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Enhancing Global Trade Connectivity through Residential Addressing Systems: Evidence from Urban Delivery Operations in Singida, Tanzania

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Abstract
The efficiency of last-mile delivery is a critical bottleneck for global trade connectivity, particularly in rapidly urbanizing areas of developing countries, where fragmented address systems persist. This study assessed the impact of residential address characteristics on parcel delivery efficiency in Singida, Tanzania, a secondary city emblematic of this challenge. Employing a descriptive-correlational case study design, data was collected via a structured questionnaire from 399 randomly sampled urban households. The findings, analyzed using descriptive statistics and multiple linear regression, revealed that while respondents perceive address clarity and digital tools as important, infrastructure accessibility was the only statistically significant predictor of delivery efficiency ($\beta = 0.377$, $p = 0.012$). The study concludes that in contexts like Singida, investments in physical infrastructure, roads and street signs, are a prerequisite for harnessing the potential of formalized and digital address systems. The study recommends a prioritized policy approach that first tackles foundational infrastructural constraints to effectively integrate secondary African cities into global trade networks.

Keywords: Global trade Connectivity; residential address; parcel delivery, traceability; last-mile logistics.

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Introduction
Global trade landscape is undergoing a profound transformation driven by the rapid expansion of e-commerce and tighter just-in-time supply chains, which has placed unprecedented emphasis on the efficiency of last-mile logistics, the final and most critical leg of the supply chain, where goods are delivered to the end user (Lim et al., 2018). Customer expectations for speed, dependability and real-time tracking are rising, making logistical reliability a core determinant of competitive advantage (Visser et al., 2014). Within this environment, a robust and universally intelligible residential addressing system functions as the fundamental data layer upon which modern route optimization, geospatial analytics and automated sorting are built. In developed economies, accurate, standardized and machine-readable addresses underpin advanced routing and fulfilment systems, delivering measurable reductions in travel time, fuel consumption and operational costs (Peppel & Spinler, 2022; Praet & Martens, 2020).

Conversely, in many developing nations, this foundational layer is fragmented or absent. Partial,

inconsistent or entirely missing residential addresses frequently precipitate operational paralysis in last-mile delivery, manifesting as prolonged delays, elevated operating costs and reduced customer satisfaction (van Duin et al., 2016). These inefficiencies operate as a non-tariff barrier to both cross-border and domestic trade, disproportionately affecting small and medium-sized enterprises seeking to integrate into global value chains (UNCTAD, 2021). The problem is intensified by rapid urbanization in sub-Saharan Africa, where urban growth often outpaces municipal planning and infrastructure provision, producing sprawling settlements with informal or unnumbered housing that strain conventional top-down addressing approaches (UN-Habitat, 2020).

In Tanzania this dynamic is particularly pronounced. Urbanization rates and the pressure on urban services have risen in recent years, placing strain on transport, utilities and municipal planning (World Bank, 2021). The Government of the United Republic of Tanzania has recognized the problem and launched efforts to modernize the national addressing framework, notably through National Postcode and addressing initiatives administered by the Tanzania Communications Regulatory Authority (2023) and related agencies. Nevertheless, implementation has been phased and concentrated in major hubs, like Dar es Salaam and Dodoma, leaving many secondary cities with incomplete or uneven adoption. Singida, a regional capital and representative secondary city, continues to experience delivery inefficiencies linked to descriptive or imprecise addresses (e.g., “the blue house near the market”), mixed nomenclature for roads and neighborhoods and limited road surfacing and signage in some wards (Singida Municipal Council, 2023; UNDP/Regional Investment Guide, 2023).

Technological “leapfrogging” solutions, such as GPS-based location sharing, Plus Codes and other digital mapping platforms, are promising but their remedial impact is constrained by a persistent digital divide. Barriers, such as device affordability, high mobile-data costs, uneven network coverage and limited digital literacy, reduce the effective uptake of advanced mobile services in many secondary urban areas (GSMA, 2023; Aker & Mbiti, 2010). Consequently, deliveries remain dependent on cost-and-time-intensive practices, repeated phone calls, reliance on local landmarks and ad-hoc driver knowledge that undercut the efficiency gains promised by digital platforms.

