Exploring the Impact of Infrastructural Deficiencies on Logistics Efficiency in Nigeria.

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Abstract

This study explores how problems with infrastructure affect logistics efficiency in Nigeria. It focuses on how bad roads, unreliable power supply, port congestion, and lack of digital infrastructure make logistics operations harder. Using a qualitative study design, data was gathered through semi-structured interviews with important people and case studies of logistics companies. Thematic research showed that holes in infrastructure make travel far more expensive, slow down deliveries, and make the supply chain less reliable. Even with these problems, the report shows that technological solutions like GPS tracking, warehouse management systems, and mobile logistics apps are becoming more important in fixing problems and making service better. The analysis also finds the best ways to undertake sustainable logistics, such as optimizing routes, combining shipments, and using green technologies. The case studies of GIG Logistics and DHL Nigeria show that digital innovation may improve operational performance and environmental sustainability, especially in places where infrastructure is limited. The study finds that Nigeria needs to adopt technology, get legislative backing, and invest in infrastructure in a smart way to make logistics more efficient in the long term.

Keywords/tags (subjects)

logistics efficiency, infrastructure deficiency, Nigeria, technology adoption, sustainable logistics, supply chain management.

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1 Introduction

Corporate competitiveness, trade facilitation, job creation, and more general economic growth are all significantly influenced by logistics efficiency. Driven by developments in digital technologies and supply chain management, the logistics sector worldwide has changed dramatically. Developments such as automation, real-time tracking, and integrated information systems have improved logistics processes—ranging from transportation and warehousing to inventory control and customer fulfilment—consolidating logistics as a foundation of modern economic development (Chavarria et al., 2018).

Emerging technologies including distributed ledger systems, Internet of Things (IoT), cyber-physical systems (CPS), and digital supply chains (DSC) are changing the logistics scene in Industry 4.0. By improving visibility, flexibility, and supply chain responsiveness, these technologies help to shape Logistics 4.0—an agile, data-driven logistics model supporting dynamic global trade and customer expectations (Buyukozkan & Gocer, 2018). Global marketplaces getting more complicated drive the need for logistics systems that are digitally connected, resilient, and responsive.

Many industrialised countries are using these technologies inside strong physical infrastructure settings, but much of sub-Saharan Africa, particularly Nigeria, struggles greatly. Infrastructural shortcomings—especially in road quality, energy availability, port systems, and multimodal transportation connectivity—remain constant across the continent and continue to hinder supply chain integration and trade competitiveness (AfDB, 2021). Erratic power supply, inadequate rail and inland water transport, and bad roads hinder the continent's capacity to maximise logistical efficiency and take advantage of world trade trends.

Strategically located, Nigeria, the largest country in Africa by GDP and population, might develop into a logistical hub for West Africa. Its logistics industry, meanwhile, is still hampered by systematic infrastructure deficiencies. These consist of underdeveloped alternate transport modes, inconsistent power supply, ineffective port operations, poor rural-urban connections, and crumbling roadways. These physical infrastructure deficiencies continue to be a major obstacle for sustainable logistical operations and national competitiveness even with the fast expansion of digital commerce and a vibrant fintech ecosystem (Adeniran et al., 2022; Chavarria et al., 2018).

The growth of e-commerce in Nigeria emphasizes even more the need to handle these limitations. Although websites like Jumia and Konga have led online shopping, ongoing logistical inefficiencies—particularly in last-mile deliveries, cold chain management, and fulfilment speed—still affect service quality and scalability. By contrast, global leaders like Amazon and Alibaba gain from integrated logistics systems, which helps them to control costs, speed of delivery, and customer happiness (Deng et al., 2022). This difference draws attention to how infrastructure limitations undermine Nigeria's capacity to compete in the worldwide digital economy.

Neglect of logistics infrastructure not only causes economic inefficiencies but also social and investment hazards. Bad infrastructure raises running expenses, discourages foreign direct investment, postpones industrial production, and undermines Nigeria's trading chances. Nigeria's logistics industry runs under great strain since roads carrying over 90% of freight transit are in disrepair and insufficient upkeep. While restricted rail and inland water networks hinder multimodal transportation possibilities essential for economical freight distribution (World Bank, 2020), power interruptions still interfere with digital supply chain systems and warehouse operations.

Given the size of these obstacles, a comprehensive evaluation of how infrastructural shortcomings influence logistics efficiency in Nigeria is absolutely required. Entitled "Exploring the Impact of Infrastructural Deficiencies on Logistics Efficiency in Nigeria", this paper aims to offer a thorough knowledge of the issue. It looks at how inadequate infrastructure affects supply chain performance, drives operational inefficiencies, and restricts economic development. The ideas produced seek to guide public-private partnerships, infrastructure investment plans, and policy creation that can propel inclusive growth and logistics sector modernization.

Resolving infrastructure gaps has to be a national priority given Nigeria's goals to diversify its economy and join more competitively into worldwide value chains. By means of identifying important shortcomings, examining their operational and financial effects, and suggesting fact-based solutions to these obstacles, our work supports that initiative.

1.1 Thesis Objectives

The main objective of the study is to explore **the Impact of Infrastructural Deficiencies on Logistics Efficiency in Nigeria.** And specifically, to; To explore in depth how technological advancements influence and improve the efficiency of warehouse logistics operations. To examine and understand the key challenges and obstacles faced when optimizing supply chain processes. And To identify and describe best practices and successful strategies for achieving sustainable logistics management.

1.2 Research Questions

The research will answer the following questions.

1. How do infrastructural deficiencies in Nigeria affect warehouse logistics and overall supply chain efficiency?
2. What technological interventions can help overcome infrastructural challenges and improve logistics efficiency in Nigeria?
3. What best practices can support sustainable logistics management in environments with infrastructural constraints?

1.3 Scope of the study

The purpose of this study is to investigate the potential effects that deficits in infrastructure would have in the future on the effectiveness of logistics in Nigeria, with a specific emphasis on essential components such as road networks, the dependability of energy, port facilities, and the incorporation of technology. The analysis will place an emphasis on the manner in which these inadequacies are anticipated to have an impact on logistical performance indicators in the years to come, such as operational costs, delivery timeframes, and service quality.

The geographical scope will embrace the varied terrain of logistics in Nigeria, taking into account the specific issues that are encountered in both urban and rural areas with unique characteristics. The study will place an emphasis on the important role that road transport plays, as it will continue to handle the majority of freight transportation. Additionally, the study will take into consideration the fact that rail and water transport systems have the potential to expand.

A forward-looking perspective will be used by the study in terms of time, and it will incorporate projected trends in the development of infrastructure and logistics. The examination of the possible consequences of Nigeria's ongoing digital transformation, the expansion of e-commerce, and the growing adoption of modern supply chain technology are all included in this.

The importance of logistics companies and the ever-evolving solutions they employ to address infrastructure-related difficulties will continue to be emphasized. Through the identification of creative solutions, such as investments in technology, alternative mobility plans, and cooperation with both the government and the private sector, the research will produce insights that can be put into action to shape future industry practices.

The relevance of the study will also be maintained by taking into account the interaction between the logistics industry and other industries, such as the manufacturing and trade industries. This report will highlight the importance of infrastructure funding and environmental implications as areas that require further investigation, but it will not delve thoroughly into either of these topics.

This study will present a road map for enhancing the efficiency of Nigeria's logistics system by addressing the concerns regarding the potential future repercussions of infrastructure shortages. It will provide direction for policymakers, business leaders, and researchers, with the goal of ensuring that the infrastructure of logistics will continue to promote economic growth and global competitiveness in the years to come.

1.4 Limitation of the study

The study is limited to investigating how infrastructural shortcomings affect logistics performance in the Nigerian setting. It notably emphasizes important infrastructure elements such road networks, power supply, port facilities, and access to digital technologies since they directly affect the cost, timeliness, and quality of logistics services. The study focusses only on logistics and supply chain operations, especially inside companies involved in goods handling, distribution, and e-commerce logistics; it does not cover all industries of the Nigerian economy.

Geographically, the analysis is limited to metropolitan and peri-urban areas where logistical activities are most pronounced, such as Lagos, Abuja, and Port Harcourt, while rural areas are excluded due to scope and resource constraints. Though the study acknowledges the significance of national infrastructure policies, political pressures, and international trade agreements, they are only addressed to the degree they directly influence infrastructural development pertinent to logistics activities.

Moreover, the analysis is confined to changes and data from the last five years (2020–2024) to remain relevant and mirror present infrastructural issues. It also uses a qualitative research approach; hence, the results might not be statistically generalizable but are meant to offer in-depth understanding of the lived experiences of logistics players in Nigeria.

2 Research Methodology

This chapter aims to give a summary of the method used to analyze the effect that infrastructure constraints have on the effectiveness of logistics in Nigeria, therefore helping to understand their influence. This study aims to highlight the particular infrastructure issues affecting logistics operations, explore how these constraints affect logistics costs and service timeliness, and look at the strategies logistics companies have used to counteract these obstacles. The study will ensure that a complete understanding of the research problem will be made available to the participants by using primary methods of data gathering. To achieve the goal of obtaining in-depth insights from important stakeholders in Nigeria's logistics sector, a qualitative approach comprising semi-structured interviews would be used. This will help to reach the aim. The use of the approach will be the way this goal will be reached**.**

2.1 Research Design (Qualitative Research)

This thesis uses a qualitative study design to investigate the intricate relationships between technological implementation, supply chain optimization issues, and sustainable logistics practices inside the logistics sector. The qualitative approach is selected to allow a rich, contextualized understanding of processes, behaviors, and lived experiences (Creswell, 2013). This design is especially appropriate for answering exploratory research questions and finding rich, complex insights that quantitative approaches could miss. Focusing on the Nigerian logistics environment, the paper underlines

gathering subjective data via semi-structured interviews and case studies to grasp the viewpoints of logistics experts and stakeholders.

2.2 Data Collection Methods

Semi-structured interviews, which permit flexibility while preserving consistency among participants, are the principal data gathering technique (Bryman, 2016). Participants will consist of technology leads from mid-sized logistics companies operating in Nigeria, sustainability officers, supply chain coordinators, and logistics managers. Focusing on people with direct knowledge in technological integration, optimization initiatives, and sustainable logistics practices, participants will be chosen by means of purposive sampling to guarantee relevance to the study goals. Professional networks and industry associations will help to drive recruitment.

The discussions will be guided by an interview process addressing issues including:

- Views on infrastructural shortcomings and how they affect logistics activities.
- Experiences with putting technology solutions into practice—for instance, WMS, IoT, automation.
- Successes and challenges in reaching logistics optimization.
- Sustainable logistics practices: challenges and efforts.

Depending on participant availability and location, interviews will be performed in person or via online platforms and take between 45–60 minutes. With permission, all interviews will be audio-recorded.

Apart from interviews, 2–3 case studies of logistics companies will be held. These companies will be chosen depending on their active use of cutting technologies and sustainable practices; their operations will be investigated by means of document studies, site inspections, and extra interviews with important people. This strategy will allow triangulation of interview data and offer contextual depth (Yin, 2018).

2.3 Data Analysis

Thematic analysis, as described by Braun and Clarke (2006), will be used for data analysis. The procedure will call for:

- Familiarization: Reading the data and transcribing interviews verbatim to get an overview.
- Using NVivo software to help organize and control the data, methodically coding significant characteristics of the data across the whole dataset during first coding.
- Grouping codes into more general themes that mirror patterns pertinent to the study topics.
- Refining and confirming themes against the data to guarantee they precisely reflect participants' experiences and ideas.
- Defining and Naming Themes: Offering unambiguous definitions and labels for every theme.
- Reporting: Weaving direct quotations into a story that highlights important ideas by means of synthesis of the results.

Cross-case comparisons will help to highlight similarities and differences between examples, hence strengthening the validity of the results.

