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Research Paper

Development of Port Infrastructure and Service Quality in Nigerian Ports

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ABSTRACT
The study examined the development of port infrastructure and service quality in the Nigerian ports from 2000-2019. The objective of the study is to examine the relationship between quality of port infrastructure index on service quality vis a vis ship turnaround time and average time spent at berth. The paper used the method of Ordinary Least Square (OLS) regression analysis based on secondary data on quality of port infrastructure index, ship turnaround time and average time spent at berth obtained from Nigerian Ports Authority Abstract Statistic and World Economic Forum. Before the estimation of the Ordinary Least Square (OLS) regression analysis, the variables were subjected to Augmented Dickey Fuller (ADF) unit root test to stabilize the data; and the result showed that all the variables were stationary to forestall spurious regression result. The estimated OLS results showed that the quality of port infrastructural has a negative and significant relationship with both ship turnaround time and average time spent at berth (service quality in the Nigerian ports). Based on the findings, the study recommended amongst others that, Nigeria ports should increase her investments in port infrastructure development in order to provide quality and efficient service to ports users.
***KEYWORDS:* Berth, Infrastructural index, Ports, Quality of port, Service quality**

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I. INTRODUCTION

The ports serves as the gateway to the nation's economy. Thus, ports are locations on a coastline or shoreline holding one or more harbours where ships can dock and transfer people or cargo to land. On the other hand, port infrastructure is the base for port operations to serve the vessel, cargo and passengers which pass through ports. The basic infrastructure features include port terminals such as docking areas; port operational equipment such as cranes, tugboats, dredgers; man-made global maritime routes and other tangible infrastructures like electronic gadget Ahmodu & Okeudo, 2021. Therefore, ports infrastructure which link an economy to the global markets contributes to economic development through decrease in shipping time, decrease in transport cost and employment creation.

Meanwhile, Nigeria ports have been characterized with high degree of centralization, high port charges, poor infrastructure, crippling bureaucracy and multiple governmental agencies which made it uncompetitive and unattractive in the West African sub-region. Also, the pre-concession era witnessed a lot of infrastructural decay with poor service quality leading to poor ship turnaround time, high cargo dwell time, poor port and hinterland connectivity. As a result of these dismal performance of ports infrastructure, the government came up with concession programme to transform the ports in the year 2006 in order to provide for public ownership of port infrastructure and transfer of cargo operational responsibilities to the private sector for efficient services. This to a large extent, has increased revenue generation and cargo throughout in the port and also led to a drastic reduction in a ship delay period, increased vessel turnaround, berth occupancy and all round operational efficiency and optimal productivity. Ahmodu & Okeudo, 202l; Ndikom, 2006).

However, the present port infrastructure are overstretched and as such require further development to deep seaports as shipping companies are leveraging on economies of scale to save costs. For instance, the only existing deep sea ports, Apapa and Tincan Ports in the Lagos axis are overstretched with the attendant inordinate delays in cargo handling and processing. This problem was occasioned by the failure to develop other ports such as Calabar, Onne, Port Harcourt and Warri ports to deep sea ports that could accommodate bigger vessels to decongest the heavy traffic in Apapa and Tincan ports. Thus, neighboring countries like Togo and Ghana with well-developed deep seaports to accommodate bigger vessels are now the hub of containerized cargo and ship to ship transfer in Sub Saharan Africa respectively, Nigerian vessels go to offshore Lomé rather than offshore Lagos to be loaded with cargo (petroleum products) for Nigerian consumers, as well Nigerian importers prefer using Lomé ports to import their containerized cargoes as a result of poor service quality and decayed infrastructure in Nigerian ports. The capital flight as a result of this practice is better imagined as this diminishes the GDP contribution from the maritime sector to the Nigerian economy (Emenyonu, Onyema, Ahmodu & Onyemechi, 2016).

As a result of these, Onwuegbuchunam (2018) averred that Nigeria's port reforms program may not have completely addressed the anomalies that it was intended to alleviate because even though investments in facilities and handling equipment has led to a reduction in average waiting times of vessels in Nigerian ports, certain challenges are still noticeable including higher tariffs, delays in cargo clearance, cargo inspection bottlenecks and lack of implementation of infrastructural investment and development plans. For instance, the appalling state of access road to Apapa port, Nigeria's biggest port is among the obvious indicators of the travails of port customers in Nigeria (Oritse & Bivbere, 2018; Sessou, 2018). The gridlock in Apapa delayed the exportation of over eighty five million naira worth of solid minerals for more than three months (Okon, 2018). The man hours wasted and delays of export container cargoes on that road negates the economic growth contribution from the maritime sector.