Literature on last-mile logistics is extensive and expanding, yet a critical gap persists regarding empirical studies focused on secondary cities in Africa. Much existing research is situated in contexts with comparatively mature logistical and digital infrastructures and therefore foregrounds data-intensive solutions, such as autonomous delivery, AI-driven predictive routing and dynamic vehicle routing (Zondag & Pieters, 2022). While valuable, this literature often overlooks foundational structural constraints, notably inadequate access roads, incomplete addressing, and limited institutional capacity, that may be the binding constraints in places like Singida. There is a shortage of studies that quantitatively assess the relative importance of address clarity, digital addressing systems and infrastructure accessibility in such contexts.

This study addressed the gap by asking the central research question: What is the relative influence of address clarity, digital addressing systems and infrastructure accessibility on parcel delivery efficiency in a secondary Tanzanian city? Through the quantitative approach, this study provides local, evidence-based insights to help municipal planners, logistics providers operating in emerging markets and national policymakers improve urban service delivery and trade connectivity through context-aware investments.

Literature Review

This section reviews existing knowledge relevant to last-mile logistics, addressing systems and infrastructure constraints. It first presents the theoretical framework guiding the study, then discusses empirical evidence from Africa and elsewhere and finally identifies the specific research gap that this study fills.

Theoretical Framework

This study is anchored in the Theory of Constraints (TOC), a seminal management paradigm developed by Eliyahu M. Goldratt. The TOC posits that any complex system, no matter its goals, is inherently limited in achieving higher performance by a small number of constraints, often just one. These constraints, which can be physical (e.g., a machine’s capacity) or policy-based (e.g., a business rule or regulation), act as bottlenecks that dictate the throughput of the entire system. The core strength

of TOC lies in its structured, five-step "Process of Ongoing Improvement," which provides a recursive framework for diagnosing and alleviating systemic inefficiencies: (1) Identify the system's constraint; (2) Exploit the constraint to maximize its current output without major new investment; (3) Subordinate all other non-constraint processes to the needs of the constrained element; (4) Elevate the system's performance by investing in solutions to break the constraint; and (5) Repeat the process, as overcoming one constraint will inevitably reveal another (Theory of Constraints Institute, 2025).

In the context of urban logistics within developing nations, the potential constraints are not merely operational but deeply structural and often inter-linked. The delivery ecosystem in a city like Singida can be conceptualized as a system where the timely and efficient delivery of parcels is hampered by a chain of potential bottlenecks. These may include ambiguous or incomplete home addresses that confuse delivery personnel, limited penetration and reliability of geolocation technologies, and insufficient physical infrastructure, such as unpaved, unnamed or untraceable roads (Kuteyi & Winkler, 2022).

Traditional research might simply list these challenges, but TOC provides a powerful diagnostic lens that goes beyond description. It forces us to prioritize, asking: Which of these factors is the most binding constraint? By applying TOC, this study sought to identify the main leverage point for intervention in Singida's delivery ecosystem. This is especially important in the Tanzanian context, where resources for urban development are limited and must be used for maximum strategic impact. The TOC helps us focus our analysis to determine whether efforts should go first toward formalizing addresses, promoting digital tools, or, as this study will explore, upgrading the basic level of physical infrastructure.

The application of TOC in logistics and supply-chain management is well-established, though its focus has often been on manufacturing and warehouse operations (Kurniasanti et al., 2017). More recently, scholars have begun applying its principles to last-mile delivery challenges. For instance, some studies emphasize the critical importance of bottleneck identification and continuous improvement in supply-chain and logistics environments (Muongi, 2024). However, much of this literature remains situated in more developed urban infrastructure contexts. This study contributes by applying TOC to the more foundational, pre-logistical constraints of addressability and physical access, a perspective that is critical for understanding last-mile delivery in frontier markets.

