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UNDERSTANDING LOGISTICS INFRASTRUCTURE CHALLENGES AND SUPPLY CHAIN PERFORMANCE: A QUALITATIVE EXPLORATION OF CUSTOMS EFFICIENCY, TRACKING PRACTICES, AND DELIVERY RELIABILITY

Daniel M. Okafor[1*], Grace N. Adeyemi[2], Michael T. Eze[2]

[1]Department of Business Management, University of Lagos, Lagos, Nigeria,
daniel.okafor@unilag.edu.ng

[2]Department of Business Management, University of Lagos, Lagos, Nigeria

Corresponding Author: Daniel M. Okafor

ABSTRACT

The effect of logistics infrastructure deficit, uncertainty in customs processes and tracking on the delivery reliability and supply-chain performance. Thematic coding, frequency distributions, percentages and descriptive comparisons were used to analyze the synthetic qualitative data of 36 logistics organisations. The results revealed the problem of road congestion and the condition of the roads as the most important infrastructure problem, and the irregular inspection and documentation as the most important customs problem. Integrated GPS and application programming interface tracking systems were linked to better delivery results, while fragmented platforms, manual updates, delayed customs milestones, and partner non-compliance were linked to suboptimal delivery results. The main performance impacts were longer lead times, higher logistics costs, customer dissatisfaction, stock-outs and production interruptions. Pre-clearance procedures, document checks, stakeholder coordination, centralized visibility systems, contracting with multiple carriers and diversification of routes were identified as coping strategies. The study finds that all physical infrastructure, customs efficiency and information visibility need to be improved together to enhance the delivery reliability. The dataset was synthetic and should be confirmed in future studies by interviewing, surveying, working in the operating situation and with case evidence from real logistics situations.

Keyboard: Logistics infrastructure; Customs efficiency; Shipment tracking; Delivery reliability; Supply-chain performance

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1. Introduction

Logistics infrastructure is the physical, institutional and digital infrastructure that facilitates the movement of goods from producers to borders, distribution centres to final customers. It affects transport time, transaction cost, inventory availability, service consistency and competitiveness of wider economic corridors. The findings of the developing-economy corridors reveal that inadequate hard infrastructure and logistics infrastructure can limit the potential gains of large-scale trade investments (Sumbal et al., 2024). Cross-country analysis also points to the interdependence of infrastructure, service competence, customs processes, tracking, and timeliness, as elements of logistics efficiency (Bayraktar et al., 2024). Logistics performance therefore goes beyond transportation activity as it influences the efficiency of trade and economic development in general (Yangailo, 2024).

Lack of infrastructure is particularly impactful when road, port, storage, energy and intermodal transportation systems are consistently constrained. Poor transport and logistics infrastructure in Nigeria has been linked to low logistics efficiency and predictability in operations (Olalekan Ahmed, 2025). The inefficiencies in hinterland transport can lengthen cargo dwell time, increase congestion and reduce port-inland market's co-ordination (Domfeh et al., 2026). Other similar challenges in sub-Saharan countries are disintegration of transport networks, logistics costs, inadequate technology integration and poor institutional coordination (Kuteyi & Winkler, 2022). Organizational sustainability efforts also depend on the quality of the infrastructure, and the quality of the operating environment cannot be adequately compensated by making organizational improvements alone (Ohakwe & Wu, 2025).

Another crucial aspect of reliable supply chains is customs efficiency. Even if there is physical shipping capacity, shipment release delays can occur due to documentation duplication, inconsistent inspection practices, valuation dispute, interruption of systems and limited coordination between border agencies. Studies carried out at the Mombasa Port reveal that the freight conditions at the border are closely associated with the performance of shipping companies in East Africa (Njuguna et al., 2025). Digital customs reform can enhance coordination through the centralization of information, data reusability and provide logistics actors with earlier visibility on the clearance status (Do & Mammadov, 2026). However, if digital systems are to cut down on administrative burdens, they need to be underpinned by solid infrastructure, procedures that are consistent, and the ability of users.

Shipment tracking links physical activities and information-based decision making. If operational data are present, data analytics can aid in predicting delays, tracking exceptions, and optimizing logistics management (Van Rensburg, 2024). Faster communication and better shipment status updates (Murugi, 2022) can enhance visibility and performance for transport operators through the adoption of technology. Another approach to coordinating distribution is through the use of integrated logistics networks which integrate transport, storage, information and delivery processes within an organization (Judijanto et al., 2024). But, disparate platforms, manual updates, slow customs milestones and varying

scanning practices by partners can lead to data gaps and put a strain on confidence in estimated arrival and delivery dates.

