Digitalization of logistics in East Africa: Potentials and bottlenecks

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ABSTRACT

Digitalization is increasingly shaping the logistics landscape in East Africa, offering opportunities to enhance trade efficiency while also posing challenges that hinder its full adoption. This study examines the digital logistics ecosystem across key East African trade corridors, focusing on Single Window Systems (SWS), Port Community Systems (PCS), and cargo tracking platforms. Guided by four specific objectives, the research maps existing digital platforms, assesses their impact on customs clearance times, port dwell periods, and overall cargo transit duration, estimates their effect on freight and transaction costs, and evaluates operational reliability through system uptime and downtime performance. A mixed-methods approach was employed, combining quantitative data from 385 logistics operators, importers, exporters, and port officials with qualitative insights from key stakeholders. Findings reveal that digital platforms have significantly improved operational efficiency, reduced cargo transit times, and lowered costs, particularly where system reliability is consistently high. Nonetheless, limited interoperability among platforms, infrastructure gaps, and occasional system downtimes continue to constrain the full potential of digital logistics. The study underscores the transformative power of digitalization in enhancing trade competitiveness and highlights the importance of complementary investments in infrastructure, human capacity, and regional integration. These insights offer practical guidance for policymakers, port authorities, and private sector actors seeking to strengthen the digital logistics ecosystem and promote more seamless, cost-effective, and reliable trade operations in East Africa. Specifically, the policy makers are recommended to harmonize regional digital trade policies, expand digital infrastructure along key corridors, and incentivize SMEs to adopt digital tools, strengthen cybersecurity frameworks, and build a skilled digital logistics workforce. Port authorities are recommended to fully automate port operations, reduce human interaction points, integrate port systems with national and regional platforms, invest in smart equipment, and improve last-mile connectivity. Private sector actors (transporters, freight forwarders, warehouses, and shipping lines) are recommended to adopt digital tracking and fleet management tools, integrate business systems with national digital platforms, digitize internal workflows, strengthen digital literacy among staff, invest in cyber-resilient operations, and participate in regional digital innovation ecosystems. Finally, all stakeholders are recommended to promote interoperability above all else, strengthen public–private dialogue, leverage big data for decision-making, and adopt green digital logistics practices.

Keywords: Digital Logistics, Operational Efficiency, System Reliability, Trade Corridors

I. INTRODUCTION

Digital transformation has become a defining feature of modern logistics, reshaping how goods, services, and information move across borders (International Monetary Fund *et al*., 2024; Organisation for Economic Co-operation and Development [OECD], 2020). Technologies such as electronic single windows, port community systems, Internet of Things (IoT) sensors, and digital freight platforms are enabling faster, more transparent, and more cost-efficient trade operations worldwide (Ptashchenko *et al.*, 2025). As logistics networks become increasingly data-driven, digitalization offers a strategic advantage by allowing for real-time decision-making, predictive analytics, and integrated visibility capabilities that reduce uncertainty, enhance reliability, and boost global competitiveness (World Bank, 2023).

The logistics sector depends heavily on continuous data exchange among customs officials, port operators, freight forwarders, and traders (World Bank, 2023). Digitalization therefore plays a crucial role in improving operational efficiency. Automated systems reduce paperwork, minimize administrative errors, and accelerate clearance processes, while also increasing transparency across supply-chain actors (Ptashchenko *et al.*, 2025). Moreover, the application of digital logistics tools such as route optimization algorithms and cargo-tracking platforms reduces idle time, prevents unnecessary fuel use, and promotes sustainability in freight operations (Lawrence & Mupa, 2024). These innovations contribute directly to lowering trade costs and strengthening resilience against disruptions such as pandemics, cyber-incidents, and port blockages (OECD, 2025; World Bank, 2023).

In developed economies, logistics digitalization is already deeply embedded through integrated electronic customs systems, advanced port-community networks, and seamless inter-agency data sharing (OECD, 2020). These systems are supported by robust ICT infrastructure, harmonized legal frameworks for digital documents, and a culture of inter-institutional collaboration that ensures predictable trade processes (OECD, 2025). In contrast, East African

countries including Kenya, Tanzania, and Uganda have introduced several digital initiatives such as electronic single windows and online customs management systems, yet implementation challenges remain (TradeMark East Africa, 2022; Hamisi, 2024). Frequent network downtimes, limited interoperability between systems, and slow adoption among small logistics operators have hindered the intended efficiency gains (Chris *et al*., 2024). For example, despite Tanzania's progress with e-customs platforms, many traders still experience long clearance times and unpredictable port dwell periods due to connectivity and integration issues (Hamisi, 2024). Consequently, the benefits achieved in digitally mature economies have not been fully realized in East Africa (Chris *et al*., 2024).

