ASSESSMENT OF SHIP-TO-SHORE (STS) HANDLING EQUIPMENT AND VESSEL TURNAROUND TIME IN EASTERN PORTS OF NIGERIA

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ABSTRACT
Ship-To-shore (STS) handling equipment is inevitable in port operations as it plays a crucial role between the ship and port. Consequently, inadequate provisions for Ship-To-shore (STS) handling equipment impede cargo handling operations. Hence, the need to evaluate the impact of Ship-To-shore (STS) handling equipment on vessel turnaround time in the eastern ports of Nigeria This study adopts a survey research design. This was carried out in all the Eastern ports situated in the South-South region of Nigeria, amongst which are the River Port Complex, Onne Port Complex, Calabar Port, and Delta Ports Complex in the South-South region of Nigeria. The Target Population includes the staff of the Nigerian Ports Authority and Terminal operators at the Eastern ports in Nigeria. The result showed that the F ratio, which is 467.622, was statistically significant at a p value of 0.00, which is less than 0.05; hence, there is a significant relationship between Ship-To-shore (STS) handling equipment and vessel turnaround time. The study concluded that Ship-to-Shore (STS) handling equipment upgrades will speed up vessel turnaround at the port. Also, improved infrastructure reduces the total time spent by vessels at the port and permits bigger vessels to enter and exit the port. It was recommended that the Nigerian Ports Authority prioritize the dredging of the navigational channel to accommodate larger ships for efficient and productive vessel operations.

Keywords: *Ship-To-shore (STS) handling equipment, vessel turnaround time, port operations, terminal operators, Nigerian Ports Authority*

1.0 INTRODUCTION
Ship-To-shore (STS) handling equipment is inevitable in port operations as it plays a crucial role between the ship and port. The growth of international trade is influenced by the degree of efficiency attained to maximise the total inward and outward of cargo, ship turnaround time and as well minimising the cargo handling cost. Throughout the globe, awareness of the need to provide sophisticated handling equipment and modern equipped berth with low labour content is gaining global attention in which port managements across the globe are adopting it to increase general competition and as well boost the economy of their nation. Sophisticated handling equipment and modern berths attracts more vessels, thereby encouraging trade and as well boost the global value chain.

Vessel turnaround time is an indicator of port performance. According to Denis (2014), ship turn-around time is a good measure for gauging operational performance. The ship turnaround time, according to UNCTAD (2019), is a crucial port performance indicator and indication of trade efficiency that affects connectivity and trade costs. Also, every hour that a ship spends less time in a port enables ports, carriers, and shippers to spend less on building port infrastructure, buying ships, and maintaining inventory of products. Low ship turnaround times in ports result in cost savings that are transmitted to the costs of imported completed goods and exported raw materials in other countries, creating a multiplier effect that lowers inflation rates and raises the quality of life for all people. Monday, Ibe and Emenike (2021) asserted that the Nigerian government needs major investments to modernize the port's infrastructure, including enough berthing facilities, wharves, yard space, quayside, and railway, as well as to broaden the hinterland road system for the transportation of cargo. Additionally, according to Adeyanju and Ojekunle (2014), berth occupancy is a reliable sign of the calibre of port services.

According to Dayananda, Vijayanand, and Dwarakish (2021), the turnaround time at a seaport demonstrates the port's capacity and ability to offer effective services. One of the most important markers of port performance is ship turnaround time. This is the length of time the ship was in port for the duration of a particular call. It is the total of the waiting period, the berthing period, the service period (i.e., the time the ship is at berth), and the sailing delay. Since 95% of international trade in goods is conducted through ports. Also, the amount of time the ship stays depends on the amount of cargo, the facilities provided, and the nature of the cargo (Chung, 1993). Furthermore, the amount of quay cranes assigned to a ship will determine how long it takes to berth. In order to load and unload cargo from ships, quay cranes are the primary component of equipment required.

