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A Review of Last-Mile Delivery in Nigeria's Logistics Sector: Challenges, Cost, and Innovation Implications for Supply Chain Management

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Abstract
This paper reviews challenges and innovative solutions in Nigeria's last-mile delivery sector, with attention to their cost, profitability, and operational performance implications. We adopted the narrative review methodology, synthesizing peer-reviewed academic literature grounded in supply chain resilience theory, the resource-based view (RBV), and Rogers' innovation diffusion theory. Sources are drawn from peer-reviewed and indexed journals published between 2009 and 2026. We found five structural challenge domains such as infrastructural deficiencies, addressing and mapping failures, urban congestion, macroeconomic pressures, and workforce and regulatory inadequacies, constituting a chronic systemic disruption environment. Five innovative responses are examined: digital mapping, mobile platforms, route optimization, local delivery network partnerships, and emerging technologies. This paper provides an integrated conceptual framework linking challenges, theoretical foundations, innovations, and firm/policy outcomes. The paper argues that innovation diffusion paradox is a bounded theoretical construct distinct from Rogers' general diffusion barriers, with explicit applicability beyond logistics to other infrastructure-constrained emerging-market innovation contexts.

KEYWORDS: Digital logistics, E-commerce fulfilment, Nigerian logistics sector, Supply chain resilience, Last-mile delivery, Innovation diffusion, Sub-Saharan Africa

Introduction

The organization of logistics systems has undergone profound structural change over the past two decades, propelled by the globalization of supply chains and the exponential growth of business-to-consumer (B2C) e-commerce. Within this transformation, last-mile delivery, the final stage of the logistics chain connecting fulfillment hubs to end consumers, has become one of the most cost-intensive and strategically consequential segments of supply chain management, accounting for an estimated 40% to 53% of total delivery cost globally (Gevaers et al., 2009; Lim & Winkenbach, 2019; Boysen et al., 2021). Its global market, valued at approximately USD 161.20 billion in 2024, is projected to reach USD 373.92 billion by 2033 at a compound annual growth rate (CAGR) of 9.8% (Patil, 2026). This reflect the segment's deepening relevance to firm-level profitability, margin management, and competitive strategy, and not merely to operational efficiency in the narrow logistical sense. From a management accounting perspective, last-mile cost-to-serve is increasingly recognized as a distinct, trackable cost driver whose mismanagement can erode net retail margins by as much as a quarter in markets where delivery failure rates are high (Capgemini,

2019; Appel, 2025), underscoring why the topic merits sustained attention from business and accounting scholarship rather than logistics engineering alone.

In Nigeria, Africa's largest e-commerce market, this significance is amplified. The sector, valued at approximately USD 8.8 billion in 2024 and growing at 14.6% CAGR (Verified Market Research, 2026), is constrained by acute structural deficits: poor road infrastructure, absent formal addressing, urban congestion, persistent depreciation of the naira, and other macroeconomic volatility that further erode financial viability, inflate the cost-to-serve and directly erode delivery margins (Kuteyi & Winkler, 2022; Raifu & Afolabi, 2024; Ayantoyinbo & Oyewale, 2025; Asaju et al., 2026). Despite this commercial and financial significance, Nigeria's last-mile delivery ecosystem remains comparatively underexplored in the peer-reviewed supply chain and management accounting literature, which has tended to focus narrowly on either macro-level logistics infrastructure (Kuteyi & Winkler, 2022) or sector-specific applications such as pharmaceutical distribution (Miko & Abbas, 2024), leaving the commercial e-commerce fulfilment ecosystem and its cost, capability, and profitability dimensions comparatively under-theorized. In response, a wave of technological and organizational innovation is reshaping Nigeria's last-mile landscape. GIS-enabled digital mapping, mobile-first logistics platforms, route optimization algorithms, micro-fulfilment partnerships, and emerging drone and e-bike technologies are progressively extending delivery reach and reliability.

This paper addresses that gap through a theoretically grounded narrative review that integrates supply chain resilience theory, the resource-based view, and Rogers' (2003) innovation diffusion theory, with explicit attention to the cost, capability, and profitability implications of last-mile challenges and innovations for Nigerian logistics operators and the wider e-commerce ecosystem. Specifically the study explores last-mile delivery in Nigeria’s logistic sector with emphasis on challenges, cost and innovation implications for supply chain management. The remainder of the paper proceeds as follows: Section 2 develops the theoretical framework, including a formal definition and conceptual model of the innovation diffusion paradox; Section 3 details the review methodology; Section 4 reviews the extant literature; Sections 5 and 6 analyze the key challenges and innovations respectively; Section 7 presents an integrated conceptual framework; Section 8 discusses the findings; and Section 9 concludes with recommendations and future research directions.

Theoretical framework

This review is grounded in three interrelated theoretical perspectives of supply chain resilience theory, the resource-based view (RBV), and Rogers' (2003) innovation diffusion theory, which together provide an integrated analytical architecture.

