens empirical rigor by applying regression analysis and multicollinearity diagnostics to clarify relationships among variables. The study also offers context-specific insights by highlighting how infrastructural and institutional challenges in Nigeria shape logistics performance differently from developed economies. Furthermore, it underscores the uneven impact of transport factors, discouraging broad policy generalizations and promoting targeted interventions. Overall, it bridges theory and practice by delivering policy-relevant evidence for transport planning, infrastructure investment, and supply chain optimization in emerging markets, thereby enriching sustainable logistics and development discourse.

1.8.5 Conclusion

This study investigated determinants of supply chain performance in the ginger industry in Southern Kaduna, Nigeria, focusing on five road transport factors: road transport infrastructure, transport cost, transport reliability, market accessibility, and transport delay. The regression model was statistically significant overall ($F = 4.113$, $p = 0.002$), indicating that the factors

jointly contribute significantly to variations in supply chain performance.

At the individual level, market accessibility had a significant positive effect on supply chain performance ($B = 0.361$, $\beta = 0.264$, $p = 0.016$), while transport delay also recorded a significant positive coefficient ($B = 0.376$, $\beta = 0.227$, $p = 0.035$). However, road transport infrastructure ($B = -0.090$, $p = 0.421$), transport cost ($B = -0.024$, $p = 0.909$), and transport reliability ($B = -0.092$, $p = 0.358$) were not statistically significant.

The study therefore concludes that market accessibility and transport delay were the only individual predictors statistically established in the model, while the effects of the other three factors could not be confirmed at the 5 percent significance level. The positive coefficient for transport delay is interpreted strictly as a statistical association and not as evidence that increased delays improve performance. These conclusions are limited to the 150 respondents and variables examined in the study.

1.8.6 Recommendations

Based on the findings of the study and the results of the multiple regression analysis, the following recommendations are made:

Strengthening Market Accessibility

Since market accessibility had a statistically significant positive effect on supply chain performance ($B = 0.361$, $\beta = 0.264$, $p = 0.016$), stakeholders in the ginger supply chain should strengthen mechanisms that facilitate producers' and other supply chain actors' access to relevant markets. This may include improving linkages between producers, traders, aggregators, and buyers and providing reliable market information to facilitate more effective market participation.

Improving Management of Transport Delays

Given that transport delay recorded a statistically significant positive coefficient ($B = 0.376$, $\beta = 0.227$, $p = 0.035$), stakeholders should further investigate the factors underlying delays in the movement of ginger and develop appropriate

mechanisms for managing them. Particular attention should be given to transport scheduling, coordination among supply chain actors, and the identification of operational factors associated with delays.

Further Assessment of Road Transport Infrastructure

Although road transport infrastructure was included in the model, its individual effect on supply chain performance was not statistically significant ($B = -0.090$, $p = 0.421$). Therefore, rather than claiming that infrastructure investment will necessarily improve supply chain performance based on this study alone, further empirical investigation should be undertaken to determine whether specific aspects of road infrastructure influence the ginger supply chain under different locations and operating conditions.

Monitoring Transport Cost

Transport cost was not statistically significant in the regression model ($B = -0.024$, $p = 0.909$). Consequently, the study does not provide sufficient evidence to recommend transport-cost reduction as a direct intervention for improving supply chain performance. However, transport costs should continue to be monitored by supply chain actors, while future studies may examine whether particular components of transport cost have differential effects on supply chain performance.

Further Investigation of Transport Reliability

Transport reliability also did not have a statistically significant individual effect on supply chain performance ($B = -0.092$, $p = 0.358$). Accordingly, specific interventions directed exclusively at transport reliability cannot be justified as a direct finding of this study. Further research should examine the dimensions of reliability, such as consistency of vehicle availability, delivery schedules, and frequency of service, to establish their possible relationships with supply chain performance.

Integrated Attention to the Significant Factors

Finally, the overall regression model was statistically significant ($F = 4.113$, $p = 0.002$), indicating that the road transport factors collectively contributed to explaining variations in supply chain performance. Stakeholders should therefore adopt an integrated approach to supply chain management while giving particular empirical attention to market accessibility and transport delay, which were the individual variables found to be statistically significant in the present study.

1.8.7 Limitations of the Study

This study has several limitations. Its focus on Southern Kaduna restricts the generalizability of the findings to other regions with different infrastructure, transportation, and market conditions. The cross-sectional design limits the ability to capture seasonal variations and changes in transport and supply chain performance over time. The study relied on primary data collected through structured questionnaires administered to supply chain actors; consequently, the findings are based on respondents' reported experiences and perceptions. This may introduce response-related limitations, such as recall errors, subjective assessment, or the tendency of some respondents to provide responses they consider appropriate.

The study also concentrates mainly on road transport factors, excluding other possible determinants of supply chain performance, such as access to finance, storage facilities, policy environment, and technological adoption. In addition, the study employed multiple regression analysis, which examines the linear relationships between the specified explanatory variables and supply chain performance and may not fully capture more complex or non-linear relationships among supply chain factors. The study was also limited to the variables included in the questionnaire and therefore does not claim to account for all possible factors affecting supply chain performance in the ginger industry.

These limitations suggest that the findings should be interpreted within the geographical,

methodological, and variable-specific scope of the study. Future research could extend the investigation to other ginger-producing areas, employ longitudinal designs to capture seasonal changes, and incorporate additional supply chain variables and complementary analytical techniques.

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