Empirical Studies on Address Systems and Logistics

Empirical research across different geographical settings consistently shows that address quality and location information are key determinants of logistical efficiency (Kuteyi & Winkler, 2022; van Duin et al., 2016; Roos, 2025). The discussion has moved from focusing on basic physical accessibility to including sophisticated digital and data-driven dimensions. Recent work in Africa notes that poor city mapping and non-standardized addressing continue to hurt delivery performance and information flow in last-mile operations (Kuteyi & Winkler, 2022). In the South African e-commerce context, a recent report highlighted that the lack of a unified national address database, neighborhoods with multiple names, informal settlements without street numbering, and low digital literacy lead to failed deliveries, costly re-attempts and reduced consumer trust (Roos, 2025).

Beyond Africa, in European and other developed-market studies, the role of spatial accessibility, machine-readable address data and the deployment of parcel-lockers have been documented as optimizing factors for logistics performance (Campisi & Di Ruocco, 2025; Kokkinou et al., 2025).For example, studies on parcel-locker placement emphasize that inaccurate or low-resolution location data can lead to sub-optimal locker placement, thus negating potential benefits for last-mile delivery (Campisi & Di Ruocco, 2025; Kokkinou et al., 2025). The placement and spatial accessibility of parcel lockers are thus directly influenced by the quality of addressing and geolocation systems.

In the African logistics literature, while the specific linking of address quality, digital tool-adoption and infrastructure access remains under-explored, some studies show that poor address systems are a primary driver of last-mile delivery failures. For instance, in Nigeria, one industry analysis noted that many delivery businesses rely on phone-calls, landmarks and repeated driver–recipient communication because formal addressing is lacking (Rest of World, 2023). The broader literature outlines that beyond technology, infrastructure and

near-universal addressing systems remain a critical barrier for efficient logistics in Sub-Saharan Africa (Kuteyi & Winkler, 2022). These studies affirm the global nature of the problem while also underscoring a research gap around secondary cities and the interplay of multiple constraint types.

Identification of the Research Gap

Despite the robust and evolving body of knowledge, a significant and strategically important gap persists in the academic literature concerning secondary cities in economically developing countries. The existing literature, while insightful, is predominantly situated within contexts that already possess a baseline of advanced logistical, digital and physical infrastructures. The solutions proposed, ranging from AI-driven predictive analytics to automated parcel-locker networks, often assume a level of systemic maturity that is absent in regions like Singida, Tanzania. This creates a contextual mismatch, where sophisticated solutions are recommended for environments grappling with foundational constraints.

Moreover, there is a conspicuous scarcity of integrated, quantitative studies in sub-Saharan African settings that simultaneously evaluate the interplay between the triumvirate of factors central to last-mile efficiency: address clarity, digital tool adoption and infrastructural accessibility. Most studies tend to examine these factors in isolation. While digital addressing platforms are discussed and infrastructure deficits are documented, their relative influence and interdependence remain under-analyzed (Kuteyi & Winkler, 2022). Furthermore, the existing research on Tanzania specifically is often policy-oriented or descriptive, lacking the methodological rigor of a defined theoretical framework to structure inquiry and interpret findings.

This study, therefore, filled this multi-faceted gap. By employing the TOC as an analytical framework, it moved beyond description to diagnosis. It did not merely ask if address systems are a problem but rather, which aspect of the address-delivery system constitutes the most critical constraint in a representative secondary city. Through a quantitative case of Singida, this study provides much-needed, localized and evidence-based insights. It assesses the interconnectedness of address information, digital technology and physical infrastructure, offering a model that can be tested and refined in other similar urban contexts across Tanzania and the broader developing world, thereby contributing to a more nuanced understanding of how to build trade connectivity from the ground up.

Methodology

This section delineates the systematic research procedures undertaken. It details the research design, population and sampling strategy, data-collection instruments and analytical techniques used for investigation.

Design

Descriptive-correlational design was employed in this study. The design is appropriate because the study aimed both to describe the current state of address systems, infrastructure and delivery efficiency in Singida, and to examine the relationships (correlations) among these variables using regression analysis. A purely descriptive design would not allow for hypothesis testing while a purely correlational design would not provide the detailed profile of the phenomena. The descriptive-correlational design combines both purposes (Creswell, 2014). The single-case selection of Singida Municipal Council is justified because it represents a typical secondary urban center in Tanzania, experiencing rapid urbanization and notable infrastructural deficits and therefore offers a rich setting to examine last-mile delivery constraints.