Despite notable investments in digital trade facilitation, East Africa continues to record high logistics costs, inconsistent clearance durations, and recurrent port congestion (World Bank, 2023). It remains uncertain whether the existing digital systems have significantly improved operational efficiency or merely automated traditional procedures without transforming underlying processes (TradeMark East Africa, 2022). Few empirical studies have examined the measurable impact of logistics digitalization particularly how it affects customs clearance time, port dwell time, and door-to-door transit duration (Chris *et al*., 2024). Likewise, limited evidence exists on how system reliability such as uptime, downtime, and user responsiveness influences congestion and demurrage costs at major East African ports (Hamisi, 2024). This lack of rigorous, data-based analysis creates uncertainty for policymakers and investors who must decide where to prioritize future digital infrastructure and institutional reforms (Ptashchenko *et al*., 2025).

Existing literature in East Africa primarily documents the introduction of digital platforms without quantifying their operational or economic outcomes (TradeMark East Africa, 2022). The absence of empirical measures such as clearance-time reductions, cost savings, and reliability indices leaves a major evidence gap (Chris *et al*., 2024). Research seldom evaluates how these systems perform in practice or how consistently they deliver the intended benefits (Hamisi & Kileo, 2024). Addressing this gap is essential for identifying which technologies are most effective in reducing delays, congestion, and trade costs. A comprehensive understanding of digital logistics performance would enable policymakers to design evidence-based strategies for scaling digital solutions across the region (World Bank, 2023).

Therefore, this study examined digitalization of logistics in East Africa with its potentials and bottlenecks. It specifically maps the existing digital logistics ecosystem across key East African trade corridors, identifying active platforms such as single windows, port-community systems, and cargo-tracking tools; quantifying the influence of digital systems on customs clearance time, port dwell time, and overall cargo transit duration; estimating the effect of logistics digitalization on freight and transaction costs incurred by importers and exporters in East Africa; and evaluating the operational reliability of key digital systems measured through uptime and downtime performance and their relationship with congestion and demurrage costs.

By focusing on measurable impacts, this study seeks to generate empirical insights into how digital logistics systems affect efficiency, costs, and reliability in East Africa. The findings will assist regional governments, development partners, and private-sector actors in identifying which technologies produce the greatest time and cost reductions. Furthermore, by assessing system reliability, the study will provide practical guidance for building more resilient, interoperable logistics infrastructures. Ultimately, the research will help position East Africa to align more closely with global logistics standards, strengthen supply-chain integration, and enhance trade competitiveness.

1.1 Research Objectives

i. To map existing digital platforms of logistics in East Africa
ii. To assess the impact of the digital platforms on customs clearance times, port dwell periods, and overall cargo transit duration in East Africa
iii. To estimate the effect of digital platforms on freight and transaction costs in East Africa
iv. To evaluate operational reliability through system uptime and downtime performance in East Africa

II. LITERATURE REVIEW

Digitalization has become a defining force in reshaping logistics systems and global trade facilitation. Around the world, the integration of digital technologies has been recognized as a key driver for reducing trade costs, improving efficiency, and enhancing transparency across supply chains (World Bank, 2023; OECD, 2025). For developing economies, and particularly those in East Africa, digital transformation in logistics through initiatives such as electronic single windows, port community systems, and real-time cargo tracking has opened new pathways toward competitiveness and trade growth (Ptashchenko *et al*., 2025; Sub-Saharan Africa Transport Policy Program [SSATP], 2024).

2.1 Theoretical Review

Digital logistics broadly refers to the application of digital technologies and data-driven systems in managing logistics operations to improve coordination, visibility, and overall efficiency (Martínez-Zarzoso & Chelala, 2020;

SSATP, 2024). These technologies include electronic data interchange (EDI), customs single windows, IoT-enabled cargo tracking, and digital freight marketplaces. Together, they replace slow, paper-based procedures with automated, interconnected systems that enhance communication among customs agencies, ports, and transport operators (World Bank, 2023). By doing so, digital logistics has the potential to reduce administrative bottlenecks, increase predictability, and lower transaction costs across borders.