These conditions of infrastructure, customs, and tracking accuracy are converted to a result that the supply chain partners and customers directly experience: delivery reliability. The data from Zanzibar Port, therefore, highlights the importance of reliable delivery in enhancing the performance of port supply chains and ensuring coordination and consistency of services offered (Migoda & Mwalukasa, 2025). Deliverability is still being discussed as a key performance indicator (KPI) in the port context in more recent literature (Migoda & Mwalukasa, 2026). In e-commerce logistics, communicating with customers is crucial and setting realistic expectations relies on implementing trustworthy delivery guarantees, timely responses, and handling service exceptions effectively (Fonseka & Sasi, 2026). The quality of containers services is also a significant factor as customers judge the logistics service providers based on the reliability and communication factors during container-shipping service (Bunzali et al., 2025).

Delayed deliveries aren't the only problem with inconsistent logistics. Inefficient transport operations increase costs, variability of lead-time, inventory control issues, and overall supply-chain performance (Kunnton, 2023). Coordination, transport capacity, information management, and timely delivery are critical in humanitarian and pharmaceutical supply chains, where disruptions can impact access to critical products (Tufa & Tebeka, 2025). The nature of these linkages implies that problems with infrastructure, customs inefficiency, tracking gaps and delivery unreliability are not to be considered as separate operational issues, but as a system of interwoven problems.

Although there is a growing body of literature on logistics performance, there has been little focus on the qualitative aspects of stakeholders' explanations of the challenges in the day-to-day context of their operations. Prior research typically focuses on individual performance measures, specific technologies or specific transport contexts, and provides less understanding on how physical constraints and information gaps impact the delivery results. The present study thus examines the relationship between infrastructure conditions, customs processes, tracking, delivery reliability and supply-chain performance. It has a qualitative focus on operational patterns, perceived relationships and organizational responses in logistics contexts. The study pursued the following objectives:

1. To identify major logistics infrastructure challenges affecting customs efficiency, shipment tracking, and delivery reliability
2. To examine how customs procedures and tracking practices influence delivery reliability across logistics operations
3. To explore how delivery reliability shapes supply-chain performance and organizational responses to logistics disruptions

2. Methodology

2.1 Research Design

The design of this study was exploratory qualitative which aimed at examining the relationships between logistics infrastructure, customs process, tracking of shipment and reliability of delivery with supply chain performance. Analysis was conducted on a purpose-built synthetic dataset that was representative of the possible operational experiences, not through evidence gathered from human participants. All the records were considered as individual logistics stakeholder case records. The design was able to facilitate comparison of themes across contexts within organizations, and simultaneously maintain narrative detail. The material was artificial and the study was presented as a methodology demonstration and no claims were made concerning any actual organisations, locations or populations.

2.2 Dataset and Case Selection

The dataset contained a total of 36 synthetic stakeholder cases evenly distributed across freight forwarding, customs brokerage, road transport, warehousing and distribution, import-export operations and e-commerce logistics. There were six professional roles, and each professional role was assigned with six cases. The organizational size was 12 small, 12 medium and 12 large organizations. Each of the four transport configurations and four generic logistics corridors contains nine cases. Experience ranged from 3 to 20 years. Constructed interview durations ranged from 31 to 61 minutes. Thus the sampling was purposive and balanced rather than probabilistic.

2.3 Interview Framework and Data Construction

The semi-structured interview method was used to create synthetic narratives based on the background of the respondents, infrastructure constraints, customs efficiency, shipment tracking, delivery reliability, performance results, and mitigation techniques. Five open-text fields were used to elicit construct-specific responses for each case. The stories illustrated operationally plausible scenarios such as congestion, customs checks, duplication of documentation, broken tracking systems, missed delivery windows and disruption of inventories. Contextual fields included type of organization, professional role, experience, size of organization, mode of transport and logistics corridor. All records were clearly labeled synthetic so as to avoid them being mistaken for real interview testimony.

2.4 Coding and Thematic Analysis

The data were analyzed using a structured thematic approach. First, all narratives were reviewed by construct to identify the primary operational issue. Second, for infrastructure, customs, tracking, delivery reliability, performance impact, and coping strategy, each case was given one primary code. Third, frequencies and percentages were calculated to describe the coded distribution, not as a replacement for qualitative interpretation. Severity was described in a five point ordinal framework but

observations were limited to levels 2 through 5. Finally, analyst memos were examined to link upstream operational constraints to reliability concerns and downstream supply chain impacts.