Given the situation above, the objective of this paper is to examine the development of port infrastructure and service quality in the Nigerian ports. Thus, the remaining parts of this paper examined conceptual framework, infrastructure-led development theory, port service quality and customer expectations, methodology, result and discussion and concluding remarks.

II. CONCEPTUAL FRAMEWORK

Port infrastructure refers to a combination of the fixed assets and long term operational facilities which support the internal marine and terminal operations of a sea port as well as the conveyance of cargoes into the port premises and out of the immediate external environments of the port. Those facilities for port-hinterland linkage include access roads, rail lines and inland waterways depending on the topography of the port environs and developable transport modes. While, Port service quality refers to the direct impact in cost and time of port operations to ship owners and cargo interests who use the sea port. Ship owners are affected by port operations in terms of ship turnaround time, port dues and inward and outward clearance charges.

The conceived relationship between port Infrastructural development and port service quality for this study is based on a basic assumption of port infrastructure as the key input in port operations which produces port services characterized by a certain degree of quality or satisfaction of the expectations of port users.

Hence the conceptual framework for this paper involves concise definitions and the assumed relationships between the dependent and independent variables as presented in Figure 1 below;

As presented in Figure 1 below, seaport infrastructural development is indicated by the state of berths and approach channels, quay walls, cargo handling facilities, stacking areas, port access and security infrastructure. The configuration of these facilities in a port combine to provide port services to ships and cargo interests including cargo access to port, ship access to port, berthing of ships, loading of cargos on ships, discharging cargoes from ships, marshaling of cargoes within the port terminal, exit of imported cargoes from the port, and security of ships and cargo in port.