Three interrelated theoretical perspectives provide a foundation for understanding how digital logistics affects trade costs: Transaction Cost Economics, Network Theory, and Diffusion of Innovation. The Transaction Cost Economics (TCE) by Williamson (1981) explains that organizations and systems evolve to minimize the costs associated with transactions, including those caused by uncertainty, limited information, and opportunistic behavior. In logistics, digital systems such as port community platforms and electronic documentation streamline interactions by improving transparency, automating information exchange, and reducing time-consuming manual tasks (Martínez-Zarzoso & Chelala, 2020; World Bank, 2023). As a result, firms and government agencies experience lower administrative costs and faster clearance processes, which directly contribute to trade cost reduction (OECD, 2025).

The Network Theory highlights how the strength and quality of relationships between institutions determine system performance (Barabási, 2016). Applied to logistics, it underscores the importance of interconnectedness among customs, transporters, freight forwarders, and traders. Digital platforms facilitate this by enabling interoperability and real-time data sharing, thereby improving trust, coordination, and the resilience of trade systems (SSATP, 2024). When logistics networks are digitally integrated, they become more responsive to disruptions, congestion, and demand fluctuations, leading to smoother cargo flow and reduced operational costs (Chris *et al*., 2024).

The Diffusion of Innovation (DOI) by Rogers (2003) explains how new technologies spread within a system, emphasizing that adoption depends on perceived benefits, compatibility, and user readiness. In East Africa, where digital literacy and infrastructure development remain uneven, DOI helps to explain the differing levels of adoption of digital logistics tools such as online customs clearance, cargo tracking systems, and electronic payment solutions (Hamisi, 2024; TradeMark East Africa, 2022). Understanding these adoption patterns enables policymakers to design incentives, training, and awareness programs that can accelerate the uptake of digital logistics innovations.

Cooperatively, these theories offer a multi-dimensional perspective on the role of digitalization in logistics. TCE focuses on reducing costs through efficiency and transparency; Network Theory emphasizes the structural integration of logistics actors; and DOI addresses behavioral and institutional readiness for technology adoption. This integrated framework provides a solid theoretical base for evaluating how digital logistics systems influence trade costs, clearance times, and overall performance in East Africa (OECD, 2025; World Bank, 2023).

Empirical evidence grounded in these theoretical perspectives suggests that digitalization enhances predictability, lowers administrative costs, and reduces procedural delays benefits that align with both cost-efficiency and network optimization principles (Martínez-Zarzoso & Chelala, 2020; Ptashchenko *et al.*, 2025). However, the full realization of these benefits often depends on system interoperability, user adoption levels, and the reliability of the digital infrastructure itself, which are the key factors that this study aims to examine.

2.2 Empirical Review

2.2.1 Empirical Evidence on Single Windows, Port-Community Systems, and Clearance Times

Empirical research consistently shows that the introduction of digital single windows and port-community systems can significantly reduce customs clearance and document processing times (Martínez-Zarzoso & Chelala, 2020; SSATP, 2024). Within the East African Community (EAC), the establishment of the Single Customs Territory has improved information sharing and coordination, although implementation challenges remain at some border points (TradeMark East Africa, 2022; Northern Corridor Transit and Transport Coordination Authority [NCTTCA], 2023). While electronic systems have minimized paperwork and enhanced data accuracy, intermittent system failures, inadequate inter-agency coordination, and limited operator training continue to hinder efficiency gains (Hamisi & Kileo, 2024). Comparative analyses of the Dar es Salaam and Mombasa ports reveal that system reliability and interoperability are central determinants of performance outcomes (Kunambi & Zheng, 2024).

2.2.2 Effects on Freight Costs and Overall Trade Costs

Digital logistics affects trade costs both directly and indirectly. By reducing delays, optimizing route planning, and improving predictability, digital systems lower demurrage, inventory, and warehousing expenses (World Bank, 2023; Martínez-Zarzoso & Chelala, 2020). Studies have demonstrated that logistics digitalization correlates with reduced trade costs and increased export competitiveness (Borojo & Weimin, 2025). However, in the East African context, the scale of these benefits varies across corridors due to differences in infrastructure, system interoperability, and operational reliability (SSATP, 2024; NCTTCA, 2023). There remains a clear research gap in quantifying how specific digital interventions translate into measurable cost reductions.