Supply Chain Resilience Theory

Supply chain resilience theory provides the foundational anchor for understanding why last-mile delivery in Nigeria is consistently disrupted and what strategic responses are required. Christopher and Peck (2004) define supply chain resilience as "the ability of a system to return to its original

state or move to a new, more desirable state after being disturbed." This capacity is especially pertinent in contexts where infrastructure deficits, institutional weaknesses, and environmental volatility are not exceptional events but endemic operating conditions. In the Nigerian context, the five challenge domains identified in this review, including infrastructural deficiencies, addressing and mapping failures, urban congestion, economic pressures, and workforce and regulatory gaps, collectively constitute a chronic disruption environment rather than a series of isolated shocks. Ponomarov and Holcomb (2009) conceptualized resilience as encompassing the proactive development of capabilities that enable anticipation, adaptation, and rapid recovery, a framework that maps directly onto the operational realities confronted by Nigerian logistics providers. Tukamuhabwa et al. (2015) identified flexibility, redundancy, collaboration, and agility as the core attributes of resilient supply chains, the presence or absence of which largely determines whether operators sustain service delivery under persistent disruption. Essentially, resilience-building in Nigeria must account not only for firm-level capabilities but also for systemic infrastructure-level vulnerabilities that lie beyond individual operator control.

The Resource-Based View (RBV)

The resource-based view (RBV), advanced by Barney (1991) and further developed by Peteraf (1993) and Teece et al. (1997), argues that sustained competitive advantage derives from a firm's possession and deployment of resources and capabilities that are valuable, rare, inimitable, and non-substitutable (VRIN). Applied to logistics strategy, the RBV shifts analytical attention from external market conditions to the internal capabilities that enable superior logistics performance (Ketchen & Hult, 2006; Olavarrieta & Ellinger, 1997). In Nigeria's last-mile sector, the RBV explains why certain providers succeed despite structural constraints while others do not. Operators who have invested in proprietary GIS-enabled routing platforms, cultivated embedded relationships with local rider networks, or developed address verification systems possess resources that competitors find difficult to replicate precisely because they are grounded in context-specific knowledge and relationships (Adeniran et al., 2022). Furthermore, the RBV illuminates the strategic rationale for collaborative models, specifically partnerships with local micro-delivery networks as relational assets that compound with technological investment to generate durable competitive differentiation.

2.3 Innovation Diffusion Theory

Rogers' (2003) innovation diffusion theory provides the third theoretical pillar, offering a framework for analyzing how and why innovative solutions are adopted at varying rates across Nigeria's last-mile landscape. Rogers (2003) defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system," and identifies five attributes that determine adoption rates, including relative advantage, compatibility, complexity, trialability, and observability. These attributes explain the differential diffusion observed in the Nigerian context. Mobile-first logistics platforms have achieved meaningful penetration because they demonstrate high relative advantage over traditional verbal-direction-based delivery, strong compatibility with Nigeria's mobile-first digital culture, and high

observability through real-time tracking interfaces. Drone delivery, by contrast, exhibits low compatibility with current infrastructure and high complexity, limiting it to a pilot stage. Arvianto et al. (2021) noted that city logistics innovations in developing economies face adoption barriers related to infrastructure compatibility, digital literacy, and regulatory uncertainty. These barriers amplify Roger's complexity and compatibility constraints in the Nigerian context.

2.4 The Innovation Diffusion Paradox: Definition and Conceptual Boundaries

A central theoretical contribution of this review is the innovation diffusion paradox. Innovation diffusion paradox refers to a condition in which the environments that exhibit the greatest need for innovation are simultaneously characterized by structural deficiencies that impede the adoption and scaling of those innovations. In this context that diffusion rates diverge systematically by capital and infrastructure intensity rather than by relative advantage alone. In the context of Nigeria's last-mile logistics sector, infrastructural inadequacies, regulatory uncertainty, and institutional weaknesses increase the necessity for technological innovation while simultaneously limiting its diffusion.

This construct is conceptually distinct from the general diffusion barriers identified by Rogers (2003). Rogers treats complexity, low compatibility, and limited trialability as innovation-level attributes that vary independently of the adopting environment's structural condition. The paradox identified here instead proposes a systematic interaction effect as the magnitude of the environmental constraint itself determines both the innovation's relative advantage (positively) and its complexity/trialability/observability (negatively) simultaneously. Rogers' framework therefore explains why innovations diffuse at different rates in a given environment. However, the paradox explains why the most needed innovations in a constrained environment are disproportionately likely to be the slowest to diffuse. Although developed in the context of last-mile logistics, the underlying logic that need and deployability move in opposite directions as a function of the same structural constraint is plausibly applicable to other infrastructure-constrained emerging-market innovation contexts, including renewable mini-grid energy adoption, telemedicine, agricultural technology, and digital financial inclusion technologies, where innovation demand coexists with institutional and infrastructural constraints (Kuteyi & Winkler, 2022; Mageto & Luke, 2024). This review advances it specifically through last-mile delivery evidence, while proposing it as a candidate general construct for emerging-market innovation diffusion research.

