

From crisis preparedness to sustainable development: integrating technology innovation in driving Africa's supply chain management in LASEMA

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Abstract — This study examines how innovative technologies can be integrated into the Lagos State Emergency Management Agency (LASEMA) supply chain management practices so as to improve crisis preparedness and promote sustainable development, highlighting challenges like inadequate infrastructure, poor information flow, limited coordination, and resource constraints. The study was grounded in the Resource-Based View (RBV) theory. The study employed the interpretivism philosophy, and a qualitative approach was adopted using forty semi-structured interviews for data collection and analysis. Secondary data were sourced from the internet, newspapers, and other reports. Study findings indicate that applying technological innovations can significantly reduce the time required for mobilising and distributing emergency resources. IoT sensors provide real-time visibility to the supply of emergency and humanitarian materials, reducing losses and bottlenecks, while blockchain technology improves transparency and traceability, drastically reducing the risk of fraud. AI and predictive analytics enhance demand forecasting, allowing LASEMA to allocate resources more efficiently, reducing overstocking and wastage. The study concludes that integrating these technologies would enhance collaboration among government agencies, the private sector, and community stakeholders, promoting a collaborative ecosystem that promotes sustainable practices. The study recommends implementing data-driven decision-making through big data analytics to provide insights into risk patterns, resource allocation, and response tactics in real-time. It is germane to develop and train LASEMA's staff with the right skills, which can be achieved by collaborating with academic institutions, tech startups, and international organisations. Hence, technology-driven advancements in supply chain management bolster LASEMA's initiatives in building resilient urban systems that align with SDGs 9 and 11. The study contributes to environmental sustainability, social equity, waste reduction, and long-term institutional resilience that are further examined alongside a phased technology-implementation roadmap that addresses cost, cybersecurity, infrastructure, data-quality, and staff-capability constraints.

Index Terms — Africa Supply Chain Management, Crisis Preparedness, Integrating Innovative Technology, Sustainable Development.

I. INTRODUCTION

The rapidly evolving global landscape, influenced by frequent crises, has significantly transformed technology into a key driver in how emergency management agencies respond to crises like pandemics, climate change, and socio-political disruptions, which has magnified the vulnerabilities inherent in supply chains across Africa. The integration of technologies such as Geographic Information Systems (GIS), blockchain, the Internet of Things (IoT), and artificial intelligence (AI) can transform supply chains from vulnerable frameworks to resilient systems capable of efficiently handling disaster response and recovery (Hughes, 2021). Within the framework of the Lagos State Emergency Management Agency (LASEMA), these technologies could boost situational awareness, enhance decision-making, and optimise logistics operational activities. GIS, for instance, can provide real-time mapping of affected areas, thus enhancing the distribution of humanitarian aid and resources in the wake of a disaster (Pipitone & Zambon, 2020). Similarly, AI can be used to forecast crisis scenarios and streamline supply chain operations, improving responsiveness. Moreover, the growing emphasis on sustainable development emphasises the need for building resilient supply chains that promote social, environmental, and economic sustainability. However, sustainable development efforts must integrate green technologies, renewable energy solutions, and circular economy principles into supply chains to promote economic growth, reduce carbon emissions, and tackle social

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disparities (Adebayo & Akintoye, 2023). The application of digital platforms capable of monitoring and tracking sustainability metrics, coupled with innovations like electric vehicles for logistics and warehouses powered by renewable energy, can transform supply chain systems in Africa. For LASEMA, sustainable SCM strategies can also contribute to the overall climate resilience of the region by reducing waste, minimising environmental impacts, and ensuring that resources are fairly distributed across vulnerable communities.

Consequently, it is critical to state at this juncture that Africa's supply chains have traditionally faced limitations due to infrastructure deficits, unstable political environments, and inadequate technological integration. Despite the promising potential of technology, several challenges impede its integration into African supply chains, especially in emergency management in Lagos State, Nigeria. A major barrier is the absence of reliable technological infrastructure and broadband connectivity, especially in rural or underserved areas where crises often hit the hardest (Olawale & Adeyemi, 2023). Further, there is a need for capacity building to ensure that the workforce, including LASEMA personnel, is properly trained in the use of these technologies. Additionally, the adoption of blockchain, AI, and IoT in supply chains demands significant investment, which may not always align with the budget limitations faced by governmental agencies in Nigeria. Moreover, ethical issues related to data privacy and security remain pertinent, particularly as more personal and organisational data are captured and shared across digital platforms. It is instructive to state that the supply chains in Africa, especially in emergency management systems like LASEMA, are often hindered by inadequate infrastructure, poor information flow, limited coordination, and resource constraints. The Lagos State Emergency Management Agency (LASEMA), a key institution tasked with disaster risk mitigation and emergency response in Lagos State, faces significant challenges in effectively managing supply chains during emergencies while striving to promote sustainable development goals (SDGs). Crisis situations exacerbate these inefficiencies, leading to slow responses, resource waste, and compromised humanitarian outcomes. While crisis management is a critical role of LASEMA, there is an increasing emphasis on sustainability and long-term development.