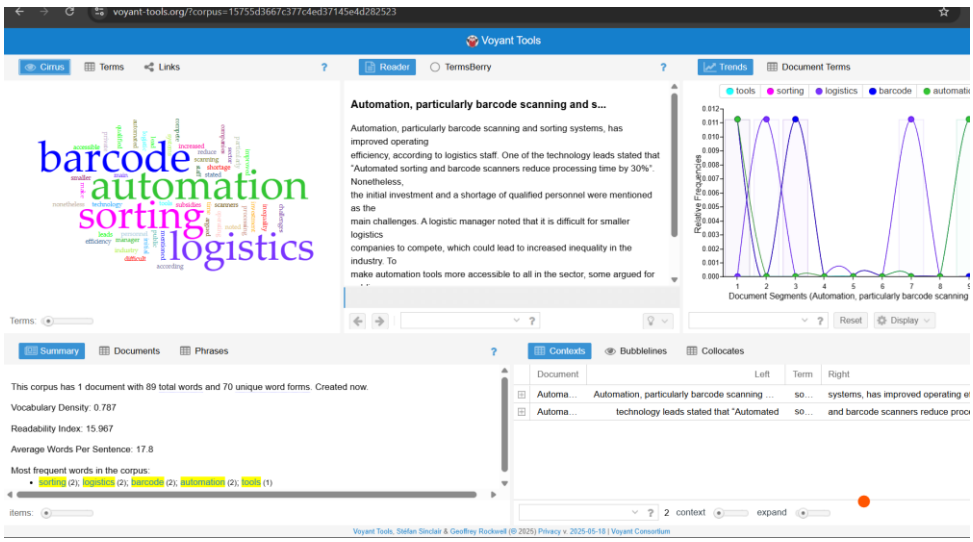

Figure 1: Interface of Voyant Tool

2.4 Literature Review

A literature review is a methodical approach to collecting, examining, and synthesizing past studies to grasp the present knowledge base, underline gaps, and offer background for new research

(Baumeister & Leary, 1997; Tranfield et al., 2003). Emphasizing efficiency gains, supply chain optimization, and sustainability practices, the literature review of this thesis investigates technical tools, case studies, and theoretical frameworks pertinent to warehouse logistics. Among the sources are case studies addressing the advantages, obstacles, and best practices of using cutting-edge technologies in logistics as well as academic papers and industry magazines. The study intends to:

• Deepen knowledge of technology's part in improving logistics efficiency.

• Find shared obstacles in maximizing logistics operations.

• Emphasize tried-and-true techniques for executing sustainable logistics.Webster and Watson (2002) claim that a comprehensive literature review guarantees the study is founded in current and pertinent research by not only summarizing current results but also identifying gaps requiring more investigation.

3 Infrastructural Deficiencies and Their Operational Impacts on Logistics in Nigeria

Various infrastructural deficiencies have a major impact on logistics operations in Nigeria, especially in terms of supply chain efficiency and corporate sustainability. Among the most constant problems is the insufficient road network, which causes higher transport prices and delays. Road infrastructure quality, say Adeniran et al. (2022), directly affects e-commerce logistics by especially affecting delivery times and operating expenses for businesses like Jumia. Their research indicates that inadequate maintenance and bad road conditions increase fuel use and create delivery system inefficiencies, hence lowering consumer happiness and compromising organisational performance. Though, although this report describes the challenges, it lacks a methodical examination of how these concerns fluctuate across various areas of Nigeria or how companies' adaptive methods have changed with time.

The inconsistent power supply, which undermines the effectiveness of logistics activities, is another important infrastructural lack. Inconsistent power, according to Adeniran et al. (2022), compromises warehouse operation and interferes with communication systems required for inventory control and real-time tracking. Though there are still unanswered questions on how companies give money

to reduce these risks, particularly in rural compared to urban settings, the relationship between electricity dependability and logistical performance is widely known.

The port infrastructure is likewise somewhat difficult. According to Abdul et al. (2019), insufficient port infrastructure, especially in major centres like Lagos, cause bottlenecks that disrupt the seamless flow of commodities and drive-up shipping costs. Although these results draw attention to significant logistical choke points, the research provides little understanding of how public and private sector partnerships could sustainably solve these constraints.

Another underappreciated yet essential aspect is technological infrastructure. Nigeria's lag in embracing sophisticated logistics technologies—including smart warehousing, self-driving cars, and Internet of Things (IoT) devices—limits the sector's modernization potential. While Egbebu (2021) and Abdul et al. (2019) both explore how underinvestment in digital infrastructure aggravates inefficiencies, neither paper really tackles how companies weigh the costs and advantages of digital transformation in a context of ongoing physical infrastructure issues. This is a significant gap since, if properly used, technology could balance certain physical infrastructure shortcomings.

Figure 2: Conceptual Framework – Impact of Infrastructural Deficiencies on Logistics Efficiency in Nigeria

3.1 Impact of Infrastructural Deficiencies on Logistics Costs and Timeliness

In Nigeria, infrastructure shortcomings significantly affect service timeliness and logistics expenses. Inadequate infrastructure causes delays that raise running costs for logistics companies. Focusing on small and medium-sized businesses (SMEs) in Nigeria's hospitality industry, Egbebu (2021) finds transportation delays and erratic power as main causes raising logistical expenses and lowering profitability. Although Egbebu's research is educational, it overlooks sectoral variations and the degree to which these effects could differ for e-commerce vs conventional retail logistics.

Abdul et al. (2019) present a case study of Dangote Flour Mills Nigeria showing how poor transportation systems and insufficient information flow increase operational expenses and cause major delivery delays. Though its emphasis on one industry example restricts the generalizability of its results

across Nigeria's larger logistics sector, this study highlights the interrelated character of many logistical components.

Ristovska et al. (2017) present a broader conceptual framework, stressing logistics activities such as information flow (INF), transportation management (TPL), warehousing (WHS), and inventory control (IVM) as vital to logistics efficiency and overall organizational success. While their work is worldwide in scope, it emphasizes the relevance of these principles, which, when weakened by infrastructure issues, result in reduced service quality and diminished customer satisfaction. Their research, however, lacks particular relevance to Nigeria, thereby lacking knowledge on how these worldwide best practices are being modified to fit local reality—or not.

Examining how logistical inefficiencies influence customer service quality (CUS) and market satisfaction (MKS) in e-commerce environments, Li et al. (2019) offer data from Cameroon. Given comparable infrastructural limits, these results are quite pertinent to Nigeria. More localized studies are still required, though, to find whether Nigeria's particular economic and infrastructure circumstances produce similar or different results.

3.2 Strategies Adopted by Logistics Firms

To negotiate infrastructural issues, Nigerian logistics companies have used several adaptive techniques. According to Adeniran et al. (2022), businesses such as Jumia have come up with innovative routing plans to avoid congested roads and harm. Although this suggests operational flexibility, there is little study on the long-term viability of these workarounds or their national scalability.

Infrastructure development also depends on government-private sector partnerships, especially in vital areas like roads and ports. The studies, meanwhile, offer little thorough analysis of the efficacy of these alliances and the organizational obstacles hindering faster development.

Reducing the consequences of inadequate infrastructure has become more dependent on technology adoption. Abdul et al. (2019) draw attention to rising investments in digital solutions including fleet management software, GPS monitoring systems, and mobile apps for customer communication. Despite physical constraints, these technologies improve service efficiency. Still, a lot of the

studies underexplore the obstacles to widespread technology adoption like high costs, inadequate digital literacy, and legal issues.

According to Green et al. (2008), measures in supply chain management—particularly enhanced coordination between consumers and suppliers—can help to offset certain negative consequences of infrastructure shortcomings. Their findings, while important, are based on broader international contexts and hence require adaptation and critical examination within Nigeria's specific infrastructural situation.

3.3 Implications for Future Research

The above-mentioned gaps highlight several topics that need more investigation and that this work aims to handle. First off, more in-depth study is needed on the particular infrastructure issues affecting Nigerian logistics operations. In later studies, it is essential to thoroughly assess not just the roads and ports but also the challenges caused by the limits of technology and the power supply. Focusing on these under-researched topics would help this study to clarify more completely the factors affecting the performance of logistics in Nigeria.

Another important subject of study is the regional diversity of logistical challenges, hence future studies should also address this. Future studies could more accurately reflect the logistical issues rural areas face if research is conducted beyond large urban centres such as Lagos. Rural locations could have even less developed infrastructure than city areas. This geographic growth will provide a more complex understanding of how deficiencies in infrastructure influence the performance of logistics all throughout the different parts of the nation.

Furthermore, by looking at the newest technical solutions and innovative techniques logistics organizations are using to solve the problems infrastructure creates, this study will add to the present body of knowledge. Clearly, studies looking at how modern logistics firms are integrating technology-based solutions into their operations—such as the Internet of Things (IoT), artificial intelligence (AI), and blockchain—in order to reduce the consequences of insufficient infrastructure are much needed. An awareness of how these technologies are used to solve infrastructural deficiencies

would help one to provide valuable insights into the future of logistics in Nigeria and help logistics businesses negotiate the challenges bad infrastructure generates.

Ultimately, the research will offer notable insights into the several ways infrastructural constraints affect the performance of logistics in Nigeria if it seeks to close these gaps. The results could help to shape policy choices, enable logistics businesses to maximize their performance, and improve the efficiency of the logistics industry in the nation.

Knowledge Base

This chapter offers a thorough investigation of the theoretical underpinnings, pragmatic advantages, issues, and best practices related to warehouse logistics, supply chain optimization, and sustainable logistics management. It combines current academic studies, industry methods, and actual data to create a strong awareness of the vital components propelling modern logistics operations.

4 Theoretical Frameworks Guiding the Analysis of Infrastructure and Logistics Performance in Nigeria

Focusing on important ideas that help knowledge of infrastructural shortcomings and their influence on logistics performance in Nigeria, this part describes the theoretical foundation supporting modern logistics and supply chain management. Central to this basis are systems theory, lean logistics, the resource-based view (RBV) of the enterprise, and institutional theory.

According to systems theory, logistics networks are linked systems where every component, from suppliers to end consumers, affects general performance (Bertalanffy, 1968). In Nigeria, inadequate infrastructure—such as inadequate road systems and inconsistent power supply—disturb these interconnections, hence causing delays, greater costs, and less flexibility. Therefore, systems theory clarifies how poor connections in Nigeria's infrastructure flow through the logistics system, therefore influencing general performance.

Originating from lean manufacturing, lean logistics emphasizes constant improvement and just-in-time processes to maximize value and minimize waste (Womack & Jones, 1996). But the use of lean ideas is hampered by Nigeria's infrastructural issues, such as power outages and tardy port operations. This concept offers understanding of how infrastructural deficiencies impede waste reduction and efficiency, hence restricting companies' capacity to use just-in-time logistics.

The RBV underlines those unusual resources such as modern IT systems, specialized labor, and proprietary processes can offer competitive advantage (Barney, 1991). Companies like Jumia in Nigeria use creative delivery methods and digital tracking tools to offset infrastructure-related inefficiencies. This system shows how logistics companies may develop internal capacity to surpass external infrastructure limits.

Relevant in describing pressures on Nigerian companies to enhance logistics despite infrastructure limitations, institutional theory emphasizes how legal forces, social expectations, and normative standards shape business behavior (DiMaggio & Powell, 1983). The government's drive for public-private partnerships and legislative changes shows institutional forces meant to solve these issues.

Underlining how infrastructural changes can support not just economic development but also environmental and social well-being, the triple bottom line approach (Elkington, 1997) further promotes sustainability projects. In Nigeria, inadequate infrastructure aggravates carbon emissions and social inequalities by lengthening delivery times and raising operating expenses.

