Key Challenges and Disruptions Faced by The Health Supply Chain in Northeast Nigeria During Humanitarian Crises

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Abstract- ***Insecurity, infrastructure damage, and chronic underfunding have strained the health system's capacity to sustain life-saving interventions, especially in hard-to-reach areas. This study aims to investigate the key challenges and disruptions faced by the health supply chain in northeast Nigeria during humanitarian crises. A mixed-methods design was adopted. The population included health supply chain stakeholders across Borno and Adamawa States with a sample size of 200 selected using the purposive sampling technique. Quantitative data were collected using questionnaire while Qualitative insights were obtained through key informant interviews with officials from government agencies, NGOs, and development partners. Quantitative data were analyzed using percentage, mean and regression statistics with the aid of the Statistical Product for Service Solution (SPSS V-27), while qualitative responses were thematically coded. Analysis was framed using a resilience systems theory model, emphasizing robustness, redundancy, resourcefulness, and rapidity. Findings revealed that The result showed that, 167 (83.5%) indicated that there is frequent disruption in the health supply chain, and the major causes were: The major causes of supply chain disruption were: conflict/insurgency (200%), poor infrastructure (100%), inadequate funding (94.5%), political instability (54.5%), poor road networks (44.5%), and natural disaster (13.0%). 39(19.5%) indicated that the current health supply chain was handled disruption well. The result further showed that more than half 114 (57.0%) indicated thatrespondents experience delays in delivery of medical supplies frequently and 113 (56.5%) indicated that there is adequate health supplies during disruption. Major limitations were: insecurity and disruptions of transportation routes during insurgencies (54.0%), persistent insecurity and disruptions of transportation routes during insurgencies (30.5%), and insecurity and conflict-induced road inaccessibility (8.5%). Key gaps included limited real-time visibility, poor coordination, and underutilization of technology. The study concludes that the disruptions faced by the supply chain in Northern Nigeria are primarily driven by a confluence of intractable factors: pervasive insecurity and ongoing conflict, dilapidated and insufficient infrastructure, and chronic, systemic underfunding. It recommends scaling up digital logistics management tools, improving transport infrastructure tailored to conflict zones, securing emergency response financing, and enhancing local actor participation in logistics planning. Strengthened coordination among government and partners is critical for sustainable impact.***

Index Terms- ***Challenges, Disruptions, Supply Chain, Northeast Nigeria***

I. INTRODUCTION

Developing countries, in particular, face greater challenges due to weaker infrastructure, limited financial resources, and governance issues (Smith, 2021). These factors exacerbate the difficulties of managing health supply chains effectively during crises. Smith (2021) noted that a resilient health supply chain requires integration of advanced technologies, diversified sourcing, and collaborative frameworks to ensure continuity in the face of disruptions. These elements are especially critical in humanitarian contexts, where rapid responses and adaptability are essential. Many countries-imposed export bans on critical medical products, leading to

inequitable distribution and affecting low-income nations the most (Shih, 2020). This crisis underscored the need for more localized and diversified supply chains to enhance resilience. In addition to pandemics, climate change has become a critical factor affecting global health supply chains. Natural disasters such as hurricanes, floods, and wildfires frequently disrupt transportation networks and healthcare infrastructure, delaying the delivery of essential medical supplies (Authority News, 2024).

The increasing frequency and severity of these events necessitate proactive strategies such as decentralized warehousing, renewable energy-powered cold storage, and green logistics solutions to ensure supply chain continuity (McKinnon, 2021). Furthermore, technological advancements such as blockchain, artificial intelligence (AI), and the Internet of Things (IoT) have revolutionized supply chain resilience by enhancing real-time visibility, efficiency, and predictive analytics (Christopher & Peck, 2020). These digital innovations enable supply chain managers to anticipate disruptions, optimize resource allocation, and improve response times, particularly during emergencies.