Based on the analysis presented, it can be argued that leveraging and implementing advanced technology in areas susceptible to disasters can enhance digital supply chain networks, leading to quicker response times in emergencies and supporting a more adaptable, data-driven approach to managing crises. At this point, it is imperative to note that there is a lack of systematic and adequate academic or published research works on the digital integration of innovative technologies to improve supply chain management within LASEMA, enabling a shift from reactive crisis response to proactive and sustainable supply chain systems capable of enduring and adapting to dynamic disruptions. Research from existing literature and credible academic sources indicates that further efforts are necessary to close this literature gap. As a result, this study examines how emerging technologies like the Internet of Things (IoT), blockchain, artificial intelligence (AI), and data analytics can be incorporated into LASEMA's supply chain management practices so as to improve crisis preparedness and promote sustainable development. This is the gap that this study tends to fill. In view of this, the research seeks to assess how technology-driven innovation impacts transparency, real-time monitoring, resource optimisation, and stakeholder collaboration to improve efficiency, accountability, and resilience in the management system of the LASEMA supply chain.

Beyond identifying this gap, it is necessary to state explicitly the contribution this study makes. Theoretically, the study advances the Resource-Based View by extending its application beyond profit-oriented firms to a public-sector emergency management context, demonstrating how technological resources acquire strategic value only when combined with organisational capabilities under conditions of crisis. Empirically, the study provides the first qualitative, multi-stakeholder account of technology adoption within LASEMA's supply chain operations, drawing on the perspectives of forty purposively and snowball-sampled informants across five stakeholder categories, a depth of primary evidence that is currently absent from the literature on African emergency management agencies. Practically, the study offers LASEMA's management, Lagos State policymakers, and comparable African emergency agencies an evidence-based, phased framework for prioritising technology investment decisions under real-world budgetary, infrastructural, and capacity constraints.

II. SIGNIFICANCE OF THE STUDY

This study is premised on leveraging technology from crisis preparedness to sustainable development. This study is critical, as it unveils Nigeria's digital supply chain networks, which may enable swifter response times during crises and a data-driven approach to emergency management at the Lagos State Emergency Management Agency (LASEMA). As a result, the study examines the organisational preparedness and inadequate digital infrastructural factors that undermine local capacity in managing disaster-prone areas for long-term sustainability. Hence, this study offers a replicable model for other African emergency agencies seeking to modernise supply chain management in line with contemporary challenges and global sustainability imperatives.

III. LITERATURE REVIEW

A. *Emergency Supply Chain Management: Conceptual Underpinnings*

Emergency supply chain management (ESCM) involves the strategic planning, coordination, and implementation of logistics processes required to deliver emergency resources to affected communities promptly, efficiently, and equitably (Eze & Nwachukwu, 2022). In contrast to commercial supply chains that operate in more stable demand environments, emergency supply chains need to operate under conditions of extreme demand uncertainty, time pressure, infrastructure disruption, and multiple stakeholders' complexity (Adeyemi & Okafor, 2024). These unique features necessitate supply chain designs that prioritise flexibility, resilience, and adaptive coordination rather than cost reduction and efficiency improvement that serve as the key objectives of commercial SCM.

The humanitarian logistics literature highlights four main challenges that consistently undermine ESCM performance worldwide: demand uncertainty due to the unpredictable nature of disaster scale and location; infrastructure vulnerability, as disasters often damage the transportation and communication networks essential for response operations; coordination complexity arising from the multiplicity of actors, which includes government agencies, international organisations, NGOs, private sector actors, and community representatives whose actions must be aligned for a successful response; and resource constraints that restrict pre-positioning and overall response capabilities (Osei-Bonsu & Quartey, 2023). Each of these four challenges is directly relevant to LASEMA's operational environment.

In the context of Africa, these generic ESCM challenges are intensified by structural factors like weak institutional frameworks, limited fiscal capacity, inadequate logistics infrastructure, and governance deficits that hinder effective public emergency management (Chukwu & Obi, 2021). Adesanya et al. (2023) observe that African emergency management organisations often operate on outdated information systems that hinder the real-time supply chain transparency needed for efficient response coordination. Nwosu et al. (2024) note that inadequate investment in supply chain technology has resulted in a notable performance gap between African emergency management agencies and those in the Global North.

B. *IoT Sensors and Real-Time Supply Chain Visibility*

The Internet of Things (IoT) denotes a network of physical devices equipped with sensors, software, and connectivity features that enable them to gather and share data in real time (Olawale & Adeyemi, 2023). In supply chain situations, IoT sensors can be deployed across the logistics network, like vehicles, storage facilities, shipping containers, and specific items, so as to provide continuous, real-time insights into the location, status, and quantity of supply chain assets. For emergency management organisations like LASEMA, this ability for real-time supply chain visibility signifies a potentially transformative operational improvement.

Bamidele and Ayodele (2022) report that in Nigerian public sector scenarios, IoT-based supply chains have minimised inventory discrepancies by up to 38% and notably improved asset utilisation rates. In emergency management, real-time IoT monitoring enables an adaptive reaction to emerging supply gaps, reduces the risk of resource stockouts during active emergency operations, and generates the data required for the

continuous improvement of supply chain operations. Adebayo et al. (2023) further demonstrate that IoT integration in humanitarian logistics contexts reduces response mobilisation times by enabling automated inventory notifications and dynamic routing suggestions driven by real-time traffic and infrastructure condition data.

However, deploying IoT infrastructure in Lagos's complex urban setting presents significant challenges. Okonkwo and Ibrahim (2024) emphasise that IoT deployment requires reliable connectivity infrastructure which comprises cellular networks and, increasingly, dedicated IoT communication protocols such as LoRaWAN that are not consistently available across all areas of Lagos State. Unreliable power supply, a pervasive challenge in Nigerian urban infrastructure, further complicates the deployment of IoT sensors that require a constant electrical supply. These infrastructure challenges necessitate careful systems design that incorporates suitable redundancy and resilience strategies.

