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VESSEL WAITING TIME AND MARITIME TRANSPORT EFFICIENCY IN LAGOS SEAPORTS

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ABSTRACT

This article examined the relationship between vessel waiting time and maritime transport efficiency in Lagos seaports, with particular attention to the operational experience of stakeholders at Apapa Port, Tin Can Island Port and Lekki Deep Seaport. The article was developed from the first objective of the parent M.Sc. study on port congestion and maritime transport in Lagos seaports. The study adopted a descriptive and explanatory research design and used a structured four-point Likert-scale questionnaire. A sample of 286 stakeholders was obtained using the Taro Yamane formula from an accessible population of 1,000, followed by stratified allocation across the three selected ports and stakeholder categories. All 286 questionnaires administered were retrieved and validated for analysis. Descriptive statistics were used to summarize respondents' views, while Pearson Product Moment Correlation (PPMC) was applied at the 0.05 level of significance. The descriptive results showed mixed perceptions: respondents agreed that vessel waiting time contributes to cargo-delivery delays and that reducing waiting time would improve overall maritime transport efficiency, while some respondents did not agree that waiting before berthing sufficiently reduced efficiency or increased the time required to complete port operations. The inferential analysis produced a weak negative relationship, $r = -0.150$, $p = 0.011$, $N = 286$. Since $p < 0.05$, the null hypothesis was rejected. The article concludes that vessel waiting time has a statistically significant but weak relationship with maritime transport efficiency in Lagos seaports. The result supports targeted attention to berth allocation, vessel scheduling, marine

traffic coordination and information sharing rather than treating vessel waiting time as the sole explanation for port performance.

KEYWORDS: Port congestion; vessel waiting time; maritime transport efficiency; Lagos seaports; Apapa Port; Tin Can Island Port; Lekki Deep Seaport; Pearson Product Moment Correlation.

1. INTRODUCTION AND BACKGROUND

Maritime transport is central to the international trading system because a large share of merchandise trade moves by sea. UNCTAD (2024) reported global maritime trade of about 12.29 billion tonnes in 2023, while the parent study notes that more than 80% of international merchandise trade by volume is carried by sea. In Nigeria, seaports provide the interface between international shipping and inland logistics, linking vessels with terminals, customs, road transport, rail, inland waterways, warehouses and distribution networks. Lagos is particularly important because the Lagos Port Complex and Tin Can Island Port concentrate substantial commercial and containerized activities, while Lekki Deep Seaport represents a newer component of the state's port system (Nigerian Ports Authority [NPA], 2023, 2024; UNCTAD, 2023, 2024).

Within this system, vessel waiting time is a visible operational manifestation of congestion. It refers to the period a vessel spends waiting for berthing or access to required port services. When vessels arrive faster than available berth and terminal capacity can process them, queues may form. Queuing Theory, associated with the logic of service arrival and service capacity, provides a useful theoretical explanation for such delays (Erlang, 1909). Stopford (2009) similarly links delays in vessel operations to increased operating costs, reduced utilization and disruptions in shipping schedules.

The Lagos environment adds further complexity. Congestion is influenced by berth availability, terminal capacity, cargo-handling equipment, landside access, cargo clearance, truck movements, intermodal connectivity and coordination among stakeholders. Rodrigue and Notteboom (2020, 2023) emphasize that port performance is embedded in wider logistics networks rather than being confined to the berth alone. Consequently, vessel waiting time should be examined as one operational component of a wider port system.

Recent literature in the parent study also identifies vessel turnaround and port infrastructure as important issues. Ogunleye (2023, 2024) examined determinants of vessel turnaround time in Nigerian seaports, while Chukwu (2023) linked infrastructure development to port efficiency. Adeyemi (2024), Akinyemi (2023), Akinola (2026) and Oladele (2025) similarly discuss port congestion and maritime transport performance. The present article narrows the analysis to the first objective of the parent study and therefore concentrates on vessel waiting time and its measured relationship with maritime transport efficiency.