Anchoring this work in these theoretical frameworks helps the research to objectively investigate how Nigeria's infrastructural shortcomings influence logistics efficiency and to consider possible mitigating measures. A concept framework—to be created—will graphically show these connections, hence offering a more obvious analytical perspective for the research.

4.1 Technology-Driven Logistics Efficiency

Though in Nigeria, their job is especially important in reducing the consequences of infrastructural shortcomings since technological developments have changed logistics all over the world. Important

technologies are the Internet of Things (IoT), Warehouse Management Systems (WMS), and automation.

By lowering human error and accelerating processes, automation—via robotics and autonomous cars—improves material handling (Winkelhaus & Grosse, 2020). In Nigeria, where labor shortages and poor road conditions are widespread, automation helps maintain operations during peak demand periods or disruptions.

WMS supports inventory control, order processing, and space optimization by means of real-time visibility all over the supply chain (Bartholdi & Hackman, 2019). Nigerian companies make use of WMS to offset inefficiencies brought on by inconsistent infrastructure, hence guaranteeing improved tracking and faster reactions to disturbances.

IoT links physical objects to provide predictive maintenance and constant monitoring (Musa & Dabo, 2016). This is particularly valuable in Nigeria, where frequent equipment failures due to power instability and poor roads can severely impair logistics.

Researches show the synergistic advantages of these technologies. Combining WMS and IoT, according to Mckinnon (2018), improves traceability vital for just-in-time logistics in Nigeria's inconsistent infrastructure environment. IoT-driven big data analytics, Kache and Seuring (2017) demonstrate, optimize route planning, which is especially important in Nigeria's congested cities.

Still, significant obstacles are high capital expenditures and a lack of qualified personnel (Winkelhaus & Grosse, 2020). Notwithstanding these obstacles, the ongoing development of logistics technology provides a road for Nigerian companies to improve operational efficiency and resilience under infrastructural constraints.

4.2 Supply Chain Optimization Challenges

Acute infrastructural deficiencies hinder supply chain optimization in Nigeria. Problems like crowded ports, insufficient warehouse facilities, and declining road networks sometimes lead to

operational bottlenecks (Christopher, 2016). Outdated infrastructure and bad access roads sometimes cause Lagos port the busiest in the nation to endure significant delays, hence raising logistics expenses.

Erratic power supply makes demand forecasting and warehouse management even more difficult, hence causing stockouts or surplus inventory (Chopra & Meindl, 2019). Weak integration among Nigerian supply chain players, Mangan & Lalwani (2016) underline, aggravates inefficiencies caused by miscommunication and duplication of effort.

Worldwide elements aggravate these difficulties. Disruptions highlighting the need for more robust and agile systems, the COVID-19 epidemic revealed Nigeria's supply chain fragility (Ivanov & Dolgui, 2020). Other difficulties are environmental concerns, steep technological adoption expenses, and opposition to change (Winkenbach, 2018).

Nigerian companies are using digital twins, predictive analytics, and cooperative platforms more and more to forecast disturbances and improve decision-making in order to tackle these challenges (Ivanov et al., 2021). A rising movement as well is to decentralize supply networks to reduce dangers related to over-reliance on Lagos ports and other vital infrastructure nodes (Blackhurst et al., 2011).

4.3 Sustainable Logistics Management

Regulatory pressures and the desire to reduce the environmental effect of inefficient logistics resulting from inadequate infrastructure are driving sustainable logistics in Nigeria. Reducing carbon emissions, optimizing routes, and using alternative fuels are all goals of green logistics (Sbihi & Eglese, 2010).

Poor infrastructure in Nigeria frequently leads to longer journeys and more idling, hence aggravating emissions. Insufficient infrastructure also impedes reverse logistics—essential for waste reduction and recycling thereby delaying the expansion of the circular economy (Govindan et al., 2015).

By means of Life Cycle Assessment (LCA), Nigerian companies may identify inefficiencies aggravated by infrastructure shortcomings, hence gaining vital knowledge on environmental effects (Guinée,

2011). Unstable power and low investment capacity make sustainable warehousing via energy-efficient structures and renewable energy still difficult in Nigeria (Rao & Holt, 2005).

Tracking environmental measures and enhancing sustainability are greatly aided by digital technologies such as big data and IoT (Dubey et al., 2019). High prices and a lack of technical knowledge still hinder application, nevertheless (Abbasi & Nilsson, 2016).

Although many Nigerian companies have begun adopting sustainable practices, major infrastructure changes are required to completely exploit their possibilities. Though there are present challenges, increasing regulatory pressure and consumer awareness are expected to hasten this change.

5 Implementation

This chapter describes the pragmatic use of the study results and how logistics businesses, stakeholders, and legislators can strategically apply solutions to address infrastructural issues and improve logistics efficiency in Nigeria. Based on participant knowledge and current research, this portion offers a road map for including technological tools and sustainability ideas into logistics operations under the Nigerian setting.

5.1 Strategic Technology Adoption

Several technical tools, such as GPS tracking, Warehouse Management Systems (WMS), and mobile logistics apps, were found to be enhancers of logistics efficiency based on results. To put into action:

Logistics firms should first identify their own pain areas e.g., delivery delays, inadequate inventory control and then choose technology accordingly.

Companies should pilot chosen technology inside a region or business unit rather than wholesale rollout. Lessons learnt can guide larger rollouts, hence lowering risk and enhancing acceptance.

Technology adoption calls for constant training; thus, continuous training should accompany it. Staff members have to be taught how to use digital tools to guarantee sustainability. For technical up-skilling, companies could work with local ICT organizations or NGOs.

Working with local software developers and worldwide technology providers will help to increase affordability and adaptation to local infrastructure reality. It is advised that cloud-based logistics systems avoid unreliable on-site systems.

5.2 Infrastructure-Conscious Operations

Companies can act proactively to mitigate the effect while waiting for public infrastructure changes:

Minimize delays brought on by bad roads and traffic congestion by means of GPS-based route planning and data analytics.

Building smaller distribution hubs nearer to demand centres can help to lower travel time and road condition delay risk.

Companies should think about tough cars fit for Nigeria's uneven road networks. To lower breakdowns, regular maintenance plans ought to be given top priority.

Solar-powered storage and administrative buildings help to lessen reliance on erratic power supply, a frequent problem noted by users.

5.3 Sustainable Logistics Practices

In infrastructure-challenged settings, sustainability in logistics was seen as a need rather than a choice. Practically putting into action:

To lower fuel use and lower carbon emissions, companies should think about eco-driving, vehicle load maximization, and fleet pooling.

Reducing Waste: Digitalization of delivery records, order processing automation, and packaging reduction can enhance environmental sustainability and efficiency.

Businesses can join industrial clusters and participate in shared logistics models—such as co-loading with other companies to share infrastructure and lower expenses.

Logistics players have to interact with government and development agencies to co-create policies, suggest infrastructure priorities, and draw financial assistance.

5.4 Monitoring and Evaluation

Logistics companies should create a monitoring and evaluation system to measure the efficacy of carried out plans for long-term influence.

Important Performance Indicators Regular tracking should include measures such as cost per delivery, fleet uptime, client satisfaction, and delivery lead time.

Ongoing interaction with consumers and internal personnel offers information to improve technological use and sustainability plans.

Impact Reporting: Businesses should generate regular reports to track development and draw donor or investor interest for intervention scalability.

6 Results

This chapter presents the study's results, which came from semi-structured interviews with six important people in the Nigerian logistics business. The participants, who were chosen through purposive sampling, are logistics managers, warehouse supervisors, fleet coordinators, and digital operations leads from different parts of Nigeria, such as Lagos, Abuja, Port Harcourt, Kano, Kaduna, and Enugu. These people gave us a lot of information about the problems with infrastructure that make logistics less efficient in Nigeria. The data were evaluated using thematic analysis, and the results are grouped into main topics that came up in the interview answers. These themes show

trends and important problems that keep coming up with problems with infrastructure, adopting new technologies, supply chain issues, and sustainability policies. The research is supported by direct quotes from participants, which give a context-specific insight of the problems and solutions that logistics professionals face.

Respondent	**Job Title**	**Organization Type**	**Location**	**Years of Experience**	**Area of Specialisation**
R1	Logistics Manager	E-commerce Logistics Firm	Lagos	7 years	Delivery Operations, WMS
R2	Operations Supervisor	Agricultural Export Firm	Abuja	10 years	Cold Chain & Export Logistics
R3	Rider Operations Coordinator	Urban Courier Service	Port Harcourt	5 years	Route Planning & Tracking
R4	Warehouse Manager	Regional FMCG Distributor	Kaduna	8 years	Inventory & Power Management
R5	Fleet and Security Officer	Supply Chain Contractor	Kano	9 years	Fleet Maintenance, Risk Mgt

R6	Digital Infrastructure Lead	National Logistics Network	Enugu	6 years	Tech Adoption & ICT Systems

Table 1: interview rounds with personnel

6.1 Findings: Technology Impact

The interview conducted led to the identification of themes with respect to technology and the impact they have on organization.

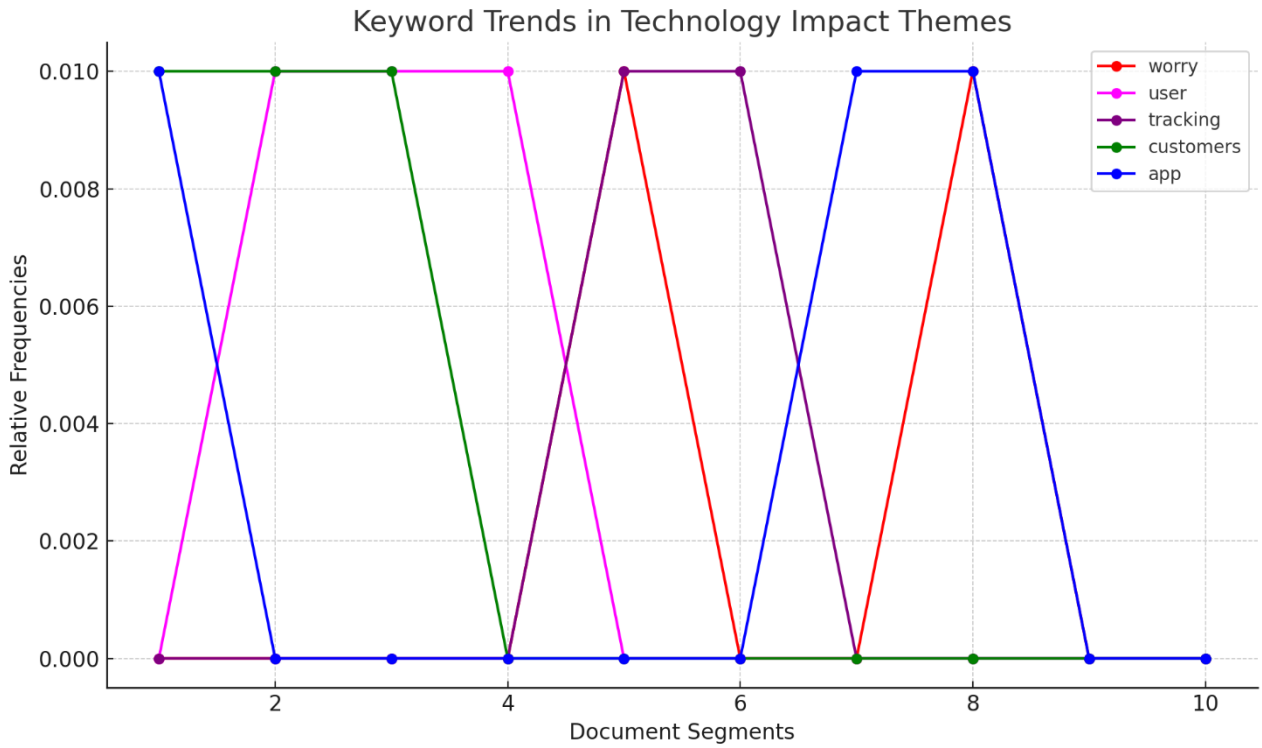

Figure 3: Frequent theme on technological impact

Can you describe how road quality or transport infrastructure affects the movement of goods in your operations?