C. *Blockchain Technology and Supply Chain Transparency*

Blockchain technology facilitates the development of unchangeable, distributed digital records that record transactions across a network of users without requiring a central trusted authority, garnering significant interest as a tool to improve supply chain transparency and accountability (Eze & Nwachukwu, 2022). In emergency supply chain situations, blockchain has the capacity to establish secure, tamper-proof records of resource flows from procurement to storage, transport, and final distribution so as to address the issues of accountability and corruption that have historically affected humanitarian logistics (Olawale & Adeyemi, 2023).

Nwosu et al. (2024) report on the application of blockchain in humanitarian supply chains across several African settings, uncovering that blockchain-based tracking systems notably reduced instances of resource diversion and misappropriation, especially in environments characterised by governance accountability deficits. The transparency advantages of blockchain extend beyond preventing corruption; they also include quality assurance (enabling verification of the condition and source of emergency supplies) and inter-agency coordination (allowing real-time sharing of resource availability and distribution status across multiple organisational actors).

For LASEMA, integrating blockchain would address noted issues regarding accountability in the procurement and distribution of emergency resources (Chukwu & Obi, 2021). Blockchain technology would greatly minimise chances for fraudulent resource misappropriation by creating an unchangeable record of every transaction in the emergency supply chain, ranging from supplier invoicing to warehouse receipt, internal transfer, and final beneficiary distribution, while also enhancing the quality of supply chain data accessible for operational analysis and external audit.

D. *Artificial Intelligence and Predictive Analytics*

Artificial intelligence and machine learning technologies have shown significant ability to improve supply chain forecasting and decision-making by identifying patterns in large datasets that exceed the analytical abilities of human decision-makers (Adeyemi & Okafor, 2024). In emergency supply chain management, predictive analytics driven by AI can improve pre-disaster resource positioning by generating probabilistic forecasts regarding the timing, magnitude, and site of disasters, using historical incident data, weather information, and socioeconomic vulnerability metrics (Bamidele & Ayodele, 2022).

Adesanya et al. (2023) show that AI-powered demand forecasting in humanitarian supply chains has reduced resource stockouts by 29% and overstocking by 34% compared to traditional planning methods, resulting in notable improvements in response time and resource efficiency. For an organisation like LASEMA, which needs to manage limited emergency resource budgets while guaranteeing sufficient pre-positioning for various potential disaster situations, AI-powered optimisation of pre-disaster resource allocation could generate significant operational and financial benefits.

The application of natural language processing (NLP), a branch of AI, to analyse social media data, emergency call logs, and community reports in real time provides LASEMA with additional opportunities to improve situational awareness during active emergency operations (Osei-Bonsu & Quartey, 2023). Real-time analysis of digital data streams can provide early warning of emerging crisis situations and support dynamic resource reallocation as the situational context evolves, compensating for the information gaps that currently limit LASEMA's response coordination.

E. *Big Data Analytics and Decision Support*

Big data analytics is the application of advanced analytical methods on large, diverse datasets generated from various sources that provides emergency management agencies a robust resource for converting data into practical operational insights (Olawale & Adeyemi, 2023). For LASEMA, relevant data sources include past historical incident records; weather and climate data; satellite images; infrastructure condition assessments; demographic and socioeconomic statistics; as well as real-time data feeds from IoT sensors and social media platforms.

The integration of these diverse data sources via a unified analytics platform, LASEMA, would enable the development of an advanced, data-driven understanding of Lagos's risk context by identifying high-risk zones and communities, predicting seasonal disaster risk trends, and tracking changes in vulnerability over time (Nwosu et al., 2024). This risk intelligence would directly guide strategic decisions about pre-positioning emergency resources, locating emergency response facilities, and prioritising infrastructure investment for resilience improvement, as all actions that directly affect LASEMA's ability to deliver its mandate.

Adebayo et al. (2023) emphasise that unlocking the potential of big data analytics requires investment in both technological infrastructure and the skilled human resources needed to effectively use these tools. This carries significant implications for LASEMA's capacity development strategy, which is further discussed in the recommendations section of this study.

F. *Conceptual Model*

Drawing on the Resource-Based View theoretical framework and the integrated literature review on IoT, blockchain, AI, predictive analytics, and big data analytics in emergency supply chain management, this study presents the following conceptual model (Figure 1) to illustrate the routes through which technological integration in LASEMA's supply chain can lead to improved crisis preparedness and sustainable development results.

The conceptual model operates through three main layers. The input layer, grounded in the RBV framework, pinpoints the strategic resource bases from which LASEMA's technological transformation must proceed: emergency logistics resources (human resources, tools, and supplies); information and data assets (historical incident records and risk assessments); organisational competencies (staff competencies and interagency collaborations); as well as financial and infrastructure resources (funding and logistics infrastructure). These inputs serve as the foundational elements of LASEMA's operational capacity, and their adequacy directly influences the potential for technological improvement.

The process layer represents the fundamental technological integration routes identified in the literature: IoT sensors enabling real-time monitoring of the supply chain; blockchain technology ensuring transparent and traceable flows of resources; AI and predictive analytics optimising demand forecasting and resource allocation; and big data analytics providing strategic decision support via integrated risk intelligence. These four technological capabilities are viewed as interdependent and mutually reinforcing, as their combined integration generates synergistic operational improvements that exceed the total of their individual contributions.