2.2.3 System Reliability, Downtime, and Their Impact on Congestion and Demurrage

System reliability is a critical yet often overlooked dimension of digital logistics performance. Frequent outages, software failures, and connectivity disruptions can erode the time and cost advantages offered by digital systems (Hamisi & Kileo, 2024; Chris *et al*., 2024). Evidence from East African ports shows that network downtime and unstable digital infrastructure contribute to congestion and demurrage charges, which undermine trade facilitation objectives (NCTTCA, 2023). Conversely, ports with stable digital operations and proactive IT maintenance achieve faster cargo processing and reduced turnaround times (Kunambi & Zheng, 2024). This underscores the importance of not only adopting digital tools but also ensuring their consistent reliability.

Although digitalization has clearly enhanced transparency and procedural efficiency, existing studies remain fragmented and largely descriptive (TradeMark East Africa, 2022; SSATP, 2024). There is limited quantitative evidence on the extent to which digital logistics systems reduce clearance times and trade costs in East Africa or how system reliability affects congestion and demurrage. This study therefore addresses these empirical gaps by mapping the digital logistics landscape; quantifying its effects on clearance and transit times; estimating cost impacts; and assessing how system reliability mediates these relationships. Grounded in Transaction Cost Economics, Network Theory, and Diffusion of Innovation, the study provides an integrated understanding of how digital logistics influences trade efficiency and competitiveness in East Africa.

III. METHODOLOGY

3.1 Research Philosophy

This study adopts a positivist research philosophy, which posits that reality is objective and can be measured through observable facts. This approach is particularly suited for examining the tangible impacts of digital logistics systems on measurable outcomes such as customs clearance times, port dwell periods, freight costs, and system reliability. By employing this perspective, the research aims to establish evidence-based relationships between the adoption of digital logistics and improvements in operational efficiency across East African trade corridors.

3.2 Research Approach

A quantitative research approach underpins this study, facilitating systematic measurement and statistical analysis of variables related to digital logistics. This approach aligns with the positivist orientation of the study and enables rigorous testing of relationships between digital logistics adoption, trade performance indicators, costs, and system reliability.

3.3 Research Design

The study employs a cross-sectional survey design, complemented by secondary data analysis. This design captures the current state of digital logistics systems, operational performance, and cost dynamics at a single point in time across multiple corridors. Integrating primary survey data with secondary records, such as system uptime logs and port performance metrics, ensures a comprehensive assessment of both adoption patterns and operational outcomes.

3.4 Area of the Study

The research focuses on the major trade corridors in East Africa, specifically: Northern Corridor: Mombasa Port through Kenya to Uganda, Rwanda, and South Sudan; Central Corridor: Dar es Salaam Port to Tanzania, Rwanda, Burundi, and the Democratic Republic of Congo; and Southern Corridor: Dar es Salaam Port to Zambia and Malawi. These corridors were selected for their strategic importance in regional trade, their adoption of digital logistics solutions, and the availability of operational data from multiple stakeholders.

3.5 Population, Sample Size and Sampling Techniques

The study focuses on logistics stakeholders operating along the selected corridors, including freight forwarders and customs-clearing agents, importers and exporters, port authorities and terminal operators, as well as administrators and developers of digital logistics platforms such as single windows, port-community systems and cargo-tracking tools. Because there is no comprehensive registry or database that captures the exact number of these actors across the corridors, the actual population size cannot be determined with confidence. Consequently, the study treats the target population as unknown or effectively very large, a standard assumption in survey research when population parameters are unavailable. Based on this, the Cochran formula for large/unknown populations is applied to determine an appropriate sample size.

$$n_0 = \frac{Z^2 p(1-p)}{e^2}$$

Where:

Z=1.96 for a 95% confidence level
P=0.5 (estimated proportion of population)
e=0.05 (margin error)

$$n_0 = \frac{(1.96)^2(0.5)(1-0.5)}{(0.05)^2} = 384.16$$

Thus, a minimum of 385 respondents was targeted, distributed proportionally among the various stakeholder categories and corridors. A hybrid sampling technique was employed, combining purposive, stratified, and convenience sampling: Purposive sampling targeted key stakeholders with direct involvement in digital logistics operations, ensuring that respondents have relevant knowledge of systems such as single windows, port-community platforms, and cargo-tracking tools. Stratified sampling ensured representation across different stakeholder categories (freight forwarders, importers/exporters, port authorities, and platform administrators) and across the three corridors, maintaining proportionality. Convenience sampling was applied where access is constrained, particularly for busy operational staff, while still maintaining diversity and relevance in responses. This hybrid approach balances rigor and practicality, ensuring a representative yet feasible sample.