Somuyiwa and Ogundele (2015) opined that the situation in Nigerian ports is that handling equipment and plant are either aged, antiquated, malfunctioning, broken down or insufficient, thus, impeding cargo handling operations, stacking and the movement of goods to its destination. The unavailability of this facility hinders the performance and productivity of the port. Similarly, delays and congestions are inevitable where inadequate facilities exist. It leads to low customers patronage and capital loss (Tahar & Hussain, 2000). Hence, the need to study the effect of Ship-To-Shore handling equipment on vessel turnaround time in Eastern ports of Nigeria.

2.0 LITERATURE REVIEW

Queuing Theory

Queueing theory originates in research by Agner Krarup Erlang, who created models to describe the system of incoming calls at the Copenhagen Telephone Exchange Company. These ideas have since seen applications in telecommunication, traffic engineering, computing, project management, and particularly industrial engineering, where they are applied in the design of factories, shops, offices, and hospitals.

A queue is formed when consumers arrive, and the facility is busy; a line is usually formed (Awodun & Jongbo, 2000). When restricted service facilities cannot meet the demands for service placed on them, bottlenecks occur, resulting in a queue or waiting line (Aminu, 2000). Michael (2001) shared a similar viewpoint, claiming that when facilities are inadequate and cannot meet demand, bottlenecks emerge, manifesting as waits, but customers are not interested in waiting in queues.

Queues will emerge when service providers are minimal (Aremu, 2005). The viewpoints mentioned above clearly demonstrate that a lack of suitable facilities is a key cause of customer waiting, particularly when arrivals are scheduled and service can be maintained consistently. Trueman (1977) and Slack, Chambers, and Johnston (2010), when evaluating various sorts of queues, stated that queues occur when units receiving certain types of service cannot be provided quickly. According to Vohra (2007), the only method to meet service demand without difficulty is to boost service capacity (and, if possible, improve the efficiency of current capacity). This may have influenced Trueman's (1977) assertion that the queuing problem emerges mostly due to economic considerations, a rare occurrence in which the service cost is so low that sufficient service facilities may be given to ensure that no one needs to wait.

The only case that comes to mind in this regard is self-service. Even though the service system can offer service faster than the pace customers arrive, queues may arise if the arrival and service processes are random. In this scenario, waiting lines may still form when arrivals and services cannot be scheduled or maintained consistently, and the facility becomes insufficient.

Queuing theory is a vital operations research component that uses mathematical theory and queuing system methods. Queuing theory is an area of mathematics concerned with studying and modelling the act of waiting in lines. Queuing theory is extremely useful for resolving and preventing operational bottlenecks and service breakdowns in an enterprise (Tolutope, Adeniyi and Aremu, 2016). Its importance must be emphasized in port operations, especially when vessels arrive at the port. A vessel's time in a port from arrival to departure is known as vessel turnaround time (Daganzo & Goodchild, 2005). Vessel Turnaround Time (VTT) is a summation of various sub-activities such as waiting for a berth, manoeuvring time, mooring/unmooring time, idle time, container handling time, and other time components until the vessel exits port limits, even though it is given as a specific time metric (Moon, 2018). At the same time, it is important to note that various influencing elements, such as the availability of berths, the number of quay cranes available, yard congestion, crane operator speed, and so on, influence these time metrics. The queuing system of the vessel is expressed in Figure1. Vessels arrive at the ports and wait for the process of handling service at the place of berth, which was seen as a queuing process. After queuing, the vessels receive services for loading and offloading cargo and leave the port. Xu and Liu (2012) described the basic features of queuing system; the main quantitative indicators are (1) Team Length: Which is the number of vessels in the port handling system; Queue Length: Which is termed as the number of vessels waiting for handling in the handling system. (2) Sojourn time: It is the period from the moment when vessels arrive at the port to the moment when ships have finished accepting handling service; Waiting time: It is the period from the moment when vessels arrive at the port to the moment when ships begin to accept handling service. Figure 2 shows that vessel arrival is equivalent to customers, handling facilities are equivalent to service desk

