



Port Infrastructure and Vessel Berthing Delays in Eastern Port

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Abstract

This study examines the relationship between Port Infrastructure and Vessel Berthing Delays in Eastern seaports of Nigeria. The study seeks to identify key factors that impact the efficiency of ship turnaround, including the port facilities, logistical operations, and regulatory influences. The study collected data through the use of a structured questionnaire and survey method, specifically employing a cross-sectional investigation approach. The study's population consisted of the staff of NPA and Terminal Operators, with a sample size of 350. The Spearman Rank Correlation Coefficient was employed to evaluate the hypotheses of the empirical investigation. The results indicated that the presence of well-maintained and up-to-date port infrastructure, such as berths and cargo handling facilities, has a substantial impact in minimizing delays during the berthing process. According to the results, it is recommended that port authorities along with pertinent government agencies give priority to investments in contemporary cargo handling machinery, berths, quays, and yard facilities. This encompasses routine maintenance to ensure the highest level of functionality. Ports should contemplate the possibility of extending their operational hours to facilitate both daytime and nighttime activities. Nevertheless, it is imperative to tackle the security, customs, and workforce-related obstacles linked to nighttime operations.

Keywords: Port Infrastructure, Cargo Operations, Ship Turnaround time, Eastern Ports, Terminal Operators

Introduction

Infrastructure deficiencies in numerous low-income countries continue to pose a significant obstacle to growth and development. This includes the substandard quality of public infrastructure, as indicated by the frequency of delays faced by businesses on port access roads throughout the year. Such delays pose a substantial threat to economic progress. In order to address these barriers to economic growth and poverty reduction, certain experts have proposed a substantial augmentation in governmental funding towards port infrastructure, following the concept of a "big push". One frequently cited argument is that



infrastructure services have a significant impact on economic growth by reducing production costs, increasing the efficiency of private resources, and generating higher returns on investment, particularly in situations where the existing infrastructure assets are limited. It is purported to be efficacious. Recent studies have shown that infrastructure can have an indirect impact on growth in port operations. This is mainly through its influence on port productivity, including factors like port access roads, channels, and superstructures (Chua et al., 2018).

According to Wiig and Silver (2019), the introduction of this external effect results in the emergence of multiple equilibria. The attainment of a stable growth equilibrium is contingent upon the initial conditions of the economy, encompassing the anticipations of private agents and the parameters that define public policy. The presence of a non-linear correlation between the efficacy of social capital and its magnitude can be substantiated through two justifications. The first perspective is grounded in the notion that infrastructure investment is a one-time expenditure, meaning that a specific quantity of infrastructure assets must amass before they can effectively contribute to private sector production activities. While agglomeration can account for piece wise linear threshold effects, it does not necessarily imply non-convexity. The second is predicated on the concept of network effects. The presence of external network effects often leads to economies of scale, which are commonly acknowledged as a drawback in infrastructure services. One important characteristic of contemporary infrastructure is the utilization of network delivery systems that cater to a diverse user base. The interconnected nature of the network implies that the advantages of an investment at one specific point are typically contingent upon the capabilities of other points within the network. Put simply, a network's structure necessitates numerous components to deliver a service. These components thus enhance one another Arboleda (2020)

Shippers and shipowners select ports based on their high efficiency and productivity. These ports are capable of offering optimal services, including quick ship turnaround times, direct berthing, minimal cargo damage, and efficient customs clearance. Such ports are considered efficient and productive. Ports and terminals serve as central locations for the management of cargo operations, ship maintenance, and various other activities that



facilitate the movement of crew, cargo, and vessels for offshore operations and voyages. (Adepoju, 2020). Furthermore, research conducted by Anderson and Gerbing (1988), Yochum and Agarwal (1987), Ferrari et al. (2010), Bottasso et al. (2013), Bottasso et al. (2014), Shan et al. (2014), and Chang et al. (2014) has demonstrated the significant role that sea ports play in the economic advancement of a country. Vessel berthing refers to the duration between a vessel's arrival at anchorage and the commencement of cargo operations upon berthing. In the event of a queue of ships awaiting docking, the ships will drop anchor and remain in place until it is their turn to dock. If a shipping line instructs its customers to deliver their export cargo on a specified date and time, taking into account the estimated arrival time and docking schedule of the vessel, any delay in the vessel's arrival at the port will result in a buildup of export cargoes awaiting berthing while the vessel is in port. (Theo and colleagues, 2022). The relationship between port infrastructure and vessel berthing operations in sea ports is always symbiotic. According to Onwuegbuchunam (2018), Nigeria's port reform program may not effectively resolve the irregularities it aims to decrease. Despite investments in port infrastructures and cargo handling equipment, waiting times and berthing difficulties at Nigerian ports have not been reduced. These challenges, including higher tariffs, delays in customs clearance, bottlenecks in the inspection process, and a lack of implementation of infrastructure development investment plans, need to be addressed. For instance, the deplorable state of the access road leading to Warri, Onne, Calabar road serves as a distinct manifestation of the challenges encountered by Nigeria's port users. Meanwhile, Nigerian ports exhibit significant levels of concentration, exorbitant port fees, inadequate port infrastructure, cumbersome bureaucracy, and the presence of multiple government agencies, rendering them uncompetitive and unappealing. In addition, the period before the establishment of the franchise experienced a significant deterioration in infrastructure, characterized by subpar service quality resulting in lengthy vessel turnaround times, prolonged cargo retention periods, and inadequate connectivity between ports and inland areas.