From a regional perspective, Africa presents unique challenges in health supply chain disruption due to its diverse socio-economic, political, and geographical factors. The continent has faced recurrent health emergencies such as the Ebola outbreak in West Africa, cholera epidemics, and the ongoing burden of malaria, all of which place immense pressure on existing health logistics systems (Yadav, 2015). These public health crises highlight the need for tailored approaches to resilience-building, including capacity building, infrastructure investment, and leveraging local resources to improve supply chain efficiency. Many African nations also struggle with political instability and armed conflicts that further complicate the delivery of healthcare services. The Boko Haram insurgency in Northeast Nigeria, for instance, has severely disrupted the health supply chain by displacing millions, destroying healthcare infrastructure, and making transportation of medical supplies unsafe (Adebusoye et al, 2024). Similarly, conflicts in the Democratic Republic of Congo and South Sudan have created logistical bottlenecks, limiting access to essential medicines and vaccines in vulnerable regions (Chikwendu, 2018).

Nigeria faces immense challenges Despite these challenges, African nations are increasingly adopting innovative strategies to enhance supply chain resilience. The use of mobile clinics, decentralized procurement, and community-based distribution networks has been instrumental in sustaining healthcare delivery during crises (UNICEF, 2021). Additionally, initiatives such as the African Vaccine Manufacturing Initiative (AVMI) aim to reduce the continent's dependence on imported pharmaceuticals by strengthening local production capacities (BMC Public Health, 2022). Regional collaborations, such as the African Union's efforts to develop cross-border health supply chain networks, have also improved logistical efficiency and emergency preparedness. The African Continental Free Trade Area (AfCFTA) is expected to further enhance supply chain resilience by facilitating the movement of medical goods across borders without trade restrictions (WHO Africa, 2022).

in strengthening its health supply chain resilience. As Africa's most populous country, Nigeria relies heavily on imported pharmaceuticals, making it particularly vulnerable to global supply chain disruptions (Adebayo, 2021). The country's health supply chain is further weakened by poor infrastructure, inadequate cold chain facilities, and bureaucratic inefficiencies in procurement and distribution (Adebayo et al., 2016). The Boko Haram insurgency in Northeast Nigeria has exacerbated these issues, making it difficult to transport medical supplies to conflict-affected areas and putting healthcare workers at risk (UN OCHA, 2021).

The North Eastern states represent some of the most affected areas, characterized by widespread displacement, destroyed infrastructure, and heightened vulnerability among populations. The health supply chain in Northeast Nigeria is under immense strain due to prolonged humanitarian crises, including conflicts, natural disasters, and socio-economic instability. These disruptions severely impact the delivery of essential medical supplies, vaccines, and life-saving drugs to vulnerable populations. The Boko Haram insurgency, which has

persisted for over a decade, has led to mass displacement, destruction of healthcare infrastructure, and insecurity, making it difficult for medical supplies to reach those in need (Alao &Murtala, 2020). If these challenges were effectively addressed, healthcare services in the region would be more reliable, mortality and morbidity rates would decrease, and health outcomes would significantly improve. While previous research has explored supply chain resilience globally (Christopher & Peck, 2004; Hosseini et al., 2022), studies focusing on conflict-affected regions like Northeast Nigeria remain limited. Hence, this study focused on the key challenges and disruptions faced by the health supply chain in Northeast Nigeria during humanitarian crises. The study provided answers to the following research questions:

1. What are the key challenges and disruptions faced by the health supply chain in Northeast Nigeria during humanitarian crises?
2. What are the major gaps and limitations in the existing resilience and adjustment strategies, and how can they be addressed?

II. METHODOLOGY

The study was conducted in Northeast Nigeria, a region comprising six states: Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe. However, the focus of the study was specifically on Borno and Adamawa States, which have been disproportionately affected by the ongoing humanitarian crises resulting from the Boko Haram insurgency, socio-political instability, and forced displacement of populations. The research adopted a mixed-methods design, combining both qualitative and quantitative approaches to generate comprehensive insights into the subject matter. The population of the study encompasses a range of actors directly or indirectly involved in health supply chain operations in conflict-affected settings. These include stakeholders from the public health system, non-governmental organizations (NGOs), development partners, community-based actors, and the broader ecosystem of health service delivery and logistics coordination.

