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DIGITAL SUPPLY CHAIN MONITORING ON VACCINE LOGISTICS PERFORMANCE IN ZARIA LOCAL GOVERNMENT AREA

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Abstract

Efficient vaccine delivery is a critical public health challenge in developing countries like Nigeria, where preventable diseases persist. This study posits that digital supply chain monitoring significantly improves vaccine logistics performance, a hypothesis tested in Zaria Local Government Area, Kaduna State. Data from 110 healthcare personnel indicate that digital tools such as the Electronic Logistics Management Information System (eLMIS), mobile reporting platforms, and cloud-based monitoring systems are moderately to highly adopted, with 72–77% reporting use. Importantly, 77–84% observed improvements in vaccine logistics performance directly attributed to these digital systems, specifically in stock availability, cold chain integrity, timely delivery, and reduction of vaccine wastage. Chi-square tests confirm a statistically significant relationship ($p < 0.05$) between digital monitoring and key logistics outcomes, supporting the rejection of the null hypothesis. These results underscore the central argument: digital monitoring systems are essential for the efficient and reliable delivery of vaccines in resource-limited settings, though infrastructure and power challenges remain. Strengthening digital system adoption, staff capability, and infrastructure is vital for optimizing vaccine supply chains at the local government level.

Keywords: Digital Supply, Chain Monitoring, Vaccine, Logistics, Performance, eLMIS, Cold, Chain Integrity

1.1 Introduction

Vaccine delivery is a pressing public health concern, especially in developing nations like Nigeria, where existing logistical barriers severely hinder immunization coverage. This study argues that addressing these barriers through digital supply chain monitoring is central to

strengthening vaccine logistics. Across sub-Saharan Africa, inadequate infrastructure, weak coordination, and a lack of real-time information have resulted in stockouts, cold chain failures, and wastage (Ukoha & Okeke, 2022). In Nigeria, the complexity is heightened by geographic diversity, system disparities, and resource constraints at all government levels. Vaccine logistics manages the movement of vaccines from central to local points, preserving their effectiveness. Despite recent gains, researchers note that Nigerian vaccine networks remain plagued by limited stock visibility and fragmented data, affecting reliability (Ibrahim & Danladi, 2023). Digital supply chain monitoring, using real-time tracking and mobile data, offers vital improvements by increasing supply chain visibility and responsiveness. As Ayuba and Salihu (2023) and Nwafor and Okeke (2025) emphasize, tools like eLMIS and GPS tracking enable data-driven, proactive management. In vaccine distribution, such digital solutions are positioned as a transformative approach, allowing accurate tracking from warehouses to clinics and enabling early detection of supply disruptions. This is the crux of our study's argument: digital monitoring shifts supply chains from reactive to proactive, a shift supported by existing research. Yet, persistent infrastructure, power, and connectivity issues in Nigeria continue to limit potential gains (Bello & Umar, 2022; Ajayi & Adeyemi, 2022).

Recurring challenges such as inaccurate data and vaccine wastage highlight the urgent need for effective digital monitoring, which is the study's central argument. Failures at the local government level, as reported by Adebayo and Yusuf (2025), show how poor information flows delay vaccine availability and reduce immunization rates. These shortcomings support the study's assertion that robust digital supply chain monitoring is crucial in areas with high disease burdens and logistical complexity. Zaria LGA, with its diverse population and setting, is a strategic site for evaluating how digital systems impact vaccine logistics performance. Although Nigeria's NPHCDA has driven eLMIS adoption, evidence of digital monitoring outcomes at local levels is still emerging (Ojo, Abdulrahman & Bello, 2023). Garba and Ahmed (2023) found wide disparities in system performance by tier, reinforcing the need for focused, evidence-driven improvement at the local level. This research directly investigates whether digital monitoring tools improve critical logistics indicators—stock availability, cold chain integrity, delivery timeliness, and data reliability—in Zaria LGA. The conceptual framework contends that digital supply chain monitoring causally improves logistics outcomes. Core constructs are precisely defined and connected, with real-time digital visibility expected to yield fewer stockouts, reduced wastage, and more reliable delivery. This framework is supported by previous findings in northern Nigeria (Garba & Ahmed, 2023) and is visually summarized in Figure 1, which outlines the pathway from digital monitoring to improved logistics performance.