The World Bank (2012) indicators are retained as historical baselines due to their cross-country comparability and continued use in logistics research, while more recent publicly accessible reports from Kale Logistics (2025), Webb Fontaine (2025), and relevant port-authority documents (2018–2024) provide updated benchmarks for digital systems, clearance processes and operational performance.

Table 1
Measures

Variable	Indicators	Measurement Scale	Source
Digital Logistics Platforms	Presence and usage of single windows, port-community systems, cargo-tracking tools	Nominal (Yes/No)	Webb Fontaine (2025); Kalelogistics (2025)
Customs Clearance Time	Average time (hours) for customs processing per shipment	Ratio	World Bank (2012); Kalelogistics (2025)
Port Dwell Time	Average duration (days) cargo remains at port before release	Ratio	World Bank (2012); Kalelogistics (2025)
Cargo Transit Duration	Total time (days) from origin to destination	Ratio	World Bank (2012); Kalelogistics (2025)
Freight Costs	Average transport cost per container	Ratio	World Bank (2012); Kalelogistics (2025)
Transaction Costs	Fees, penalties, and demurrage costs incurred	Ratio	World Bank (2012); Kalelogistics (2025)
System Reliability	Uptime (%) and downtime (hours) per month	Ratio	Kalelogistics (2025); Webb Fontaine (2025)
Congestion/Demurrage Costs	Additional costs incurred due to delays	Ratio	World Bank (2012); Kalelogistics (2025)

3.6 Data Collection

Primary data were collected through structured questionnaires directed at logistics stakeholders. These questionnaires captured perceptions on platform adoption, transaction costs, and operational bottlenecks. Secondary data were sourced from port authorities and customs agencies (clearance times, dwell periods); digital platform administrators (uptime and downtime logs); freight companies (cost data, transit durations); data collection were combined on-site visits, email correspondence, and online survey distribution, ensuring accessibility to a broad range of stakeholders.

3.7 Validity and Reliability

Content validity is ensured through careful alignment of survey items with the research objectives and consultation with logistics experts. Construct validity were evaluated via factor analysis to confirm that survey items accurately capture intended constructs such as system reliability and operational efficiency. Reliability was assessed using Cronbach's alpha, with a threshold of ≥0.7 indicating satisfactory internal consistency. Secondary data were cross-verified from multiple sources to enhance credibility.

3.8 Data Analysis

Descriptive statistics (means, standard deviations, frequencies) summarized digital platform adoption, cargo transit times, costs, and reliability measures. Inferential statistics examined relationships between variables: correlation analysis to explore associations between digital logistics adoption and performance outcomes; and multiple regression analysis to quantify the effects of digital logistics on freight costs, transaction costs, and operational reliability. The testing was conducted at a 5% significance level (p<0.05). Analyses were performed using IBM SPSS version 27, with results presented in tables, charts, and figures to correspond with the four study objectives.

IV. FINDINGS & DISCUSSION

4.1 Mapping the Digital Logistics Ecosystem across East African Trade Corridors

The first objective of this study was to map the existing digital logistics ecosystem across major East African trade corridors, including the Northern Corridor (Mombasa–Uganda–Rwanda–South Sudan), Central Corridor (Dar es Salaam–Tanzania–Rwanda–Burundi–DRC), and Southern Corridor (Dar es Salaam–Zambia–Malawi). Analysis revealed that Single Window Systems (SWS) are the most widely implemented platforms, with 83.1% of stakeholders reporting active usage. Port Community Systems (PCS) and cargo tracking tools (RECTS) were also widely adopted, reported by 76.6% and 80.5% of respondents, respectively. The mean scores on a five-point scale indicated high utilization for all platforms: SWS (M = 4.25, SD = 0.79), PCS (M = 4.12, SD = 0.85), and RECTS (M = 4.18, SD = 0.82) (Table 1).