INPUTS		PROCESSES (Technology Integration)		OUTPUTS
Resource-Based View (RBV) Foundation		Technological Capabilities		Sustainable Development Outcomes
Emergency Logistics Resources (personnel, equipment, materials)	→	IoT Sensors & Real-Time Monitoring (supply visibility, loss reduction)	→	Improved Crisis Preparedness & Faster Response
Information & Data Assets (historical incident data, risk maps)	→	Blockchain Transparency (traceability, fraud reduction)	→	Enhanced Accountability & Reduced Resource Wastage
Organisational Capabilities (LASEMA staff, interagency networks)	→	AI & Predictive Analytics (demand forecasting, allocation optimisation)	→	Efficient Resource Allocation & Reduced Overstocking
Financial & Infrastructure Resources (funding, logistics infrastructure)	→	Big Data Analytics & Decision Support (risk pattern analysis, real-time insights)	→	Collaborative Ecosystem (Government, Private Sector, Communities)
MODERATING FACTORS: Governance Framework Stakeholder Collaboration Staff Capacity Infrastructure Adequacy				
SDG ALIGNMENT: SDG 9 (Industry, Innovation & Infrastructure) SDG 11 (Sustainable Cities & Communities)				

Figure 1: Conceptual Model: Technology Integration in LASEMA Supply Chain Management for Sustainable Development

Note. The model is grounded in the Resource-Based View (RBV) theory (Barney, 1991). Moderating factors represent enabling and constraining conditions that influence the strength of the input-process-output relationships. SDG = Sustainable Development Goal.

The output layer captures the sustainable development outcomes expected from effective technological integration. This improved crisis preparedness and faster emergency response; increased accountability and reduced resource wastage; optimised resource allocation by minimising both stockouts and overstocking; and the development of a collaborative ecosystem involving government bodies, private industry, and community partners. These results are directly aligned to the fulfilment of SDG 9 (Industry, Innovation, and Infrastructure) and SDG 11 (Sustainable Cities and Communities).

Critical to the model is the recognition of moderating factors that will influence the strength and stability of the relationships between inputs, processes, and outputs. These moderating conditions like governance frameworks, stakeholder collaboration quality, staff analytical capacity, and infrastructure adequacy represent the enabling environment that is essential for even the most advanced technological investments to realise their full potential. This recognition has direct implications for the implementation strategy discussed in the study's recommendations.

Resource-Based View Integration and Construct Relationships

To ground the conceptual model more firmly in the Resource-Based View, it is necessary to specify how the model's constructs map onto Barney's (1991) VRIN criteria, whereby a resource generates sustained competitive advantage when it is Valuable, Rare, Inimitable, and Non-substitutable. Within this study, LASEMA's emergency logistics resources, information and data assets, organisational competencies, and financial and infrastructure resources constitute the agency's resource base in RBV terms. These resources are valuable insofar as they directly enable crisis response; however, in their current, largely undigitised state, they are neither rare nor difficult to imitate, since comparable resource deficits are common across African emergency agencies (Nwosu et al., 2024). The technologies examined in this study are AI, IoT, blockchain,

predictive analytics, and big data analytics. These are theorised as capability-building mechanisms that convert these ordinary resources into the kind of valuable, rare, and difficult-to-imitate strategic assets that RBV associates with sustained advantage. For instance, IoT-enabled real-time visibility transforms a generic logistics fleet (a common resource) into a dynamically monitored, traceable asset base (a rarer, harder-to-replicate capability); blockchain converts routine transactional records into an unchangeable audit trail that is difficult for peer agencies to replicate without comparable investment; and AI-enabled forecasting converts historical incident data, an asset every agency possesses in some form, into predictive intelligence that few African emergency agencies currently hold. Organisational competencies and interagency collaboration act as the complementary, path-dependent capabilities that RBV scholars identify as necessary for resources to yield sustained rather than temporary advantage, since technology alone, without the tacit organisational knowledge to deploy it effectively, remains imitable and therefore strategically insufficient on its own.

Regarding the relationships among constructs, the model should be read as a mediated input-process-output chain rather than a set of independent associations. The resource base (input layer) does not act directly on sustainable development outcomes (output layer); its effect is mediated by the four technological processes like IoT, blockchain, AI/predictive analytics, and big data analytics, which convert raw resources into operational capabilities such as visibility, traceability, forecasting accuracy, and decision support. The moderating factors like governance frameworks, stakeholder collaboration quality, staff analytical capacity, and infrastructure adequacy, do not generate outcomes on their own; rather, they strengthen or weaken the input-to-process and process-to-output relationships. For example, IoT deployment (a process variable) will translate into improved crisis-response efficiency (an output) only where infrastructure adequacy (a moderator) is sufficient to sustain connectivity; where infrastructure is poor, the same technological investment yields a substantially weaker or even negligible improvement in outcomes. This mediated, moderated structure clarifies that the model does not propose that resources or technologies produce sustainable development outcomes uniformly, but that the strength of this relationship is conditional on the enabling environment identified by participants in this study's findings.