Ibrahim and Oladipo (2024) examined the implementation of digital logistics tools, including electronic logistics information systems (eLMIS) and mobile reporting platforms. Their findings revealed that facilities using digital monitoring reported a significant reduction in stock discrepancies, improved cold chain maintenance, and faster response to stock imbalances compared to facilities relying on manual record keeping. The authors concluded that digital systems enhance both responsiveness and accountability within vaccine supply chains, noting that these effects were particularly pronounced in rural and semi-urban settings where logistical

inefficiencies traditionally undermine immunization coverage (Ibrahim & Oladipo, 2024, p. 158). Ojo, Abdulrahman, and Bello (2023) investigated the impact of eLMIS utilization on vaccine availability in Lagos State. Their quantitative analysis indicated that facilities with higher engagement with digital monitoring tools experienced fewer stockouts, higher compliance with cold chain standards, and more accurate reporting. The authors highlighted that real-time alerting functionalities of eLMIS enabled proactive redistribution of vaccines prior to stockouts or expiry, effectively reducing wastage and ensuring continuous vaccine availability (Ojo, Abdulrahman & Bello, 2023, p. 74). This demonstrates how digital tools can transform reactive logistics into proactive management systems. In northern Nigeria, Garba and Ahmed (2023) explored determinants of logistics performance in Kaduna and Sokoto states. They found that digital monitoring tools were positively associated with key performance indicators, including delivery timeliness, inventory accuracy, and cold chain compliance. However, their study also emphasized that infrastructural challenges, such as unreliable power supply, intermittent internet connectivity, and limited technical support, restricted the full potential of digital systems. This aligns with broader national logistics challenges identified by Bello and Umar (2022), who highlighted persistent infrastructural and operational barriers to effective vaccine distribution in Nigeria (Garba & Ahmed, 2023, p. 198). Despite these contributions, empirical evidence at the local government level, particularly in LGAs like Zaria, remains limited. Zaria LGA represents a complex logistical environment due to its mix of urban and semi-urban settlements, population density variations, and diverse health facility capacities. Understanding how digital supply chain monitoring functions in such a context is essential, as urban-rural interface dynamics can shape vaccine distribution differently than in purely metropolitan or rural areas.

Technology Acceptance Model (TAM), originally proposed by Davis (1989), posits that the adoption and consistent use of technology are influenced by users' perceptions of its usefulness and ease of use. In the context of vaccine logistics, TAM explains how health workers' attitudes toward digital supply chain monitoring tools affect actual usage. Nigerian researchers have applied TAM to understand health information system adoption. For instance, Ibrahim and Oladipo (2024) found that logistics personnel who perceived digital systems as easy to operate and beneficial for inventory accuracy were more consistent in reporting and tracking vaccine stocks. Similarly, Ejiofor and Okeke (2022) emphasized that user acceptance of electronic logistics systems is critical for improving data quality, reducing reporting delays, and enhancing immunization program effectiveness in Nigeria. Supply Chain Visibility Theory, as developed by Christopher and Holweg (2011), underscores the importance of real-time information sharing across supply chain partners to improve coordination, reduce uncertainty, and enhance responsiveness. In vaccine logistics, visibility entails the continuous monitoring of inventory levels, shipment status, and environmental conditions such as temperature, which is crucial for cold chain integrity. Nigerian studies have demonstrated the practical relevance of visibility in public health logistics. Eze and Musa (2022) argued that insufficient visibility contributes directly to stockouts, cold chain breaches, and reporting inaccuracies. They concluded that digital monitoring systems strengthen visibility, enabling managers to identify bottlenecks early and take corrective actions before significant performance deterioration occurs. Together, TAM and Supply Chain Visibility Theory provide a robust framework for this study. TAM explains the human and behavioral dimension of technology

adoption, how healthcare workers engage with digital tools, while Supply Chain Visibility Theory elucidates the operational and functional impacts of digital monitoring on vaccine logistics performance. This dual-theoretical lens allows for a comprehensive understanding of how digital supply chain monitoring tools influence vaccine availability, cold chain integrity, stock management, and delivery timeliness in Zaria LGA.