Structural environment constraint (infrastructure deficit, regulatory absence, capital scarcity)	**Innovation needs intensity (severity of operational pain point)**
⬇ raises barrier to deployment (Rogers' complexity, trialability, observability suppressed by missing enabling infrastructure)	⬇ raises incentive to adopt (relative advantage of the innovation increases with problem severity)
RESULT: Diffusion rate is suppressed for capital-/infrastructure-intensive innovations (example, drones, AVs) despite high theoretical relative advantage	**RESULT: Diffusion rate accelerates for low-capital, infrastructure-independent innovations (example, mobile platforms) that bypass the constraint entirely**
INNOVATION DIFFUSION PARADOX: The same structural constraint that maximizes the need for an innovation simultaneously minimizes the feasibility of its deployment, producing a diverged diffusion curve; rapid uptake of infrastructure-independent solutions alongside stalled uptake of infrastructure-dependent ones, within the same environment and the same firm.	

Figure 1. Conceptual model of the innovation diffusion paradox

Source: Authors' own development, drawing on Rogers (2003) and Christopher and Peck (2004).

As Figure 1 illustrates, the structural environment constraint operates through two opposing causal paths simultaneously. It is this dual, opposing-direction effect, rather than a simple barrier, that constitutes the paradox and distinguishes it from a conventional diffusion-barriers account.

Methodology

This paper adopts a narrative review methodology appropriate for synthesizing a heterogeneous, multidisciplinary literature and generating theoretically integrated insight, rather than statistically aggregating homogeneous quantitative findings (Snyder, 2019). The review nonetheless follows a structured, transparent, and replicable protocol in line with Mangiaracina et al. (2019) and Boysen et al. (2021), summarized below and in Figure 2. Searches were conducted across Scopus (214 records), Web of Science (96 records), and Google Scholar (142 records), using Boolean strings combining last-mile delivery, Nigeria/Sub-Saharan Africa, infrastructure/addressing/congestion, digital mapping/route optimization/drones, and the three theoretical frameworks. This yielded 452 records. After removing 87 duplicates, 365 records underwent title/abstract screening against the criteria in Table 1, of which 194 were excluded. The remaining 171 records were assessed in full text against the same criteria; 121 were excluded for insufficient thematic relevance, low indexing quality, or duplicated findings. Backward/snowball citation searching (Wohlin, 2014) added 18 further sources. The search was bounded to publications between 2009 and 2026, with seminal pre-2009 theoretical works including Barney (1991) and Rogers (2003) retained for their

foundational relevance. The final literature comprises 68 sources, synthesized using the thematic synthesis method (Thomas & Harden, 2008).

Table 1. Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Publication type	Peer-reviewed journals; World Bank/ILO reports	Blogs; non-transparent market reports
Date	2009–2026 (seminal works retained pre-2009)	Pre-2009 unless seminal
Geography	Nigeria; SSA; global studies with transferable findings	Developed-market-only, non-transferable
Theme	Last-mile delivery, urban logistics, e-commerce fulfilment, resilience, innovation	Upstream supply chain with no last-mile relevance
Indexing	Scopus/Web of Science or equivalent	Non-indexed/predatory journals

Source: Authors' own compilation.

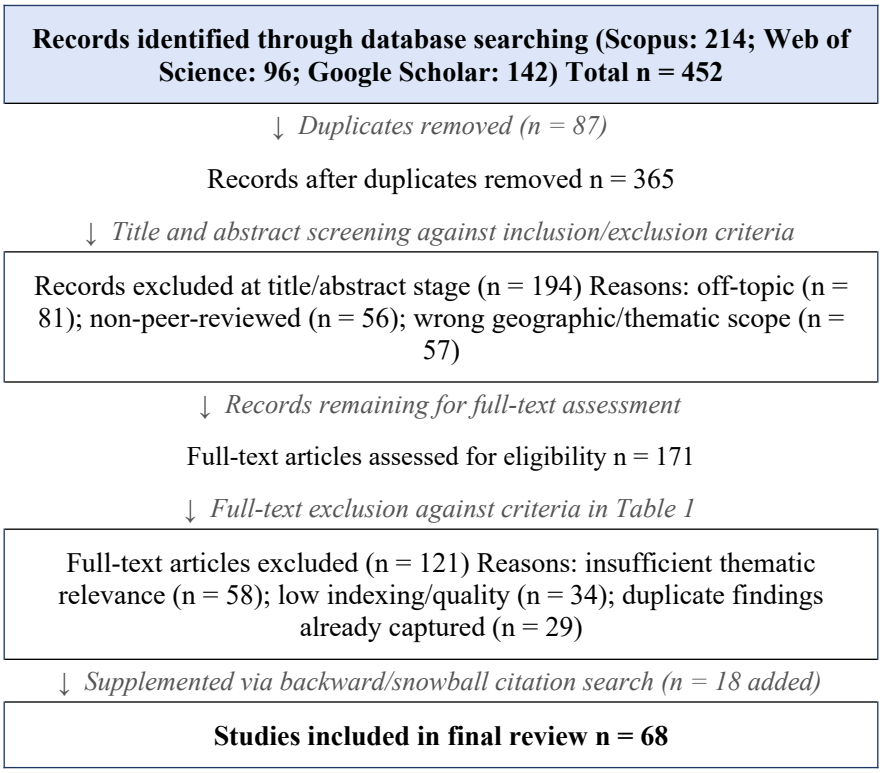

Figure 2. Study selection flow diagram

Source: Authors' own compilation, adapted from PRISMA reporting conventions

Quality assessment of included sources was conducted along three dimensions: journal indexing status and reputation, recency relative to Nigeria's rapidly evolving logistics and macroeconomic environment, and methodological transparency for empirical studies. Sources published in Scopus journals or widely cited institutional reports were accorded the greatest weight; findings drawn from lower-ranked sources were corroborated against higher-ranked sources before inclusion or treated as illustrative rather than definitive. A limitation of this protocol, consistent with narrative review methodology generally, is that source selection retains an element of researcher judgement at the screening and quality-assessment stages; this is mitigated, though not eliminated, by the explicit, replicable criteria documented in Table 1 and Figure 2 above.