IV. METHODOLOGY

The methodology used is a qualitative research design, employing stakeholder interviews for data collection. Collecting primary data involves conducting semi-structured interviews with key frontline LASEMA officials, technology providers, and supply chain stakeholders. Operational data includes key performance indicators like IoT-based asset tracking and AI-powered demand forecasting tailored to the LASEMA operating environment. A population of forty in-depth interviews was conducted with key informants, comprising LASEMA senior officials and operational staff (n = 16), emergency management practitioners from partner agencies (n = 8), technology specialists with relevant sector expertise (n = 8), representatives of private sector logistics partners (n = 4), and community stakeholder representatives from Lagos's disaster-prone neighbourhoods (n = 4). This multi-stakeholder sampling strategy was designed to capture the pre-, during-, and post-emergency crises perspectives of all significant actor groups whose engagement is necessary for successful technological integration.

Additionally, participants hold expert knowledge and perspectives regarding the contextual understanding of emergency crisis preparedness and management. The information gathered from interviews is supported by documentary analysis from secondary sources like articles, newspaper editorials, and other reports. The Lagos State Emergency Management Agency (LASEMA) in Nigeria was selected through the use of the purposive sampling method due to its extensive and diverse workload and the cosmopolitan nature of Lagos State, where emergencies are frequently imminent daily. Based on suggestions from the original participants, snowball sampling was employed to locate important key informant respondents. Each interview ranged from forty-five to sixty minutes and was carried out in a hybrid format based on the participant's preference. All interviews were audio recorded, transcribed verbatim, and analysed thematically using NVivo software to detect recurring themes and patterns. The approach of constant comparison was employed to improve and validate the themes that emerged from various data sources. The validity of the instruments was determined

by triangulating and comparing interview data with results from documentary analysis. An audit trail was maintained to guarantee the clarity and reproducibility of the study process.

A. *Interview Protocol Design*

The interview protocol followed a semi-structured format comprising four components: an opening section establishing rapport and confirming informed consent; a core section of eight open-ended questions addressing current supply chain challenges, awareness and perceptions of IoT, blockchain, AI, and big data technologies, anticipated barriers to adoption, and expectations regarding sustainability outcomes; a set of follow-up probes tailored to each stakeholder category (for example, technology specialists were probed further on infrastructure and cybersecurity considerations, while community representatives were probed further on equity and access); and a closing section inviting additional comments. The protocol was piloted with two LASEMA officials prior to full data collection, and minor wording revisions were made to improve clarity.

B. *Data Saturation and Sample Adequacy*

Data saturation, understood as the point at which additional interviews cease to generate new themes or codes (Guest, Bunce, & Johnson, 2006), was monitored continuously through data collection using a saturation grid that tracked the emergence of new codes against interview number. No new substantive codes emerged after the thirty-fourth interview; two further interviews were conducted beyond this point to confirm that saturation had been reached before data collection was concluded at forty interviews.

C. *Coding Procedure and Coder Involvement*

Data analysis followed Braun and Clarke's (2021) six-phase thematic analysis procedure: familiarisation with the data, generation of initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final analysis. Coding was conducted independently by two researchers using NVivo software, beginning with open, line-by-line coding of the first eight transcripts. The two coders then met to compare and reconcile codes, resolving discrepancies through discussion, and jointly developed a codebook that was applied to the remaining transcripts through axial coding, in which individual codes were grouped into candidate themes, and subsequently selective coding, in which themes were refined and mapped onto the study's conceptual model. Inter-coder agreement on the initial eight-transcript sample was assessed using Cohen's kappa, yielding a coefficient of 0.79, indicating substantial agreement (Miles, Huberman, & Saldaña, 2014).

D. *Validation, Trustworthiness, and Ethical Considerations*

In addition to triangulating interview data with documentary analysis and maintaining an audit trail, member checking was conducted by sharing summarised thematic findings with six purposively selected participants drawn across the five stakeholder categories, who confirmed that the themes accurately reflected their views; this process led to minor refinements in the labelling of two themes. Credibility was further supported through investigator triangulation, whereby both coders independently interpreted emergent themes before reconciling their interpretations, and through a reflexive journal documenting analytic decisions throughout the research process (Lincoln & Guba, 1985). All participants gave informed consent, and confidentiality was preserved by reporting findings at the level of stakeholder category rather than by individual identity.

V. FINDINGS AND DISCUSSION

A. *Current Challenges in LASEMA's Supply Chain Management*

Data from the interviews presented a clear and consistent overview of LASEMA's current supply chain management challenges, confirming and situating the deficiencies noted in the extant literature. Participants identified four main clusters of challenges: inadequate physical and digital infrastructure; poor information flow and visibility; limited interagency coordination; and resource constraints.

Regarding infrastructure, senior LASEMA officials described logistics networks marked by outdated warehouse management systems, inadequate transportation fleets, and unreliable communication infrastructure. A participant (LASEMA Senior Official, personal communication) described the context as one where 'we are anticipated to handle 21st-century emergencies and crises with 20th-century frameworks'.

This observation directly echoes the findings of Bamidele and Ayodele (2022) regarding limitations in logistics infrastructure within the Nigerian public sector.

Deficiencies in information flow were identified as particularly significant.

Participants from operational response teams described instances where field coordinators lacked real-time visibility into resource availability at warehouses and distribution sites, leading to duplicated mobilisation efforts, resource wastage, and response delays. Representatives of the community affirmed that information gaps frequently translated into inequitable resource allocation, where urban areas with better access received faster and more adequate support compared to flood-prone areas on the outskirts.

Limitations in interagency coordination were evident due to both technical and institutional factors.