2. Problem Statement and Study Objective

Persistent congestion in Lagos seaports has implications for vessel scheduling, cargo flow, logistics coordination and the reliability of maritime transport. The parent dissertation documents historical and recent evidence of long cargo dwell times, variable ship turnaround, truck congestion and capacity constraints in the Lagos port environment. It also notes interventions such as the Eto electronic truck call-up system, rail-supported cargo evacuation, electronic barriers and other digital processes introduced or strengthened by port authorities (NPA, 2021, 2025). Despite these measures, the dissertation identifies a continuing mismatch between cargo and traffic demand and the capacity of physical, institutional and intermodal systems supporting Lagos ports.

The problem is not simply that vessels wait; rather, the analytical issue is whether measured vessel waiting time is statistically associated with maritime transport efficiency among stakeholders operating in the selected Lagos ports. The parent study therefore formulated the first objective as: “Examine the effect of vessel waiting time on maritime transport efficiency in Lagos seaports.” The corresponding null hypothesis stated that vessel waiting time has no significant effect on maritime transport efficiency in Lagos seaports. This article retains that wording and reports the evidence from the parent study without extending the inference beyond the sampled population.

The focus is important because vessel waiting can create additional time costs, disrupt schedules and interact with other bottlenecks. At the same time, the parent study found a weak correlation, meaning that waiting time alone did not account for a large proportion of variation in the measured efficiency indicator. This distinction is important for evidence-based port management: a statistically significant association does not imply that the variable is the only or dominant determinant of efficiency.

3. Conceptual Review: Vessel Waiting Time

Vessel waiting time is an operational indicator of port congestion that captures delays before a vessel secures berthing or completes the access process necessary for cargo operations. The parent study's questionnaire measured this construct through five statements: long waiting before berthing and its effect on efficiency; delays in berthing and completion time; contribution to cargo-delivery delays; effects on operating and transportation costs; and whether reducing waiting time would improve overall maritime transport efficiency.

The concept is closely connected to berth capacity, terminal service rates, vessel arrival patterns and the coordination of marine-side operations. Stopford (2009) explains that port time has direct cost implications for shipping companies because vessels generate costs while in port. Ogunleye (2023) and Ogunleye (2024) similarly examine vessel turnaround as an outcome influenced by operational and infrastructural conditions in Nigerian seaports. Chukwu (2023) associates infrastructure development with port efficiency, while Kumar and Ibrahim (2025) discuss the relationship between logistics infrastructure and port performance in developing economies.

Vessel waiting also has network implications. Maritime transport is not an isolated sea movement; it is part of a logistics chain that includes cargo reception, customs, terminal handling and inland distribution. Rodrigue (2022) and Rodrigue and Notteboom (2020, 2023) emphasize the network nature of transport efficiency. A delay at the maritime interface can therefore affect downstream schedules, although the strength of that effect may vary according to terminal organization, cargo type, clearance arrangements and alternative transport capacity.

Digitalization has increasingly been presented as a means of improving port coordination. Nguyen and Kalu (2025), Ogunleye and Yusuf (2023), and Okonkwo and Aliyu (2024) discuss digital transformation and port efficiency. Within Lagos, the NPA's digital truck and terminal initiatives provide an institutional context in which vessel and landside movements can increasingly be coordinated through shared information systems (NPA, 2025).

4. Theoretical Framework

Five theoretical perspectives were reviewed in the parent study: Queuing Theory, Port Performance Theory, Network Theory of Transport Systems, Time-Cost Trade-Off Theory and the Theory of Trade Facilitation.

Queuing Theory is particularly relevant to vessel waiting because it explains how waiting lines arise when arrivals approach or exceed service capacity. Erlang's (1909) foundational work on waiting systems provides the historical basis for queue analysis. In a seaport, vessels can be considered arrivals requiring berth and terminal services. When capacity is constrained, waiting time may increase.

Port Performance Theory provides a broader performance perspective by considering indicators such as vessel turnaround, berth utilization, cargo handling and throughput. This perspective is compatible with UNCTAD (2023, 2024, 2025) and World Bank (2022, 2023) discussions of port and logistics performance.

Network Theory of Transport Systems emphasizes interdependence among transport nodes and links. Rodrigue (2022) and Rodrigue and Notteboom (2020) support this perspective by treating ports as components of larger transport and logistics networks. Vessel waiting may therefore interact with road, rail, inland waterway and terminal operations.