The sample size for the study was 300 which was selected using the purposive sampling technique. The instruments for data collection in this study were structured questionnaires and semi-structured interview guides. Validity of the research instruments was conducted through expert review and pilot testing. To ensure the reliability of the structured questionnaire, a pilot study was conducted with 30 participants selected from health facilities in Gombe State, which shares similarities with the main study area but was not part of the target population. Cronbach's alpha coefficient was calculated for the questionnaire to assess internal consistency. An alpha value of 0.82 was obtained, indicating a high level of reliability.

The data collection spanned a period of three months, from January to March 2025. Field assistants, trained in ethical research conduct, supported the distribution of questionnaires and scheduling of interviews across health facilities and humanitarian offices in Borno and Adamawa States. Respondents for the questionnaire were given sufficient time to complete the forms, and follow-up visits were conducted to ensure maximum return rates. Interviews were conducted either face-to-face or via secure online platforms for respondents in hard-to-reach or security-sensitive areas. Each interview session lasted between 30 and 60 minutes, depending on the respondent's availability and willingness to engage. The study adopted a two-pronged approach to data analysis, reflecting its mixed-methods design. Quantitative data from the structured questionnaires were analyzed with the aid of the Statistical Package for the Social Sciences (SPSS) version 27 using percentage, mean and regression at 0.05 level of significance.

III. RESULTS

The results of the study are shown below:

Table 1: Percentage distribution showing disruption in the health supply chain

Items	Frequency (f)	Percentage (%)
How often does disruption in the health supply chain occur		
Frequently	167	83.5
Occasionally	17	8.5
Rarely	11	5.5

Never	5	2.5
Major causes of supply chain disruptions*		
Conflict/insurgency	200	100
Poor infrastructure	200	100
Inadequate funding	189	94.5
Poor road networks	89	44.5
Natural disaster	26	13.0
Political instability	109	54.5
How well current health supply chain handle disruption		
Very well	29	14.5
Well	39	19.5
Neutral	97	48.5
Poorly	35	17.5
How frequent respondents experience delays in delivery of medical supplies		
Very frequently	46	23.0
Frequently	114	57.0
Occasionally	11	5.5
Rarely	29	14.5

Table 1b: Percentage distribution showing disruption in the health supply chain

Items	Frequency (f)	Percentage (%)
Availability of health supplies		
Available	17	8.5
Averagely available	119	59.5
Rarely available	64	32.0
Adequacy of health supplies during disruption		
Adequate	113	56.5
Neutral	23	11.5
Inadequate	64	32.0

*Multiple response.

Table 1 presents the percentage distribution showing disruption in the health supply chain. The result showed that, 167 (83.5%) indicated that there is frequent disruption in the health supply chain, and the major causes were: The major causes of supply chain disruption were: conflict/insurgency (200%), poor infrastructure (100%), inadequate funding (94.5%), political instability (54.5%), poor road networks (44.5%), and natural disaster (13.0%). 39(19.5%) indicated that the current health supply chain was handled disruption well. The result further showed that more than half 114 (57.0%) indicated thatrespondents experience delays in delivery of medical supplies frequently and 113 (56.5%) indicated that there is adequate health supplies during disruption.

The findings from the qualitative aspect of the study also buttress this result:
A key informant interviewee (Supply Chain Manager, Private sector pharma distributor) highlighted that:

One of the major disruption I have encountered was unpredictable demand from displaced populations, which complicates planning. There are also frequent supply interruptios due to border closures or inaccessible roads.

Another interviewee (NGO representative) reiterated how issues like security, infrastructure, or funding affected health supply chain thus:

Security dictates our movements and limit our reach to some of the most vulnerable populations. Infrastructure challenges lead to longer transit times, increased wear and tear on vehicles, and higher operational costs. Funding often dictates the scale and duration of our programs, impacting our ability to maintain consistent supply lines.