2.5 Methodological Consistency and Ethical Position

Methodological consistency was ensured by a predefined interview guide, a common coding structure, a comprehensive codebook, and similar construct fields for all 36 cases. Coding categories were maintained exactly as recorded. No cases were dropped due to missing data. The descriptive calculations were checked against the source worksheet. The narratives were synthetic, so conventional qualitative credibility procedures such as member checking, investigator triangulation and empirical saturation were not used. Ethical approval and informed consent were not required, but the process was fully transparent and the generated excerpts were not treated as real participant quotations.

3. Results

3.1 Characteristics of the Synthetic Cases

The synthetic sample comprised 36 cases of logistics stakeholders. The largest organizational group was freight forwarders (n = 8, 22.2%) followed by road carriers (n = 7, 19.4%). Six cases were from customs brokers and import/export firms. 41.7% were medium-sized organizations, and the predominant mode was road transport (38.9%). The central corridor had 12 cases (33.3%) which was higher than the cross border urban, northern and southern corridor. These variations provided a wider base for comparing organizational and operational views across the five results domains represented in the synthetic qualitative logistics dataset (Table 1).

Table 1. Profile of the synthetic logistics cases

Variable	Category	Frequency (n)	Percentage (%)
Organization type	Freight forwarder	8	22.2
	Customs brokerage	6	16.7
	Road carrier	7	19.4
	Warehousing and distribution	5	13.9
	Import/export firm	6	16.7
	E-commerce logistics	4	11.1
Organization size	Small	11	30.6
	Medium	15	41.7

	Large	10	27.8
Primary transport mode	Road	14	38.9
	Multimodal	9	25.0
	Sea-road	8	22.2
	Air-road	5	13.9
Logistics corridor	Northern corridor	8	22.2
	Southern corridor	7	19.4
	Central corridor	12	33.3
	Cross-border urban corridor	9	25.0

3.2 Infrastructure and Customs-Related Challenges

Road congestion and deterioration was the most frequently mentioned infrastructure challenge (n=10, 27.8%), followed by port and terminal congestion (n=8, 22.2%). Six cases (16.7%) were attributed to poor warehousing facilities, whereas unreliable utilities, poor last-mile connectivity and limited intermodal connectivity were less common. The most common customs findings were random inspections (n = 9, 25.0%) and duplicate documentation (n = 8, 22.2%). The other cases involved system outages, uneven application, classification issues, and limited pre-clearance benefits. These cases exhibit more variation in operational challenges than the original balanced construction design (Table 2).

Table 2. Prevalence and severity of infrastructure and customs-related challenges

Domain	Challenge	Cases (n)	Percentage (%)	Mean severity	Rank
Infrastructure	Road congestion and deterioration	10	27.8	4.30	1
Infrastructure	Port and terminal congestion	8	22.2	4.10	2
Infrastructure	Inadequate warehousing capacity	6	16.7	3.80	3

Infrastructure	Unreliable power and digital connectivity	5	13.9	3.60	4
Infrastructure	Weak last-mile access	4	11.1	3.40	5
Infrastructure	Limited rail and intermodal connectivity	3	8.3	3.20	6
Customs	Unpredictable inspections	9	25.0	4.40	1
Customs	Duplicate documentation	8	22.2	3.90	2
Customs	Customs-system outages	6	16.7	3.80	3
Customs	Inconsistent border enforcement	5	13.9	3.60	4
Customs	Classification and valuation disputes	4	11.1	3.50	5
Customs	Limited benefit from pre-clearance	4	11.1	3.10	6

3.3 Tracking Practices and Delivery Reliability

Delivery reliability was clearly different between tracking arrangements. Integrated GPS and API tracking led to six out of ten deliveries being successful and only one being unreliable. Instead, the fragmentation of platforms and manual updates created four unreliable cases each. The weak last-mile visibility led to three unreliable deliveries from five cases, and delayed customs milestones three out of four. Both cases of partner data non-compliance were not dependable. Overall, 17 of 36 cases (47.2%) were deemed to be unreliable, which highlights the need for integrated and timely shipment information (Table 3).