Multiple participants observed that LASEMA's mandate required collaboration with various state and federal agencies, like the Nigeria Police Force, the National Emergency Management Agency (NEMA), the Federal Roads Safety Corps, and several Lagos State ministries; however, the absence of integrated information systems made real-time coordination extremely challenging. Logistics partners in the private sector expressed their frustration with coordination mechanisms that mainly depended on phone communication, describing them as 'inefficient and error-prone' (personal communication with a private sector logistics partner).

A technology specialist further reflected on the human cost of poor visibility, noting: 'When we don't know exactly where the resources are at the point of a flood, families wait. We have seen it delay things by hours that matter' (Technology Specialist, personal communication).

B. *Technological Integration Potential: IoT and Real-Time Monitoring*

Experts in the technology sector consistently identified IoT sensor deployment as the most impactful technological intervention that LASEMA made available. The ability to track emergency resources including medical supplies, food packages, rescue tools, and vehicles in real time was described as essential to the broader technological shift in LASEMA's supply chain.

Olawale and Adeyemi (2023) support this evaluation, identifying supply chain visibility as the main operational benefit of deploying IoT in humanitarian logistics situations.

Technology expertise participants described practical scenarios for IoT deployment at LASEMA, like GPS-enabled vehicle tracking for managing the emergency response fleet, RFID-enabled inventory management in LASEMA's warehouses, and environmental sensors monitoring for assessing conditions in areas vulnerable to flooding. These applications, although modest in their technical complexity, would collectively generate the real-time supply chain visibility that current operations conspicuously lack.

A private-sector logistics partner observed: 'If our trucks were tagged and visible on a shared dashboard, LASEMA would not need to call five times to confirm where a delivery is' (Private Sector Logistics Partner, personal communication).

Adebayo et al. (2023) estimate that similar IoT deployments in related humanitarian logistics settings have reduced response mobilisation times by 25% and 40%, a finding that underscores the operational significance

of this technology for an agency whose performance is measured by lives saved. As with the figure above, this percentage range is drawn from Adebayo et al.'s (2023) published evidence in comparable humanitarian logistics settings and should be read as an expected, literature-derived benefit rather than a result produced by this study's interviews.

C. *Blockchain for Accountability and Transparency*

Findings from interviews with LASEMA officials, civil society members, and community representatives aligned on accountability as a critical aspect of supply chain performance that current systems fail to address. Multiple participants recounted documented cases where emergency resources failed to reach intended beneficiaries, attributing these failures to a combination of administrative error, inadequate tracking systems, and, occasionally, deliberate theft.

These findings align with Chukwu and Obi's (2021) analysis of resource accountability challenges in public emergency management in Nigeria.

Participants with expertise in technology identified blockchain as the most suitable solution for addressing LASEMA's accountability deficit. It is instructive to state that blockchain will fundamentally transform the accountability structure of LASEMA's supply chain by establishing an unchangeable, transparent record of all resource transactions available in real-time to authorised stakeholders such as LASEMA management, civil society monitors, partner agencies, and international donors.

A community stakeholder representative stated: 'We hear that supplies were sent, but what reaches our ward is sometimes half of what was announced. A record nobody can quietly change would restore some trust' (Community Stakeholder Representative, personal communication).

Eze and Nwachukwu (2022) observe that implementing blockchain in similar humanitarian logistics settings has reduced confirmed cases of resource diversion by over 60%, indicating that the accountability gains from blockchain adoption could significantly transform LASEMA's operational integrity and public trust. This percentage reflects Eze and Nwachukwu's (2022) systematic review evidence rather than a statistic generated within this study's qualitative sample; it is included to indicate the scale of accountability gains reported elsewhere in the literature, which participants in this study expected blockchain adoption to replicate at LASEMA.

D. *AI-Driven Demand Forecasting and Resource Optimisation*

The findings of AI and predictive analytics emerged as technologies playing key roles as the most potential capabilities of improving LASEMA's strategic resource planning and pre-disaster preparedness. LASEMA officials described the current resource pre-positioning method as heavily reliant on historical patterns, expert judgement, and basic seasonal forecasting. An approach that frequently resulted in either resource deficits during unexpectedly major emergencies or wasteful overstocking of supplies that exceeded demand.

Adesanya et al. (2023) identify that this demand forecasting challenge is inherent to emergency management agencies operating lacking advanced analytical tools.

Technology experts and academic participants described AI demand forecasting models capable of integrating various data sources like historical LASEMA incident records; Lagos State meteorological and hydrological data; satellite-derived land use and infrastructure maps; and assessments of community vulnerabilities to produce probabilistic forecasts of emergency resource demand across diverse Lagos communities and situations. These models would enable LASEMA to shift from reactive to proactive supply chain management by strategically pre-positioning appropriate resources based on evidence-based risk assessments rather than relying on reactive improvisation.

An emergency management practitioner from a partner agency remarked: 'Right now we prepare for the last disaster, not the next one. A system that tells us where the next one is more likely would change how we stock our stores' (Emergency Management Practitioner, personal communication).

Bamidele and Ayodele (2022) affirm that similar AI-enabled pre-positioning techniques have significantly reduced response times and minimised resource waste in related emergency management situations.

E. *Big Data Analytics for Strategic Decision-Making*

Interviews with senior officials, technology experts, and academic scholars often described how big data analytics could transform LASEMA's strategic decision-making. Participants reported a situation where LASEMA had significant amounts of operational data, like incident records, resource deployment logs, and after-action reports, but lacked the analytical infrastructure to extract actionable insights from these data assets.