1.2 Statement of the Problem

Vaccine delivery is a vital element of public health systems, especially in developing countries like Nigeria, where preventable diseases continue to pose significant threats to population health. Despite national programs and policies aimed at increasing immunization coverage, many local government areas face persistent challenges in vaccine logistics. These challenges include frequent stockouts, breaches in cold chain management, inaccurate reporting, and delays in vaccine delivery. Such issues are often more severe at the sub-national level, where infrastructural deficits, limited funding, and shortages of skilled personnel reduce the effectiveness of vaccine distribution systems. To address these problems, digital supply chain monitoring tools have been introduced. These include electronic logistics management information systems, mobile reporting platforms, and cloud-based tracking solutions designed to improve visibility, responsiveness, and accountability throughout the supply chain. Digital monitoring can help track stock levels, monitor cold chain conditions, and ensure timely vaccine deliveries. Evidence from other regions in Nigeria shows that facilities using digital systems experience improved stock management, fewer cold chain failures, and more accurate reporting. The main problem this study addresses is the lack of localized evidence on the impact of digital supply chain monitoring on vaccine logistics performance in Zaria LGA. Investigating this relationship is essential for designing interventions that improve vaccine delivery efficiency, enhance immunization coverage, and strengthen public health outcomes in the region.

1.3 Purpose of the Study

The primary purpose of this study is to examine how digital supply chain monitoring affects vaccine logistics performance within Zaria Local Government Area. Specifically, the study seeks to assess whether the adoption of digital tools such as electronic logistics management information systems, mobile reporting platforms, and cloud-based tracking systems enhances the efficiency, reliability, and effectiveness of vaccine distribution at the local level.

The study also aims to identify specific areas in which digital monitoring contributes to improved vaccine logistics, including stock management, cold chain maintenance, timely delivery, and reduction of vaccine wastage. By generating empirical evidence at the LGA level, the research intends to provide actionable insights for policymakers, health managers, and public health practitioners to optimize vaccine supply chains, improve immunization coverage, and strengthen overall public health outcomes. Additionally, the study seeks to explore the challenges and constraints faced by healthcare facilities in implementing digital supply chain monitoring, with a view to recommending strategies that can enhance system adoption and operational efficiency in similar contexts across Nigeria.

1.4 Research Questions

To achieve the objectives of this study, the following research questions were posed:

1. To what extent are digital supply chain monitoring tools adopted in vaccine logistics within Zaria Local Government Area?
2. How does digital supply chain monitoring influence the performance of vaccine logistics in terms of stock availability, cold chain integrity, timely delivery, and reduction of vaccine wastage?

1.5 Hypothesis

The study tested the following hypothesis to provide empirical evidence on the relationship between digital supply chain monitoring and vaccine logistics performance.

H_0: Digital supply chain monitoring does not have a significant effect on vaccine logistics performance in Zaria Local Government Area.

H_1: Digital supply chain monitoring has a significant effect on vaccine logistics performance in Zaria Local Government Area.

2. Methodology

This section provided a detailed explanation of the methodology employed in this study, which was designed to investigate the relationship between digital supply chain monitoring and vaccine logistics performance within Zaria Local Government Area (LGA). The methodology describes the research design, population and sample, sampling techniques, data collection instruments, validity and reliability measures, data collection procedures, and methods of data analysis. The aim was to ensure a systematic, rigorous, and reproducible approach that accurately captures the perspectives of healthcare personnel involved in vaccine logistics and generates findings that can inform policy and operational improvements. The study adopted a descriptive survey research design, which is particularly suited for examining current practices, behaviors, and perceptions of healthcare personnel regarding the adoption and use of digital supply chain monitoring tools. The descriptive survey design allows the collection of quantitative data from a substantial number of respondents, enabling the identification of trends, patterns, and relationships between digital monitoring practices and vaccine logistics performance. This design is appropriate for understanding how health workers use electronic systems in managing vaccine inventories, ensuring cold chain integrity, and responding to logistical challenges, while also capturing their experiences and perceptions regarding operational efficiencies and bottlenecks. The target population for the study consisted of healthcare personnel actively involved in vaccine logistics within Zaria LGA. This population included health workers responsible for vaccine storage, handling, and distribution in primary healthcare centers (PHCs), logistics officers and cold chain managers overseeing inventory and supply chain processes, as well as supervisory and administrative staff at the Local Government Health Department involved in monitoring vaccine delivery. According to records from the Zaria LGA Health Management Office (2023), there are approximately 150 personnel across 25 PHCs directly involved in vaccine logistics activities, representing the core stakeholders responsible for ensuring the efficiency and reliability of vaccine delivery and maintaining cold chain standards. A sample size of 110 respondents was determined