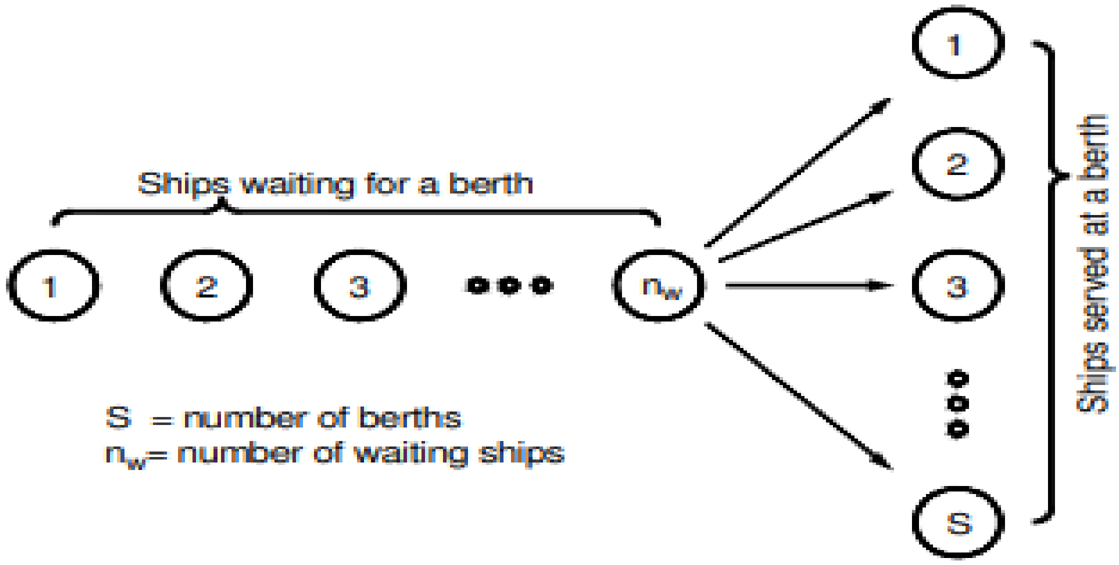

Figure 1: Queuing system of vessel
Source: El-Naggar (2010)

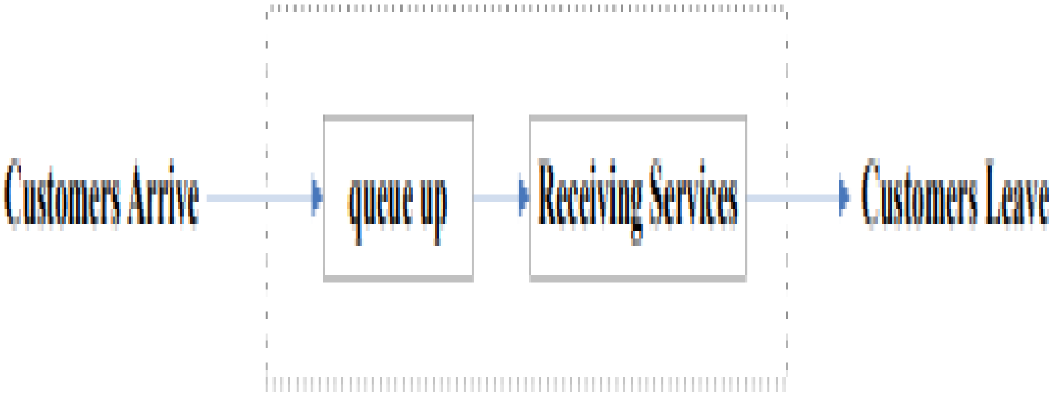

Figure 2: Queuing system customers Source: Xu and Liu (2012)

3.0 METHODOLOGY

Survey research design was adopted for this study. This form of research allows for a wide range of approaches for recruiting participants, gathering data, and utilizing various instruments. Quantitative research technique (e.g., using numerically rated items on questionnaires) or qualitative research technique (e.g., utilizing close-ended questions) can be used in survey research (i.e., mixed methods). This study was carried out in all the Eastern ports situated in South-South region of Nigeria amongst which are River Port Complex, Onne Port Complex, Calabar Port and Delta Ports Complex.in South-South, Nigeria. The Target Population include the staff of Nigerian Ports Authority and Terminal operators at the Eastern ports in Nigeria. Simple random sampling techniques were employed to select the ports in the south-south region of Nigeria. However, Yemane (1967) provides a simplified formula to calculate sample sizes

$$n = \frac{N}{1 + N(e)^2} \qquad \text{.......} \quad \textit{(equ 1)}$$

Where:

n = sample size
N = population size
e = level of significance (our level of significance is chosen at 5%)

Applying the formula at a significant level of 5%

$$\frac{4971}{1 + 4971\,(0.05)^2}$$

$$\frac{4971}{13.43}$$

$$= 370.14$$

Therefore, the sample size = 370 approximately.