The findings of this study highlight the transformative potential of digitalization in East Africa's logistics sector. Digital platforms such as Single Window Systems (SWS), Port Community Systems (PCS), and cargo tracking tools have become integral to improving the efficiency of trade operations. In Kenya, the Kentrade SWS has streamlined customs procedures by integrating multiple stakeholders into a unified digital platform, reducing paperwork and expediting clearance processes (KenTrade, 2025). Similarly, Tanzania's Electronic Single Window System (TeSWS) has enhanced port performance by enabling real-time data exchange between customs, port authorities, and transport operators. These results support the view that digital platforms serve as crucial enablers of trade facilitation, aligning with the East African Community's integration goals.

Despite these advancements, challenges remain. Interoperability between different digital platforms is limited, resulting in fragmented data flows that can reduce operational efficiency. Addressing these gaps through standardized protocols and seamless integration is critical to fully harnessing the benefits of digital logistics.

Table 2

Distribution of Digital Logistics Platforms across Trade Corridors (n = 385)

Platform Type	Frequency	Percentage	Mean Score	Std. Dev.
Single Window Systems (SWS)	320	83.1	4.25	0.79
Port Community Systems (PCS)	295	76.6	4.12	0.85
Cargo Tracking Tools (RECTS)	310	80.5	4.18	0.82

4.2 Influence of Digital Systems on Customs Clearance, Port Dwell Time, and Cargo Transit Duration

The second objective examined the effect of digital logistics on key operational performance indicators. Descriptive statistics show that customs clearance time averaged 18.4 hours (SD = 6.2), port dwell time averaged 4.6 days (SD = 1.8), and overall cargo transit duration averaged 12.8 days (SD = 4.1) (Table 2).

Regression analysis further demonstrated that the adoption of digital platforms significantly improved these metrics. Specifically, digital logistics adoption was associated with a reduction of 4.12 hours in customs clearance time ($\beta = -4.12$, $p < 0.001$), a 1.25-day reduction in port dwell time ($\beta = -1.25$, $p = 0.001$), and a 3.15-day reduction in cargo transit duration ($\beta = -3.15$, $p < 0.001$) (Table 4). These results underscore the pivotal role of digital systems in enhancing operational efficiency along East African trade corridors, corroborating earlier studies that highlight the positive influence of technology-enabled logistics solutions (World Bank, 2012; CSM Tech, 2025).

This study demonstrates that digital logistics significantly improves operational performance, consistent with evidence from other regional contexts. For example, Kenya's Integrated Customs Management System (iCMS) has reduced customs clearance times by approximately 60%, thereby lowering overall cargo dwell time (Rudahigwa & Tombola, 2021; Hamisi & Kileo, 2024; Urassa *et al.,* 2024; Panga *et al.* 2024). Similarly, the TeSWS in Tanzania has reduced congestion at the Dar es Salaam port, demonstrating the potential of digital systems to accelerate cargo movement (Martínez-Zarzoso & Chelala, 2020; Nandule, 2023). However, occasional delays due to system downtimes or document processing issues indicate that technological adoption alone is insufficient; operational efficiency also depends on supporting infrastructure and capacity-building measures (Shippers Council of East Africa, 2024).

Table 3

Descriptive Statistics for Operational Performance Indicators (n = 385)

Indicator	Mean	Std. Dev.	Min	Max
Customs Clearance Time (hours)	18.4	6.2	6	36
Port Dwell Time (days)	4.6	1.8	1	9
Cargo Transit Duration (days)	12.8	4.1	5	25

4.3 Effect of Digitalization on Freight and Transaction Costs

The third objective assessed the impact of digitalization on freight and transaction costs. Descriptive results indicated that the mean freight cost per container was USD 2,450 (SD = 520), while mean transaction costs, including demurrage and associated fees, averaged USD 1,120 (SD = 310) (Table 4).

Table 4

Descriptive Statistics for Freight and Transaction Costs (n = 385)

Cost Indicator	Mean (USD)	Std. Dev.	Min	Max
Freight Cost per Container	2,450	520	1,500	3,800
Transaction Costs (Fees, Demurrage, Penalties)	1,120	310	400	2,100

Regression analysis confirmed that digital logistics adoption significantly reduces both cost categories. Freight costs decreased by USD 425 per container ($\beta = -425$, $p < 0.001$), while transaction costs dropped by USD 140 ($\beta = -140$, $p = 0.001$) (Table 5). These findings highlight that beyond operational efficiencies, digitalization provides tangible financial benefits to importers and exporters by reducing delays and improving process transparency (World Bank, 2012; Kale Logistics, 2025).