using the Yamane formula for finite populations, which provides a reliable estimate with a 95% confidence level and a 5% margin of error. To ensure representative coverage across the diverse roles and facility types, a stratified random sampling technique was employed. Stratification was based on staff roles and the nature of the facility, including urban PHCs, semi-urban PHCs, and LGA administrative offices. Within each stratum, respondents were randomly selected to ensure proportional representation and reduce selection bias. This approach ensures that the collected data accurately reflects the operational realities and perspectives of personnel working across different parts of Zaria LGA's vaccine supply chain.

Data were collected using a structured questionnaire developed specifically for this study. The questionnaire comprised four sections. The first section captured demographic information, including respondents' age, gender, educational qualification, role in vaccine logistics, and years of experience. The second section focused on the adoption and use of digital supply chain monitoring tools, such as the Electronic Logistics Management Information System (eLMIS), mobile reporting platforms, and cloud-based tracking systems. The third section assessed vaccine logistics performance, including stock availability, cold chain compliance, timely delivery, and vaccine wastage reduction. The fourth section addressed challenges and opportunities affecting the use of digital monitoring systems, such as infrastructure limitations, technical capacity, financial constraints, and human resource factors. Responses were captured using a 5-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree," allowing for quantification of perceptions and experiences. To ensure validity, the questionnaire was reviewed by three experts in public health logistics and supply chain management. Their evaluation focused on the clarity, relevance, and comprehensiveness of the instrument in capturing the key constructs under investigation. For reliability, a pilot test was conducted in neighboring LGAs with 15 respondents. The internal consistency of the instrument was assessed using Cronbach's Alpha, yielding a score of 0.87, which exceeds the recommended threshold of 0.70, indicating that the questionnaire is reliable for data collection. Data collection was carried out over three weeks following approval from the Zaria LGA Health Department. Questionnaires were administered in person to selected respondents at PHCs and administrative offices. Completed questionnaires were collected on the same day, ensuring high response rates and reducing the likelihood of non-response bias. The collected data were analyzed using both descriptive and inferential statistical techniques. Descriptive statistics, including frequency counts, percentages, means, and standard deviations, were used to summarize demographic characteristics, adoption levels of digital monitoring tools, and vaccine logistics performance indicators. To test the study hypothesis concerning the relationship between digital supply chain monitoring and vaccine logistics performance, Chi-square tests were employed with a significance level set at $p < 0.05$. The analysis was performed using SPSS version 26, which facilitated accurate computation of statistical measures, visualization of results, and interpretation of relationships between variables. This methodology ensures a systematic and robust approach to exploring how digital supply chain monitoring influences vaccine logistics performance in Zaria LGA, providing a foundation for actionable recommendations aimed at improving public health outcomes.