4.0 RESULT

The result shows the turnaround time of ships in Eastern ports, Nigeria. Onne port has the lowest turnaround time while Calabar port has the highest turnaround time of vessels across all the ports situated in South-South region of Nigeria from 2008 to 2020.

Table 1 shows the frequency of Ship-To-Shore (STS) with the grand total of 4706 at 100% and grand mean ($\bar{x} = 3.1373$). It was discovered that lack of maintenance affects the productivity of ship-to-shore crane which was ranked first (1st) with the mean ($\bar{x} = 3.2427$), inadequate manpower affects the handling operations was ranked second (2nd) with the mean ($\bar{x} = 3.1387$), old and antiquated cranes are still in operations which mar the loading and unloading of cargo was ranked third (3rd) with the mean ($\bar{x} = 3.1413$) and inadequate scheduling of crane affects the loading and offloading of cargo was ranked fourth (4rd) with the mean ($\bar{x} = 3.0267$)

It can be deduced that lack of maintenance was predominant and thus affects the productivity of ship-to-shore crane. Table 2 shows the frequency of turnaround time with the grand total of 3624 at 100% and grand mean ($\bar{x} = 3.221$). It was discovered that prolong waiting time of vessel affect the vessel turnaround time was ranked first (1st) with the mean ($\bar{x} = 3.344$), idle time was ranked second (2nd) with the mean ($\bar{x} = 3.328$) and sailing delay was ranked third (3rd) with the mean ($\bar{x} = 3.2840$).

It can be deduced that prolong waiting time of vessels was predominant and thus affects the vessel turnaround time.