Adepoju (2020) confirmed that the government introduced the concession program in 2006 to address the under-performance of port infrastructure. The program aimed to allow public ownership of port infrastructure and transfer operational responsibilities. Nevertheless, the existing port infrastructure is overwhelmed and thus necessitates additional enhancement,



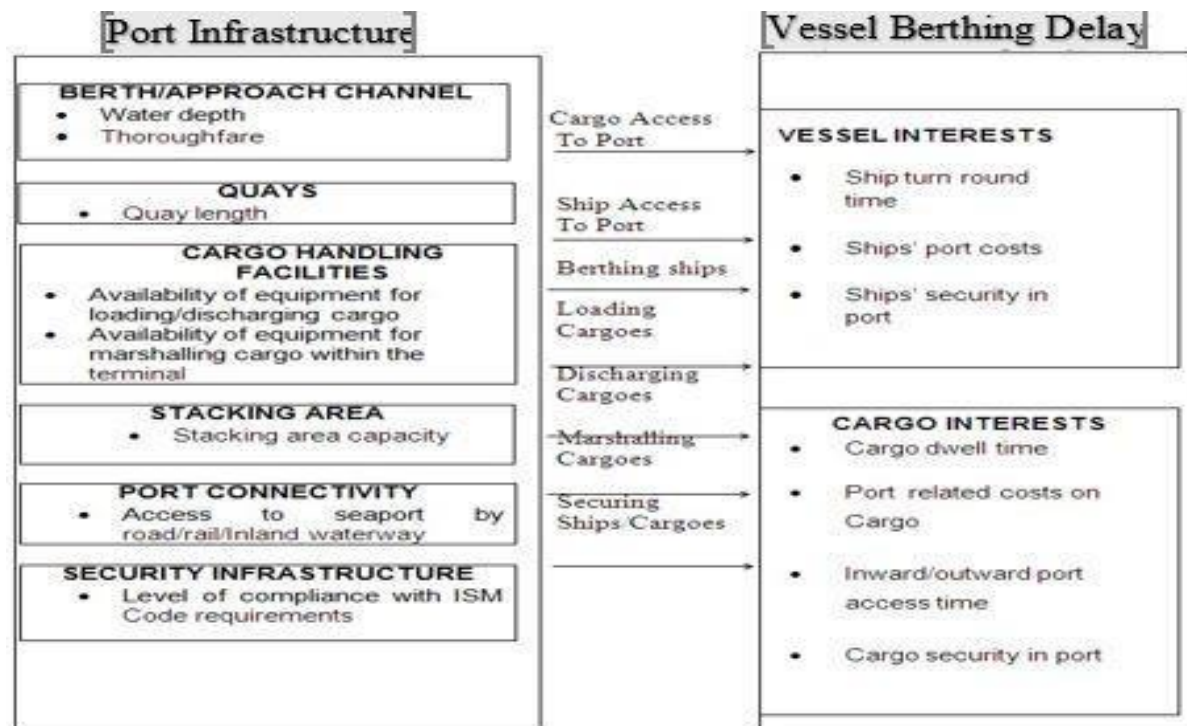
as shipping companies exploit economies of scale to minimize expenses. For instance, the deepwater ports in the Lagos area, specifically Apapa and Tin can, are experiencing excessive congestion. Additionally, the Lekki port is not functioning at its maximum capacity, resulting in significant delays in the handling and processing of cargoes. Consequently, nearby nations like Togo and Ghana, which possess advanced deep-water ports capable of handling bigger vessels, have emerged as central points for containerized cargo and ship-to-ship shipping in Sub-Saharan Africa. Emenyonu, et al, (2016) stated that the inadequate development of port infrastructure, along with investment challenges, organizational issues, and ineffective management, has adversely affected the arrival of ships at its seaports. This impedes the progress of the shipping industry in Nigeria, which in turn can hinder the rate of economic growth. In light of the aforementioned circumstances, the aim of this investigation is to assess the influence of port infrastructure on the occurrence of delays in the berthing of vessels in the Eastern Sea Ports of Nigeria.