3. Result

Adoption of Digital Supply Chain Monitoring Tools in Zaria LGA

Table 1: Adoption of Digital Supply Chain Monitoring Tools

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total (%)
Use of eLMIS in vaccine stock management	40 (36.4)	45 (40.9)	10 (9.1)	10 (9.1)	5 (4.5)	100
Mobile reporting platforms are regularly used	35 (31.8)	50 (45.5)	12 (10.9)	8 (7.3)	5 (4.5)	100
Cloud-based tracking systems enhance monitoring	30 (27.3)	48 (43.6)	15 (13.6)	10 (9.1)	7 (6.4)	100
Digital alerts and notifications improve decision making	38 (34.5)	46 (41.8)	12 (10.9)	8 (7.3)	6 (5.5)	100

The data indicate a moderate to high adoption of digital supply chain monitoring tools in Zaria LGA. A combined total of 72–77% of respondents agreed or strongly agreed that eLMIS, mobile reporting, and cloud-based systems are actively used to track vaccine stock, manage cold chain conditions, and support timely decision-making. However, 10–15% of respondents were neutral or disagreed, suggesting that adoption is not uniform across all facilities, possibly due to factors such as limited training, infrastructure challenges, or intermittent power/internet supply

Table 2: Influence of Digital Supply Chain Monitoring on Vaccine Logistics Performance

Performance Indicator	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total (%)
Improved stock availability	45 (40.9)	48 (43.6)	7 (6.4)	6 (5.5)	4 (3.6)	100
Maintains cold chain integrity	42 (38.2)	50 (45.5)	8 (7.3)	6 (5.5)	4 (3.6)	100
Ensures timely delivery of vaccines	40 (36.4)	48 (43.6)	12 (10.9)	6 (5.5)	4 (3.6)	100
Reduces vaccine wastage	38 (34.5)	50 (45.5)	12 (10.9)	6 (5.5)	4 (3.6)	100

A combined total of **77–**84% of respondents agreed or strongly agreed that digital monitoring tools positively influence vaccine logistics performance. Respondents reported that these systems help reduce stockouts, maintain cold chain conditions, improve delivery timeliness, and reduce vaccine

wastage. This supports the view that digital tools enhance visibility, accountability, and responsiveness in the vaccine supply chain. However, a small minority (5–10%) disagreed, which may reflect challenges such as power interruptions, limited system literacy, or inadequate infrastructure.

Hypothesis Testing

Null Hypothesis (H_0): Digital supply chain monitoring has no significant effect on vaccine logistics performance in Zaria LGA.

Alternative Hypothesis (H_1): Digital supply chain monitoring has a significant effect on vaccine logistics performance in Zaria LGA.

A Chi-square test of independence was conducted to test the relationship between adoption of digital monitoring tools and vaccine logistics performance.

Table 3: Chi-Square Test of Digital Supply Chain Monitoring and Vaccine Logistics Performance

Variables	χ^2	df	p-value	Decision
Digital Monitoring vs Vaccine Stock Availability	24.56	4	0.000	Reject H_0
Digital Monitoring vs Cold Chain Integrity	20.48	4	0.001	Reject H_0
Digital Monitoring vs Timely Delivery	18.92	4	0.002	Reject H_0
Digital Monitoring vs Vaccine Wastage Reduction	22.36	4	0.001	Reject H_0

The Chi-square analysis shows that there is a statistically significant relationship ($p < 0.05$) between the adoption of digital supply chain monitoring tools and all key vaccine logistics performance indicators. This means that higher usage of eLMIS, mobile reporting, and cloud-based monitoring is associated with better stock availability, improved cold chain integrity, timely vaccine delivery, and reduced wastage. Therefore, the null hypothesis is rejected, and the alternative hypothesis is accepted, confirming that digital supply chain monitoring significantly improves vaccine logistics performance in Zaria LGA.

4. Discussion of Findings

The findings of this study show that digital supply chain monitoring tools are adopted moderately to highly across healthcare facilities in Zaria Local Government Area (LGA). A total of 72–77% of respondents reported active use of electronic systems, such as the Electronic Logistics Management Information System (eLMIS), mobile reporting platforms, and cloud-based tracking tools. These systems help monitor vaccine stock, manage cold chain conditions, and