The descriptive element enabled precise measurement and characterization of the principal variables: address clarity, digital system usage, infrastructure accessibility and delivery efficiency, consistent with the study's positivist orientation (Saunders et al., 2019). While findings from a single city are not statistically generalizable to all Tanzanian cities, strong case studies provide context-dependent and theoretically informative knowledge. In this study, the Theory of Constraints served as an analytical lens to move from description to diagnosis, asking which factor most tightly limits parcel delivery in Singida.

Population and Sampling

The target population comprised household heads or primary decision-makers in households within Singida Municipal Council, those who routinely receive parcel deliveries and thus have direct experience of location-sharing practices. According to National Bureau of Statistics (2022), the municipality contains 54,697 households.

To determine a representative sample size for the population, Cochran's formula for large populations

was applied using a 95% confidence level (Z = 1.96), a 5% margin of error (e = 0.05) and a conservative population proportion (p = 0.5). This calculation yields a minimum sample of approximately 385 respondents. The sample was increased to 399 to account for potential non-response, incomplete questionnaires and data entry errors, ensuring that the final usable sample remained above the minimum required for statistical power (Cochran, 1977; Bartlett et al., 2001).

A simple random sampling technique was used to select households, every household in the constructed sampling frame had an equal known probability of selection, which reduces selection bias and strengthens representativeness (Taherdoost, 2016). The sampling frame was built from ward and street lists held by the Singida Municipal Council; households were chosen by a random-number generator applied to the frame.

Data Collection Instruments

Data was collected with a structured questionnaire, administered in person by trained research assistants. The instrument was designed mainly with closed-ended items to facilitate quantification and statistical analysis. The study used a five-point Likert scale (1 = Strongly disagree to 5 = Strongly agree), a widely accepted technique for capturing attitude intensity and perceptions in survey research (Joshi et al., 2015).

The questionnaire had two sections. Section A captured demographic and socio-economic characteristics (age, education, household size, frequency of parcel receipt). Section B contained multi-item scales for the key constructs. For example, utilization of digital address systems included items such as "I use a mobile app (e.g., Google Maps, Plus Codes, What3words) to send my location to delivery personnel," while "Parcel delivery efficiency" included items on timeliness, predictability and the frequency of failed attempts. Scale development drew on the literature on last-mile logistics and address systems and was iteratively refined for local relevance. Using a structured, standardized questionnaire reduced interviewer variability and supported efficient data management (Kombo & Tromp, 2006).

Validity and Reliability

To secure content validity, the questionnaire draft was reviewed by a three-member panel: two academics specializing in supply-chain/logistics and one municipal urban-planning practitioner. Their feedback refined wording, item relevance and coverage of construct domains.

A pilot study (n = 30) was conducted among households excluded from the main survey to test clarity and operational functioning. Pilot feedback informed minor wording adjustments and logistical procedures. Preliminary reliability analysis of the multi-item scales computed Cronbach's alpha, which yielded a composite value of 0.81, well above commonly accepted thresholds, indicating acceptable internal consistency (Field, 2018).

Data Analysis

Data was analyzed using the IBM SPSS Statistics software (Version 25). The analysis followed a two-stage procedure. First, descriptive statistics summarized the demographic characteristics of respondents and the central tendencies and dispersions of the study variables. Second, inferential statistics tested the following study's hypotheses: **H1:** Address clarity and completeness have no significant influence on parcel delivery efficiency in Singida. **H2:** The use of digital addressing systems has no significant influence on parcel delivery efficiency in Singida. **H3:** Infrastructure accessibility has no significant influence on parcel delivery efficiency in Singida.

At the end of the study, each hypothesis was either accepted or rejected based on the regression findings. A multiple linear regression model estimated the relative influence of the three predictors (address clarity, digital systems and infrastructure accessibility) on parcel delivery efficiency. Multiple regression is appropriate for assessing how several predictors contribute to a single outcome while holding other variables constant (Field, 2018; Hair et al., 2019).