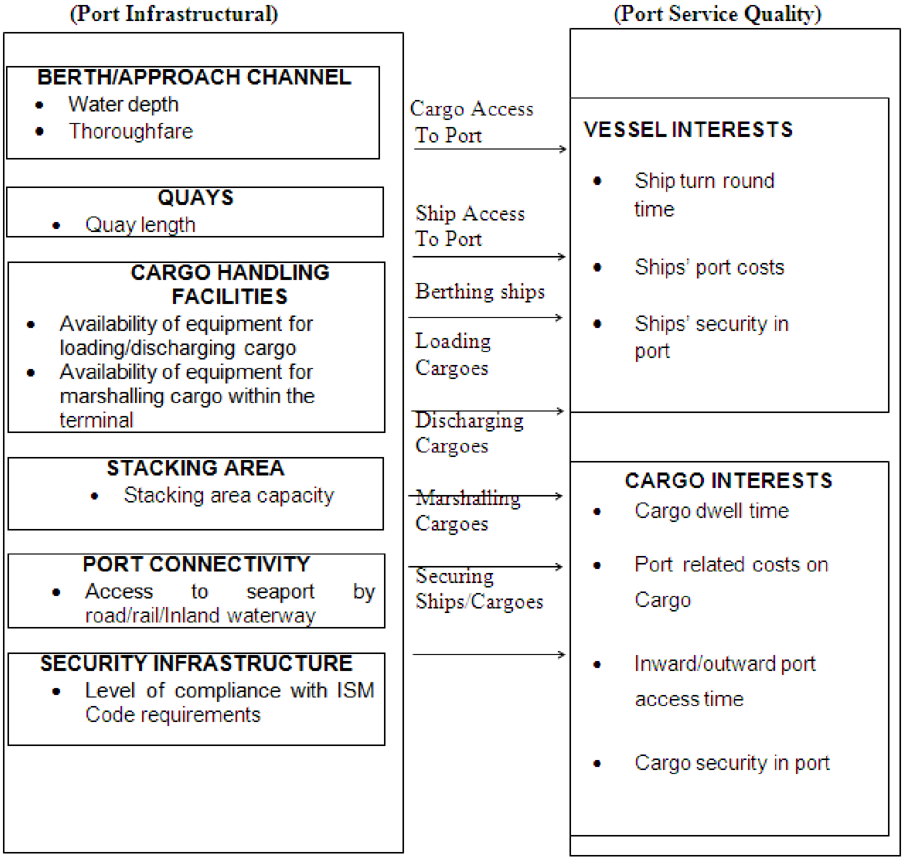

Figure 1: *Relationship between Port infrastructural and port service quality*

Source: *Autours' Conception*

III. THEORETICAL FRAMEWORK: INFRASTRUCTURE-LED DEVELOPMENT THEORY

The theory of infrastructure-led development was proposed by Professor Pierre – Richard Agenor in 2006 in a discussion paper series of the Centre for Growth and Business Cycle Research at the University of Manchester. In the final version of this theoretical postulation in February 2010, the theory proposes a long-run development linked to public Infrastructure being the key mechanism of growth (Agenor, 2010). The justification for this basic thesis of Agenor's (2010) theory is that the lack of growth and development in most low income countries is attributable to lack of infrastructure. With particular reference to sub-Saharan Africa, Agenor (2010) observed that only 16% of roads are paved, and that less than one out of five Africans statistically have access to electricity.

The justification of Agenor's (2010) theory of infrastructure-led development is hinged on two key motivations. The first justification is that infrastructural investment must reach a certain minimum level before it begins to produce any significant effect on development and as such investments in infrastructural provisions beneath the threshold from where it begins to have effect is not proportionate to the zero level of developmental effect at that level. This assumption explains the non-linearity relationship held by the theory (Agenor, 2010). Secondly a network-chain of effects on other developmental catalysts is recognized and incorporated in the position of the theory. In this light, the World Bank (1994) also agrees that the short coming of not achieving economies of scale from network externalities is a major setback of geographical locations lacking in infrastructural provisions.

Consequently the theory of infrastructure-led development is modified and hypothesized as the theory of port infrastructure-led service quality improvement and posited that "for an existing and operational port, port infrastructural development is positive and linearly related to port service quality".

IV. Port Service Quality and Customer Expectations

Ports service quality is hinged on the expectations of the ship interest and cargo interests in a sea port. These expectations are in the form of benefits offered to these interests by the sea port which relate to the expediting and pecuniary requirements of the business of ship operations and goods merchandising which the services rendered by sea ports are expected to ultimately support. Put differently, both ship owners and cargo owners require prompt business turnover in order to improve business service speed and business asset utilization capacity, and also need cost effectiveness of their supply chain.

From the perspective of ship owners, Bichou and Gray (2004) explain that their specific expectations during port visits include non-delayed berth allocation, speedy loading and discharging of cargo, speedy documentation process, adequate safety and security measures in place, minimal disruptions in operations, effective and efficient ancillary services to ship and crew members, dependable agency and communication network and economically reasonable port charges. A further analysis of these requirements suggest that each of this requirement contribute in one way or the other to either promptness of operations or cost effectiveness of the ships port call (Bichou, 2013).

Operationally the time a ship spends in a port is of paramount significance to the business of ship operation and management because a ship only earns freight revenue when it is sailing with cargo. This applies basically to liner operations and voyage charters where the ship's remuneration is expressed as a price per every unit of cargo shipped or transported over a given distance (Yuen & Thai, 2015). This time which is counted in hours from the point where the vessel arrives in the ports waiting area or approach channel through to the point where the vessel departs the ports habour into the open sea is known as the ship turnaround time (Notteboom, 2006).

Apart from ship turn round time, the costs of inward and outward clearance of a ship in combination with the cost of all charges for conventional port services rendered to a ship in a sea port is a key expense input that determines to a significant extent, the profitability of ship operations.

From the foregoing discourse, port service quality can be seen to concern timeliness and cost requirements by both ship and cargo interests. In a nut shell, the quality of port service from the stand point of ship owners is determined by the ports capacity to expedite operations to ensure minimal ship time in the port and to optimize the aggregate cost of port calls to ships. In the same vein, a cargo owner's assessment of port service quality is based on his requirement for minimal cargo stay time in port, minimal access time to port and optimal cost of all port related cost on cargo.

V. METHODOLOGY

The ex-post facto research design is used for the study. Thus, secondary data was obtained from the World Bank's data base and the annual operational statistics of the Nigerian Ports Authority (NPA). Data on Nigeria's quality of port infrastructure index from 2000 to 2019 was obtained from the World Bank's data base as a quantitative measure of port infrastructural in Nigeria for those periods. Data on ship turnaround time (days) and average time awaiting at berth (days) in Nigerian ports was obtained from NPA statistics for the years 2000 to 2019.