Time-Cost Trade-Off Theory highlights the relationship between time spent in transport operations and associated costs. Longer waiting periods can increase vessel operating costs, demurrage exposure and schedule disruption, although the magnitude depends on operational arrangements and contractual conditions.

The Theory of Trade Facilitation focuses on reducing unnecessary procedural and logistical barriers to the movement of goods. The parent study's discussion of customs processes, documentation and intermodal connectivity fits this perspective. Together, the theories indicate that vessel waiting should be interpreted as part of an interconnected port system.

5. Empirical Review

Empirical evidence reviewed in the parent study shows that port congestion and efficiency are multidimensional. Adebayo (2022) and Afolabi (2022, 2024) examine port operational efficiency and logistics costs in Nigerian seaports. Adeyemi (2024) and Akinyemi (2023) focus on port congestion and maritime transport efficiency, while Akinola (2026) considers maritime logistics performance in West African ports. These studies provide a regional context for the present analysis.

Specific attention to vessel performance appears in Ogunleye (2023, 2024), who examine determinants of vessel turnaround time in Nigerian seaports. The parent dissertation relates its first finding to this literature, noting that vessel waiting is operationally relevant but that the weak coefficient suggests that it does not explain a large proportion of variation in maritime transport efficiency.

Infrastructure and port capacity are also recurrent themes. Chukwu (2023), Chinedu and Ibrahim (2022), and Kumar and Ibrahim (2025) discuss infrastructure and port performance. These studies are relevant because berth capacity, terminal facilities and cargo-handling systems affect the service capacity that determines waiting.

Digitalization has become another important dimension. Nguyen and Kalu (2025), Ogunleye and Yusuf (2023), and Okonkwo and Aliyu (2024) identify digital systems as part of modern port-efficiency strategies. In the Lagos context, NPA (2024, 2025) provides institutional evidence of operational and digital initiatives.

The literature therefore suggests a plausible relationship between vessel waiting and efficiency, but the parent study sought to test that relationship empirically within its selected population rather than assume it. The article's analysis is consequently anchored in the parent study's survey data and statistical result.

6. METHODOLOGY

The parent study adopted a descriptive and explanatory research design. The descriptive component was used to explain the nature, causes and effects of port congestion, while the explanatory component was used to examine relationships between congestion indicators and maritime transport efficiency. The study population comprised stakeholders involved in port operations across Apapa Port, Tin Can Island Port and Lekki Deep Seaport. Stakeholder categories included freight forwarders, truck operators, importers/exporters, customs officers, shipping companies/agents, terminal operators and NPA officials.

The accessible population was treated as 1,000 for the sample-size calculation. Taro Yamane's (1967) formula produced a sample of approximately 286 respondents. Stratified sampling was then used to represent the three ports: Apapa 45%, Tin Can Island 35% and Lekki Deep Seaport 20%. Within each port, the sample was further distributed across stakeholder categories.

Primary data were collected with a structured questionnaire using a four-point Likert scale: Strongly Agree, Agree, Disagree and Strongly Disagree. The instrument was aligned with the objectives and research questions. Content and face validity were established through expert assessment. Reliability was assessed through a pilot study involving 30 respondents outside the main sample, with Cronbach's Alpha of 0.70 or above treated as acceptable.

For analysis, descriptive statistics included frequencies, percentages and weighted means. Pearson Product Moment Correlation was used to test the hypotheses at the 0.05 significance level through SPSS 27.0. The decision rule was to reject the null hypothesis when $p < 0.05$ and not reject it when $p > 0.05$. The study retrieved all 286 questionnaires, producing a 100% retrieval and validity rate.

7. DESCRIPTIVE ANALYSIS AND RESULTS

The descriptive analysis in Table 4.8 shows mixed perceptions regarding vessel waiting time. The first item, concerning long vessel waiting time before berthing reducing efficiency, recorded a mean of 2.6 and was rejected against the criterion mean of 3.0. The second item, concerning delays in vessel berthing increasing the time needed to complete port operations, recorded a mean of 2.7 and was also rejected.