Table 3. Tracking practices by delivery-reliability outcome

Tracking practice	Reliable, n	Partially reliable, n	Unreliable, n	Total, n	Unreliable (%)
Integrated GPS and API tracking	6	3	1	10	10.0
Fragmented tracking platforms	1	3	4	8	50.0
Manual status updates	1	2	4	7	57.1
Weak last-mile visibility	0	2	3	5	60.0
Delayed customs milestones	0	1	3	4	75.0
Partner data non-compliance	0	0	2	2	100.0
Total	8	11	17	36	47.2

3.4 Effects on Supply-Chain Performance

The most reported performance effect was longer order-to-delivery lead time with 24 cases (66.7%) and a mean impact score of 4.20. Then it was followed by 21 (58.3%) cases of higher logistics cost and 18 (50.0%) cases of customer dissatisfaction. There were 14 cases of stockouts and production interruption, 12 of excess safety stock, and nine of lost sales or cancelations. The downward trend indicated that the time and cost performance were initially affected by logistical limitations, which had more serious effects on inventory and market issues (Table 4).

Table 4. Effects on supply-chain performance

Performance effect	Cases reporting effect (n)	Percentage of cases (%)	Mean impact score	SD	Rank
Longer order-to-delivery lead time	24	66.7	4.20	0.80	1
Higher logistics cost	21	58.3	4.00	0.90	2
Customer dissatisfaction	18	50.0	3.80	0.90	3
Stockouts and production interruption	14	38.9	3.60	1.00	4
Excess safety stock	12	33.3	3.40	1.10	5
Lost sales and order cancellation	9	25.0	3.20	1.00	6

3.5 Coping Strategies and Integrated Relationships

The most common coping strategy was pre-clearance and document review (20 cases, 55.6%), with an average effectiveness score of 4.10. Multiple-carrier contracting was present in 16 cases, and border-stakeholder coordination in 14, with an average effectiveness of 4.00. Control towers were less common but had the highest effectiveness score (4.20). Relationship assessments were mostly moderate-to-strong (38.9%) or strong (27.8%). Overall these results suggested that coordination and visibility measures were seen to be more effective than inventory buffer or route diversification (Table 5) (Table 6).

Table 5. Use and perceived effectiveness of coping strategies

Coping strategy	Cases using strategy (n)	Usage (%)	Mean effectiveness	SD	Rank
Central visibility control tower	7	19.4	4.20	0.70	1
Pre-clearance and document review	20	55.6	4.10	0.80	2

Coordination with border stakeholders	14	38.9	4.00	0.80	3
Multiple-carrier contracting	16	44.4	3.80	0.90	4
Route diversification	9	25.0	3.60	1.00	5
Safety stock and time buffers	12	33.3	3.20	1.10	6

Table 6. Strength of the relationship between logistics challenges and supply-chain performance

Relationship strength	**Frequency (n)**	**Percentage (%)**	**Numeric score**
Weak negative relationship	2	5.6	1
Moderate negative relationship	10	27.8	2
Moderate-to-strong negative relationship	14	38.9	3
Strong negative relationship	10	27.8	4

4. Discussion

Unique logistics infrastructure, customs formalities, tracking and reliability of delivery all play a part in the performance of supply chains. The most common infrastructure issues reported were road congestion and deterioration, followed by port/terminal congestion and lack of warehousing capacity. The problems show that infrastructure constraints can build up at various points in the logistics chain rather than being limited to a point in one transport. Evidence indicates that roads, border facilities, communication systems and trade supporting infrastructure have significant impact on export competitiveness within the East African Community (Olyanga et al., 2022). The present results also correlate these shortcomings to higher operating expenses, stock interruptions, longer delivery times, and customer dissatisfaction.

The impacts of poor physical infrastructure were exacerbated by customs-related issues. Duplicate documentation and unpredictable inspections were found more often than classification disputes and

benefits from pre-clearance were limited. It indicates that the efficiency of the customs depends not only on the availability of the facilities at the border but also on the consistency of customs procedures, the accuracy of customs documents, the coordination and timely exchange of information. Literature review also shows that customs capability, operational responsiveness, service integration and coordination are also significant factors influencing the cross-border efficiency of third-party logistics (3PL) providers (Shaharudin et al., 2025). The present results show that poor customs clearance can result in delays in the supply chain that negatively impact delivery commitments, storage needs and customer trust in logistics services.

There were some differences in the reliability of delivery that could be obtained from tracking practices. Of the 10 cases, there were six successful GPS and API-based deliveries and one failed delivery. Conversely, less reliable delivery results were correlated with fragmented platforms, manual updates, missed customs milestones, and partner data that is not complete. The result aligns with the perspective that digital transformation contributes to the improvement of international logistics performance, providing greater visibility, information transfer, coordination, and quicker decision-making (Islam 2026). It is also aligned with research studies that focus on the need for a global logistics integration that demands interoperable digital systems for connecting geographically distributed actors in the supply chain (Wang et al., 2024). However, the results indicate that technology can only add limited value if logistics partners do not deliver accurate, standardized and timely tracking data.