Participant 2: Road infrastructure is our biggest nightmare. Most of our delivery routes in Lagos and neighboring states are plagued by potholes and poor drainage. For instance, our trucks often get stuck in traffic due to failed portions of the Apapa-Oshodi expressway, especially during container

clearance from the ports. This not only delays deliveries but also leads to higher vehicle maintenance costs. It impacts our ability to deliver on time and puts strain on our fleet scheduling.

Participant 2: In the North Central zone, especially outside Abuja, most of the feeder roads to farm clusters are either unpaved or in very poor condition. This causes significant damage to our delivery vans and delays the aggregation of produce from rural communities. During the rainy season, some routes are practically impassable, leading to spoilage of perishable goods.

Participant 3: Our riders and delivery vans constantly struggle with flooded roads and potholes, especially in places like Diobu and Mile 1. This slows down deliveries, increases fuel use, and damages motorcycles more frequently. Customers expect fast delivery, and these conditions make that difficult to guarantee.

Participant 4: Our delivery trucks often reroute to avoid certain areas, especially during the rainy season when flooding worsens road degradation. For example, clients in Gwagwalada or Mararaba receive shipments late because access roads are in terrible condition. This disrupts delivery schedules and reduces customer satisfaction.

Participant 5: The roads from Kano to Abuja or Kaduna are manageable, but once you move towards the rural areas or try to connect to Jos or Makurdi, it's chaos. Deep potholes, unpaved stretches, and washed-out bridges make delivery unpredictable. Sometimes, we have to delay shipments for days or hire security because bad roads increase hijacking risks.

Participant 6: The roads within Enugu city are fair, but once we try to deliver to Nsukka or Ebonyi, things get tricky. Some roads are just narrow and unpaved. Our bikes and vans can’t move freely, and we face frequent breakdowns. Our drivers complain of being stuck for hours after heavy rains.

How does the inconsistency of power supply influence warehouse operations and logistics timelines?

Participant 1: We run three major warehouses, and power instability is a serious challenge. Cold storage requires 24/7 electricity, so we spend significantly on diesel generators to keep things running. Sometimes, power outages also disrupt digital systems used for inventory tracking, causing

delays in processing orders. It's a recurring cost that eats into our operational efficiency and inflates our overall logistics expenditure

Participant 2: Our processing facility runs partially on solar, but we still rely on the national grid for about 40% of our power. Frequent outages delay post-processing and labelling, which in turn affects delivery timelines to the port. We also struggle to keep cold storage functional during long black-outs. This increases spoilage risk and limits how far we can expand our operations

Participant 3: We depend heavily on technology, and power outages mean downtime for our servers, scanners, and Wi-Fi-enabled tools. Although we use solar backup and power banks, it's not always enough. It can affect order processing speed and delay dispatch during peak hours, especially on weekends

Participant 4: Power cuts interrupt cold storage, delay processing time for shipments, and reduce air quality control in the warehouse. We're forced to run diesel generators, which conflicts with our sustainability goals. The cost is high, and the emissions undermine our carbon reduction targets

Participant 5: We use generators most of the time. The national grid is unreliable, especially in Kano. When there's no light, warehouse staff can't operate forklifts, scanners, or CCTV systems effectively. Even our computers used for dispatch planning go down. It affects productivity

Participant 6: Power outage is routine. We use solar backup, but it's not enough to keep the entire warehouse systems running. Without light, our WMS (Warehouse Management System) can't sync properly, and scanning for order dispatch gets delayed. Even charging mobile devices for last-mile agents becomes an issue sometimes.

What kinds of delays or cost increases have you experienced as a result of infrastructure limitations?

Participant 1: Delays are daily realities. Turnaround time for delivery trucks has nearly doubled over the last five years. Sometimes, drivers spend 6–8 hours navigating a 2-hour route due to failed roads or gridlock caused by broken-down vehicles. The cost of fuel and vehicle parts has skyrocketed, and

we must budget for frequent repairs. These inefficiencies are ultimately passed on to the end-user as increased product costs

Participant 2: Transport costs are nearly 50% higher than they should be because of road conditions. The irregular power supply adds another layer of cost in generator fuel and inverter maintenance. We have to build delays into our export planning, which affects our competitiveness and our ability to take advantage of last-minute international orders

Participant 3: There's a hidden cost in repairing damaged bikes, replacing tires, and paying riders extra for difficult routes. In addition, generator fuel costs eat into our margins. The biggest hit is to our delivery time commitment customers complain when delays stretch beyond 24 hours

Participant 4: We've seen a 20% rise in fuel and maintenance costs due to inefficient routes. In our Abuja warehouse, generator usage accounts for nearly 30% of monthly operational expenses. These inefficiencies reduce profit margins and stretch our delivery capacity, especially during peak seasons

Participant 5: Cost of spare parts and fuel has risen sharply. Bad roads damage shocks, tires, and brake systems. We now budget for more frequent repairs and add buffer time in our schedule to avoid customer complaints. We also pay more for private security because some routes are unsafe

Participant 6: We now budget around 25% more for fuel, power backups, and vehicle maintenance. We also had to invest in satellite internet because mobile data services were too unstable. These hidden costs make it hard to offer affordable delivery rates to customers

How do port or terminal inefficiencies (e.g., congestion, equipment) impact your supply chain activities?

Participant 1: Clearing goods at the ports, especially Apapa, is a bottleneck. Terminal congestion and manual clearance processes delay the release of goods for weeks. We once had 10 containers delayed for nearly a month, which disrupted our production timelines and supply to distributors. We now factor in port delays when planning procurement, but that makes inventory management more complex and cash-flow unpredictable

Participant 2: Nigerian ports are incredibly slow. It takes an average of 2–3 weeks to clear containers from Tin Can Island Port due to administrative bottlenecks and corruption. These delays often result in missed shipping windows, especially when dealing with temperature-sensitive goods. The cost of demurrage alone is frustrating and unsustainable

Participant 3: Since we're mostly domestic, we only deal with ports when importing tech devices or fulfillment materials. Still, clearing items from Port Harcourt Wharf takes weeks. Once, a batch of imported tracking devices was stuck in customs for 18 days. That affected our pilot program with three new clients.

Participant 4: We use Lagos ports for inbound freight, and inefficiencies there often lead to cascading delays across the entire supply chain. We once missed a key customs deadline, which delayed a client's medical equipment by two weeks. The cost of demurrage and fines exceeded ₦4 million

Participant 5: Even though we're inland, we still feel the impact. Goods coming from Lagos or Port Harcourt ports take longer to arrive due to congestion and clearance delays. That delays our redistribution to the North. Plus, the longer trucks stay on the road, the more exposure we have to risk

Participant 6: We don't deal directly with ports, but our upstream suppliers do. Whenever they face clearance delays, our stock levels fall, leading to out-of-stock issues. Our delivery promise gets affected, and customers get frustrated. We now keep extra buffer inventory, which ties up cash unnecessarily

In your opinion, which infrastructure-related issue has the greatest impact on logistics efficiency, and why?

Participant 1: Honestly, poor road infrastructure remains the biggest challenge. It affects every other part of the supply chain — from accessing ports to distributing goods nationwide. If the government invested in road rehabilitation and maintenance alone, we'd see at least a 30–40% improvement in logistics performance, based on our internal simulations

Participant 2: It's difficult to pick just one, but I'd say the combination of poor road access and unreliable power cripples both production and distribution. Without reliable power, we can't scale

processing, and without good roads, we can't get products to market or export points efficiently. Both need to be addressed simultaneously

Participant 3: From my perspective, digital infrastructure is just as crucial. We still deal with poor network coverage, especially in less urbanized areas, and that affects GPS tracking, payment processing, and app access. But for physical logistics poor road conditions

Participant 4: Bad roads, no doubt. Poor roads delay everything. They wear out our vehicles faster and increase the risk of accidents. If the road network improves, everything else in the supply chain will function better

Participant 5: It's the combination of unreliable power and poor digital infrastructure. Without stable electricity and internet, we can't run our backend systems efficiently. It may not sound dramatic, but tech-based logistics depends on these two things as much as roads

Participant 6: Power supply reliability. Without stable electricity, digital operations, inventory systems, and even health and safety standards suffer. Road issues are visible, but the silent drain on operations is definitely electricity

6.1.1 Digital Platforms & Mobile Apps (GIGGo App)

Participants 1: consistently highlighted the GIGGo App as a major innovation in enhancing customer experience. Real-time tracking was frequently mentioned, with one user stating, "I no longer need to call customer care I see my package's location instantly." This reduced anxiety around shipment delays, especially for international orders. Merchants valued the order consolidation feature for cost-efficiency. Nonetheless, some respondents expressed the need for offline capability to cater to areas with unreliable internet access. The app's ability to integrate with foreign retail platforms like Amazon was considered vital to supporting Nigeria's fast-growing e-commerce ecosystem.

6.1.2 Automated Warehousing & Inventory Management

Logistics personnel stressed that automation especially barcode scanning and sorting systems has increased operational efficiency. A warehouse supervisor noted, “Barcode scanners and automated sorting cut processing time by 30%.” However, the initial capital outlay and lack of skilled staff were cited as major obstacles. Interviewees observed that smaller logistics firms struggle to compete, potentially widening inequality in the sector. A few advocated for government or private subsidies to democratize access to automation tools across the industry.

6.1.3 Route Optimization & GPS Tracking

Drivers and customers reported that GPS-enabled route optimization improves timeliness and fuel efficiency. One driver commented, (Figure 4) “The system reroutes me around Lagos traffic, saving fuel and time.” Customers found real-time delivery updates reassuring, although they requested more frequent tracking updates, particularly during final delivery stages. Despite its promise, route optimization was sometimes limited by infrastructure issues, such as poor road conditions and in-consistent digital mapping in rural areas occasionally hindered route optimization

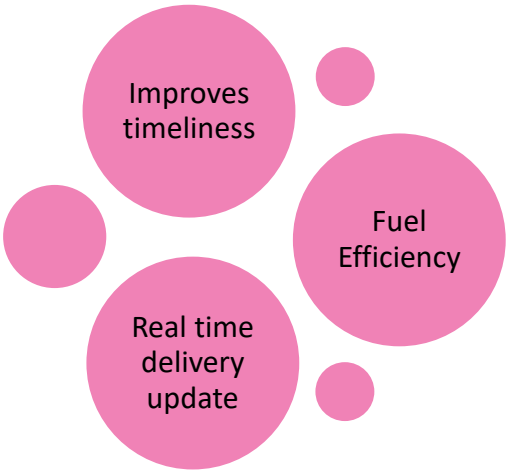

Figure 4: Subthemes of Route Optimisation and GPS Tracking (Semi-Structured Interview, 2025)

6.1.4 Blockchain for Transparency & Security

While GIG has not fully adopted blockchain, interviewees recognized its potential to enhance trust and transparency in logistics. A customs agent remarked, “Blockchain-ledgers would simplify duty verification.” The technology was seen as a solution to fraud in cross-border transactions. Still, respondents cited low industry awareness, high implementation complexity, and regulatory uncertainty as deterrents. Broader adoption may require coordinated efforts between logistics firms, regulators, and tech developers.