Digitalization has further translated into tangible economic benefits. The implementation of electronic cargo tracking systems has improved cargo visibility, allowing importers and exporters to optimize routing, anticipate delays, and reduce demurrage costs (Helo & Thai 2024; Zeng *et al.*, 2025). These efficiencies help lower freight and transaction costs, enhancing the competitiveness of East African trade. Nevertheless, initial investment in digital infrastructure, including training and technology procurement, remains a barrier for some stakeholders, particularly SMEs, which may limit the equitable distribution of benefits (Mkocha & Mwisila, 2025).

Table 5

Regression Results – Impact of Digital Logistics on Operational Performance and Costs (n = 385)

Dependent Variable	β (Unstandardized)	SE	β (Standardized)	t-value	p-value	R^2
Customs Clearance Time (hours)	-4.12	0.72	-0.45	-5.72	0.000	0.203
Port Dwell Time (days)	-1.25	0.38	-0.31	-3.29	0.001	0.096
Cargo Transit Duration (days)	-3.15	0.65	-0.38	-4.85	0.000	0.145
Freight Costs (USD)	-425	95	-0.32	-4.47	0.000	0.102
Transaction Costs (USD)	-140	42	-0.29	-3.33	0.001	0.084

4.4 Operational Reliability of Digital Systems and Relationship with Congestion

The final objective evaluated the reliability of digital systems and their influence on congestion and demurrage costs. Descriptive statistics indicate that digital platforms maintain high reliability, with system uptime averaging 96.3% (SD = 2.1) and downtime averaging 3.8 hours per month (SD = 2.0). Despite these high reliability levels, congestion and demurrage costs persist, averaging USD 210 (SD = 95) (Table 5). These results suggest that while digital systems substantially improve operational performance, occasional infrastructure-related disruptions continue to impact port efficiency. This underscores the need for complementary investments in ICT infrastructure and energy stability to maximize the benefits of digitalization (Mkocha & Mwisila, 2025; Webb Fontaine, 2025).

High operational reliability is a critical determinant of the success of digital logistics systems. Systems with high uptime facilitate smoother operations and minimize congestion (CSM Tech, 2024). However, inconsistent system performance, coupled with infrastructure constraints such as port capacity limitations or unreliable energy supply, can undermine the potential benefits of digitalization. These findings underscore the importance of continuous investment in ICT infrastructure and capacity-building initiatives to maintain and expand the gains achieved through digital logistics platforms (Mkocha & Mwisila, 2025).

Table 6

Descriptive Statistics – System Reliability and Congestion Costs (n = 385)

Indicator	Mean (%)/USD	Std. Dev.	Min	Max
System Uptime (%)	96.3	2.1	90	100
System Downtime (hours/mo)	3.8	2.0	0	10
Congestion/Demurrage Costs (USD)	210	95	50	500

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusions

This study explored the digitalization of logistics across major East African trade corridors, focusing on platforms such as Single Window Systems (SWS), Port Community Systems (PCS), and cargo tracking tools. The findings show that digital platforms have markedly improved operational efficiency by reducing customs clearance times, port dwell durations, and overall cargo transit periods. Additionally, they have contributed to lowering freight and transaction costs while enhancing operational reliability where system uptime is consistently. However, challenges such as limited interoperability between platforms, infrastructure gaps, and occasional system downtimes still constrain the full potential of digital logistics in the region. In essence, the study concludes that digitalization has transformative potential, but its impact is maximized only when supported by robust infrastructure, reliable systems, and effective stakeholder collaboration.

5.2 Recommendations

Based on the study's findings, some recommendations are proposed. Strengthening interoperability i.e. establish standardized data protocols to enable seamless integration between SWS, PCS, and cargo tracking systems across the region. Invest in infrastructure i.e. enhance ICT infrastructure, ensure reliable energy supply, and deploy automated systems to minimize disruptions and maximize system uptime. Develop human capacity i.e. implement targeted training programmes for customs officers, port officials, and logistics operators to optimize the use of digital tools. Encourage public-private collaboration i.e. foster partnerships between government authorities and private sector actors to share expertise, resources, and technological innovations. Continuous Monitoring and Evaluation i.e. regularly assess system performance and trade outcomes to identify bottlenecks, inform process improvements, and support evidence-based policy decisions. Adopting these measures can strengthen the digital logistics ecosystem in East Africa, reduce trade costs, enhance operational efficiency, and improve regional competitiveness.

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