

Influence of ICT Adoption on the Operational Inefficiencies in Apapa and Tin Can Island Ports, Lagos State, Nigeria

Aworemi J. R., Abel O. K.

Department of Transport Management, Ladoke Akintola University of Technology, Ogbomosho, Oyo State, Nigeria

DOI: <https://dx.doi.org/10.47772/IJRISS.2025.910000450>

Received: 16 October 2025; Accepted: 23 October 2025; Published: 15 November 2025

ABSTRACT

The maritime sector is a critical component of global trade and economic development, playing an indispensable role in facilitating the movement of goods and services across international borders. This study explores the influence of ICT adoption on operational inefficiencies in Apapa and Tin Can Island Ports, Lagos State, Nigeria. The study employed a survey research design with the use of structured questionnaires over the final quarter of 2024. According to the Nigerian Ports Authority (2022), Apapa and Tin Can Island collectively account for the majority of Nigeria's cargo throughput, with an estimated workforce of 34,773 employees, from which a sample size of 396 respondents was selected using purposive and stratified sampling techniques. Inferential statistics of multiple regression analysis were applied to analyze the data. Findings from the regression analysis revealed that four out of six explanatory variables were statistically significant in explaining the variation of operational inefficiencies. These variables are automation of cargo handling systems ($p < .000$), electronic documentation ($p < .002$), real-time tracking of cargo ($p < .001$), and competence of ICT-skilled personnel ($p < .000$). The study concludes that ICT adoption substantially improves port operations by reducing inefficiencies. It was recommended that port authorities and the government continue investing in digital infrastructure, capacity building, and system integration to enhance competitiveness and service delivery.

Keywords: ICT adoption, Operational inefficiency, Maritime logistics, Apapa Port, Tin Can Island Port

INTRODUCTION

The maritime sector is a critical component of global trade and economic development, playing an indispensable role in facilitating the movement of goods and services across international borders (United Nations Conference on Trade and Development [UNCTAD], 2021). Ports serve as the primary gateways for global commerce, handling significant volumes of cargo and contributing to national economic growth (World Bank, 2020). Efficient port operations require a combination of robust security mechanisms and advanced technological infrastructures to ensure smooth logistics, prevent illicit activities, and maintain competitive advantages (Notteboom & Winkelmans, 2020). In Nigeria, the maritime sector remains a fundamental pillar of trade and economic activities, with its ports serving as major transit points for imports and exports (Akinyemi & Olanrewaju, 2020). The country's strategic location along the Gulf of Guinea positions it as a key player in regional and international trade (International Maritime Bureau [IMB], 2021).

Information and Communication Technology (ICT) has transformed the efficiency, transparency, and security of port activities by facilitating real-time tracking of cargo, automating customs clearance processes, and enhancing communication between stakeholders in the maritime sector (Notteboom, 2020). The global maritime industry has witnessed significant advancements in digital port management systems, including blockchain-based documentation, electronic cargo tracking, and automated vessel monitoring. These innovations have played a crucial role in improving port efficiency, reducing operational costs, and enhancing the competitiveness of ports in international trade.

The extent to which ICT adoption influences operational inefficiencies in Nigerian ports remains unclear. While ICT has been widely recognized as a tool for reducing inefficiencies in port operations, its impact in the Nigerian context has not been adequately quantified (Adeniran, 2017; Emeaghalu & Okeke, 2021). Operational inefficiencies, such as prolonged cargo clearance times and high logistics costs, continue to plague Nigerian ports, undermining their competitiveness (Notteboom & Rodrigue, 2018; Bichou, 2011). A detailed analysis of the relationship between ICT adoption and operational inefficiencies is essential to provide actionable insights for policymakers and port authorities. In light of these gaps, this study will evaluate the extent to which ICT adoption influences operational inefficiencies in Nigerian ports.

LITERATURE REVIEW

Concept of ICT in Ports

ICT encompasses a range of digital tools and systems that facilitate data exchange, communication, and automation across various sectors, including the maritime industry. In port operations, ICT adoption involves the use of technologies such as electronic documentation systems, automated container handling, and digital tracking solutions to streamline logistics processes and enhance overall efficiency. According to González and Trujillo (2018), ICT solutions in port operations are designed to minimize delays, reduce paperwork, and improve coordination among stakeholders, including terminal operators, customs authorities, shipping lines, and regulatory agencies.

Nigerian ports have increasingly embraced ICT-driven solutions to address long-standing inefficiencies associated with manual operations and bureaucratic bottlenecks. The implementation of electronic port community systems, digital customs clearance platforms, and automated terminal operating systems has significantly improved cargo clearance, reduced congestion, and enhanced security in Nigerian ports (Ugochukwu & Ekong, 2020). Despite these advancements, many Nigerian ports still struggle with full-scale ICT adoption due to infrastructural deficits and limited technological expertise among port workers.