By contrast, the third item recorded a mean of 3.3, indicating agreement that vessel waiting time contributes to delays in cargo delivery to importers and exporters. The fifth item recorded a mean of 3.0, indicating agreement that reducing vessel waiting time would improve overall maritime transport efficiency. The fourth item recorded a mean of 2.9 and was labelled “Agreed” in the original table, although the parent study itself notes that this value is technically below the criterion mean of 3.0 and should therefore be treated as rejected if the stated decision rule is applied strictly.

These results suggest that respondents recognized some practical consequences of vessel waiting but did not consistently endorse every proposition about its effect on operational efficiency. The descriptive pattern therefore supports the need for inferential testing rather than relying solely on aggregate perceptions.

8. Inferential Analysis

The hypothesis concerning vessel waiting time was tested using Pearson Product Moment Correlation. The analysis paired the statement that long vessel waiting time before berthing

reduces maritime transport efficiency with the statement that reducing vessel waiting time would improve overall maritime transport efficiency.

The correlation coefficient was $r = -0.150$, with $p = 0.011$ and $N = 286$. The relationship was classified in the parent study as weak and negative. Because the p-value was below 0.05, the relationship was statistically significant and the null hypothesis was rejected. The result provides evidence of a statistically significant association between vessel waiting time and the measured maritime transport efficiency indicator.

The weak magnitude is important. It means that the relationship is small and that other variables not represented by this single bivariate relationship may account for additional variation in maritime transport efficiency. The finding should therefore be interpreted as evidence of association, not as proof that vessel waiting time independently determines overall port efficiency.

The result is consistent with the parent dissertation's overall conclusion that vessel waiting time is an important congestion-related factor associated with maritime transport efficiency, but that congestion dimensions do not have uniform statistical relationships with efficiency.

9. Analysis Table

The following table reproduces the key analysis used for the first objective and presents it in article-ready form.

Table 1: Descriptive Analysis of Vessel Waiting Time Items.

Item	Mean	Decision
Long vessel waiting time before berthing reduces the efficiency of maritime transport in Lagos seaports.	2.6	Rejected
Delays in vessel berthing increase the time required to complete port operations.	2.7	Rejected
Vessel waiting time contributes to delays in cargo delivery to importers and exporters.	3.3	Agreed
Prolonged vessel waiting time increases the operating and transportation costs of shipping activities.	2.9	Original table: Agreed; strict criterion: Rejected
Reducing vessel waiting time would improve the overall efficiency of maritime transport in Lagos seaports.	3.0	Agreed

Source: Field Survey (2026).

Table 2: PPMC Analysis of Vessel Waiting Time and Maritime Transport Efficiency.

Relationship	r	p	N	Decision
Vessel waiting time ↔ maritime transport efficiency	-0.150	0.011	286	Reject H ₀₁

Source: Field Survey (2026).

10. DISCUSSION OF FINDINGS

The finding of a weak but statistically significant negative relationship between vessel waiting time and maritime transport efficiency is consistent with the operational logic of Queuing Theory. Where demand for berth and terminal service exceeds available capacity, waiting can arise. In this sense, the result is theoretically plausible. The weak coefficient, however, indicates that the relationship is not large.

The finding also aligns with Stopford (2009), who identifies time spent in port as an important component of shipping economics. It is also compatible with Ogunleye (2023, 2024), whose work on vessel turnaround time identifies operational and infrastructural factors as relevant to Nigerian port performance. Chukwu (2023) similarly links infrastructure development with port efficiency, suggesting that vessel waiting may be connected to wider capacity constraints.

The result differs in emphasis from the descriptive findings. Some respondents did not agree that long waiting before berthing sufficiently reduced efficiency, yet the bivariate test was statistically significant. This illustrates why inferential analysis is useful: perceptions on individual items can be mixed even where the paired measures show a statistically detectable association.

The finding should also be interpreted alongside the broader port network. Road congestion, cargo dwell time, customs procedures, infrastructure and intermodal connectivity can all affect efficiency. The parent study's other hypotheses confirm this multidimensional nature: cargo dwell time and road traffic congestion were not statistically significant at the 5% level, while port infrastructure inadequacy was significant. Therefore, vessel waiting is best treated as one part of a broader performance system.