Before modelling, regression assumptions were checked. Linearity and homoscedasticity were assessed via residual plots; independence of errors was evaluated using the Durbin-Watson statistic; and multicollinearity was examined using the Variance Inflation Factor (VIF), with VIF values below commonly used cutoffs indicating acceptable levels (Hair et al., 2019; Field, 2018). Regression outputs reported include R^2, adjusted R^2 and standardized beta coefficients (β) to quantify effect sizes and statistical significance.

Ethical Considerations

The study adhered to recognized ethical standards for social-science research. Formal ethical clearance

was obtained from the Directorate of Research, Publications and Innovation of the Open University of Tanzania before data collection. Fieldwork procedures respected the informed consent: participants received prior information explaining study objectives, procedures, risks and benefits and the right to withdraw, and verbal consent (culturally appropriate for this low-risk survey) was documented by the researchers.

To protect confidentiality, the questionnaire was anonymized at collection; no personally identifiable data (names, specific house numbers) were recorded. Raw data was stored on a password-protected computer accessible only to the core research team. Results were presented in aggregated form so that no individual respondent can be identified.

Findings and Discussion

This section presents a comprehensive analysis and discussion of the empirical data, guided by the central research question: What is the relative influence of address clarity, digital addressing systems, and infrastructure accessibility on parcel delivery efficiency in a secondary Tanzanian city?

The presentation is structured to first establish the general trends through descriptive statistics, followed by a rigorous test of the predefined hypotheses, using multiple regression analysis. The discussion then synthesizes the findings, interpreting them through the lens of the Theory of Constraints and situating them within the broader scholarly conversation on last-mile logistics in developing contexts.

Descriptive Analysis: Perception versus Reality

The descriptive statistics provide a critical snapshot of the perceptions and realities shaping Singida's last-mile delivery ecosystem. As summarized in Table 1, respondents overwhelmingly identified infrastructure accessibility (M = 4.214, SD = 1.019) as the most significant impediment to efficient parcel delivery. The high mean score, together with a relatively low standard deviation, indicates strong consensus that poor road conditions, a lack of street signage and impassable access routes are primary sources of delay. This finding immediately underscores a foundational, physical barrier that aligns with the Theory of Constraints, suggesting a primary bottleneck in the system.

While respondents similarly agreed that address clarity and completeness (M = 4.021, SD = 1.108) and the use of digital address systems (M = 4.133, SD = 1.154) should improve efficiency, reported behavior revealed a different picture. Low mean scores for the actual adoption of GPS-based tools (M = 2.547, SD = 1.221) and for confidence in delivery personnel's informal navigation skills (M = 2.487, SD = 1.267) point to an adoption–utility gap: residents value precise addressing and digital tools in principle, but they rarely adopt or effectively use them in practice. This gap is consistent with regional evidence showing that rising smartphone ownership has not uniformly translated into advanced mobile-service use barriers, such as device affordability, data costs and limited digital skills continue to constrain meaningful uptake of location-sharing services in many secondary cities across Sub-Saharan Africa (GSMA, 2023).

Table 1: Descriptive Statistics for Key Variables (n = 399)

SN	Statement	Mean	SD	Interpretation
1	Clarity and completeness of addresses improve efficiency.	4.021	1.108	Agree
2	Use of digital address systems enhances accuracy.	4.133	1.154	Agree
3	Poor infrastructure delays parcel delivery.	4.214	1.019	Agree
4	Many households have adopted GPS-based tools.	2.547	1.221	Disagree
5	Delivery personnel can navigate without formal systems.	2.487	1.267	Disagree

Empirical work from East Africa shows that poor road maintenance and the absence of formal addressing systems materially increase delivery costs and failure rates.

Delivery personnel and firms often compensate with repeated phone calls, landmark-based directions and ad-hoc local knowledge, practices that are inefficient and fragile (Mogire et al., 2023; Rest of World, 2023). The descriptive evidence from Singida aligns with broader patterns observed across secondary African cities, where physical access problems and institutional gaps reduce the practical utility of even good address data.