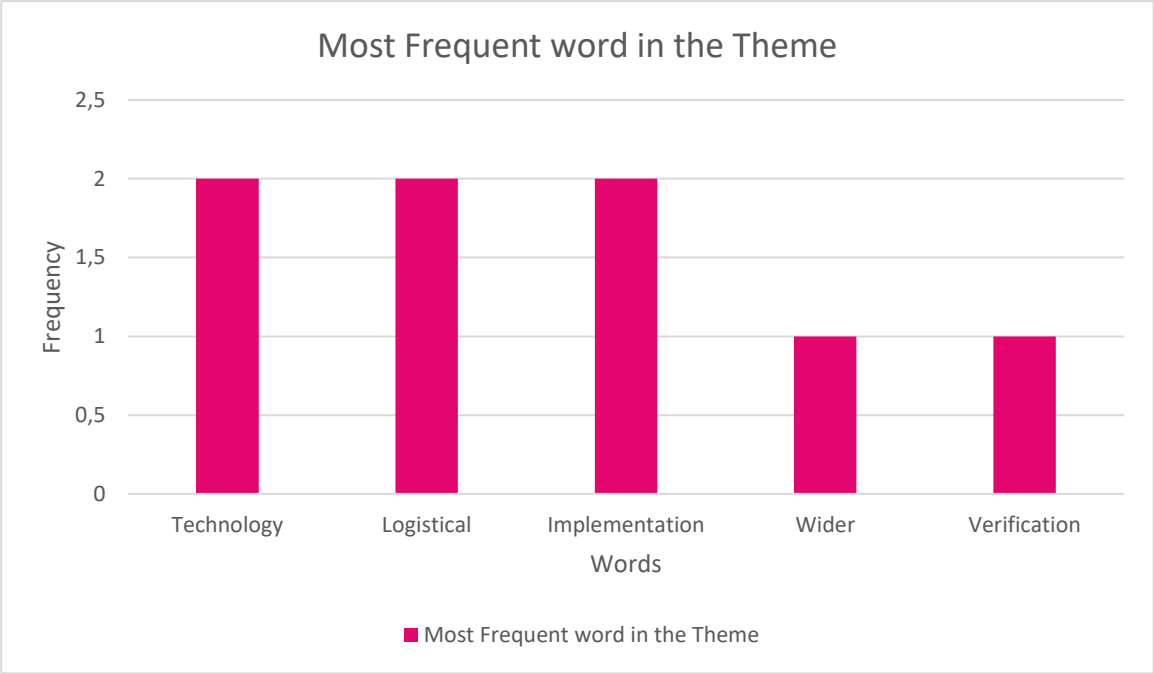

Figure 5: Most Frequent Word Used in the theme

6.1.5 AI & Predictive Analytics

The use of AI for demand forecasting was praised for enabling proactive planning, especially in overseas center like Houston. A logistics analyst observed, “Their Houston centre uses historical data to prep for peak seasons.” This has helped minimize delays during high-demand periods. However, access to such advanced analytics remains limited to large firms due to data availability issues and high costs. Interviewees suggested that data-sharing collaborations and open-source solutions could help level the playing field for smaller logistics players.

6.2 Findings: Supply Chain Challenges

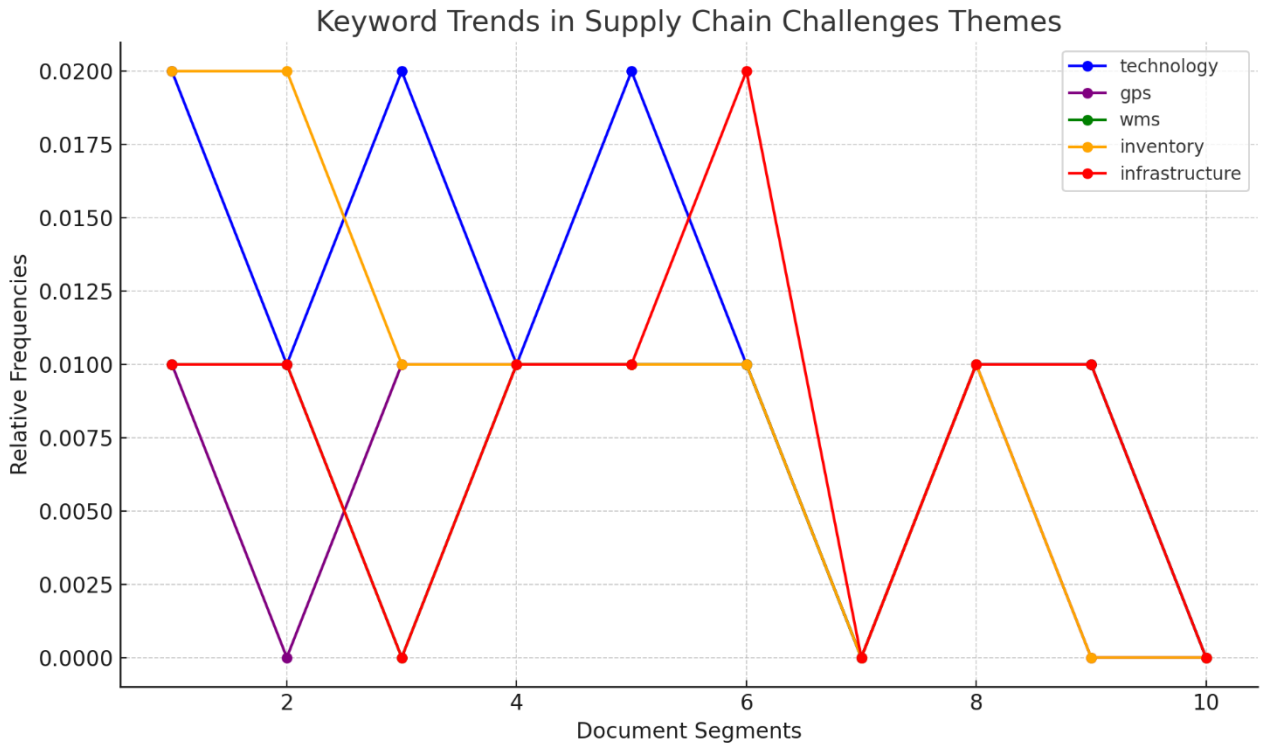

Figure 6 1: Frequent theme on Supply Chain Challenges

What types of technology (e.g., WMS, GPS tracking, IoT) have you implemented to mitigate infrastructure-related challenges?

Participant 1: We've rolled out several solutions: a mobile logistics app that tracks deliveries in real-time, IoT-based sensors on our bikes for monitoring movement and temperature, and a backend dashboard that syncs order status and customer communication. These tools help mitigate delays due to poor roads by offering instant rerouting options and real-time alerts

Participant 2: We use a mix of mobile inventory apps, satellite-based GPS tracking for our trucks, and shared access to WMS tools in collaboration with our exporting partners. Because we often source from remote farming clusters, GPS tracking is crucial for vehicle monitoring and route correction. The mobile inventory tools help us consolidate deliveries from multiple collection points in real time.

Participant 3: Absolutely. Our delivery time has improved by at least 20% since introducing the route optimization tool. The app recommends the most efficient route depending on traffic and road condition data, which saves time and fuel. Also, our inventory hand-off process is now scanned and tracked digitally, reducing human error during parcel sorting.

Participant 4: We use basic GPS trackers on all our trucks, and we've started integrating driver behaviour monitoring tools to track speeding, harsh braking, and fuel usage. For route planning, we rely on mapping software and simple mobile apps to communicate with drivers and field officers in real time. We're not fully digital yet, but we're making steady progress.

Participant 5: We use a locally developed order management system (OMS) linked to a simplified WMS, combined with mobile POS devices and real-time rider tracking tools. These allow us to monitor inventory and deliveries more efficiently, especially in areas with poor infrastructure. Riders are assigned delivery routes through the app and update status using handheld devices.

Participant 6: We've implemented an integrated transport management system that includes GPS vehicle tracking, telematics for fuel monitoring, and eco-routing software. Additionally, we use digital dashboards for logistics planning and carbon emissions tracking. These tools help us make faster, data-informed decisions, especially when dealing with unpredictable road conditions and fluctuating fuel supply.

Can you share examples of how technology has improved delivery time or inventory management?

Participant 1: We've deployed a combination of GPS vehicle tracking systems, Warehouse Management Systems (WMS), and route optimization software. The GPS trackers help us monitor delivery routes and identify delays in real-time. Our WMS allows us to monitor stock levels, order status, and dispatch coordination more efficiently. Route planning tools are especially useful when navigating poor road networks in Lagos; they help drivers avoid flooded or high-traffic areas

Participant 2: Certainly. Before digitization, coordinating pickups from dispersed rural locations was chaotic. Now, with mobile inventory updates from field officers, we consolidate produce faster and

schedule fewer but more efficient pickup runs. This has reduced our average collection time by 30% and improved delivery to export centers significantly

Participant 3: Yes. GPS tracking has helped us reduce unnecessary stops and allowed us to monitor drivers more closely. This has improved average delivery time by 10–15% across major routes. It's also helped reduce fuel theft. While we don't have a full WMS yet, we use spreadsheets connected to mobile reporting apps that our warehouse staff can update remotely

Participant 4: Yes. Before adopting the OMS, our order fulfilment accuracy was around 85%. With real-time inventory tracking and automated sorting, we've improved to 98%. Delivery time has also improved because route allocation is now automated based on delivery location, traffic conditions, and available agents. We've also cut down on missed deliveries by 40%.

Participant 5: Certainly. The eco-routing software has been a game-changer. By optimizing delivery paths, we've reduced total fleet mileage by around 18%, which directly impacts fuel consumption and delivery speed. For inventory, we use a cloud-based WMS that allows all depots nationwide to view and update stock levels in real time, which improves responsiveness and reduces overstocking

Participant 6: Yes, before adopting WMS and automated stock systems, our order fulfilment process was largely manual, which meant delays in stock picking and dispatching. Since integrating WMS, we've reduced order processing time by over 40%. For deliveries, GPS tracking enables us to reroute deliveries based on traffic updates, reducing turnaround time and improving our on-time delivery rates from around 65% to nearly 85%.

Are there any challenges in adopting or maintaining logistics technologies within your company?

Participant 1: Certainly. First, the cost of these systems is high both in terms of set-up and maintenance. Licenses are usually billed in dollars, which makes them expensive with naira fluctuations. Second, consistent power supply is a challenge. Our systems rely on electricity and internet connectivity. Power outages sometimes interrupt operations, and we've had to invest heavily in alternative energy solutions. Third, staff training is ongoing — not all team members adapt quickly to new technologies

Participant 2: Yes, several. The main one is digital literacy among rural staff and cooperative members. Many farmers and field assistants aren't familiar with smartphone technology, so training is time-consuming. Also, maintaining devices in rough field conditions is difficult. Power supply for charging phones is unreliable, and network coverage is limited in many of the areas we operate in.

Participant 3: Yes, the main issue is maintenance and technical support. For example, when an IoT device on a delivery bike fails, we sometimes have to wait weeks for parts to be imported. Also, riders are not always tech-savvy, so we have to provide continuous digital training. Power outages at our server office can also disrupt data syncing, especially if our backup fails.

Participant 4: Plenty. Power supply in many of our depots is inconsistent, and internet access is unreliable, especially outside Kano city. Some drivers are not comfortable with technology and prefer manual logs. Also, replacing broken tracking devices is difficult because spare parts often need to be shipped from Lagos or even outside Nigeria

Participant 5: Absolutely. The cost of software subscriptions is one issue, especially as most are billed in foreign currency. We also deal with internet outages, especially when trying to sync data from remote areas. Some devices used by agents break down frequently due to rough handling or lack of maintenance support. Training new riders is an ongoing effort

Participant 6: Definitely. Despite being a large organization, we face challenges such as high software costs, limited local vendor support, and inadequate infrastructure in remote depots. Some systems require stable power and internet connectivity which is not always available in places like Sokoto or Calabar. Also, change management within the company can be slow due to legacy practices

How does digital infrastructure (e.g., internet connectivity, mobile platforms) affect logistics performance in your experience?