The linear regression method was used to model the relationship between quality of port infrastructure and port indicator of service quality variables in Nigeria. The model describing the relationship between the dependent variable 'SQ' and a set of 'Q_P' independent variable "can be expressed as follow;

$SQt = \beta_0 + \beta_1 Q_P + \mathcal{E}t$ …………….(1)

Where; SQ service quality (proxy by ship turnaround time and average time awaiting at berth), Qp is quality of infrastructure index (proxy for port infrastructure development), β_0 is the intercept parameter, β_1 is the slope parameters and $\mathcal{E}$ is error term.

VI. RESULTS AND DISCUSSION

6.1 Data Presentation

This aspect of the analysis seeks to build a functional models for estimating development of port infrastructural and service quality in Nigerian ports. The trend in the data for the OLS regression analysis was presented in Table 1.

Table 1: Research Data

YEAR	**Ship Turnaround Time (Days) (STT)**	**Average Time Awaiting Berth (Days) (AWT)**	**Quality of Port Infrastructure Index (QPI)**
2000	7.01	0.34	0
2001	7.91	1.27	0
2002	11.34	3.99	0
2003	7.89	2.17	0
2004	6.44	1.44	0
2005	7.4	2.6	0
2006	5.31	1.05	3.05
2007	3.75	0.36	2.69
2008	4.59	1.01	2.62

2009	6.55	1.95	2.8
2010	5.38	1.11	2.98
2011	5.48	1.21	3.31
2012	5.75	1.71	3.55
2013	4.9	1.2	3.44
2014	4.3	1.4	3.16
2015	4.2	1.4	2.98
2016	3.9	1.9	2.8
2017	4.7	0.9	2.8
2018	4.3	1.4	2.5
2019	4.3	1.4	2.7

Source: Nigerian Ports Authority Abstract Statistic (Various Issues) and World Economic Forum (globaleconomic.com)

6.1.1 Ship Turnaround Time

The average turnaround time corresponds to the average difference between date of departure and date of arrival among all container vessels calling at a port (or country) within one month of navigation. The unit is the number of days per call. Meanwhile, the trend in average ship turnaround time showed that there was fluctuations between the 2000 and 2019. Precisely, between the year 2000 and 2002 there was a steady increase in average turnaround time. It was within these periods that average turnaround time got to its peak of 11.34days in the year 2002. After the peak period in 2002, average turnaround time decline. Particularly, after port concession in 2006, it fluctuated at a declining rate. Thus, it can be inferred that departure and date of arrival among all container vessels calling at Nigeria ports within one month of navigation improved greatly after ports concession. To be precise, the average turnaround time for vessels which usually take between 7 and 11 days before ports concession, now stood at between 3 and 6 days. See the illustration in Figure 2