support timely decision-making. This level of adoption shows that Zaria LGA is increasingly using digital technologies to improve vaccine logistics efficiency and reliability. However, 10–15% of respondents were neutral or disagreed with adoption statements. This highlights that usage is not uniform across all facilities, possibly due to limited training, intermittent internet connectivity, power supply issues, or lack of technical support. These findings align with recent Nigerian studies. For example, Ayuba and Salihu (2023) reported that infrastructural and human capacity gaps are still major barriers to consistent adoption of digital monitoring systems in northern Nigerian LGAs. Regarding impact, 77–84% of respondents agreed or strongly agreed that digital tools improve stock availability, cold chain integrity, timely delivery, and reduce vaccine wastage. This shows that digital monitoring enhances supply chain visibility, accountability, and responsiveness. It enables proactive stock management and helps maintain cold chain conditions. These findings support the work of Ibrahim and Oladipo (2024), who observed major improvements in stock management, fewer cold chain failures, and faster reporting in Kano State. Ojo, Abdulrahman, and Bello (2023) also found that real-time digital alerts through eLMIS reduced stockouts and ensured cold chain standards in Lagos State.

The inferential analysis further reinforces these results. Chi-square tests revealed a statistically significant relationship ($p < 0.05$) between the adoption of digital supply chain monitoring tools and all key vaccine logistics performance indicators. This confirms that facilities with higher adoption of digital tools experience better stock availability, improved cold chain integrity, timely vaccine delivery, and reduced wastage. Consequently, the null hypothesis that digital supply chain monitoring does not significantly affect vaccine logistics performance is rejected, and the alternative hypothesis is accepted. This finding aligns with Garba and Ahmed (2023), who demonstrated in Kaduna and Sokoto states that digital supply chain monitoring is positively associated with delivery timeliness, inventory accuracy, and overall logistics efficiency, although challenges such as unreliable power supply and internet connectivity can limit the full potential of these systems. Overall, the findings indicate that digital supply chain monitoring is a critical enabler of efficient vaccine logistics in Zaria LGA. Adoption of these tools supports operational decision-making, ensures vaccine availability, maintains cold chain compliance, and minimizes wastage. Nonetheless, gaps in infrastructure, training, and system literacy need to be addressed to ensure consistent adoption and optimize the performance of the vaccine supply chain. These results underscore the importance of integrating policy interventions, capacity-building programs, and infrastructure investment to maximize the benefits of digital supply chain monitoring for immunization programs in Nigerian local government areas.

5. Conclusion

The findings clearly show that digital supply chain monitoring improves vaccine logistics performance within Zaria Local Government Area. The evidence demonstrates that tools such as eLMIS, mobile reporting platforms, and cloud-based tracking systems help improve stock availability, cold chain maintenance, timely delivery, and waste reduction. Descriptive analysis found that 72–77% of respondents use digital monitoring tools actively. In addition, 77–84% confirmed that these systems have a positive impact on vaccine logistics outcomes. Chi-square analysis showed a statistically significant relationship ($p < 0.05$) between digital monitoring and

all performance indicators. This led to rejection of the null hypothesis and acceptance of the alternative.

The study also identified several factors that influence the effectiveness of digital tools. These include infrastructure limitations, inconsistent internet and power supply, and varying staff competence in system use. Despite these challenges, digital monitoring improves supply chain visibility, accountability, and responsiveness. This confirms its role as a key enabler of efficient vaccine distribution. These findings agree with Nigerian studies by Ibrahim and Oladipo (2024), Garba and Ahmed (2023), and Ojo, Abdulrahman, and Bello (2023). Their studies highlighted real-time digital monitoring's benefits for improving logistics outcomes in both northern and southern Nigerian states. In conclusion, digital supply chain monitoring is a vital strategy for optimizing vaccine logistics in Zaria LGA. It boosts operational efficiency, reduces preventable stockouts and wastage, and strengthens public health results. The evidence shows that proper adoption and support of digital tools can transform local vaccine delivery systems.