Operational Inefficiency

Operational inefficiency in Nigerian ports has been increasingly conceptualized in recent studies as a multidimensional phenomenon shaped by the interplay of infrastructural, institutional, procedural, and technological factors (Nwaogbe et al., 2024; Osadume, 2024). From the infrastructural perspective, inefficiency emerges when existing port capacity fails to meet rising trade demands, producing vessel queuing, berth congestion, and prolonged turnaround times (Nwaogbe et al., 2024; Braimoh, 2023). Beyond capacity issues, institutional and governance challenges remain critical, as overlapping mandates between the Nigerian Ports Authority, customs, and private concessionaires weaken coordination, reduce accountability, and undermine reform outcomes (Nsikan, 2023; World Bank, 2021).

Procedural bottlenecks also constitute a major dimension of inefficiency. Multiple cargo inspections, complex documentation requirements, and cumbersome clearance procedures raise transaction costs and extend cargo dwell times far above global benchmarks (Osadume, 2024; Braimoh, 2023). Equally, inefficiency is conceptualized through technological shortfalls, where the limited adoption and integration of port community systems, e-single windows, and automated terminal operating systems constrain digital transformation and reduce operational speed (Nsikan, 2023; World Bank, 2021).

Past studies emphasize that these inefficiencies are not isolated but systemic, with infrastructure gaps, procedural delays, governance failures, and weak digital adoption reinforcing one another to sustain persistent congestion and high logistics costs (Nwaogbe et al., 2024; Osadume, 2024). Consequently, contemporary scholarship proposes a holistic conceptualization in which inefficiency is understood as an emergent property of interdependent subsystems rather than as discrete operational failures (Braimoh, 2023; Nsikan, 2023). This systems-based view suggests that targeted reforms in one dimension, such as infrastructure expansion without procedural or technological improvements, may only shift bottlenecks rather than resolve them, thereby underscoring the need for integrated solutions to port inefficiency in Nigeria.

Empirical review

Emelogu (2023) study, which is based on semi-structured interviews with leaders and managers of maritime enterprises in Lagos, Nigeria, finds that the integration of digital strategies into business processes can transform the industry by improving operational efficiency and capturing more value. The author recommends continuous integration of technology-based solutions, workforce digital upskilling, and strict intervention and support by the government and other stakeholders to drive compliance and influence change in the management of maritime business operations. These findings are consistent with Janmethakulwat and Thanasopon (2024), who provide a similar analysis in the context of Thailand's maritime industry. The authors identify factors such as reliable IT infrastructure, organizational culture, and government support as key drivers of digital adoption. Their findings suggest that the institutionalization of digital technologies requires not only technical solutions but also organizational and regulatory support. This perspective is consistent with Adenigbo et al. (2023), who examine the air cargo logistics industry in South Africa and find that technological innovations significantly improve operational efficiency and customer satisfaction.

However, Adenigbo et al. (2023) also note that the industry's reluctance to adopt new technologies stems from a lack of awareness and investment, a challenge that is equally relevant to the maritime sector. The authors recommend the prompt adoption and implementation of technological innovations to improve quality service delivery, customer satisfaction, and loyalty in the air cargo logistics industry. These findings highlight the importance of addressing the barriers to ICT adoption in the maritime industry, particularly in developing economies where infrastructure and investment are often lacking.

METHODOLOGY

The study focused on Apapa and Tin Can Island Ports in Lagos State, which handle over 70% of Nigeria's cargo traffic. A survey research design was adopted using structured questionnaires administered over the final quarter of 2024. The study employed a survey research design with the use of structured questionnaires over the final quarter of 2024. According to the Nigerian Ports Authority (2022), Apapa and Tin Can Island collectively account for the majority of Nigeria's cargo throughput, while the estimated workforce population across both ports stands at 34,773 employees (Author's Computation, 2024). Using purposive and stratified sampling, a sample size of 396 respondents was selected to represent port operators, regulatory officials, law enforcement personnel, and ICT professionals. Data analysis employed multiple regression analysis to examine the influence of ICT adoption on the operational inefficiencies.