The study aims to investigate the impact of port infrastructure on the occurrence of berthing delays for vessels in the Eastern Sea Ports of Nigeria. It will also examine the influence of these delays on the maritime industry and assess the readiness of stakeholders in the maritime industry to invest in port infrastructure. This study aims to enhance the existing empirical knowledge on the significance and goals of port infrastructures. Therefore, the industry stakeholders will utilize financial investments in port infrastructures to enhance the existing body of literature and provide value to government agencies such as NPA, NIMASA, NSC, as well as other stakeholders in the maritime industry and future researchers.

Literature Review

The term "infrastructure" is derived from the Latin word that signifies "under," while "structure" refers to the organization or arrangement (Gómez-Ibáñez 2003). Infrastructure encompasses various elements such as canals, airways, railways, roads, terminals, and pipelines. Terminals encompass various types of transportation hubs, such as ports, truck terminals, storage facilities, bus stations, train stations, and airports. Nijkamp (2000) asserted that infrastructure encompasses various modes of transportation (such as roads, railways, airports, pipelines, and ports) as well as superstructures like

networks, communications, culture, and education. Infrastructure can be defined as the fundamental basis or support system for a particular entity or system (Walter, 2014). While numerous studies have shown that investing in port infrastructure can enhance the productivity of domestic seaports, most of these studies primarily examine the impact on ship productivity. They focus on Nigerian seaports or a specific region, and provide a comprehensive understanding of how port infrastructure and vessel productivity are improving. The increase in cargo output will bolster maritime trade and positively impact the country's economy. Pierre-Richard Agenor introduced the concept of infrastructure-based development in 2006.



Source: Ahmodu et al., 2021)

According to Ahmodu et al. (2021), the presence and accessibility of functional port infrastructure enhance various port operations, including the scheduling of incoming vessels, allocation of quay areas and cranes for vessel servicing, cargo loading and unloading, and the operation of wharves and gates. Hence, the presence of effective shipping facilities and operations is directly manifested in the levels of port cargo volumes and revenues, thereby significantly enhancing the overall economy. Port



infrastructure refers to the collection of permanent assets and operational facilities that facilitate the internal maritime and terminal activities of a seaport, as well as the transportation of goods in and out of the port's immediate surroundings. In addition, Omoke et al. (2018) stated that the infrastructure required to connect ports to the surrounding areas, such as access roads, railway lines, and inland waterways, depends on the geographical features of the port and is necessary for the smooth operation of a seaport. Conversely, the quality of port services pertains to the immediate financial and temporal consequences of port operations for ship owners and cargo stakeholders who utilize ports. Shipowners are impacted by port operations in relation to the duration it takes for their vessels to complete a round trip, the charges imposed for entering the port, and the fees associated with entering or leaving the port. The study conducted by Pieterse et al. (2018) demonstrates that there is a significant correlation between the development of port infrastructure and the quality of port services. Specifically, the study finds that port infrastructure plays a crucial role in facilitating port operations and ensuring the delivery of high-quality services that meet the satisfaction of port users.

Port operators have the duty of up keeping various elements of infrastructure, including transfer sheds, quay aprons, warehouses, roads, navigation aids, rivers and canals, locks, docks, superstructures, and port equipment such as forklifts, straddle carriers, and cranes. The Port Authority is accountable for the management of terminal operators and the issuance of licenses. Port operators offer commercial services to cargo and vessels that visit a port, and possess and manage assets within the port. In addition, the expense of obtaining the necessary port infrastructure for efficient port operations at a contemporary seaport is substantial, taking into account the railway lines, truck access roads, cargo handling equipment, loading yards, and extensive storage areas (Bird, 1963). A port is considered effective and efficient when it minimizes the amount of time ships spend in the port, generates the required cargo volume for its country, possesses state-of-the-art equipment, and provides all the necessary facilities for cargo operations. This strategy consistently optimizes the amount of time it takes for vessels to complete their operations at ports, resulting in increased efficiency and ultimately leading to higher revenues from global trade. Port operations encompass a diverse array of tasks, and it is imperative to guarantee seamless functioning through the involvement of customs officials, ship

brokers, ship agents, cargo agents, surveyors, outfitters, auditors, naval officers, seafarers, and dock workers. Jochimesen (1966) proposed a classification of infrastructure into three distinct categories: Institutional, Material, and Personal infrastructure.