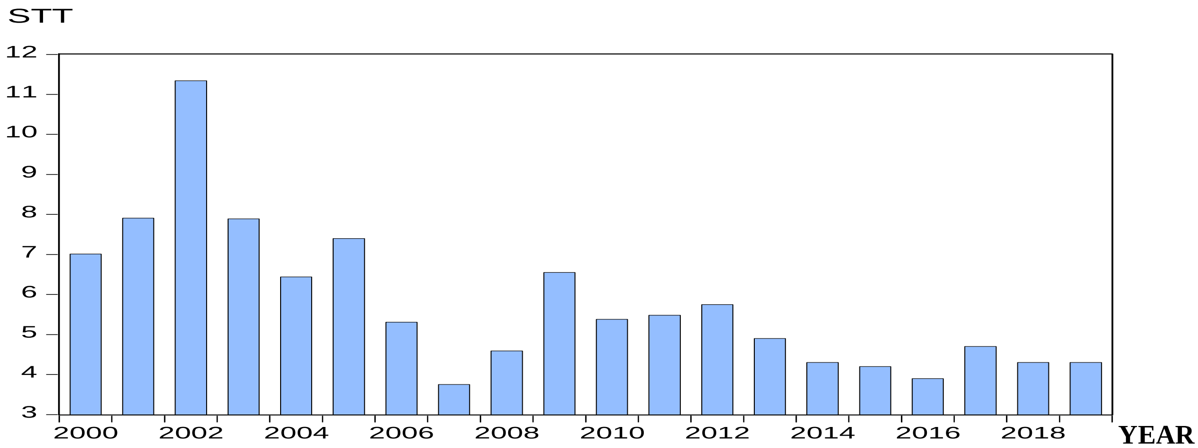

Figure 2: Trend in Ship Turnaround Time

Source*: Nigerian Ports Authority Abstract Statistic*

6.1.2 Average Time Awaiting Berth

The time awaiting at berth is the time vessels waited at sea for green light to be taken by pilot to ports. Once vessel arrived at docks to unload the cargo, it can be call vessel (ship) berthed. If more congestion is there in a port, arrived vessel may have to wait for long period to get berthed. The data for average time awaiting at berth from 2000-2019 was obtained from Nigerian Ports Authority Abstract Statistic and it serves as one of the dependent variable used to measure service quality in Nigerian ports. Meanwhile, the trend in average time awaiting at berth which is the time the time vessels waited at sea for green light to be taken by pilot to ports increases steadily between the years 2000 and 2005. Precisely, it was 0.34days, 1.27 days and 3.99days respectively in the year 2000, 2001 and 2002. Thus, average time awaiting at berth stood between 0 and 3days between the years 2000 and 2005 which coincided with pre-concession of Nigeria ports. But from the year 2006 to 2019 average time awaiting at berth stood in-between 0 and 1day.. The graph in Figure 3 presented the trend in average time awaiting at berth between the years 2000 and 2019.

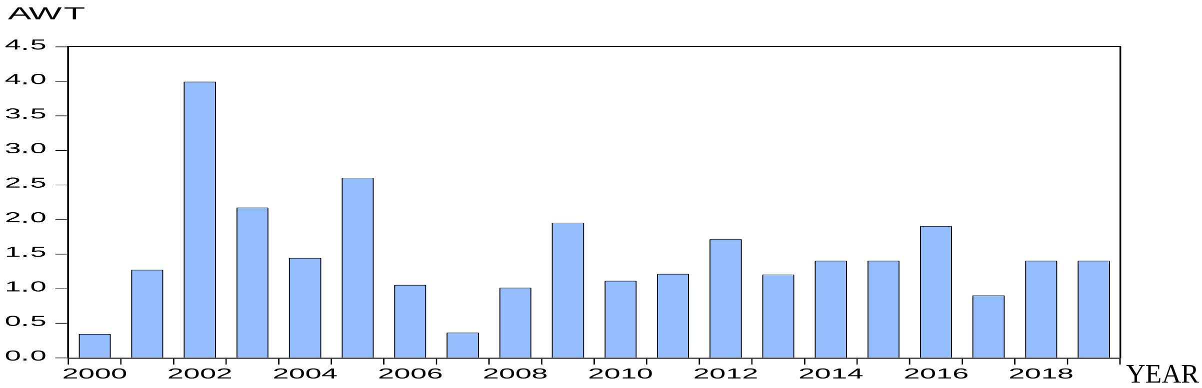

Figure 3: Trend in Average Time Awaiting at Berth

Source*: Nigerian Ports Authority Abstract Statistic*

6.1.3. Quality of Port Infrastructure Index

Quality of port infrastructure index represents an assessment of the quality of port facilities in a given country based on data from the World Economic Forum (WEF). Thus, quality of port infrastructure index data from 2000-2019 was obtained from World Economic Forum (WEF) and it serves as an independent variable in the study which measures port infrastructural development in Nigerian ports. Meanwhile, in analyzing the trend, the index of quality of port infrastructure ranges between 0 and 3.55. In the year 2006, index of quality of port infrastructure stood at 3.05, but decline slightly to 2.69 in 2007. But for the next five years (i.e. from 2008 and 2012), index of quality of port infrastructure increase progressively and got to its peak of 3.55 in 2012. After the peak period in 2012, index of quality of port infrastructure decline steadily between 2013 and 2019. But except the year 2018 which was 2.50, the rate of decrease never go below the first phase of decrease which coincided with the period of 2007. Thus, it can be inferred that index of quality of port infrastructure improved to some extent after port concession in 2006. The bar chart in Figure 4 presented the graphical illustration of the trend in index of quality of port infrastructure between the years 2000 and 2019.