A key informant who is a health facility staff (Nurse) noted:
Sometimes supply vehicles cannot reach us because of security problems, leading to critical shortages. Our storage facilities are basic, and we lack proper cold chain equipment. Funding issues at higher level mean we often receive less than what is needed.

A respondent who is a government official also specified a disruption in the health supply chain given below:

As a government official, I oversee operations where security challenges require escorts and limit movement to daylight hours, causing delays. Additionally, poor infrastructure – especially road conditions – extends transit times and raises vehicle maintenance expenses. Inconsistent funding further complicates budgeting for major procurements and critical logistics, such as maintain the cold chain.

Table 2: Major gaps and limitations in resilience and adjustment strategies

Items	Frequency (f)	Percentage (%)
Major gaps and limitations		
Persistent insecurity and disruptions of transportation routes during insurgencies	61	30.5
Insecurity and conflict-induced road inaccessibility	17	8.5
Insecurity and disruptions of transportation routes during insurgencies	108	54.0
Insurgency-related insecurity leading to blocked access routes	3	1.5
Security threats preventing access to last mile health facilities	11	5.5
Other limitations to consider		
Bureaucratic delays in procurement approvals during crises	3	1.5
Difficulty accessing last-mile locations due to fear of attacks, sudden donor policy shifts disrupt planned supply chains	46	23.0
Inadequate capacity to manage the supply chain by the state stakeholders	6	3.0
Political interference and limited stakeholder coordination, high staff turnover and lack of incentive for frontline logisticians	59	29.5
Political interference, community resistance due to lack of sensitization, corruption and weak accountability	2	1.0
Psychological trauma among staff affects performance, sudden donor policy shifts disrupt planned supply chains	44	22.0
Sudden donor policy shifts disrupt planned supply chains	18	9.0
Weak accountability in distribution process and limited engagement of local communities	5	2.5
Weak health data systems, low staff motivation in remote zones	17	8.5

Table 2 presents the major gaps and limitations in resilience and adjustment strategies. The result showed that the major limitations were: insecurity and disruptions of transportation routes during insurgencies (54.0%), persistent insecurity and disruptions of transportation routes during insurgencies (30.5%), and insecurity and conflict-induced road inaccessibility (8.5%). Other limitations to consider were: politicalinterference and limited stakeholder coordination, high staff turnover and lack of incentive for frontline logisticians (29.5%), psychologicaltrauma among staff affects performance, difficulty accessing last-mile locations due to fear of attacks, sudden donor policy shifts disrupt planned supply chains (23.0%), and sudden donor policy shifts disrupt planned supply chains (22.0%).

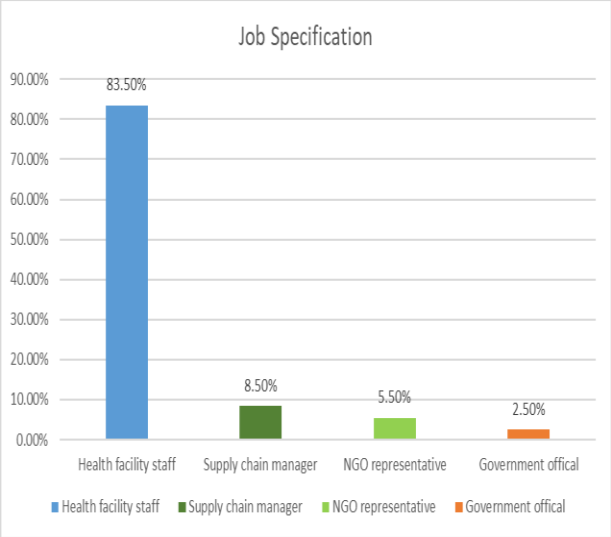

Fig 1: Bar chart showing role of respondents in the health supply chain

Fig 1 presents the bar chart showing the role of respondents in the health supply chain sector. The result showed that majority 167 (83.5%) of the respondents were health facility staff, 17 (8.5%) were supply chain managers, 11 (5.5%) were NGO representatives, while 5 (2.5%) were government officials.