Literature review

This section reviews the extant literature on last-mile delivery, organized thematically to contextualize the Nigerian experience within global and emerging-market scholarship. The review proceeds across three clusters: the evolution of global last-mile delivery research; last-mile delivery in urban and emerging-market contexts; and the specific Nigerian and Sub-Saharan African literature.

The Evolution of Global Last-Mile Delivery Research

Scholarly interest in last-mile delivery has grown markedly over the past two decades. Boysen et al. (2021) provide a comprehensive survey cataloguing delivery models ranging from traditional vehicle routing to autonomous delivery robots and drone-based systems. Mangiaracina et al. (2019) demonstrate that the field has shifted progressively from cost minimization toward holistic efficiency, sustainability, and customer experience, driven by the maturation of B2C e-commerce and intensifying competitive pressure on logistics providers.

Kumar and Chidambara (2024), in a review spanning 2018 to 2022, identified five dominant research clusters: transportation and logistics (43%), social science and economics (25%), supply chain management (21%), sustainability (14%), and technology and engineering (6%), reflecting the field's inherently cross-disciplinary character. Pourmohammadreza et al. (2025) further noted that over 89% of alternative delivery location studies appeared within the preceding six years, underscoring the explosive contemporary relevance of the field.

However, this literature remains geographically skewed toward developed markets in Europe, North America, and East Asia markets characterized by matured road infrastructure, formalized addressing systems, and developed regulatory frameworks. Janjevic and Winkenbach (2020) directly address this imbalance, arguing that urban last-mile distribution strategies in emerging markets are systematically distinct from their counterparts in developed markets and cannot be adequately understood through frameworks derived from Western logistics contexts. Their integrated conceptual framework, distinguishing between infrastructure-dependent, agent-network, and technology-mediated distribution strategies, provides the most rigorous analytical basis for examining last-mile logistics in countries such as Nigeria.

Innovative Solutions in the Global Literature

The global literature documents an expanding landscape of innovative responses to last-mile challenges, with technology playing an increasingly central role. Mangiaracina et al. (2019) categorized B2C last-mile innovations across four dimensions: attended home delivery optimization, alternative delivery point models, crowdsourced logistics, and autonomous delivery technologies. It found that no single solution is universally optimal, a conclusion with direct relevance to the Nigerian context.

Digital mapping and GIS-based address standardization have emerged as foundational enablers in contexts where formal address infrastructure is absent. According to Kumar and Chidambara (2024), technology-enabled address verification is a precondition for route optimization, while Janjevic and Winkenbach (2020) identify digital geolocation capability as a critical differentiator between logistics operators across market contexts. Route optimization algorithms capable of real-time adaptation to traffic conditions have delivered efficiency gains of between 10% and 30% relative to static routing approaches across multiple market contexts (Boysen et al., 2021). Mobile-first platforms integrating real-time tracking, crowdsourced address data, and on-demand dispatch have demonstrated particular relevance in Sub-Saharan Africa, where smartphone penetration has outpaced fixed broadband infrastructure (Kuteyi & Winkler, 2022; Adeniran et al., 2022). Also, collaborative micro-delivery models leveraging local knowledge and social networks to overcome addressing information asymmetries represent an organizational adaptation with clear application to the African context (Janjevic & Winkenbach, 2020; Arvianto et al., 2021).

At the innovation frontier, drone delivery offers significant potential advantages in delivery speed and cost reduction in congested or remote contexts, but faces substantial regulatory, infrastructural, and social acceptance barriers that limit near-term scalability; particularly in developing economies (Jazairy et al., 2025; Arvianto et al., 2021). Electric bicycles on the other hand, represent a more immediately scalable green innovation, with growing evidence of its cost-effectiveness in reducing congestion-related delivery delays (Boysen et al., 2021; Santiago-Montaño et al., 2024).

Last-Mile Delivery in Nigeria and Sub-Saharan Africa

Despite the growth of global research, Sub-Saharan Africa, and Nigeria in particular remains significantly underrepresented in the peer-reviewed literature. Kuteyi and Winkler (2022) provide the most comprehensive regional account, documenting systemic infrastructure deficits, policy fragmentation, and digital divide dynamics across SSA while identifying leapfrogging potential through mobile and digital logistics technologies. Arvianto et al. (2021) explicitly note the under-representation of African contexts and call for contextualized empirical research on city logistics in Sub-Saharan African cities.