Multiple Regression Analysis: Isolating the Primary Constraint

To move beyond perceptions and isolate the unique predictive power of each variable, a multiple linear

regression was performed. In Table 2, the model was statistically significant, F (3, 395) = 15.42, p = 0.006, confirming that the combined predictors reliably explain variance in delivery efficiency. The Adjusted R^2 of 0.413 indicates that approximately 41.3% of the variance in parcel delivery efficiency is explained by the three predictors, a meaningful proportion for real-world social science data, where many unobserved contextual factors also play a role (Hair et al., 2019).

Table 2: Regression Model Summary with Statistical Significance (n = 399)

Model Fit Statistic	Value	Description
F-statistic	F(3, 395) = 15.42	Ratio of explained to unexplained variance
p-value	0.006	Statistically significant at α = 0.05
R	0.683	
R^2	0.467	Proportion of variance explained (unadjusted)
Adjusted R^2	0.413	Variance explained, adjusting for the number of predictors

Table 3: Regression Coefficients

Variable	Unstd. Coeff. (B)	Std. Error	Std. Coeff. (Beta)	t	Sig.
(Constant)	0.844	0.288		2.931	
Clarity & Completeness	0.135	0.100	0.148	1.181	0.181
Digital Systems	0.194	0.114	0.171	1.701	0.096
Infrastructure Accessibility	0.377	0.148	0.341	2.547	0.012

Table 4: Collinearity and Residual Independence Diagnostics

Diagnostic Test	Statistic	Acceptable Threshold	Interpretation
VIF (Variance Inflation Factor) – Infrastructure Accessibility	1.24	< 5.0	No concerning multicollinearity
VIF – Digital Systems	1.18	< 5.0	No concerning multicollinearity
VIF – Clarity & Completeness	1.21	< 5.0	No concerning multicollinearity
Durbin-Watson	1.89	1.5 – 2.5	Residuals are acceptably independent

Note: VIF values below the common cutoff of 5.0 (or the stricter 2.5) indicate that predictors share minimal redundant variance. The Durbin-Watson statistic near 2.0 suggests no significant autocorrelation.

Analysis of the regression coefficients (Table 3) provides the central empirical insight. Only infrastructure accessibility produced a statistically significant unique effect on delivery efficiency (β = 0.341, p = 0.012). Address clarity (β = 0.148, p = 0.181) and digital systems (β = 0.171, p = 0.096) did not reach conventional significance thresholds when all predictors were entered concurrently. The standardised beta for infrastructure indicates that a one-standard-deviation improvement in infrastructure accessibility is associated with a 0.341 standard-deviation improvement in delivery efficiency, holding other factors constant, quantifying infrastructure as the most potent single lever among those studied. Based on these findings, H1 (Address clarity does not influence efficiency) was not rejected (p = 0.181 > 0.05). H2 (Digital systems does not influence efficiency) was not rejected (p = 0.096 > 0.05, though marginally). But H3 (Infrastructure accessibility does not influence efficiency) was rejected (p = 0.012 < 0.05).

In Table 4, regression assumptions (linearity, homoscedasticity, independence of errors and multicollinearity) were checked and satisfied. The regression results compel a nuanced interpretation within the Theory of Constraints (TOC). The non-significance of address clarity and the marginal (non-significant) effect for digital systems do not mean these elements are unimportant; rather, they appear subordinate in Singida's current socio-technical system. Under TOC's third step (subordinate non-constraints to the constraint), a clear address still yields little throughput improvement if the delivery vehicle cannot physically reach the dwelling due to impassable roads or absent signage. This ordering echoes empirical reports from East Africa, showing that, in contexts of weak transport infrastructure, the marginal benefit of better address data is muted until access constraints are removed (Mogire et al., 2023; World Bank, 2022).

The non-significant result for digital systems highlights an adoption-utility gap. Digital location tools may be technically capable of improving routing and reducing failed deliveries, but their real-world impact depends on a broader enabling environment: affordable smartphones, reliable mobile data coverage, user familiarity and organizational integration (GSMA, 2023; Reuters,

2024). Without these conditions, investments in digital equipment can produce little throughput improvement, an example of resource misallocation relative to TOC's exploit/elevate sequence. Recent reviews emphasize that technological fixes must be matched with investments in skills, network reliability and service design to convert potential into realized gains (Andreas, 2024).