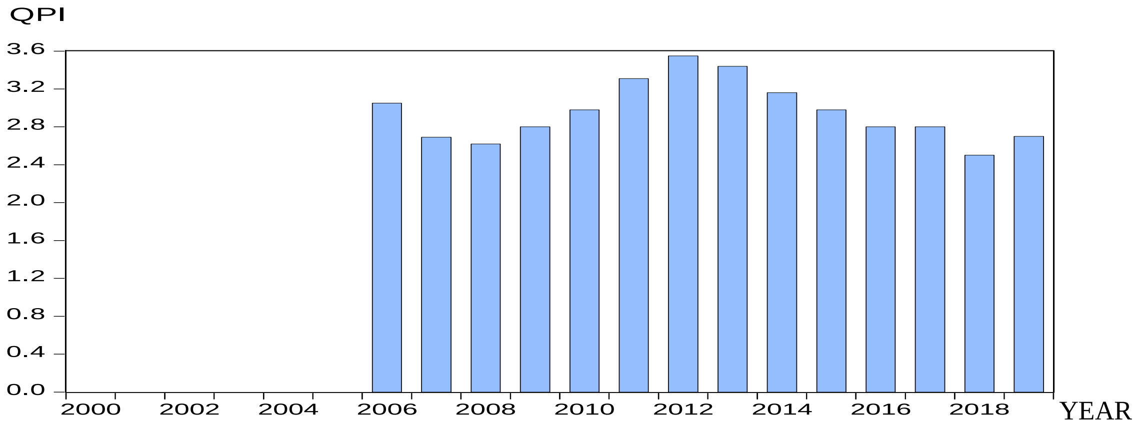

Figure 4: Trend of Index of Quality of Port Infrastructure

Source: *World Economic Forum Data, 2019*

6.2 Basic Data Analysis

Having collected all the required data, the next step analyzed the data. The analysis began with descriptive statistics in order to establish the general characteristics of the collected data. It then followed by the ordinary least square regression analysis to ascertain the relationship between the dependent and the independent variables.

Table 2: Descriptive Statistics for Underlying Series

Variables	Obs	Mean	Std. Dev.	Skewness	Jarque-Bera	Pobability
Quality of Port Infrastructure Index (QPI)	20	2.069000	1.413960	-0.759105	3.239778	0.197921
Average Turnaround Time (STT)	20	5.770000	1.858381	1.407264	9.783737	0.007507
Average Time Awaiting Berth (AWT)	20	1.490500	0.799154	1.479738	15.00204	0.000553

Source: *Researcher's Computation from E- view 10*

The descriptive statistics reported in Table 2 indicated that quality of port infrastructure index (QPI) has an approximate mean of 2.069 with the corresponding standard deviation of 1.414. Also, average turnaround time (STT) has an approximate mean of 5.770 with the corresponding standard deviation of 1.858. In like manner, average time awaiting berth (AWT) has an approximate mean of 1.491 with a corresponding standard deviation of 0.799. Thus, it can be infer from the analysis that the standard deviation of all the variables were not higher than their respective means. Therefore, they converged around their respective mean. Meanwhile, the skewness test showed that while quality of port infrastructure index (QP) is negatively sloped, the variables (average time awaiting berth and average time spent at berth) all have positive values; meaning that they are positively slope. Also, the probability of Jarque-Bera statistics showed that only on variable (average time waiting at berth) passed the alternative hypothesis of normal distribution. While in the remaining two variables, the null hypothesis of not normal distribution were accepted. Thus, the variables were not normally distributed. Implying their distributions is higher than normal. The above problem may have resulted from the problem of spurious data. Thus, the need to stabilize the data with the estimation of unit root test became necessary.

Table 3: Unit Root Test Result of the Series at Level and First Difference

Variables	ADF Test @ 5% Critical Value	ADF Test Statistic @ Level/1st Difference	Status
Quality of Port Infrastructure Index (QPI)	-4.572024	-3.040391	Stationary
Average Turnaround Time (STT)	-4.762323	-3.040391	Stationary
Average Time Awaiting Berth (AWT)	-4.176216	-3.081002	Stationary

Source: *Researcher's Computation from E- view 10*

The unit root test of stationarity for each of the series via the Augumented Dickey Fuller (ADF) test as presented in Table 3 showed that the three variables were stationary. This is because each of the ADF test statistic value was greater than the corresponding critical values at 5%. Having discovered that all the series are stationary, the Ordinary Last Square regression analysis was then carried out in order to analyze objective of the study.