Nigeria-specific contributions have begun to emerge. Adeniran et al. (2022) provide qualitative evidence on e-commerce logistics adoption, identifying technology compatibility, platform trust, and logistics reliability as the primary determinants. Ayantoyinbo and Oyewale (2025) offer

quantitative evidence from Lagos courier companies confirming a positive and statistically significant relationship between delivery efficiency and e-commerce adoption. There is also causal pathways through which infrastructure, addressing, and congestion challenges which according to Asaju et al. (2026), suppress platform adoption in Lagos State. Yakeen (2024) adds granularity through stakeholder perception analysis of urban freight logistics.

Taken together, this body of literature establishes three (3) important conclusions that motivate the present review. First, the global literature on last-mile delivery is rich but geographically skewed, and its frameworks and findings cannot be straightforwardly applied to the Nigerian context without context-based analysis. Second, the emerging Nigerian-specific literature, while growing, remains fragmented and largely focused on individual challenge dimensions rather than the integrated challenge-innovation landscape that is the focus of this paper. Third, the innovations documented in the global literature, like digital mapping, mobile platforms, route optimization, local network partnerships, and emerging technologies, have differential applicability and diffusion trajectories in the Nigerian context, shaped by the country's infrastructure profile, digital economy characteristics, and institutional environment. These conclusions frame the thematic analyses in Sections 5 and 6.

Findings

Key challenges in last-mile delivery in Nigeria

Nigeria's last-mile delivery ecosystem operates within one of the most demanding logistics environments in Sub-Saharan Africa. This section provides a thematic analysis of five principal challenge domains, drawing on supply chain resilience theory to situate each within the broader context of systemic operational vulnerability. Infrastructural deficiencies are the most foundational challenge; approximately 80% of Nigeria's road network is estimated to be in poor condition (World Bank, 2024). Similarly, Adepoju (2021) argued that Nigerian highways suffer from design specifications and functionality below minimum engineering standards, with potholes, flooding, and structural failures endemic across federal and state networks; severely limiting vehicle movement and inflating maintenance, idle-time, and towing costs across major freight corridors such as Lagos–Aba, Lagos–Abuja, and Lagos–Port Harcourt (Olikagu, Okereke, & Uzoma, 2024). These costs are disproportionately borne in peri-urban and rural areas, where road quality deteriorates sharply beyond core metropolitan zones; leading to accelerated vehicle wear, route rerouting that increases fuel consumption, and extended delivery times, particularly in peri-urban and rural areas where conditions are most severe (Kuteyi & Winkler, 2022). From a supply chain resilience perspective, the systemic nature of Nigeria's road deficit demands correspondingly systemic remedial action at both policy and firm levels.

Addressing and mapping failures compound this structural deficit. NIPOST (2022) estimated that only 5% of mail in Nigeria was correctly addressed prior to its partnership with the what3words geocoding platform, forcing delivery personnel to rely on verbal directions and landmark navigation. This generates frequent missed deliveries, elevated re-delivery costs, and measurable customer attrition from e-commerce platforms (Ekeh & Adebayo, 2022; Asaju et al., 2026). The

problem is particularly critical in informal settlements like areas of rapid, largely unplanned urban expansion that house a significant proportion of Nigeria's urban population and represent substantial e-commerce demand. Similarly, Janjevic and Winkenbach (2020) identified informal urbanization as a defining structural feature of emerging-market logistics that fundamentally distinguishes it from developed-market counterparts, requiring last-mile distribution strategies to be redesigned from the ground up.

Urban congestion and mobility constraints, particularly in Lagos, one of the world's most severely gridlocked cities, materially degrade delivery throughput, vehicle utilization, and cost efficiency (Fadare & Ayantoyinbo, 2010; Dosunmu & Ojo, 2024). For last-mile delivery specifically, Gevaers et al. (2009) revealed that delivery cost is highly sensitive to stop density and route efficiency, with urban traffic conditions interacting with both variables to produce non-linear cost escalation. Chidubem and Aluko (2023) identified adaptive routing capability as the primary determinant of cost competitiveness among Lagos logistics operators confronting chronic congestion. Likewise, Yakeen (2024) which further documented that negative congestion experiences generate persistent consumer skepticism about delivery reliability that suppresses e-commerce adoption. Beyond Lagos, secondary cities including Abuja, Kano, Enugu, and Port Harcourt face similar challenges, indicating that the mobility constraint is systemic across Nigeria's urban logistics landscape.

Economic and macroeconomic cost pressures intensified sharply following the May 2023 fuel subsidy removal, which saw pump prices rise from approximately ₦220 to over ₦1,200 per litre within eighteen months, alongside substantial naira depreciation (Raifu & Afolabi, 2024). These pressures compound the structural reliance on cash-on-delivery payment models, which themselves elevate operational risk, extend per-stop delivery time, and generate non-delivery costs (Adeniran et al., 2022; Ayantoyinbo & Oyewale, 2025). Standard Bank's Africa Trade Barometer (2024) documented that Nigerian businesses reported the most significant decline in business confidence of any surveyed African country, with logistics cost inflation identified as the primary driver. These cost effects are passed through to consumers as elevated delivery fees, suppressing e-commerce demand and preventing the scale economies needed to reduce per-unit costs.