The transportation delays were not the only performance consequences identified. The most common result reported was longer order to delivery time, followed by increased logistics costs and dissatisfaction with customers. Stock outs, production disruptions, surplus safety stock and lost sales were less common but were organizational serious consequences. The results indicate a continuum of challenges starting from infrastructure and customs related issues that have a direct impact on delivery time and operating costs, and then moving on to inventory availability, production continuity, and customer relationship. This is similar to the literature that focuses on vulnerabilities in the international logistics system being interconnected rather than singular operational events (Lopez Garcia, 2026). Better tracking and vulnerabilities identification may thus allow organizations to take action before the individual delays escalate to broader supply chain failures.

There are several strategies that organizations used to deal with these challenges. Pre-clearance and document review was the most widely-used response, while centralized visibility control towers were the least common response, but the highest-rated by convenience. Among the other aspects of the coordination with border stakeholders, it was decided that it was of the highest order, highlighting the need for collaboration in the case of logistics issues involving public agencies and private companies. Inconsistent results also show that PPC can be a key tool for enhancing transport logistics by providing infrastructure investments, operational knowledge, resource sharing, and coordination of stakeholders

at inland strategic points (Okonge & Nyaronga, 2025). Multiple carrier contracting and route diversification also enabled operation flexibility, but were seen as less effective than integrated information systems and coordinated customs-clearance planning.

The results overall are integrated and give an explanation for delivery reliability. Physical infrastructure is a factor in whether or not goods can be transported efficiently, customs is a factor in whether or not goods can be released in a predictable manner, and tracking systems are a factor in whether or not an organization can identify and communicate the status of a shipment. The reliability of delivery is thus a measure of the overall quality of these three. When only one aspect is improved, some improvement is observed, but not much. For instance, if the capacity of the terminals is increased but the customs procedures remain unchanged, the delays may not change. Likewise, if they do not have partner support for tracking, it can lead to missing shipment visibility. To enable effective improvement, coordinated investment in transport infrastructure, customs processes, digital standards, and employee capability and interorganizational governance is needed.

The results indicate that logistics organisations should focus on the following areas: document verification, real-time milestone sharing, common partner-data standards and exception-management procedures. Performance monitoring should be linked to the accuracy of deliveries, consequences on inventory, costs, and customer results from the infrastructure and customs events. Policymakers should also ensure investments along the transport corridors, dry ports, customs clearance centres and digital platforms are coordinated. The data set is synthetic, however, and the numerical results show plausible analytical relationships—this is not to suggest a prevalence or causality relationship has been established. To confirm these relationships, future research is recommended to be based on interviews with freight forwarders, customs brokers, carriers, warehouse operators, importers and e-commerce service providers along various transport corridors and countries.

5. Conclusion

These logistics infrastructure gaps, coupled with unclear customs processes and lack of supply-chain tracking, compound the delivery reliability and performance of supply-chain problems. Poor road infrastructure, port congestion, low warehousing stocks and poor intermodal connectivity impede the physical flow of goods and lead times. When customs procedures have unpredictable inspections, multiple documents, varying enforcement, downtime, and classification issues, these challenges are exacerbated. This situation complicates the predictability of clearance and results in extra storage, transport and administrative expenses. The results also show that weak information sharing between logistics partners, outdated status updates and delayed customs milestones limit end-to-end shipment visibility, as well as fragmented tracking platforms. Organizations with poor tracking data don't know what to expect, cannot tell customers what they will be getting, and have a hard time coordinating appropriate responses when something goes wrong. As a result, customers' satisfaction can be affected,

stock-outs can occur, production can be interrupted, safety stock can be carried, and sales can be lost. Digital tracking, document verification, pre-clearance, stakeholder coordination and route diversification can contribute to an enhanced operational responsiveness and delivery reliability. The results, however, are not from actual logistics organizations, but are a synthetic, qualitative analytical framework. The reported patterns illustrate how qualitative themes can be coupled with numerical summarizations to analyze relationships between logistics performance. To confirm the results it is suggested that future studies are conducted using real field data obtained from interviews, operational records, surveys and case studies in different countries, transport corridors and different logistics sectors.

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