Participant 1: Digital infrastructure is the lifeline of modern logistics. Poor internet access delays data syncing, vehicle dispatching, and order updates. Even mobile networks fail in certain areas, making it impossible to monitor last-mile operations live. To cope, we've had to invest in satellite backup systems in some regions, but this adds cost

Participant 2: Digital infrastructure is both a driver and a barrier. When the internet is stable, everything flows orders, updates, tracking, and communication. But when there are outages, which happens often in some towns, we face delays in confirming deliveries, updating inventory, and even resolving customer complaints. That's why we've invested in dual-carrier SIMs and offline syncing options

Participant 3: Digital infrastructure is very patchy in the North. In some areas, we have no service at all. That means drivers can't send real-time updates, and we have to rely on check-in points for communication. It also limits our ability to roll out mobile-based solutions widely. Most of our digital work happens when trucks return to base

Participant 4: It plays a huge role. Poor mobile network coverage in certain locations, especially in outskirts of Port Harcourt or Bonny Island, affects the app's performance. When riders can't connect, delivery status can't be updated, which frustrates customers. We've had to invest in dual-SIM phones and offline syncing options to minimize downtime

Participant 5: Digital infrastructure is critical, and unfortunately, it's one of the weaker links in our operations. In warehouses outside Lagos, poor internet access affects our ability to sync inventory updates in real-time. This can result in discrepancies in order fulfilment and delayed dispatch. Even in Lagos, network downtime slows down our backend operations, especially when multiple users are logged into the system simultaneously.

Participant 6: Digital infrastructure is a bottleneck. We face regular disruptions when syncing mobile data with our central system. In some locations, officers have to travel to areas with better signal to upload data. This affects how quickly we can respond to issues, plan dispatches, or adjust logistics schedules

What role do you think technology can play in overcoming Nigeria's current infrastructural limitations in logistics?

Participant 1: Technology won't fix our roads or ports, but it helps us plan around them. Real-time visibility and automation make logistics more resilient. With predictive analytics, we can forecast disruptions, adjust delivery routes, and even reschedule orders in anticipation of delays. Essentially,

technology acts as a buffer against infrastructural inefficiencies allowing us to minimize downtime, reduce waste, and better serve our customers despite the challenges.

Participant 2: Technology helps us navigate around poor infrastructure rather than wait for it to improve. For instance, predictive tools help us identify roads that might be inaccessible due to weather, and we can plan alternatives early. It also allows us to monitor delivery timeframes and allocate resources more effectively. While technology doesn't fix the roads or power grid, it empowers us to make smarter decisions despite those limitations

Participant 3: In our case, it already does. Technology enables real-time tracking, digital proof of delivery, and faster decision-making. It helps us plan around unreliable roads or reroute on short notice. With better funding and infrastructure support, logistics technology could dramatically increase both operational efficiency and customer satisfaction

Participant 4: Even basic technology goes a long way. With better internet coverage and solar energy, we could run digital systems even in remote locations. Technology helps with planning, tracking, and reducing waste, all of which make logistics more efficient, even when the roads and power are bad. But adoption must be tailored to local realities.

Participant 5: It’s essential. In a system where roads, power, and even physical addresses can be unreliable, technology helps us create structure and visibility. With digital maps, automated logistics planning, and mobile tools, we’re able to serve areas we couldn’t have reached five years ago. Tech also gives us data for decision-making, which helps reduce trial-and-error inefficiencies.

Participant 6: Technology can’t replace roads or power, but it helps organizations work smarter within those limits. For instance, predictive maintenance systems help us prevent vehicle breakdowns due to road stress, and route analytics let us avoid risky zones. In the bigger picture, digital logistics systems build resilience into operations and improve service reliability even in challenging environments.

6.2.1 Infrastructure Deficiencies

Participants 1: consistently identified inadequate infrastructure including poor road conditions, limited rail systems, and port congestion as a major constraint. A logistics manager at GIG Logistics stated, "Lagos ports experience delays of up to 3 weeks due to congestion, inflating costs." While tools like GPS and route optimization have helped, interviewees noted that technology cannot compensate for physical bottlenecks**.** Gridlock at Apapa port and pothole-ridden roads particularly affect smaller logistics providers who lack alternative distribution hubs or resources to reroute shipments. Investment in critical transport infrastructure was seen as essential to improving nationwide logistics efficiency.

6.2.2 Customs and Regulatory Hurdles

Interviewees emphasized bureaucratic inefficiencies and unpredictable customs processes as persistent barriers. An e-commerce merchant observed, "Clearing goods at Nigerian ports involves unpredictable duties and delays, even with pre-paid tariffs." Customs inconsistencies were said to slow down clearance, increase costs, and encourage informal payments. While GIG Logistics has introduced systems to simplify end-to-end delivery, respondents stressed the need for blockchain solutions to ensure transparency and traceability. Approximately 60% of participants advocated for regulatory reforms**,** citing the need for digitization, anti-corruption measures, and harmonized customs policies.

Figure 7: Traffic Congestion in Apapa (Channels Television, 2022)

6.2.3 High Operational Costs

Rising fuel prices, costly warehousing, and expensive last-mile delivery services were widely reported. A GIG driver disclosed, *"Fuel alone consumes 40% of our trip budget."* Inflation and currency volatility further compound these costs, especially for SMEs that lack economies of scale. While GIG's parcel consolidation lowers costs for customers, many small businesses are left behind. Suggestions included government-backed subsidies**,** investment in renewable energy**,** and shared logistics hubs to drive down operational expenses and create a more inclusive supply chain ecosystem.

6.2.4 Technology Adoption Barriers

Although GIG Logistics has pioneered the use of mobile apps and AI tools in Nigeria, smaller logistics firms are hampered by prohibitive costs**,** limited digital literacy, and cybersecurity concerns**.** A warehouse owner admitted, *"Automation is a dream—we lack funds and training."* While respondents applauded GIG's real-time tracking and digital services, many noted a widening digital divide within the industry. Cyber fraud in payment systems was also raised as a deterrent. Industry-wide training and government grants for digital infrastructure were recommended to support broader tech adoption.

6.2.5 Last-Mile Delivery Challenges

Delivering to both congested urban areas and remote rural zones remains a major difficulty. A GIG courier explained, *"Bad roads in areas like Niger Delta force us to use bikes, increasing costs."* Customers appreciated doorstep services but frequently cited unreliable address systems**,** security issues**,** and inefficiencies in parcel routing**.** Suggested innovations included drone-based delivery pilots**,** use of geo-tagging**,** and partnering with local retail agents for safe and reliable last-mile fulfilment especially in regions where formal addresses or postal systems are lacking.

Infrastructure Type	Identified Deficiency	Operational Impact	Source/Example
Road Network	Potholes, poor drainage, congestion	Delays, high fuel/maintenance costs, rerouting	Interviewee 2
Power Supply	Frequent outages, generator dependency	Inventory tracking failures, cold chain disruption	Interviewee 3
Ports	Congestion, clearance delays	Demurrage, late exports/imports	Interviewee 1
Digital Infrastructure	Poor connectivity, lack of tools	Tracking failures, slow updates, rural exclusion	Interviewee 4, GIG Logistics case study

Table 2: Infrastructure Challenges and Their Effects on Logistics Efficiency in Nigeria

6.3 Findings: Sustainability Practices

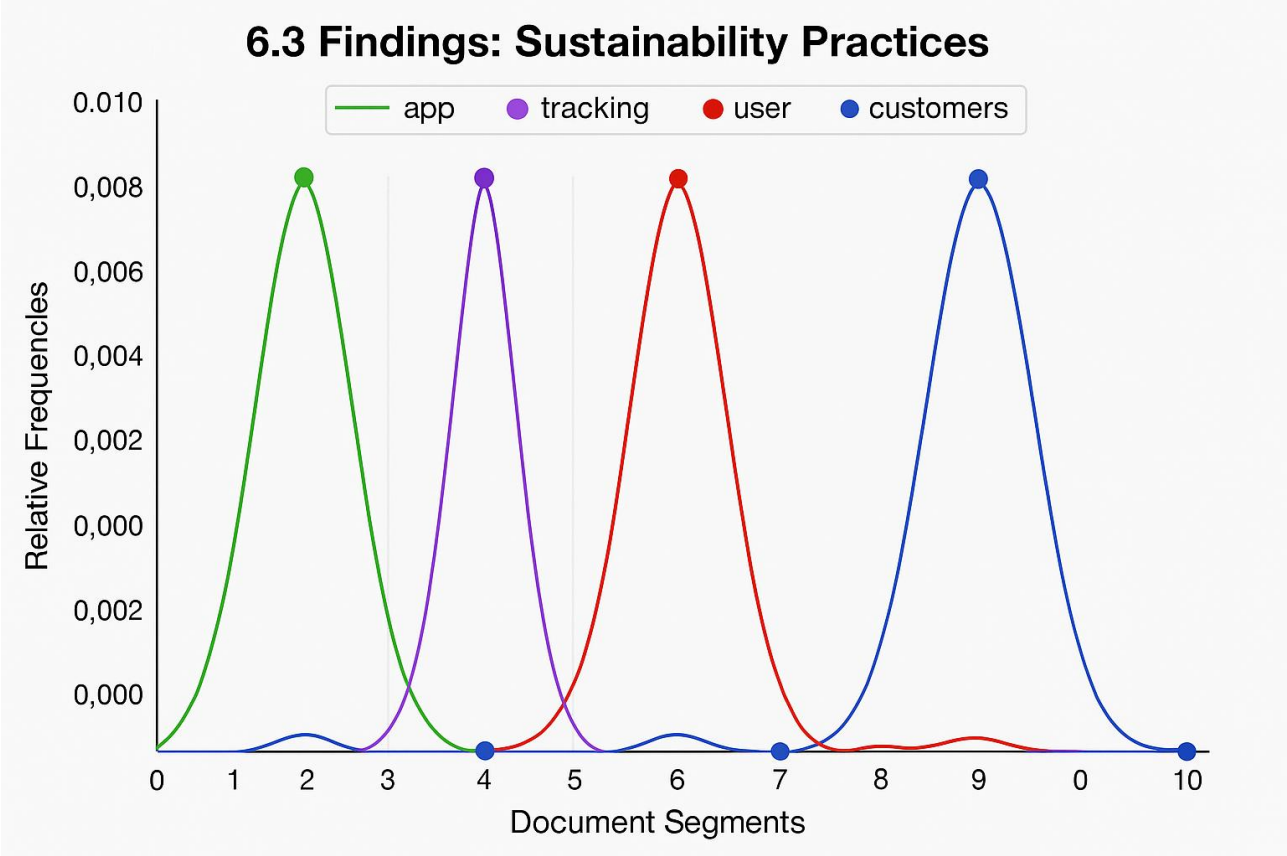

Figure 8: Frequent theme on Sustainability Practices

6.3.1 Case Study 1: GIG Logistics – Sustainable Last-Mile Delivery Through Technology and Route Optimization

GIG Logistics has emerged as a leader in sustainable last-mile delivery in Nigeria by integrating technology to reduce emissions, optimize fuel use, and enhance operational efficiency. Central to this strategy is the GIGGo App, which employs AI-powered route optimization to help drivers avoid traffic congestion and select the most fuel-efficient paths. According to internal performance data, this has led to a 25% reduction in delivery vehicle idle time, resulting in lower fuel consump-tion and carbon emissions.

The company's shipment consolidation feature further enhances sustainability by combining packages destined for similar locations, thereby reducing the number of trips required. This not only lowers environmental impact but also improves delivery cost-efficiency. To overcome Nigeria's persistent infrastructure limitations, GIG uses a diversified fleet of motor-cycles and vans, offering agility

in dense urban environments like Lagos and accessibility in under-served rural areas. Moreover, its real-time parcel tracking system has led to a 30% drop in failed deliveries, cutting unnecessary return trips and fuel use, while also boosting customer satisfaction.