11. Implications for Port Management

The evidence supports focused attention to vessel scheduling and berth management. NPA and terminal operators can use berth-planning systems, advance vessel information and real-time coordination to reduce avoidable waiting. Digitalization may support these processes by

improving information exchange among shipping lines, terminals and port authorities, consistent with the literature on digital port transformation (Nguyen & Kalu, 2025; Ogunleye & Yusuf, 2023; Okonkwo & Aliyu, 2024).

Infrastructure planning is also relevant because service capacity affects queue formation. Chukwu (2023), Kumar and Ibrahim (2025), and NPA (2024) emphasize the role of infrastructure and operational capacity. However, the study's weak correlation indicates that infrastructure and scheduling interventions should be integrated with other process improvements rather than viewed as a single-variable solution.

Performance monitoring should include vessel waiting time, berth utilization, vessel turnaround, cargo dwell time and cargo evacuation indicators. UNCTAD (2024, 2025) and World Bank (2023, 2024) emphasize the importance of port performance and logistics indicators for trade facilitation. Regular monitoring would allow managers to identify whether waiting occurs because of berth shortages, arrival bunching, documentation constraints, weather, equipment availability or other operational factors.

12. CONCLUSION

The article examined the first objective of the parent study: the effect of vessel waiting time on maritime transport efficiency in Lagos seaports. The descriptive evidence showed mixed stakeholder perceptions, with agreement on cargo-delivery delays and the potential benefit of reducing waiting time. The inferential analysis yielded $r = -0.150$, $p = 0.011$, $N = 286$. The null hypothesis was rejected because $p < 0.05$.

The evidence therefore indicates a statistically significant but weak negative relationship between vessel waiting time and maritime transport efficiency within the sampled population. The result supports the view that vessel waiting is operationally relevant, while also demonstrating that its measured relationship with efficiency is modest. The finding should not be generalized beyond the study population without additional evidence.

Overall, the article reinforces a systems perspective: improving maritime transport efficiency in Lagos requires attention to vessel scheduling and berth management together with infrastructure, cargo processing, road, rail, inland-waterway and stakeholder-coordination measures.

13. Recommendations and Contribution

Based on the first objective and its statistical result, the following recommendations are retained from the parent study and expressed in article form:

1. Vessel waiting time should be reduced through improved berth allocation, vessel scheduling and marine traffic coordination.
2. Real-time information sharing among NPA, terminal operators, shipping lines and other maritime stakeholders should be strengthened.
3. Port infrastructure should be upgraded and maintained in line with projected vessel and cargo demand.
4. Digital scheduling, electronic information exchange and integrated operational databases should be expanded where appropriate.
5. Vessel waiting time should be monitored as a routine port-performance indicator alongside berth utilization, vessel turnaround and cargo dwell time.
6. Interventions should remain multidimensional because the study found only a weak association between vessel waiting time and maritime transport efficiency.

The contribution of the article lies in isolating one congestion dimension and documenting its empirical relationship with maritime transport efficiency in Lagos. This disaggregation is useful because the parent study found different statistical outcomes for the four congestion dimensions. The evidence therefore supports targeted, rather than uniform, port-management responses.

14. Limitations and Research Implications

The article inherits the limitations of the parent study. First, it is based on cross-sectional questionnaire responses and therefore captures stakeholder perceptions at the time of the survey rather than continuous operational observations. Second, the PPMC analysis is bivariate and does not control simultaneously for infrastructure, cargo dwell time, road congestion, customs processes or other factors. Third, the study covers selected Lagos seaports and should not automatically be generalized to all Nigerian ports.

Future research could combine survey evidence with administrative port records on vessel arrival, anchorage time, berth waiting, service time and turnaround. Time-series or panel analysis could help distinguish seasonal and structural patterns. Multivariate models could also examine whether infrastructure, cargo handling, customs clearance and intermodal connectivity moderate or mediate the relationship between vessel waiting and efficiency.

Such work would extend the evidence base while preserving the present study's contribution as a focused empirical assessment.

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