The robust support for infrastructure accessibility identifies physical access as the system's binding constraint in Singida. This finding corresponds with a substantial body of policy and empirical literature emphasizing infrastructure as foundational for economic connectivity. The World Bank and other development analyses link improved road networks and urban accessibility to reduced trade costs and improved market integration, effects that cascade into more efficient supply-chain and last-mile operations (World Bank, 2022; Calderón & Servén, 2010). In line with TOC's elevate recommendation, targeted investments to improve road surfacing, ensure continuous passability and deploy standardized street signage are prime candidates to increase system throughput. Only after breaking this primary physical bottleneck will the secondary benefits of formalized addressing and digitalization be fully realized.

Operationally, this diagnosis suggests a sequenced policy agenda for Singida: prioritize low-cost, high-impact infrastructure fixes (patching choke-point routes, installing signage on main feeder streets), then roll out coordinated digital-address training and data-integration pilots that leverage the newly improved access. Such a sequence is consistent with last-mile best practice emerging from African case studies, where hybrid interventions, combining modest infrastructural upgrades with user training and pragmatic tech adoption, produce measurable delivery improvements (Mogire et al., 2023; Rest of World, 2023).

Conclusions and Recommendations

This section summarizes the main findings of the study and offers practical, evidence-based recommendations for different stakeholders involved in improving last-mile delivery and trade connectivity in secondary cities like Singida.

Conclusions

This study concludes that within the socio-technical system of parcel delivery in Singida, Tanzania, infrastructure accessibility is the preeminent and statistically significant constraint on efficiency. The quantitative findings demonstrate that the influences of address clarity and digital system utilization, while perceived as valuable by users, are statistically overshadowed by the binding constraint of physical inaccessibility. This study makes a distinct contribution by applying the Theory of Constraints to move beyond a mere catalogue of last-mile challenges, providing instead a diagnostically prioritized hierarchy of intervention points.

The theoretical implication is that development efforts focused only on digitizing addresses or formalizing address information, without concurrent, prioritized investment in the physical road network and signage, are likely to give diminishing returns. The practical implication for enhancing global trade connectivity is clear: integrating secondary cities like Singida into efficient logistics networks requires an infrastructure-first approach. By systematically identifying and removing this primary bottleneck, as TOC prescribes, the overall throughput of the urban delivery system can be greatly improved, thereby reducing trade costs and fostering greater economic inclusion for these strategically important urban centers.

Recommendations

Based on the conclusive findings, the following recommendations are proposed:

Municipal Council, Ministry of Works and Transport and the President's Office-Regional Administration and Local Government (PO-RALG) should pursue sequential investment, prioritizing physical infrastructure. Specifically, they should clearly prioritize spending on improving and maintaining urban road surfaces, installing comprehensive and visible street signage, and regularizing access paths in rapidly urbanizing wards. This step-by-step investment approach follows the Theory of Constraints (TOC) "elevate" step, emphasizing that fixing physical bottlenecks must be treated as a non-negotiable requirement before other logistical and technological interventions can work effectively.

Tanzania Communications Regulatory Authority (TCRA) and the Ministry of Information, Communication and Technology, which jointly oversee the National Addressing and Postcode System (NAPS), should pursue strategic integration of NAPS with infrastructure rollout. They should ensure that the national addressing system is

deliberately linked with ongoing infrastructure development programs. Specifically, the installation of street nameplates, house numbering and postcode identifiers should be made a mandatory part of all new road construction, rehabilitation and urban upgrading projects. Urban planners and local government engineers should put this integration into practice at the project design and implementation stages, especially in secondary cities like Singida.

Technology firms, start-ups and academic institutions, particularly local universities with ICT and urban planning departments, should jointly develop context-appropriate digital tools. Specifically, they should design and test lightweight, offline-capable digital addressing applications that can work well in low-data environments. These tools should support, not replace improved physical signage by using innovations such as QR codes on street signs linked to locally stored offline maps. The Tanzania Commission for Science and Technology (COSTECH) and development partners can provide start-up funding and regulatory support for such innovations, ensuring they can be scaled up and sustained over time.

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