Finally, workforce and regulatory gaps, especially predominant gig-economy informality without insurance, pension, or formal labour protection, combined with weak enforcement of vehicle roadworthiness, safety standards, multiple taxation at state and local government levels, extortion by law enforcement agencies, and regulatory inconsistencies across jurisdictions. These further elevate operational costs and drive elevated rider attrition and inconsistent service quality (Asaju et al., 2026; Cieslik et al., 2022; Nwokedi et al., 2021). Also, Arvianto et al. (2021) asserted that regulatory fragmentation and informal institutional arrangements are among the most persistent barriers to logistics efficiency improvement, making the regulatory dimension of Nigeria's last-mile challenges inseparable from the structural policy environment. Collectively, these five domains constitute a structural and largely irreducible cost-to-serve inflation that directly

compresses last-mile delivery margins across the Nigerian logistics sector, rather than a set of isolated operational frictions amenable to one-off remediation.

From a cost accounting perspective, the five challenge domains are best understood not as independent line items but as interacting cost drivers whose combined effect on per-delivery cost-to-serve substantially exceeds the sum of their individual contributions. Infrastructure deficits raise the time and fuel cost of every delivery; addressing failures convert a proportion of deliveries into costly re-delivery attempts; congestion multiplies the time cost of both first and repeat attempts; macroeconomic volatility periodically resets the underlying cost base upward without a corresponding adjustment in consumer willingness to pay delivery fees; and workforce instability imposes recurring recruitment and training costs on top of the preceding four. This interaction effect, rather than any single challenge domain in isolation, is the underlying reason last-mile delivery margins in Nigeria remain persistently thinner than the headline market growth figures cited in Section 1 might otherwise suggest.

Innovative Solutions And Emerging Practices In Nigeria's Last-Mile Delivery Sector

The structural challenges outlined above have catalyzed substantial innovation in Nigeria's last-mile delivery landscape. Consistent with Rogers' (2003) innovation diffusion theory, the nature and pace of innovation vary considerably across solution types, with digitally grounded interventions demonstrating the fastest diffusion while emerging hardware technologies remain at comparatively early stages of deployment.

Digital mapping and address standardization through the deployment of GIS-enabled digital mapping and address standardization represent the most foundational category of last-mile innovation, directly addressing the structural location ambiguity identified as a systemic operational constraint. The what3words platform, which assigns a unique three-word address to every 3-by-3 metre square on the earth's surface, has created a technical basis for formalizing delivery destinations in the absence of conventional street addressing (NIPOST, 2022). Beyond proprietary geocoding, the integration of OpenStreetMap data, crowdsourced geographic information, and participatory mapping is expanding granular, ground-truth location data in areas where formal cartographic infrastructure is absent. Asaju et al. (2026) demonstrated that combining community-generated mapping data with algorithmic route planning materially reduces missed delivery rates, while Janjevic and Winkenbach (2020) positioned progressive address formalization as a precondition for route optimization deployment.

The proliferation of mobile-first logistics platforms represents the most commercially visible and rapidly diffusing category of innovation. Platforms such as Gokada which pivoted from ride-hailing to logistics following regulatory restrictions on motorcycle passenger services and Kwik Delivery have developed integrated infrastructure combining real-time order dispatch, GPS-enabled rider tracking, crowdsourced address data, and customer-facing delivery transparency (Ayantoyinbo & Oyewale, 2025). The rapid adoption of these platforms reflects favourable alignment with Rogers' (2003) diffusion accelerators which poses high relative advantage over traditional verbal-direction-based delivery, strong compatibility with Nigeria's mobile-first digital

culture, and high observability through real-time tracking interfaces that build consumer trust. Daramola and Etim (2022) identified logistics and courier platforms as among the most economically significant platform categories in Sub-Saharan Africa, noting their capacity to create structured intermediation in previously informal, relationship-dependent delivery markets; enabling standardized service quality, performance measurement, and incremental workforce formalization. Adeniran et al. (2022) also confirmed that real-time tracking capabilities are among the most significant determinants of consumer trust and platform adoption in Nigerian e-commerce logistics. Furthermore, Castillo et al. (2022) demonstrated that mobile platform-mediated crowdsourcing enables operators to dynamically balance fleet capacity with demand volatility.

Dynamic route optimization, which is the application of algorithmic and AI-driven tools to continuously recalculate delivery routes in response to real-time traffic conditions, weather, order volumes, and time window constraints, represents a critical innovation stream with direct relevance to Nigeria's congestion-dominated last-mile challenges. According to Boysen et al. (2021), there is an efficiency gain of between 10% and 30% in fuel consumption and delivery completion rates relative to static routing, with benefits increasing with traffic complexity. In Nigeria, route optimization's value is amplified by the severity and unpredictability of urban traffic. Chidubem and Aluko (2023) identified adaptive routing as the primary competitive differentiator among Lagos-based operators. Kobo360, a Nigerian logistics technology platform, has deployed real-time tracking and data analytics across its freight network to optimize routing and reduce costs (Eze & Okonkwo, 2023). According to Asaju et al. (2024), combining route optimization with digital address data produces multiplicative efficiency gains. Where addressing accuracy reduces route calculation errors and dynamic routing minimizes the impact of residual errors.