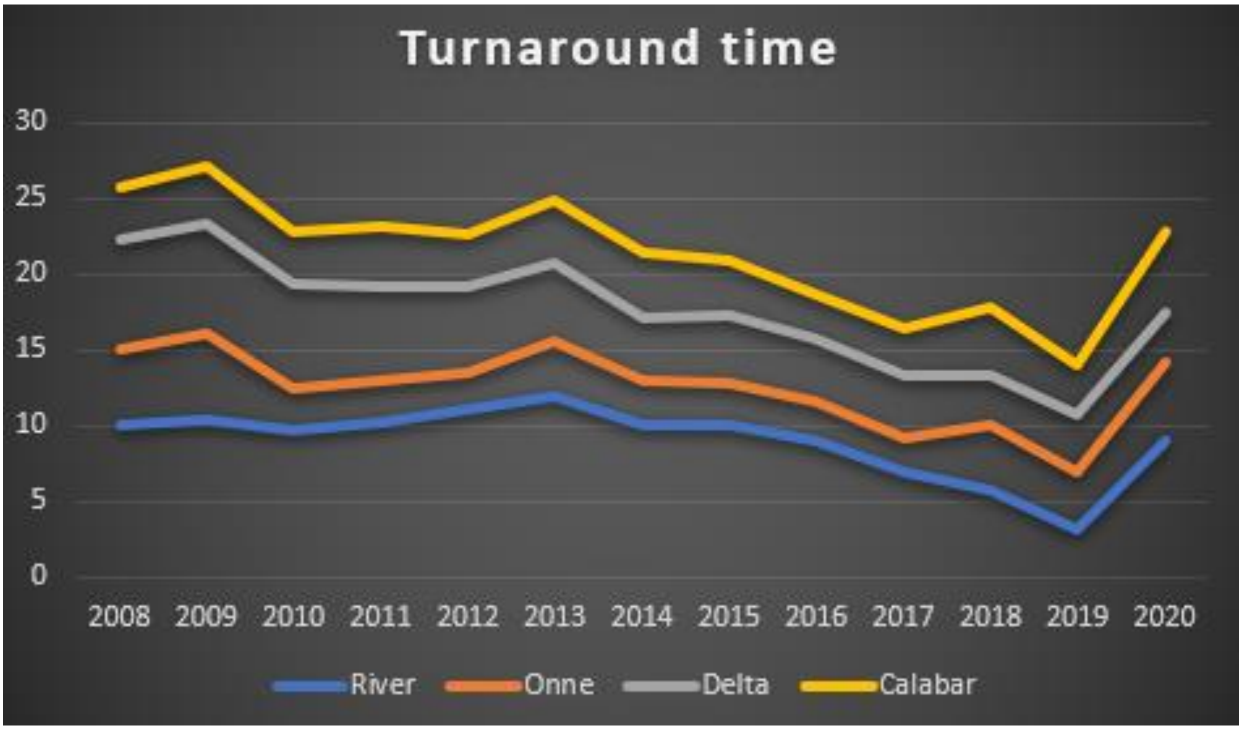

Figure 4.3: Turnaround time
Source: NPA, 2020

Table 1: Frequency of Ship-To-Shore handling equipment

QUESTIONS	STRONGLY AGREED (4)	AGREED (3)	DISAGREED (2)	STRONGLY DISAGREED (1)	TOTAL	MEAN	RANK
Lack of maintenance affects the productivity of ship-to-shore crane	182 (48.5%) 728	130 (34.7%) 390	35 (9.3%) 70	28 (7.5%) 28	375 (100) 1216	3.2427	1st
Inadequate manpower affects the handling operations	171 (45.6%) 684	122 (32.5%) 366	45 (12.0%) 90	37 (9.9%) 37	375 (100) 1177	3.1387	2nd
Inadequate scheduling of crane affects the loading and offloading of cargo	147 (39.2%) 588	128 (34.1%) 384	63 (16.8%) 126	37 (9.9%) 37	375 (100) 1135	3.0267	4th
Old and antiquated cranes are still in operations which mar the loading and unloading of cargo	159 (42.4%) 636	141 (37.6%) 423	44 (11.7%) 88	31 (8.3%) 31	375 (100) 1178	3.1413	3rd
Total	659	521	187	133	1500	3.1373	
	2636	1563	374	133	4706		

Table 2: Frequency of vessel turnaround time

QUESTIONS	STRONGLY AGREED (4)	AGREED (3)	DISAGREED (2)	STRONGLY DISAGREED (1)	TOTAL	MEAN	RANK
Prolong waiting time of vessel affect the vessel turnaround time	181 (48.3%) 724	156 (41.6%) 468	24 (6.4) 48	14 (3.7%) 14	375 (100%) 1254	3.344	1st
Sailing delay affect the vessel turnaround time	149 (39.7%) 596	123 (32.8%) 369	54 (14.4%) 108	49 (13.1%) 49	375 1122	2.992	3rd
Idle time increase the vessel turnaround time	192 (51.2%) 768	134 (35.7%) 402	29 (7.7%) 58	20 (5.4%) 20	375 1248	3.328	2nd
Total	522	413	107	83	1125	3.221	
	2088	1239	214	83	3624		

Source: Researcher's Field Survey, 2022

Test of Hypothesis

Ho1: There is no significant relationship between handling equipment and turnaround time of vessels in ports.

$Y = a + bx + e$
Y = Dependent variable
a = constant
b = slope
x = Independent variable
Where Y= Turnaround time
X = Handling equipment

Table 3: gives the estimate of b value and tells us about the relationship between dependent variable and independent variable. However, the b value indicates a positive relationship from the below model.
Y = 4.560 - 0.649x + e

However, the b value indicated that handling equipment increased by one unit, turnaround time decrease by 0.649 units. The statistics for collinearity were also shown in Table 3. For the collinearity statistics, tolerance and VIF (Variance Inflation Factor) were also employed. The severity of multicollinearity is assessed using VIF in the ordinary least square (OLS) regression analysis. Furthermore, tolerance is the name given to the reciprocal of VIF. They both assess how much the variance (standard) error is inflated. **Decision rule**: Multicollinearity does not occur when the VIF or tolerance is equal to 1 (one). Additionally, it implies that the variance of the i^{th} regression coefficient is not inflated. Multicollinearity exists if the VIF is more than 4 and the tolerance is lower than 0.25. Tolerance and VIF are equal, according to the statistics for collinearity in Table 3. As a result, there is no multicollinearity between the two variables.