According to Bichou and Gray (2004), shipowners have certain expectations during port calls. These expectations include timely allocation of berths, efficient loading and unloading of cargo, prompt completion of documentation processes, implementation of appropriate safety measures, and adherence to minimum standards. This encompasses efficient and limited flight interruptions. Our services offer efficient support for ships and crew, dependable agents and communication networks, and port fees that are economically reasonable. Additional examination of these requirements indicates that each of them plays a role in enhancing the efficiency of vessel operation or the cost-effectiveness of port calls (Bichou, 2013). The duration of a ship's stay in port is crucial for ship operations and management, as the ship can generate revenue from cargo only when it is sailing with cargo on board. The reference is from Yuen and Thai (2015). The ship turnaround time refers to the duration, measured in hours, starting from when the ship reaches the holding area or access channel of the port until it leaves for the open sea of the port (Notteboom, 2006).

Methodology

The population of this study shall comprise port users within Warri, involved in the loading and discharging operations. Simple random technique was adopted using taro Yamane to determine the sample size 350. Spearman's rank correlation coefficient was used to analyze relationships between the variables.

Table 1: Automated Seaports Reduces Vessel Traffic in Port

S/N	Response	Frequency	Percent
1.	SA	200	57.1
2.	A	130	37.1
3.	D	10	2.9

4.	SD	10	2.9
	Total	350	100

The participants' responses regarding the reduction of vessel traffic in port through Automated Seaports were presented in Table 1. Out of the total study population, 57.1% strongly agreed with the statement that Automated Seaports reduce vessel traffic in port, which amounts to 200 respondents. Additionally, 37.1% of the respondents agreed with this notion. In addition, 10 individuals (2.9%) expressed disagreement with the notion that Automated Seaports decrease vessel traffic in the port, while the remaining 2.9% strongly disagreed with this idea. This suggests that a considerable portion of the entire population agrees with the position on the continuum. This discovery indicates that 96% of the individuals involved in the study within the specified area were included. Furthermore, it is worth mentioning that only a small 4% of the total population expressed disagreement with the statement that Automated Seaports decreases the amount of vessel traffic in the port.

S/N	Response	Frequency	Percent
1.	SA	186	53.1
2.	A	140	40.0
3.	D	14	4.0
4.	SD	10	2.9

Table 2: Lack of Automated CHE Causes Port Congestion

The participants' responses regarding the lack of automated CHE causing port congestion were presented in Table 2. Out of the total study population, 186 respondents, which accounts for 53.1%, strongly agreed with statement two, "Lack of automated CHE causes port congestion." Additionally, 40.0% of the respondents agreed with this notion. In addition, 14 individuals, representing 4.0% of the total, expressed disagreement with the assertion that a lack of automated CHE (Container Handling Equipment) leads to port congestion. Conversely, 2.9% strongly disagreed with this statement.

This indicates that a substantial portion of the entire population agrees with the position on the continuum. This discovery indicates that 93.1% of the participants in the study area were included. Furthermore, it is worth mentioning that only 6.9% of the total population expressed disagreement with the statement that the absence of automated CHE leads to port congestion.

Table 3: Automated Seaports Reduces Berthing Delays of Vessels in Port

S/N	Response	Frequency	Percent
1.	SA	206	58.9
2.	A	136	38.9
3.	D	4	1.1
4.	SD	4	1.1

Responses regarding the impact of automated seaports on reducing berthing delays of vessels in port were presented in table 3. A total of 206 respondents, representing 58.9% of the overall study population, strongly agreed with statement three, "Automated seaports reduce berthing delays of vessels in port." Additionally, 38.9% of the respondents agreed with this notion. In addition, 4 individuals (1.1% of the total) expressed disagreement with the notion that automated seaports decrease the time it takes for vessels to dock in port, while an additional 1.1% strongly disagreed with this statement.

This suggests that a considerable portion of the entire population agrees with the position on the continuum. This discovery indicates that 97.8% of the individuals in the study area were included. Furthermore, it is worth mentioning that only 2.2% of the entire population expressed disagreement with the statement that automated seaports decrease the amount of time ships spend waiting to dock in port.