This finding aligns with Nwosu et al.'s (2024) observation that data underutilisation signifies a significant missed opportunity in African emergency management agencies.

A unified big data analytics platform would enable LASEMA to identify spatial and temporal patterns in Lagos's disaster risk environment, assess the effectiveness of previous emergency responses, benchmark supply chain performance with similar agencies, and generate data evidence for strategic investment decisions. In the study, community groups particularly emphasised the potential of big data analytics to address historically recorded disparities in emergency resource allocation, pointing out that systematic analysis of previous response patterns could reveal and help address the geographic inequities affecting Lagos's most vulnerable communities.

A LASEMA senior official commented: 'We generate reports after every incident, but they sit in files. Nobody has built the bridge between what we recorded and what we do differently next time' (LASEMA Senior Official, personal communication).

F. *Environmental Sustainability, Social Equity, Waste Reduction, and Long-Term Resilience*

While the preceding subsections centre on crisis-response efficiency, participants also raised concerns that extend beyond speed of response into environmental sustainability, social equity, waste reduction, and long-term institutional resilience, and these are examined here as a distinct analytic theme rather than a secondary comment. On waste reduction, LASEMA officials and technology specialists both identified the spoilage of perishable medical and food supplies as a recurring, largely undocumented loss driven directly by the poor visibility described in Section 5.1. A LASEMA operational officer explained: 'We have lost stock to expiry because nobody could see, in one place, what was already sitting in a warehouse before ordering more' (LASEMA Operational Staff, personal communication). Participants linked this directly to IoT-enabled inventory visibility (Section 5.2) as a waste-reduction mechanism, not only an efficiency mechanism.

On environmental sustainability, technology specialists and private-sector logistics partners pointed to inefficient, undocumented routing of emergency vehicles as a source of avoidable fuel consumption and emissions, and several linked AI-enabled route and demand optimisation (Section 5.4) to a reduction in this footprint. Participants further noted the potential for warehouses to draw on solar power given Lagos's frequent grid outages, framing this as both a resilience measure and an environmental one: 'Solar is not just about being green for us; it is about a fridge full of vaccines not spoiling when the grid fails' (Technology Specialist, personal communication).

On social equity, community stakeholder representatives reiterated the geographic disparities noted in Sections 5.1 and 5.5, whereby flood-prone, less-connected neighbourhoods on Lagos's outskirts systematically receive slower and less complete support than better-connected urban areas. Participants argued that technology adoption at LASEMA should be evaluated not only by aggregate efficiency gains but by whether it narrows or widens this gap, with several recommending that equity of distribution be adopted as an explicit performance metric alongside speed and cost.

On long-term resilience, senior officials and academic participants distinguished between resilience understood as surviving a single crisis and resilience understood as an agency's capacity to learn and adapt across successive crises. Several participants observed that LASEMA's current after-action reports (Section

5.5) are rarely translated into revised procedures, representing an institutional learning gap that technology alone cannot close without a corresponding change in organisational practice. Taken together, these findings indicate that the sustainable development contribution of technology integration at LASEMA depends on deliberately designing for environmental, equity, and institutional-learning outcomes, rather than assuming that these outcomes will follow automatically from gains in crisis-response efficiency.

VI. CONCLUSION AND POLICY IMPLICATIONS

The study concludes that integrating these technologies would enhance collaboration among government agencies, the private sector, and community stakeholders, promoting a collaborative ecosystem that encourages sustainable practices. By leveraging digital tools, LASEMA can improve its crisis preparedness skills while also promoting sustainable development goals. Hence, technology-driven advancements in supply chain management bolster LASEMA's initiatives in building resilient urban systems aligned with the SDGs, especially Goal 9 (Industry, Innovation and Infrastructure) and Goal 11 (Sustainable Cities and Communities).

The study recommends implementing data-driven decision-making through big data analytics to provide insights into risk patterns, resource allocation, and response tactics in real-time. It is germane to develop and train LASEMA's staff with the right skills needed to implement and sustain advanced technologies like AI, blockchain, and IoT. This can be actualised through collaboration with academic institutions, tech startups, and international organisations; LASEMA can remain at the forefront of the technological curve and integrate innovative solutions into disaster response frameworks. Also, incorporating renewable energy into logistics systems by investing in green technologies would aid sustainable development and reduce carbon emissions. As a result, the policy implications encompass the following: the study advocates for sustainable supply chain practices so as to reduce environmental impacts through transportation optimisation and waste reduction, while bolstering social equity by ensuring timely access to essential resources during emergencies. This study underscores the critical role of integrating innovative technology in transforming Lagos State Emergency Management Agency supply chains from fragmented, crisis-driven operations into cohesive, sustainable systems.

These conclusions and recommendations should be tailored alongside the environmental sustainability, social equity, waste reduction, and long-term resilience findings presented in Section 5.6, and against the phased implementation roadmap set out below, which together situate LASEMA's technology adoption within realistic budgetary, security, and capacity constraints rather than as an unconditional prescription.

A. *Phased Technology Implementation Roadmap*

The recommendations above must be read against the practical constraints that participants repeatedly raised: limited and uncertain budgets, exposure to cybersecurity risk as more systems and data move online, uneven underlying infrastructure, questions about the quality and consistency of existing data, and gaps in staff capability. Addressing these constraints simultaneously and at scale is unrealistic for an agency operating under LASEMA's resource conditions; a phased roadmap is therefore proposed to sequence investment in a way that builds foundational capacity before layering on more advanced technologies.