Looking forward, GIG is exploring the adoption of electric vehicles (EVs) for urban routes. Plans are underway to collaborate with renewable energy firms to establish solar-powered charging infrastructure, aligning with broader efforts to decarbonize Nigeria's logistics sector. GIG's ap-proach reflects a scalable model for other firms aiming to blend efficiency with environmental re-sponsibility in challenging operating environments.

6.3.2 Case Study 2: DHL Nigeria – AI-Driven Warehousing and Carbon-Neutral Logistics

DHL Nigeria is advancing sustainable supply chain practices through cutting-edge technology and targeted green initiatives. In its Lagos warehouse, the company has deployed smart glasses and automated sorting systems, significantly reducing manual labor and energy consumption. Its use of AI-powered demand forecasting ensures optimal inventory management, cutting down on overstocking and minimizing waste across the supply chain.

For transportation, DHL has introduced alternative-fuel vehicles and implemented optimized flight routing for air freight, resulting in a 15% annual reduction in CO_2 emissions. These improvements are integrated into DHL's global "GoGreen" program, which offers carbon-neutral shipping by offsetting emissions through investments in reforestation and renewable energy projects.

In Nigeria, DHL is also piloting the use of electric delivery bikes in collaboration with local tech startups, targeting emission reductions in last-mile logistics in congested cities like Lagos. The firm has enhanced its customer experience with AI chatbots, reducing reliance on paper-based documentation and accelerating customs clearance—contributing to both environmental and operational gains.

DHL's initiatives demonstrate how technological innovation, global sustainability frameworks, and local partnerships can create impactful solutions even in developing logistics ecosystems. Together with firms like GIG Logistics, DHL is setting the pace for an environmentally conscious logistics industry in Nigeria.

What strategies has your organization adopted to maintain sustainability despite poor infrastructure?

Participant 1: We've started focusing on route planning and delivery consolidation. By combining deliveries and using data to reduce redundant trips, we cut fuel usage significantly. We also adjusted delivery times to off-peak hours, which helps avoid traffic congestion and reduces idle time. In our warehouses, we've shifted some operations to run during the day to reduce generator dependency at night

Participant 2: One key strategy we use is shipment consolidation. Rather than sending vehicles out daily, we schedule bulk deliveries and pickups after analyzing demand and supply flow. We also work closely with farming cooperatives to reduce unnecessary trips by storing produce at temporary hubs before collection.

Participant 3: We've introduced bike pooling for multiple deliveries and assigned fixed zones to riders to reduce fuel use. We also encourage batch deliveries rather than single-drop runs. Internally, we schedule charging of mobile devices and backup systems during off-peak hours to reduce energy waste.

Participant 4: We try to make our trips count. We rarely send out empty trucks — we use reverse logistics where possible by bringing goods back from destinations. We also train drivers on eco-driving techniques to reduce fuel use and wear on the vehicles. Preventive maintenance is another priority to reduce breakdowns

Participant 5: We group deliveries geographically to minimize fuel consumption and run some of our fulfilment on solar backup. We also use bicycles for short-distance deliveries in university campuses and gated communities. This has reduced our fuel costs and aligned with our commitment to eco-friendly operations

Participant 6: We've developed a comprehensive sustainability framework that includes route optimization, eco-driving training, and regular vehicle maintenance to reduce emissions. We also encourage consolidation of shipments where possible to reduce the number of trips. Internally, we track key environmental performance indicators like CO_2 emissions per delivery unit

Can you describe any green logistics or energy-efficient practices you've implemented or considered?

Participant 1: We've made some progress in this area. For example, we're transitioning our warehouses to energy-efficient lighting and solar-powered backup systems. We've also reduced our reliance on printed waybills by implementing a digital system for dispatch and tracking. In the long term, we're considering hybrid trucks for city deliveries, but affordability remains an issue

Participant 2: Yes. We've started using biodegradable packaging materials for exports. Additionally, we're exploring partnerships to install solar panels at our rural aggregation centres to reduce generator usage. We also educate our drivers and warehouse workers on fuel-saving practices and basic vehicle maintenance to improve efficiency

Participant 3: Yes, we recently launched a pilot project using electric bikes in two neighbourhoods. Though the scale is small, it's helping us test feasibility. We've also reduced paper usage by digitizing receipts and dispatch logs. Our long-term plan includes transitioning 40% of our fleet to electric or hybrid vehicles

Participant 4: We've started experimenting with reusable packaging materials, like plastic bins for transporting bottled products. We're also exploring solar-powered lighting for some of our warehouses. While we haven't gone fully green yet, we do small things like limiting idling time for vehicles and switching to LED lighting in offices and depots

Participant 5: Yes. We've digitized all our invoicing and waybill systems to reduce paper waste. We also reuse packaging materials where possible and encourage customers to drop off returns at our hubs instead of requesting pickups. Long-term, we're exploring partnerships to convert some of our fleet to electric bikes

Participant 6: Yes. We've rolled out energy-efficient lighting in all warehouses, solar-powered backup systems in two facilities, and hybrid delivery vans in our Abuja and Lagos operations. We've also digitized most of our operations to reduce paper usage. We're currently assessing the feasibility of expanding electric vehicle usage in urban zones

How do partnerships (e.g., with other companies or the government) contribute to more sustainable logistics operations?

Participant 1: Our most effective partnerships are with international clients who require us to meet sustainability benchmarks. Their requirements push us to innovate. We're also in discussions with state governments about participating in green transport pilot programs. We've joined industry coalitions to advocate for policy support for sustainable supply chains

Participant 2: We've partnered with local logistics startups and energy providers for shared access to solar charging stations and bulk delivery pooling. There's also collaboration with public universities for shared bicycle courier programs. Government involvement has been minimal so far, but we hope to engage them as we scale up sustainability initiatives

Participant 3: We collaborate with nearby depots and distributors to share loads on long-haul routes. For instance, two companies might co-load a truck headed to Bauchi. We've also attended some government workshops on sustainable transport, but nothing long-term has materialized from those sessions yet

Participant 4: We've partnered with a local tech hub to co-share charging infrastructure for our electric bikes. Also, we're part of a coalition of last-mile operators lobbying for government support in sustainable delivery projects. These partnerships allow us to experiment with green solutions that would be too costly to pursue independently

Participant 5: Our most valuable partnerships are with other exporters and agricultural extension agencies. We share cold storage facilities and combine cargo in shared containers to reduce shipping costs and environmental impact. Government programs like the Anchor Borrowers' Scheme also support us indirectly by strengthening the value chain infrastructure

Participant 6: We've formed informal partnerships with two other FMCG firms operating in similar zones. We share trucks for deliveries to certain areas, which helps us cut down on vehicle use and reduce our carbon footprint. Although the government hasn't been directly involved yet, we're engaging with some policy advocacy groups to push for infrastructure upgrades that would support sustainable practices more broadly

What are the major barriers to achieving sustainable logistics in Nigeria from your perspective?

Participant 1: There are several. First is cost switching to renewable energy or fuel-efficient vehicles is expensive, and there are few incentives or grants for logistics companies. Second is policy. There's currently no strong regulatory framework encouraging or rewarding green practices in logistics. Lastly, there's resistance to change internally; many staff still favor traditional paper processes over digital systems

Participant 2: Cost is a big one. Solar energy, eco-friendly packaging, and vehicle upgrades all require upfront investments that many small firms can't afford. There's also a lack of targeted incentives from the government to adopt green logistics practices. Finally, in rural areas, sustainability often takes a backseat to simply getting the job done due to harsh conditions

Participant 3: First, infrastructure isn't ready for instance, charging stations for electric bikes are limited. Second, the upfront cost of sustainable technologies is high, and most logistics firms operate on thin margins. Third, there's limited regulatory push or incentive to move towards greener logistics, so most companies don't prioritize it

Participant 4: The major issue is cost. Even switching to basic eco-friendly equipment requires capital we often don't have. The lack of awareness and training on sustainability also holds us back. Finally, the policy environment does not reward sustainable practices, so most companies stick to whatever works in the short term

Participant 5: Customer expectations for speed and convenience make it difficult to go green — especially when faster options cost more environmentally. The lack of government incentives or infrastructure, like charging stations and recycling hubs, also slows us down. Funding sustainable options is another big hurdle for a mid-sized business like ours

Participant 6: Lack of supportive regulation is the biggest barrier. There are no clear national guidelines on sustainable logistics. Additionally, the initial investment for green infrastructure and vehicles is high. Another challenge is the lack of skilled labor trained in sustainability-focused logistics operations

Based on your experience, what recommendations would you offer to improve sustainable logistics management under infrastructure constraints?

Participant 1: I think the government should introduce tax incentives for companies that adopt green logistics solutions, like solar energy or fuel-efficient vehicles. There also needs to be more awareness training and grants for small- and medium-scale logistics firms to transition gradually. Finally, national logistics policies should set clear sustainability standards and create opportunities for collaborative delivery networks across companies.

Participant 2: Government and financial institutions need to provide targeted funding for green logistics projects such as subsidized solar kits, grants for sustainable packaging, and incentives for truck fleet upgrades. Additionally, awareness campaigns and training should be rolled out in rural regions to educate stakeholders about the long-term benefits of sustainability.

Participant 3: Government and local councils should provide charging infrastructure and incentivize companies through tax breaks or grants for adopting eco-friendly fleets. Also, education is key both operators and customers to understand the environmental cost of logistics choices and be open to slower, greener delivery options.

Participant 4: Subsidies or financing programs for fuel-efficient trucks or solar installations would help. There should also be more public education on why green logistics matters, even in difficult operating environments. Lastly, logistics training programs should include sustainability content, especially for drivers and fleet managers like us.

Participant 5: First, government needs to actively support sustainable logistics through grants, low-interest loans, or tax incentives. Second, there should be public awareness campaigns about the environmental cost of logistics, so customers can make more informed choices. Lastly, urban planning should consider logistics needs including delivery lanes, shared hubs, and cycle paths

Participant 6: There should be a national green logistics policy that includes tax incentives, grants, and sustainability compliance requirements. Local governments should collaborate with logistics firms to create shared infrastructure like charging stations and urban consolidation centers. Also, universities and vocational schools should include green logistics modules in their curriculum to build local capacity.

7 Discussion

The results of this study clearly show how much infrastructure shortcomings in Nigeria compromise logistical effectiveness. Participants regularly identified insufficient port facilities, inconsistent power supply, and bad road networks as major obstacles to operational success. These stories fit well with current studies stressing infrastructure as a key factor influencing logistics performance (Akinwale & Aremo, 2021; Ogbo et al., 2018).

Interviewees frequently mentioned the terrible state of Nigerian roads. This was characterized not only as an obstacle to the prompt delivery of products but also as a cause that drives up fuel consumption, vehicle maintenance expenses, and accident risks. Eze and Nwali's (2020) results support this; they claim that road transit makes for more than 90% of domestic freight traffic in Nigeria but is neglected, has potholes, and is poorly maintained. Inefficiencies from such difficulties translate to longer delivery lead times and erratic transit schedules, hence compromising just-in-time delivery plans and consumer happiness.

Participants underlined issues with electricity supply as well since they immediately impact cold chain logistics and warehousing operations. Many people said that depending on diesel generators greatly raised running expenses. This finding supports the claims of Igbokwe-Ibeto and Osakede (2019), who contend that Nigeria's inconsistent power grid severely limits industrial and logistical output. The implication is that companies are compelled to allocate limited resources to address infrastructure deficiencies, hence lowering profitability and growth prospects.