RESULTS AND DISCUSSION

Findings from the result of multiple regression analysis provided critical insights into the influence of ICT adoption on operational inefficiencies in Apapa and Tin Can Island Ports. The Model Summary in Table One (1) revealed that the regression model explains 28.5% ($R^2 = 0.285$) of the variance in operational inefficiencies, with an adjusted R^2 of 0.274 indicating that the model maintains robustness even after controlling for complexity. The standard error of the estimate (.621) suggests a moderate level of accuracy between predicted and observed values. This indicates that ICT adoption variables collectively play a meaningful role in reducing inefficiencies within Nigerian ports. Furthermore, the ANOVA results in Table One (1) demonstrated the model's statistical significance, with an F-statistic of 25.859 and a p-value < 0.000 . This confirms that the combined effect of the predictors (automation of cargo handling systems, electronic documentation, real-time tracking of cargo, digital customs clearance, cybersecurity infrastructure, and competence of ICT-skilled personnel) significantly explains operational inefficiencies.

The Coefficients Table Two (2) provided detailed insights into the specific contributions of each ICT predictor to operational inefficiencies. Competence of ICT-skilled personnel has the strongest and most significant positive impact ($\beta = .263$, $p < .000$), underscoring the importance of human expertise in leveraging technology to drive efficiency. Real-time tracking of cargo also demonstrated a strong positive effect ($\beta = .237$, $p < .001$), highlighting the critical role of visibility and monitoring systems in minimizing delays and bottlenecks. Similarly, automation of cargo handling systems ($\beta = .238$, $p < .000$) significantly improves operational efficiency by reducing manual processes and turnaround time. Electronic documentation ($\beta = .137$, $p < .002$)

makes a meaningful contribution, emphasizing the reduction of paperwork bottlenecks and improved transparency in operations. Digital customs clearance ($\beta = .091$, $p < .042$) has a modest yet significant effect, pointing to its role in expediting trade facilitation and clearance procedures. Cybersecurity infrastructure ($\beta = .098$, $p < .029$) also contributes positively, albeit to a smaller extent, ensuring secure and reliable ICT-driven port operations.

The analysis underscores the pivotal role of ICT adoption in addressing port operational inefficiencies. The findings suggest that while ICT-skilled personnel competence, real-time cargo tracking, and automation systems are the most critical drivers of efficiency, there remain opportunities to strengthen electronic documentation, enhance digital clearance systems, and reinforce cybersecurity frameworks. By strategically prioritizing these ICT dimensions, Nigerian ports can substantially reduce inefficiencies, improve service delivery, and align more closely with global best practices in maritime logistics.

Table 1: Model Summary and ANOVA^a

Multiple R		.534 ^a				
R Square (R ²)		.285				
Adjusted R Square (R ²)		.274				
Standard Error		.621				
Analysis of Variance Table						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	59.797	6	9.966	25.859	.000 ^b
	Residual	149.922	389	.385		
	Total	209.720	395			

Source: Data Analysis (2024)

Table 2: Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.557	.163		3.426	.001
	Automation of cargo handling system	.148	.028	.238	5.224	.000
	Electronic documentation	.095	.031	.137	3.079	.002
	Real time tracking of cargo	.161	.031	.237	5.247	.001
	Digital customs clearance	.063	.031	.091	2.044	.042
	Cyber security infrastructure	.061	.028	.098	2.193	.029
	Competence ICT skilled personnel	.179	.032	.263	5.640	.000

a. Dependent Variable: Operational Inefficiency

Source: Data Analysis (2024)

The findings from the multiple regression analysis suggest that ICT adoption plays a significant role in influencing operational inefficiencies at Apapa and Tin Can Island Ports. The model, which includes factors such as automation of cargo handling systems, electronic documentation, real-time tracking of cargo, digital customs clearance, cybersecurity infrastructure, and competence of ICT-skilled personnel, explains 28.5% of the variance in port inefficiencies ($R = .534$, $R^2 = .285$, Adjusted $R^2 = .274$). The regression analysis confirms the significant contributions of these ICT adoption predictors, with an F-value of 25.859 and a $p < .000$, indicating that the model is statistically significant.

Among the predictors, competence of ICT-skilled personnel, real-time tracking of cargo, and automation of cargo handling systems exert the strongest positive influence on reducing inefficiencies. For instance, ICT-skilled personnel ($\beta = .263$, $p < .000$) and real-time cargo tracking ($\beta = .237$, $p < .001$) demonstrate critical

contributions, while automation of cargo handling systems ($\beta = .238$, $p < .000$) shows substantial influence in streamlining port operations. Electronic documentation ($\beta = .137$, $p < .002$) also makes a meaningful impact, reducing bureaucratic bottlenecks and enhancing transparency. Digital customs clearance ($\beta = .091$, $p < .042$) and cybersecurity infrastructure ($\beta = .098$, $p < .029$) contribute positively but to a lesser extent. These findings align with existing literature emphasizing ICT as a driver of port efficiency and competitiveness in global maritime logistics (Okeke & Anyanwu, 2020; Akinwale et al., 2022; Nwokedi, 2023). The results indicate that while ICT adoption significantly improves port operations, certain areas such as digital clearance and cybersecurity require continuous optimization to maximize efficiency gains.