. Similarly, table 4. shows that the F ratio which is 467.622 was statistically significant at p value = 0.00 which is lesser than 0.05, hence, there is a significant relationship existing between the examined variables. This implies that the null hypothesis (H_{01}) was rejected and the alternate hypothesis (H1) was accepted. It simply means there is a relationship between the examined variables.

Table 3: Coefficients of Ship-To-Shore (STS) handling equipment and turnaround time

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	T	Sig.	Tolerance	VIF
1	(Constant)	4.560	.084		54.505	.000		
	Turnaroundtime	-.649	.030	-.746	-21.625	.000	1.000	1.000

a. Dependent Variable: turnaroundtime

Table 4: ANOVA of handling equipment and turnaround time

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	254.798	1	254.798	467.622	.000[b]
	Residual	203.240	373	.545		
	Total	458.037	374			

a. Dependent Variable: turnaroundtime

b. Predictors: (Constant), equipment

Table 5: Model Summary of handling equipment and turnaround time

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.746[a]	.556	.555	.73816	.175

a. Predictors: (Constant), equipment

b. Dependent Variable: turnaroundtime

Also, there is a positive relationship in table 5 as the result shows the correlation co – efficient (r) of 0.746 and co – efficient of multiple determinant (r^2) of 0.556. It simply means that above 75% of variation in independent variable may be attributed to a magnitude increase in the dependent variable which is turnaround time while 23% account for the unexplained variable.

The inferential statistics also adopts ANOVA and is stated as follows:

H_0: $\mu_1 = \mu_2$

H_1: Means are not all equal.

The test statistic for testing H_0: $\mu_1 = \mu_2$

Table 4 shows that the F ratio which is 467.622 was statistically significant at p value = 0.00 which is lesser than 0.05, hence, there is a significant relationship existing between the examined variables. This implies that the null hypothesis (H_{01}) was rejected and the alternate hypothesis (H1) was accepted. It simply means there is a relationship between the examined variables.

This study agreed with the study of Monday, Ibe, and Emenike (2021), who asserted that port infrastructures are the key stimuli for cargo turnaround time. Dayananda, Vijayanand, and Dwarakish (2021) agreed that a seaport's turnaround time reveals the port's capacity and capability to provide efficient services.

Baird (2006) opined that higher ship turnaround time imposes a higher cost of port usage, which, from the perspective of the customers, is a sure sign of poor port performance as it indicates that vessels spend longer than necessary in such ports. Time is an important factor in cost determination in transportation. According to Ilaria, Salani, Bierlaire, and Matteo (2010), the number of quay cranes assigned to a vessel affects how long it spends berthing. As a result, quay cranes are the primary piece of equipment used for vessel loading and unloading of cargo. Due to their high cost, quay cranes are typically one of the terminal's most in-demand resources. Somuyiwa and Ogundele (2015) opined that the scenario in Nigerian ports is that cargo handling operations, stacking, and the transit of goods to their final destination are all hampered by handling equipment and plants that are either old, outmoded, malfunctioning, broken down, or insufficient. Investment in Ship-To-Shore handling equipment enhanced fast turnaround time of vessel.

5.0 CONCLUSION AND RECOMMENDATIONS

The study concluded that there is a significant relationship between Ship-To-Shore handling equipment and turnaround time. Ship-to-Shore handling equipment upgrades will speed up vessel turnaround at the port. The study also concluded that an improved infrastructure reduced the total time spent by vessels at the port, permitted bigger vessels to enter and exit the port.

The following recommendations were made in light of the findings indicated above:

1. The Nigerian Ports Authority should prioritize the dredging of the navigational channel to accommodate larger ships for efficient and productive vessel operations.
2. To expedite freight processing, the concessionaire should supply modern handling equipment.
3. Concessionaires should make sure that staff members receive periodic training so they can use modern equipment in a variety of ways.

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