Socio-demographic characteristics

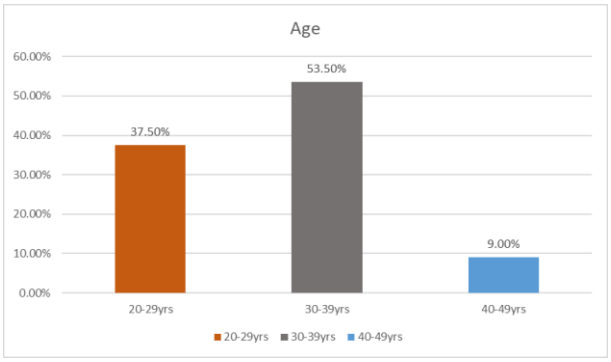

Fig 2: Bar chart showing age distribution of the respondents

Fig 2 presents the bar chart showing age distribution of the respondents. The result showed that more than half 107 (53.5%) of the respondents were within the age range of 30-39 years, 75(37.5%) were aged 20-29 years while 18 (9.0%) were aged 40-49 years.

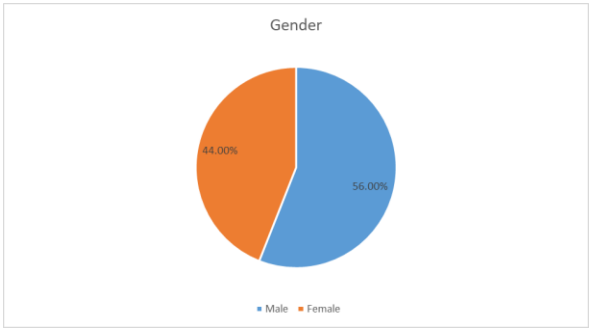

Fig 3: Pie chart showing gender distribution of the respondents

Fig 3 presents the pie chart showing gender distribution of the respondents. The result showed that more than half 112 (56.0%) of the respondents were male and 88 (44.0%) were females.

IV. DISCUSSION OF THE FINDINGS

The findings of the study were discussed below:
The empirical findings, derived from quantitative analysis, overwhelmingly demonstrated that disruptions within this vital supply chain are a frequent and pervasive occurrence, with a staggering 83.5% of surveyed respondents confirming this regularity. This pervasive instability contrasts sharply

with more predictable supply chain environments, underscoring the severe operational difficulties inherent in the region.

The root causes of these multifarious disruptions were unequivocally identified. Conflict and insurgency emerged as the most dominant factor, cited by 100% of respondents. This finding is profoundly significant, as it highlights that the primary impediment to health supply chain functionality in Northeast Nigeria is not merely logistical or economic, but deeply rooted in the security landscape. Poor infrastructure also attained a 100% consensus, indicating a foundational systemic weakness. Inadequate funding followed closely at 94.5%, suggesting a critical resource deficit that hinders both proactive resilience building and reactive adjustment. Other substantial contributing factors included political instability (54.5%), poor road networks (44.5%), and, to a lesser extent, natural disasters (13.0%). The distinction between "poor infrastructure" and "poor road networks" suggests a broader issue encompassing storage, communication, and energy infrastructure, not solely transportation routes.

These comprehensive findings align strongly with and significantly expand upon the theoretical underpinnings of supply chain resilience. Scholarly frameworks, such as those by Hosseini, Barker, and Ramirez-Marquez (2016), emphasize that robustness, redundancy, resourcefulness, and rapidity are the four cardinal components of genuinely resilient supply chains. The diverse strategies observed in this study, including the meticulous maintenance of buffer stock and the development of alternative supplier networks, directly reflect concerted efforts to embed robustness and build critical redundancy into the system. Furthermore, the widespread adoption and utilization of digital monitoring systems and real-time tracking technologies emphatically demonstrate a strategic emphasis on enhancing rapidity and visibility—attributes that Christopher and Peck (2004) posited as absolutely crucial for fostering integrated resilience and effective adjustment. The remarkably high emphasis placed on collaboration (with 73.5% considering it "extremely critical") is also profoundly consistent with the burgeoning body of literature that champions collaborative frameworks as indispensable for effective supply chain management, particularly within the unpredictable and demanding crucible of crisis environments (Smith, 2021).