Phase 1 (Foundation, Months 0–12) prioritises the lowest-cost, highest-readiness interventions: auditing and cleaning existing incident and inventory records to establish a reliable data-quality baseline; deploying basic IoT asset-tracking on LASEMA's existing vehicle fleet and principal warehouses, prioritising areas with adequate connectivity; establishing minimum cybersecurity safeguards, including access controls, encrypted data storage, and a basic incident-response plan, before any system is connected to external partners; and delivering foundational digital-literacy training to operational staff. Budgetary exposure at this stage is limited by focusing on off-the-shelf hardware and existing staff rather than bespoke system development.

Phase 2 (Core Deployment, Months 12–24) builds on this foundation: expanding IoT coverage to secondary warehouses and high-risk flood-prone zones, contingent on infrastructure readiness assessments conducted in Phase 1; piloting blockchain-based tracking on a single, high-accountability-risk resource category (for

example, medical supplies) before wider rollout, to contain both cost and cybersecurity exposure; formalising data-governance protocols, including defined data-quality standards, ownership, and audit responsibilities; and formalising partnerships with academic institutions and technology providers to co-fund specialist staff training identified as a constraint in the findings.

Phase 3 (Advanced Integration, Months 24–36) introduces AI-enabled predictive analytics and a unified big data analytics platform once the data-quality, infrastructure, and cybersecurity foundations from Phases 1 and 2 are in place, since predictive tools are only as reliable as the data and safeguards underlying them. This phase also formalises the equity and environmental-sustainability metrics identified in Section 5.6 as standing components of LASEMA's performance reporting, alongside a recurring, budgeted cybersecurity audit and staff recertification cycle to sustain the capabilities built in the earlier phases. Sequencing investment in this way allows LASEMA to demonstrate incremental, budget-realistic returns at each phase, which participants indicated would also strengthen the case for continued donor and government funding.

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HIK: contributed in: conceptualization, methodology, formal analysis and investigation, writing - original draft preparation and writing

JOE: contributed in reviewing and editing, resources and supervision

POM: Contributed in reviewing and co-supervision

INFORMED CONSENT

Informed consent was obtained from all participants for participation in the study.

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Od pripravljenosti na krize do trajnostnega razvoja: vključevanje tehnoloških inovacij v upravljanje Afriških dobavnih verig v LASEMA

Izvilleček – Ta študija preučuje vključevanje inovativnih tehnologij v prakse upravljanja oskrbovalne verige Agencije za upravljanje izrednih razmer v zvezni državi Lagos (LASEMA), da bi izboljšali pripravljenost na krize in spodbudili trajnostni razvoj, pri čemer poudarja izzive, kot so neustrezna infrastruktura, slab pretok informacij, omejeno usklajevanje in pomanjkanje virov. Študija uporablja filozofijo interpretativizma in na virih temelječo teorijo (angl. resource based view). Zbiranje in analiza podatkov pa temeljita na kvalitativnem pristopu s pomočjo štiridesetih polstrukturiranih intervjujev. Sekundarni podatki so bili pridobljeni iz interneta, časopisov in drugih poročil. Ugotovitve študije kažejo, da lahko uporaba tehnoloških inovacij

znatno skrajša čas, potreben za mobilizacijo in razdeljevanje sredstev za izredne razmere. Internet stvari omogoča vpogled v zaloge nujnih in humanitarnih materialov v realnem času, s čimer se zmanjšujejo izgube in ozka grla, medtem ko tehnologija veriženja blokov izboljšuje preglednost in sledljivost ter drastično zmanjšuje tveganje za goljufije. Umetna inteligenca in prediktivna analitika izboljšujeta napovedovanje povpraševanja, kar agenciji LASEMA omogoča učinkovitejšo razporeditev virov ter zmanjšuje prekomerne zaloge in izgube. Študija ugotavlja, da bi integracija teh tehnologij izboljšala sodelovanje med vladnimi agencijami, zasebnim sektorjem in zainteresiranimi stranmi v skupnosti ter spodbudila sodelovalni ekosistem, ki podpira trajnostne prakse. Študija priporoča uvedbo odločanja na podlagi podatkov prek analitike velikih podatkov, da se v realnem času zagotovijo vpogledi v vzorce tveganj, razporeditev virov in taktike odzivanja. Pomembno je razviti in usposobiti osebje LASEMA z ustreznimi veščinami, kar je mogoče doseči s sodelovanjem z akademskimi institucijami, tehnološkimi start-upi in mednarodnimi organizacijami. Zato tehnološko pogojeni napredek na področju upravljanja dobavne verige krepi pobude agencije LASEMA pri gradnji odpornih urbanih sistemov, ki so v skladu s ciljema trajnostnega razvoja 9 in 11. Študija prispeva k okoljski trajnosti, socialni pravičnosti, zmanjšanju količine odpadkov in dolgoročni institucionalni odpornosti, ki se dodatno preučujejo skupaj s postopnim načrtom uvajanja tehnologije, ki obravnava omejitve v zvezi s stroški, kibernetско varnostjo, infrastrukturo, kakovostjo podatkov in usposobljenostjo osebja.

Ključne besede – upravljanje oskrbovalnih verig v Afriki, pripravljenost za krizne razmere, vključevanje tehnoloških inovacij, trajnostni razvoj