6. Recommendations

Based on the findings and conclusions of this study, the following recommendations are proposed to improve vaccine logistics performance through digital supply chain monitoring in Zaria LGA:

1. Continuous training should be provided for health workers, logistics officers, and administrative staff. This ensures they can effectively use digital supply chain tools. Training should focus on system navigation, real-time data entry, and understanding logistics dashboards. This will increase operational efficiency. Studies by Ibrahim and Oladipo (2024) and Ejiofor and Okeke (2022) show that user competence directly affects adoption and system effectiveness.
2. Government and local health authorities should invest in reliable power supply, internet connectivity, and maintenance of digital devices. Inadequate infrastructure limits consistent system use. Solving these infrastructure gaps will help real-time monitoring tools work smoothly in all health facilities.
3. Digital monitoring systems like eLMIS, mobile reporting platforms, and cloud databases should be fully integrated. This allows seamless data sharing across health facilities and administrative offices. The integration reduces reporting delays, improves data accuracy, and supports proactive decision-making. This follows the Supply Chain Visibility Theory.
4. Health workers and facility managers should be encouraged to use digital monitoring tools regularly. This can be done through incentives, recognition, or career development opportunities. Studies in Nigeria show that motivation and perceived usefulness of technology are important for high adoption rates.
5. Periodic audits and evaluations should check system usage, data accuracy, and logistics performance. Feedback will help find challenges, guide interventions, and reinforce accountability in vaccine supply chains.
6. Policymakers should support digital supply chain efforts with clear guidance, funding, and partnerships. Involving local communities, health facility staff, and LGA administrators will help digital tools fit well into operations.

REFERENCES

Adebayo, T., & Yusuf, A. (2025). Information flows and immunization efficiency: Challenges in Nigerian local government vaccine supply chains. *Journal of Public Health Logistics in Nigeria, 4*(1), 45–62.

Ajayi, M., & Adeyemi, S. (2022). Infrastructure and digital vaccine logistics in peripheral health facilities in Nigeria. *African Journal of Health Systems, 8*(2), 112–129.

Ayuba, H., & Salihu, F. (2023). Digital supply chain monitoring in Nigerian healthcare: Enhancing visibility and decision-making. *International Journal of Health Informatics, 10*(1), 54–63.

Bello, R., & Umar, I. (2022). Challenges of vaccine logistics in Nigeria: Infrastructure, data, and human resource constraints. *Nigerian Journal of Health Management, 6*(3), 88–105.

Chukwuemeka, P., & Eze, N. (2024). Digital visibility in vaccine supply chains: Proactive management for immunization programs. *Journal of Nigerian Public Health, 12*(1), 85–95.

Christopher, M., & Holweg, M. (2011). *Supply chain 2.0: Managing supply chains in the era of turbulence*. London, UK: Financial Times Prentice Hall.

Ejiofor, C., & Okeke, D. (2022). Technology adoption in health information systems: Lessons from Nigerian immunization programs. *Nigerian Journal of Health Informatics, 7*(2), 23–39.

Eze, J., & Musa, L. (2022). Vaccine logistics performance in Nigeria: Stock availability, cold chain integrity, and delivery effectiveness. *African Journal of Health Logistics, 5*(1), 33–50.

Garba, M., & Ahmed, S. (2023). Digital monitoring tools and vaccine logistics performance in Northern Nigeria. *Nigerian Journal of Supply Chain Management, 9*(1), 193–205.

Ibrahim, A., & Danladi, T. (2023). Weaknesses in Nigerian vaccine distribution networks: Implications for immunization programs. *Journal of Public Health Research and Policy, 11*(2), 210–219.

Ibrahim, A., & Oladipo, K. (2024). Adoption of electronic logistics management information systems in primary healthcare centers in Kano State, Nigeria. *Nigerian Journal of Health Informatics, 8*(1), 150–162.

Nwafor, P., & Okeke, B. (2025). Resilient vaccine logistics through digital supply chain monitoring in Nigeria. *African Health Management Journal, 11*(1), 70–82.

Ogunleye, J., & Musa, F. (2023). Public confidence in immunization programs and the role of logistics in Nigeria. *Journal of Nigerian Public Health, 12*(2), 66–78.

Ojo, T., Abdulrahman, S., & Bello, R. (2023). eLMIS utilization and vaccine availability in Lagos State, Nigeria. *Nigerian Journal of Health Systems, 15*(1), 68–78.

Ukoha, C., & Okeke, D. (2022). Public health challenges in vaccine logistics in Nigeria: Geographic and systemic factors. *Nigerian Journal of Public Health Management, 6*(1), 22–36.