Table 4: Result of Quality of Port Infrastructure and Ship Turnaround Time

Dependent Variable: Ship Turnaround Time (STT)				
Variables	**Coefficients**	**t-statistics**	**Probability**	**P-Value @ 5%**
QP	-1.003783	-5.019519	0.0001	0.05
Constant	0.497136	15.78408	0.0000	0.05
R-Squared	0.5832	f-statistics	25.19557	Prob(f-stat)=0.000089

Note: *QPI is Quality of Port Infrastructure (QPI), STT is Ship Turnaround Time*
Source: *Researcher's Computation from E-view 10*

The result of the regression analysis carried out in Table 4 estimated the effect of the independent variable (quality of port infrastructure) on the dependent variable (ship turnaround time). Meanwhile, the result showed that there is an indirect relationship between quality of port infrastructure and ship turnaround times (an indicators of service quality) in the Nigerian ports. Meaning that a unit improvement in quality of port infrastructure will lead to a reduction in the number of days per call of all container vessels calling at Nigeria port within one month of navigation by about 100.3783%. Also, given that the calculated p-value of 0.0000 which is less than 0.05 critical value. Thus, it would therefore appear that an improvement in quality of port infrastructural development will positively influenced ship turnaround times in the Nigerian ports during the period of study. Moreover, judging from the high f-value (25.1955) with a relatively low p-value of 0.00089 which is less than critical p-value of 0.05, the study concludes that the model has significant explanatory power and therefore reliable. Based on the high value of coefficient of determination (0.5832) which is otherwise referred to as R-squared (R^2), it is therefore concluded that a systematic change in the dependent variable accounted for by the explanatory variable is 58%. Thus, the explanatory power of the model is 58%. This shows that the model is a good fit.

Table 5: Result of Quality of Port Infrastructure and Average Waiting Time

Dependent Variable: Average Waiting Time (AWT)				
Variables	**Coefficients**	**t-statistics**	**Probability**	**P-Value @ 5%**
QP	-0.21514	-2.74644	0.0279	0.05
Constant	1.93552	6.320588	0.0000	0.05
R-Squared	0.64489	f-statistics	3.505	Prob(f-stat)=0.02776

Note: *QPI is Quality of port infrastructure (QPI) and CDT is Cargo dwell time*
Source: *Researcher's Computation from E-view 10*

The regression analysis carried out in Table 5 estimated the effect of the independent variable (quality of port infrastructure) on the dependent variable (average waiting time). A quick inspection of the results in Table 5 showed that there is an indirect relationship between quality of port infrastructure and average waiting time of vessel in the Nigerian ports. Meaning that a unit improvement in quality of port infrastructure will lead to a reduction in the time vessels waited at sea for green light to be taken by pilot to unload the cargo by about 21.514%.

Also, given that the calculated p-value of 0.0279 which is less than 0.05 critical value; thus, an improvement in quality of port infrastructural will positively influenced average waiting times of vessels in the Nigerian ports during the period of study. Moreover, adjudging from the f-value (3.505) with a relatively low p-value of 0.02776 which is less than critical p-value of 0.005, the study concludes that the model has significant explanatory power and therefore reliable. Also, based on the high value of coefficient of determination (0.64489), it is therefore concluded that a systematic change in the dependent variable accounted for by the explanatory variable is 64%. Thus, the explanatory power of the model is 64%. This shows that the model is a good fit.

VII. CONCLUDING REMARKS

The principal focus of this paper is to explore the effect of development of port infrastructural on service quality in the Nigerian ports from 2000-2019. The research was carried out using Ordinary Least Square (OLS) regression analysis based on secondary data obtained from Nigerian Ports Authority Abstract Statistic and World Economic Forum. The estimated results showed that quality of port infrastructural has a significant effect on service quality in the Nigerian ports. Based on empirical results, it was recommended that, government should develop and implement ports development policy that will address the bottle necks such as grid lock in the Nigerian major ports, particularly, Apapa port in order to allow free flow of traffic and discharge of cargoes. Also, government should increase her investments in the port infrastructure in order to bring about efficient service to port users.

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