Table 4: Automated seaports reduce handling days of cargoes in port

S/N	Response	Frequency	Percent
1.	SA	200	57.1

2.	A	136	38.9
3.	D	10	2.9
4.	SD	4	1.1

Responses regarding the reduction of handling days for cargoes in port due to automated seaports were presented in Table 4. A total of 200 respondents, representing 57.1% of the overall study population, strongly agreed with statement four, which states that automated seaports reduce the time it takes to handle cargoes in port. Additionally, 38.9% of the respondents agreed with this notion. In addition, 10 individuals (2.9%) expressed disagreement with the notion that automated seaports decrease the amount of time it takes to handle cargo in port, while a further 1.1% strongly disagreed with this idea.

This indicates that a substantial segment of the entire population shares the same viewpoint on the spectrum of agreement. This discovery indicates that 96% of the individuals involved in the study from the specific area were included. Furthermore, it is worth mentioning that only 4% of the entire population expressed disagreement with the claim that automated seaports decrease the amount of time it takes to handle cargoes in port.

Table 5: Port Automation Reduces Vessels Turnaround Time in Port

S/N	Response	Frequency	Percent
1.	SA	176	50.2
2.	A	150	42.9
3.	D	14	4.0
4.	SD	10	2.9

Responses regarding the reduction of vessels' turnaround time in port due to port automation were presented in Table 5. A significant proportion of participants, specifically 176 individuals representing 50.2% of the total study population, strongly supported the statement that port automation leads to a reduction in vessels' turnaround time in port. Additionally, 42.9% of respondents agreed with this notion. In addition, 14 individuals, accounting for 4.0% of the total, expressed disagreement with the notion that Port automation decreases the time it takes



for vessels to complete their operations in the port. Furthermore, an additional 2.9% strongly disagreed with this statement.

This suggests that a considerable portion of the entire population agrees with the position on the continuum. This discovery indicates that 93.1% of the individuals in the study area were included in the analysis. Furthermore, it is worth mentioning that a significant proportion of the total population, specifically 6.9%, expressed their disagreement with the claim that port automation leads to a decrease in the time it takes for vessels to complete their operations in port.

Test of Hypothesis

HO1: There is no statistically significant relationship between Port Automation and Vessel Traffic in the Eastern Sea Ports

The aforementioned hypothesis was evaluated utilizing the Spearman Rank Order Correlation. The selection of this statistical tool was based on its capacity to ascertain the association between two or more interconnected variables by utilizing their ranked values instead of their unprocessed scores.

Model Specification

The variable d_i represents the disparity in rank between x^1 , which pertains to port Automation, and x^2 , which pertains to vessel traffic. Meanwhile, n denotes the total number of observations or samples.

The decision rule is a principle or guideline used to make decisions in various contexts. It provides a systematic approach for selecting the most appropriate

When the p-value is less than the significance level ($\alpha = 0.05$) at a specific degree of freedom (df): The null hypothesis (H_0) is rejected.

When the p-value is greater than the significance level ($\alpha = 0.05$) at a specific degree of freedom (df), it is not appropriate to reject the null hypothesis (H_0).

Table 6: Correlation between port Automation and vessel traffic in the Eastern Sea Ports in Nigeria

Correlations				
			Port Automation	Vessel traffic
Spearman's rho	Port Automation	Correlation	1.000	.700**
		Coefficient		
		Sig. (2-tailed)	.	.016
	Vessel traffic	N	353	353
		Correlation	.700**	1.000
		Coefficient		
		Sig. (2-tailed)	.016	.
		N	350	350

**. Correlation is significant at the 0.05 level (2-tailed).

The correlation analysis output in table 4.32 presents the association between port Automation and vessel traffic. The findings indicate a strong correlation ($r = -0.700$, $p = 0.016$) between port Automation and vessel traffic. This was evidenced by the statistical significance of the correlation coefficient. It can be inferred from this analysis that an increase in port Automation would result in a corresponding reduction in vessel traffic.

Conclusion

The findings highlight the crucial significance of infrastructure, technology, and streamlined operational practices in determining the efficiency and effectiveness of Eastern ports. Significant findings from this study comprise. The presence and state of cargo handling equipment and port infrastructure have a substantial impact on the duration it takes for ships to complete their operations and the occurrence of delays in docking. Sufficient investments in contemporary equipment and infrastructure are imperative for optimizing port efficiency. Increasing the operating hours at ports can decrease the amount of time ships spend waiting and improve the flow of vessels. However, the effectiveness of this approach relies on



effectively managing issues related to security, customs, and the workforce. Based on these discoveries, it is clear that a comprehensive strategy for port development is crucial for Eastern Sea ports in Nigeria to maintain their competitiveness in the global maritime industry. Prioritizing investments in infrastructure, machinery, automation, and employee growth is essential. Furthermore, it is crucial to have synchronized endeavors among port administrators, stakeholders, and government entities in order to tackle operational obstacles and optimize procedures.

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