CONCLUSION AND RECOMMENDATION

The study concludes that ICT adoption has a statistically significant influence on reducing operational inefficiencies in Apapa and Tin Can Island Ports, with competence of ICT-skilled personnel, automation of cargo handling, and real-time cargo tracking emerging as the most critical drivers, while electronic documentation, digital customs clearance, and cybersecurity infrastructure also play supportive roles. To enhance efficiency and global competitiveness, port authorities should prioritize continuous ICT capacity building, sustain investment in automation and cargo visibility systems, and strengthen digital clearance processes alongside robust cybersecurity frameworks, ensuring more seamless and effective port operations.

REFERENCES

- Adenigbo, O., Chinomona, R., & Sandada, M. (2023). The role of technological innovations in improving efficiency and customer satisfaction in the air cargo logistics industry: Evidence from South Africa. *Journal of Transport and Supply Chain Management*, 17(1), 1–13.
- Adeniran, A. I. (2017). Port reform in Nigeria: Efficiency gains and challenges. *Maritime Policy & Management*, 44(8), 1035–1050.
- Akinwale, Y., Akinbami, J., & Adepoju, A. (2022). Digital technologies and competitiveness of Nigerian ports: Challenges and prospects. *African Journal of Science, Technology, Innovation and Development*, 14(7), 1763–1775.
- Akinyemi, F. O., & Olanrewaju, S. A. (2020). Maritime trade, port efficiency and economic development in Nigeria. *Journal of Maritime Research*, 17(3), 21–31.
- Bichou, K. (2011). Assessing the impact of procedural and regulatory frameworks on port performance. *Maritime Economics & Logistics*, 13(2), 142–169.
- Braimoh, A. K. (2023). Infrastructural deficits and systemic inefficiencies in Nigerian seaports: A systems-based perspective. *Journal of African Maritime Studies*, 5(2), 45–62.
- Emelogu, C. (2023). Digital transformation strategies and efficiency gains in Nigeria's maritime sector. *International Journal of Maritime Economics and Logistics*, 25(4), 412–428.
- Emeaghalu, O., & Okeke, P. (2021). Information technology adoption and efficiency of port operations in Nigeria. *African Journal of Business and Economic Research*, 16(2), 101–117.
- González, M. M., & Trujillo, L. (2018). Efficiency drivers in port operations: ICT adoption and institutional frameworks. *Transport Policy*, 61(1), 15–28.
- International Maritime Bureau (IMB). (2021). Piracy and armed robbery against ships: Annual report 2021. IMB.
- Janmethakulwat, P., & Thanasopon, B. (2024). Digital adoption and efficiency in Thailand's maritime logistics sector. *Asian Journal of Shipping and Logistics*, 40(1), 32–44.
- Notteboom, T. (2020). The role of ICT in port governance and efficiency: A global perspective. *Research in Transportation Business & Management*, 34(1), 100428.
- Notteboom, T., & Rodrigue, J. P. (2018). Challenges in port operations: Institutional, technological and procedural dimensions. *Maritime Economics & Logistics*, 20(2), 241–256.
- Notteboom, T., & Winkelmann, W. (2020). Port security, ICT adoption and efficiency performance. *Journal of Transport Security*, 13(1), 33–50.
- Nsikan, A. (2023). Institutional and governance constraints in Nigerian port operations. *Nigerian Journal of Maritime Policy and Strategy*, 9(1), 66–82.
- Nwaogbe, O. R., Oladipo, O., & Nweke, C. (2024). A systems-based approach to analyzing operational inefficiencies in Nigerian ports. *Journal of African Transport Studies*, 12(1), 89–104.

17. Nwokedi, A. (2023). ICT adoption and competitiveness in African ports: Evidence from Nigeria. *African Maritime Review*, 15(2), 119–138.
18. Okeke, C., & Anyanwu, K. (2020). The role of ICT adoption in port competitiveness: A Nigerian case study. *International Journal of Logistics and Transport*, 10(3), 201–214.
19. Osadume, R. (2024). Procedural bottlenecks and operational inefficiencies in Nigeria's port clearance system. *Maritime Policy Review*, 8(1), 77–95.
20. Ugochukwu, N., & Ekong, F. (2020). ICT-driven solutions and efficiency gains in Nigerian ports. *Journal of Transport and Supply Chain Management*, 14(1), 1–11.
21. United Nations Conference on Trade and Development (UNCTAD). (2021). Review of maritime transport 2021. UNCTAD.
22. World Bank. (2020). Port reform toolkit: Effective approaches to improving port performance. World Bank.
23. World Bank. (2021). Nigeria economic update: Addressing port inefficiency challenges. World Bank.