Despite the diligent implementation of these diverse strategies, the persistently low perception of overall resilience (with only 14.0% viewing it as resilient) is a critical takeaway. This suggests that while individual implemented strategies are undoubtedly vital and contribute to operational continuity, their cumulative impact is still heavily constrained by the overwhelming and intractable nature of the underlying challenges, particularly the relentless insecurity and chronic funding limitations. This section robustly confirms that stakeholders are indeed actively implementing a wide spectrum of diverse strategies, thereby conclusively addressing and fulfilling the second research objective. However, the qualitative insights concurrently reveal a remarkable degree of ingenuity and adaptive capacity at the grassroots level. These often take the form of "self-organized responses," a phenomenon well-described by Complex Adaptive Systems (CAS) theory, where decentralized agents autonomously devise and execute collective actions, frequently without explicit central directives, thereby enhancing the system's robustness against unpredictable shocks (Barasa, Mbau, & Gilson, 2018; Holland, 2014). This profound observation unequivocally underscores the indispensable and often under-recognized role of local adjustment and bottom-up innovation in navigating and surviving within highly volatile and unpredictable operating contexts.

The profound implications of these findings for the health supply chain in Northeast Nigeria are unequivocally significant. They underscore the urgent and undeniable need for a holistic, integrated approach that not only focuses on improving rudimentary logistical infrastructure and securing adequate funding but also fundamentally integrates local community initiatives. Crucially, such an approach must also confront and address the underlying security and governance challenges that perpetually undermine the system. True resilience in this complex context is not merely about passively bouncing back to a previous state; it is fundamentally about continuous adjustment, proactive learning from the unpredictable and hostile operating environment,

and the cultivation of an inherent capacity for dynamic evolution, as cogently suggested by the principles of Complex Adaptive Systems (CAS) theory, where adaptive learning ensures systems progressively improve their fitness over time (Barasa, Mbau, & Gilson, 2018; Holland, 2014; Levin et al., 2013).

CONCLUSION

The comprehensive findings of this study unequivocally demonstrate that frequent and debilitating disruptions are not an anomaly but a deeply ingrained norm. These disruptions are primarily driven by a confluence of intractable factors: pervasive insecurity and ongoing conflict, dilapidated and insufficient infrastructure, and chronic, systemic underfunding. Despite these deeply embedded fragilities and the formidable nature of the challenges, the study definitively concludes that adaptive measures such as the strategic diversification of supply routes, the judicious leveraging of local partnerships, and the purposeful utilization of technology for enhanced inventory management and real-time tracking are not merely beneficial but demonstrably crucial and effective in ensuring the continuous availability and unhindered accessibility of essential healthcare services during crises.

RECOMMENDATIONS

Based on the findings of the study, the following recommendations were made:

1. There is need to scale up digital logistics management tools, improving transport infrastructure tailored to conflict zones, securing emergency response financing, and enhancing local actor participation in logistics planning.
2. Policy frameworks must be urgently developed and implemented to ensure flexible budget reallocations during emergencies, thereby imbuing the system with the essential agility required to respond effectively to unforeseen and rapidly evolving disruptions.
3. Addressing the pervasive issue of poor infrastructure and the woefully inadequate road networks is a critical to addressing the disruption in the supply chain. This necessitates significant and sustained investment in the rehabilitation, upgrading, and, where necessary, the new development of key transportation routes to fundamentally improve accessibility to remote and conflict-affected areas.
4. Data analytics capabilities within the supply chain must be significantly strengthened to enable advanced predictive analysis of future demand patterns and potential disruption scenarios, allowing for more proactive and data-driven decision-making.

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