The strategic deployment of partnerships with local riders, community agents, and micro-delivery networks represents one of the most distinctively African adaptations in Nigeria's last-mile landscape, drawing on the RBV's logic of relational and network-based competitive advantage. In contexts where formal address infrastructure is absent, road conditions are unpredictable, and community social networks carry information that no digital mapping system can fully capture, the tacit knowledge and trusted relationships held by local delivery agents constitute a genuinely inimitable resource (Barney, 1991; Komakech et al., 2025). Fatehi and Wagner (2021) demonstrated analytically that crowdsourced delivery models can provide fast, reliable service under conditions of significant demand uncertainty, provided compensation structures and coordination mechanisms are appropriately designed. Castillo et al. (2022) extended this finding to hybrid systems combining dedicated fleet capacity with crowdsourced local delivery. The study found that the hybrid model outperforms either pure approach on both cost and service quality in high-density urban environments with volatile demand. In Nigeria specifically, community-embedded delivery arrangements often generate higher rider retention and stronger service commitment than purely transactional gig arrangements, reinforcing supply chain resilience. The frontier of last-mile innovation in Nigeria encompasses drone delivery and electric bicycles (e-bikes). According to Jazairy et al. (2025), drone delivery's core advantages are the elimination of road-network dependency, significant reductions in delivery time in congested environments, and

lower operating costs in low-density or geographically isolated contexts. Electric bicycles on the other hand, represent a more immediately deployable innovation. Santiago-Montaño et al. (2024) asserted that e-bike delivery achieves favourable cost-effectiveness relative to conventional motorcycles and vehicles in urban environments characterized by congestion and short average delivery distances. The lower acquisition cost, minimal fuel dependency, and reduced maintenance requirements of e-bikes make them commercially viable in Nigeria's post-subsidy-removal fuel cost environment (Raifu & Afolabi, 2024). Babaee Tirkolaee et al. (2025) further extended the efficiency frontier by modelling multimodal systems combining drone and cargo-bike delivery, combining drone penetration advantages with the load capacity and rider skill base already established in Nigeria's motorcycle-delivery ecosystem. Diffusion of these technologies, however, faces substantial barriers consistent with Rogers' (2003) framework. Specifically, drone delivery faces regulatory uncertainty as Nigeria's civil aviation framework for commercial drone operations remains underdeveloped. Also are infrastructure readiness constraints, including unreliable power supply for recharging and absence of designated landing infrastructure (Jazairy et al., 2025). The trajectory of innovation is clear, and the strategic logic of early-stage pilot investment, to build regulatory relationships, operational know-how, and market positioning, is compelling even where near-term commercial deployment is not yet viable.

Integrated Conceptual Framework

Figure 3 below integrates the theoretical foundations, structural challenges, innovative responses, and firm- and system-level outcomes developed across Sections 2, 5, and 6 into a single conceptual framework. The framework depicts last-mile delivery performance in Nigeria as the outcome of a continuous interaction between structural constraint and capability-based response, mediated by the diffusion dynamics, rather than as a linear chain from problem to solution. First, the relationship between challenges and innovative responses is bidirectional rather than unidirectional: structural challenges drive the search for innovative responses, but the same structural conditions simultaneously constrain which innovations can feasibly be deployed, the mechanism formally captured by the innovation diffusion paradox in Figure 1. Secondly, outcomes are explicitly disaggregated into firm-level outcomes, cost-to-serve reduction, capability-based competitive advantage, service reliability, and margin protection; and system-level outcomes concerning e-commerce ecosystem growth and the need for continued policy and regulatory reform.

THEORETICAL FOUNDATIONS	Supply chain resilience theory • Resource-based view (RBV) • Innovation diffusion theory (incl. diffusion paradox)
↓	
STRUCTURAL CHALLENGES	Infrastructure deficits • Addressing/mapping gaps • Urban congestion • Macroeconomic/cost pressures • Workforce/regulatory gaps
↓ drives / ↑ constrains	
INNOVATIVE RESPONSES	Digital mapping • Mobile platforms • Route optimization • Local network partnerships • Emerging technologies (drones, e-bikes)
↓	
FIRM-LEVEL OUTCOMES	Cost-to-serve reduction • Capability-based competitive advantage • Service reliability • Margin protection
↓	
SYSTEM-LEVEL OUTCOMES	E-commerce ecosystem growth • Digital economy development • Policy/regulatory reform need

Figure 3. Integrated conceptual framework: challenges, theory, innovation, and outcomes

Source: Authors' own development.

Discussion

Three interpretive threads emerge from this review. First, Nigeria's last-mile challenges constitute chronic systemic vulnerability rather than episodic disruption (Tukamuhabwa et al., 2015), requiring proactive rather than reactive resilience strategies (Negi et al., 2025) and directly implicating cost structures and margin sustainability rather than service quality alone. This reframing carries practical weight as firm that treats road deterioration or fuel price volatility as a temporary shock to be absorbed will systematically under-invest relative to one that treats them as permanent features of the cost base requiring structural adaptation. The distinction determines whether resilience-building expenditure is budgeted as exceptional, one-off cost or as recurring operating expenditure embedded in the firm's standard cost structure, with material consequences for how such investment is internally appraised and approved.