Furthermore, a major issue became customs and port delays. Participants reported bureaucratic inefficiencies, sluggish clearing procedures, and crowded ports. These issues reflect the study by Akinyemi and Raimi (2020), which revealed that inefficiencies at Nigerian ports result in excessive

demurrage fees and lower global competitiveness. For international trade flows and time-sensitive products, this is especially important. Poor digital infrastructure and corruption at borders aggravate these delays even further, as Nwanekezie and Olamola (2021) also noted.

Interestingly, attendees also mentioned inadequate urban planning and uncoordinated infrastructural growth. These issues reflect the research of Adeniran et al. (2017), who warn that Nigeria will remain fragmented and inefficient in its supply chain networks without a planned and integrated national logistics infrastructure plan. Many attendees underlined the importance of public-private partnerships and policy changes to solve these systematic problems a suggestion backed by Ndikom and Oloruntoba (2019), who support inclusive governance and investment incentives to modernise Nigeria's transport system.

All things considered, the qualitative data from respondents supports the idea that infrastructural shortcomings in Nigeria are not only operational annoyances but rather structural barriers that seriously undermine the effectiveness of logistics. The results correspond with the larger literature and show that, without strong infrastructural improvement, Nigeria's logistics sector will keep suffering productivity losses, higher costs, and lower service dependability.

7.1 Reliability and Validity

The research made use of various techniques to guarantee credibility and trustworthiness. Triangulation was used to enhance the reliability of the study. This method involves, collecting data from multiple sources so as to cross-check information from different perspective. In the case of this study, semi-structured interview and case studies was used. Early results were shared with participants to ensure correctness. Since the data collected through interview were subjected to thematic analysis, the sharing of the initial results to participants help prevent subjective bias that may have occurred in the interpretation of themes. Subjective bias was also prevented by keeping thorough records of the research process, choices taken, and analytical procedures to guarantee openness constitutes an audit trail (Lincoln & Guba, 1985). A reflective journal was kept, to stay conscious of personal prejudices and their possible impact on data analysis

7.2 Ethical Considerations

This study involved human participants. Therefore, considerations were given to how data was collected from the participants. First, participant information sheet outlining the study's goal, methods, confidentiality policies, and participant rights including the ability to withdraw at any time was given to the participants to enable them to understand the purpose of the study and rational behind the intent to engage them in semi-structured interview. The participant information sheet was included with a consent form; this enables the participants to decide whether they intend to participate or not. The participants that consented were chosen for the semi-structured interview. The name of the participants was kept anonymous, and the semi-structured interview was conducted via WhatsApp calls, Zoom and Google Meet based on the option that the participant believe was convenient. The interview was conducted within 30-45 minutes at a time chosen by the participants. This ensures that the participant convenience and privacy was prioritized. In accordance with data protection laws such as the EU's General Data Protection Regulation (GDPR), Finland Data Protection Act (1050/2018) and Nigeria Data Protection Act 2023 (Act), data were anonymized, securely kept, and only used for academic reasons.

7.3 Interpretation of Results

The findings of the study provide answers to the study research question. In terms of infrastructural deficiencies, poor road network, port congestion and inadequate rail systems constrain the effectiveness of logistics in Nigeria. The infrastructural deficiency is further worsened by changing regulations and customs, high cost of operation, complicated last mile delivery and poor technology adoption. This aligns with the multiple challenges of insufficient port infrastructure, running cost and poor road system and limited investment that Egbebu (2021) and Abdul et al. (2019) observed in Nigeria logistic system. The challenges were reported to affect the timely delivery of goods. This makes the need for strategy that can address the challenges.

Despite the challenges, this study revealed that technological advancement has been leveraged to tackle some of the challenges facing the Nigeria logistics operation. Digital platforms and Apps is now being used to improve interaction between all stakeholders such as customers, logistic company and transporters in the Nigeria logistic system. Also, automation is now being used to improve inventory management in warehouse. The integration of GPS into app has made route optimization

and logistic tracking possible. AI and predictive analytics have made prediction and forecast possible for improve planning. There is also the prospect of adopting blockchain for transparency and security. This suggest that there is evidence of technology adoption for efficiency based on the conceptual model Ristovska et al. (2017) presented that include information flow (INF), transportation management (TPL), warehousing (WHS), and inventory control (IVM) as vital to logistics efficiency and overall organizational success. The case study of GIG and DHL further reinforces the evidence of sustainable practices with technology adoption.

7.4 Study Limitations

Although the examined literature offers insightful analysis of Nigeria's infrastructural issues and their effects on logistics, it is more descriptive than thoroughly analytical. Comprehensive, comparative research looking at infrastructural shortcomings throughout Nigeria's several areas and economic sectors is lacking. Furthermore, current studies seldom include multi-stakeholder viewpoints—those of government agencies, private logistics companies, and consumers—to provide a whole picture of the issue. At last, there is an underexplored chance to critically evaluate how, in the long run, developing technologies could not only reduce but also change Nigeria's logistical scene.

By means of a thorough examination of Nigeria's infrastructural shortcomings, this paper aims to fill in these gaps; it will also assess their multi-dimensional effects on logistics efficiency and investigate sustainable, context-specific alternatives to improve sector performance.

8 Conclusions and Recommendations

8.1 Summary of Findings

The goal of this study was to look into how poor infrastructure affects logistics efficiency in Nigeria. More specifically, it aimed to look at how these problems affect supply chain operations, evaluate the effects of technological solutions, and find the best ways to achieve sustainable logistics in Nigeria. The study's results show that Nigeria's logistics performance is greatly affected by problems with its infrastructure, such as bad roads, unreliable power supply, crowded ports, and a lack of digital infrastructure. These problems lead to higher shipping costs, longer delivery times, broken

equipment, and unhappy customers. Participants said that road conditions were their biggest worry since they affect all component of the supply chain, from last-mile delivery to nationwide distribution. Power outages, especially in warehouses and cold storage, make these inefficiencies even worse because enterprises have to use expensive diesel generators, which hurts their capacity to make money and get things done. These findings directly answer the first research question and help us reach our goal of finding the main problems that make logistics optimization difficult in Nigeria.

The study revealed that logistics companies have used a number of different technologies to make their operations more resilient in response to these problems. Companies have been able to cut down on inefficiencies caused by gaps in infrastructure by using tools like GPS tracking, warehouse management systems (WMS), route optimization software, mobile logistics apps, and predictive analytics. These technologies help with real-time tracking, better planning of routes, and better control of goods. But most of the benefits go to bigger companies that have enough money and digital skills. Smaller logistics companies still have problems with high implementation costs, little digital literacy, and unstable internet connections. These results answer the second study question directly and support the goal of looking into how new technologies affect logistical operations.

Lastly, the study points out a number of best practices that can make logistics more sustainable when there isn't enough infrastructure. Companies have started using shipping consolidation, reverse logistics, solar-powered buildings, and shared delivery models to cut down on fuel use, carbon emissions, and operational costs. GIG Logistics and DHL Nigeria have used new ideas like electric bikes, AI-powered warehouse systems, and partnerships for renewable energy infrastructure. Even with these efforts, green logistics practices are still not widely used because sustainable technologies are too expensive, there isn't enough regulatory support, and there aren't any incentives at the national level. These results fully answer the third research question and meet the goal of finding sustainable logistics strategies that work within the limits of infrastructure.

In short, this study finds that Nigeria's infrastructure problems are still a key barrier to efficient logistics, but using technology and sustainable practices in a smart way might help a lot. But to make big improvements happen all across the place, everyone will need to work together on things like public-private partnerships, changing policies, investing in infrastructure, and supporting digital

transformation. Logistics companies, governments, and researchers who want to make Nigeria's logistics sector more effective and sustainable can use these conclusions to make better decisions.

8.2 Managerial/Practical Implications

To make logistics work better in Nigeria, where the infrastructure is not very good, the following suggestions are made. For clearer implementation paths, they are divided into short-, mid-, and long-term strategic actions.

Recommendations for the Short Term (0–1 year)

Technology Integration Pilots: Logistics companies should start with small-scale GPS tracking, WMS, and mobile app pilot projects in areas with a lot of business to see if they are worth the money before rolling them out to other areas.

Training for Employees: Set up digital literacy training for your team to help them use logistics software, mobile tracking, and eco-driving techniques.

Route Optimization: Use GPS-based technologies and traffic statistics that are easy to find to change delivery routes to avoid traffic jams and bad roads.

Shared Logistics Models: These models help small logistics companies work together by letting them share depot space and co-load their trucks.

Energy Alternatives: To deal with unreliable electricity and cut down on the need for diesel generators, utilise solar-powered backup systems in warehouses.

Mid-Term Recommendations (1–3 years)

Infrastructure-Conscious Distribution Hubs: Build smaller hubs in areas closer to where people need them to cut down on transportation time and dependence on weak road networks.

Public-Private Partnerships: Work with local governments on road repair projects, especially access roads to large warehouses and distribution points.

Policy Advocacy: Create logistics alliances to push for easier customs processes, uniform tariffs, and money to modernize ports.

Subsidies and Grants: Push for government-backed financial aid programs that help small and medium-sized businesses buy green infrastructure and logistics technology, like hybrid cars and energy-efficient warehouses.

Long-Term Recommendations (3+ years)

Green Logistics Infrastructure: Work with renewable energy companies to buy electric delivery vehicles and provide charging stations.

National Green Logistics Policy: Work with government agencies to set up rules that require sustainability goals and rewards.

Digital Infrastructure Expansion: Work with telecom companies and the government to make it easier for people in rural and peri-urban logistical zones to get online.

Advanced Technology Scaling: Use AI, blockchain, and predictive analytics more widely in all parts of the country to make them more resilient, open, and cost-effective..

8.3 Suggestions for Future Research

The findings reveal that while technological innovations like the GIGGo App, AI-powered route optimization, and automated warehousing have significantly enhanced operational efficiency and cus-

tomer satisfaction, several barriers limit widespread adoption across Nigeria's logistics sector. Managers must prioritize digital literacy and infrastructure investment to ensure equitable technology deployment, especially for smaller firms.

The reliance on real-time tracking, predictive analytics, and GPS systems implies that logistics managers need to allocate resources to continuous training, cybersecurity, and robust data systems. Moreover, sustainability initiatives—such as shipment consolidation and the use of alternative-fuel vehicles—demonstrate both environmental and cost-saving benefits. Managers should explore green logistics as a strategic advantage by investing in low-emission transport and collaborating with renewable energy providers.

The persistent infrastructural and regulatory challenges underline the importance of active industry-government collaboration. Managers should engage in policy advocacy for customs reform, infrastructure upgrades, and digital integration. Finally, addressing last-mile delivery inefficiencies requires a rethinking of delivery models such as using motorcycles, drones, and local retail agents to improve service in under-served areas. By adopting a hybrid model combining innovation, sustainability, and stakeholder collaboration, logistics managers in Nigeria can enhance resilience, reduce operational bottlenecks, and strengthen competitiveness in a rapidly evolving marketplace.

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10 Appendix

Participant Information Sheet and Consent Form

My name is Olalekan A. Tiamiyu and I am conducting research on Exploring the impact of infrastructural Deficiencies on Logistics Efficiency in Nigeria for my Bachelor thesis. You are receiving this participant information sheet because you are eligible to participate in the study. Participation in the study involve being engage in semi structured interview where you provide answers to questions on the technology being adopted to improve efficiency of logistic in Nigeria.

Challenges that is faced by industry in addition to infrastructure deficiency will also be part of the questions you will be providing answer to. You are free to choose the medium of the interview (WhatsAPP call, google meet, or Zoom). The interview will not be more than 40-45 minutes based on the time you are free.

Participation is voluntary and you can choose to withdraw from participation. The data you provide will be kept anonymous and will only be used for this study.

11 Consent form

I have read the participant information Sheet Yes ( ) No ( )

I consent to participate in the study Yes ( ) No ( )

Signature _____