Second, the structural difficulty of Nigeria's operating environment inconsistently amplifies the strategic and cost-advantage value of context-specific. Specifically, RBV-consistent capabilities as local network relationships and proprietary address data are not easily replicated and constitute durable sources of competitive and financial advantage precisely because the barriers to imitation are raised by the market's informality (Barney, 1991; Komakech et al., 2025). Firms that have

invested early in such capabilities are consequently difficult for new entrants, including well-capitalized multinational operators, to dislodge.

Third, the innovation diffusion paradox formalized in Section 2 explains the sector's diverged innovation landscape. Example; rapid uptake of low-capital digital solutions alongside stalled uptake of capital-intensive hardware innovations, independent of their relative operational or cost advantage. This has direct implications for capital allocation decisions by logistics executives. Hence, investment appraisal should explicitly weight deployment feasibility alongside theoretical efficiency gain and for the prioritization of public infrastructure investment, since firm-level innovation alone cannot resolve constraints such as address infrastructure, drone regulation, and workforce formalization that lie outside firm control (Kuteyi & Winkler, 2022; Mageto & Luke, 2024).

Taken together, these three threads carry a consistent implication for business and accounting practice in Nigeria's e-commerce ecosystem: last-mile delivery performance should be understood and managed as a cost and margin variable subject to the same disciplined capital allocation, risk assessment, and performance measurement rigour applied to any other major operating cost center, rather than as a purely logistical or operational concern delegated to operations teams in isolation from financial planning. Logistics executives who integrate cost-to-serve analysis, capability investment appraisal, and innovation feasibility screening into a single decision framework as informed by the resilience, RBV, and diffusion-paradox lenses developed in this review are better positioned to protect margins and sustain competitive advantage under Nigeria's structurally demanding operating conditions than those who treat last-mile delivery as a fixed operational cost to be minimized rather than a strategic capability to be built.

Conclusion, Recommendations and Future Research Directions

Conclusion

This study reviewed the operational challenges, cost implications, innovations and sustainability of last-mile delivery in the logistics sector in Nigeria. The review's principal contribution is theoretical: the formal definition and conceptual modelling of the innovation diffusion paradox, integrated with supply chain resilience theory and the RBV into a single framework (Figure 3) linking Nigeria's structural last-mile challenges to firm- and system-level cost, capability, and profitability outcomes. The paradox construct, together with the accompanying conceptual model and worked illustration in Section 2, distinguishes this contribution from a general application of Rogers' (2003) diffusion barriers and offers a transferable analytical tool for researchers examining innovation adoption in other infrastructure-constrained emerging-market settings. Last-mile delivery is not a peripheral operational concern for Nigeria's digital economy but a foundational determinant of its cost competitiveness and growth trajectory.

Recommendations

Based on the conclusion, the study makes the following recommendation:

For practitioners:

i. Prioritize investment in proprietary digital addressing and mobile platform infrastructure as cost-reducing, margin-protecting capability assets rather than discretionary technology spend, since these directly target the addressing deficit identified as the most pervasive driver of missed-delivery cost.
ii. Deploy dynamic route optimization given current fuel cost pressures, where even marginal routing efficiency gains translate into material fuel savings.
iii. Deepen local delivery network partnerships as a source of inimitable competitive advantage that capital alone cannot replicate.
iv. Adoption of a staged approach to emerging technology investment, by prioritizing e-bikes near-term while building regulatory readiness for drones rather than treating drone deployment as an immediate planning assumption.

For policymakers

i. Accelerate national address-infrastructure standardization, building on the NIPOST/what3words precedent through legislative mandate and integration with planning approval systems.
ii. Develop a clear commercial drone regulatory framework that resolves the deployment-feasibility constraint.
iii. Establish minimum gig-economy workforce protections to reduce rider attrition and its associated service-quality cost.
iv. Prioritize road investment along key e-commerce logistics corridors connecting secondary cities to major fulfillment hubs. These actions address constraints that lie structurally beyond firm-level resolution and are preconditions for realizing the cost and efficiency gains identified throughout this review.

Directions for Future Research

Future research should pursue four specific lines of inquiry.

First, quantitative and longitudinal studies should empirically test the innovation diffusion paradox using time-series adoption data across innovation categories with varying capital intensity, to establish whether the diffusion-rate divergence predicted in Figure 1 holds under statistical testing rather than narrative synthesis alone. Second, comparative case studies across other Sub-Saharan African markets including Kenya, Ghana, and South Africa, each with differing infrastructure profiles and regulatory maturity should test whether the paradox generalizes beyond Nigeria and beyond logistics into other infrastructure-constrained innovation domains such as telemedicine or mini-grid energy adoption. Third, management accounting research should quantify the direct cost-to-serve and margin impact of each challenge domain identified, using firm-level financial data from Nigerian logistics operators; an empirical gap this narrative review could not address given its reliance on secondary literature rather than primary financial disclosures. Fourth, research should examine the firm performance consequences of gig-economy workforce formalization,

using matched before/after data from operators that have voluntarily adopted minimum labour standards, to provide the evidence base needed to support the policy recommendations.

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