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INFRASTRUCTURAL DEVELOPMENT AND SERVICE QUALITY IN THE NIGERIAN PORTS

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Abstract: *The study examined infrastructural development and service quality in the Nigerian ports. The paper used quantitative estimation by applying the Ordinary Least Square (OLS) multiple regression analysis based on secondary data on quality of port infrastructure index, linear shipping connectivity, logistic performance index and cargoes dwell time obtained from Nigerian Ports Authority Abstract Statistic and World Economic Forum. Prior the OLS test, the variables were subjected to Augmented Dickey Fuller (ADF) unit root test to stabilize the data. The outcome of the unit root test showed that all the variables were stationary to forestall spurious regression result. The estimated OLS results showed that the coefficient of determination is 82%; thus, the model is a good fit. Quality of port infrastructural index has a significant effect on cargoes dwell time (service quality in the Nigerian ports). Also, both liner shipping connectivity and logistics performance indexes were indirectly related to cargoes dwell time (service quality of the Nigerian ports). Based on the findings, the study recommended amongst others that, Nigeria ports should improve her shipping connectivity and logistic performance to avoid running the risk of losing same to other regional ports. Also, investments in port infrastructure development should be done under the public private partnership.*

Keywords: Cargoes dwell time, Logistic performance index, Infrastructural development, Ports and Service quality,

1. Introduction

"A port is a location on a coast or shore containing one or more harbours where ships can dock and transfer people or cargo to or from land. Port locations are selected to optimize access to land and navigable water, for commercial demand, and for shelter from wind and waves" (Olaogbebikan, Ikpechukwu, Faniran & Enosko, 2014). The sea port help to provide services to ships and import/export cargoes. These services include but are not limited to berthing of ships; loading and discharging of cargoes on and from ships; marshalling cargoes around the port for inspection and other operational such as; short-term accommodation and storage of cargoes in transit sheds, as well as security of cargoes and ships. Thus, the need for the development of port infrastructure to contribute to quality of services to ships by port organizations cannot be overemphasized.

Meanwhile, prior to the concession resolution, the Nigerian ports were characterized by high degree of centralization, high port charges, poor infrastructure, crippling bureaucracy and multiple governmental agencies which made it not competitive and distasteful in the West African sub-region. It was based on this dreadful state that the 2006 port concession program came up to transform the ports (Ndikom, 2006). Thus, the simple tenet of this reform program provide for public ownership of port infrastructure and transfer of cargo operational responsibilities to the private sector for efficient services.

Since the Nigerian port's terminal had been handed-over to private concessionaires in the year 2006, there has been appreciable increase on infrastructure and efficiency in service delivery. This, to a great extent, has increased revenue generation and cargo throughout in the port, increased vessel turnaround, and has drastically reduced ship delay period, and optimal productivity.

However, the present port infrastructure in the Nigerian ports 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, Apapa and Tincan Ports in the Lagos axis, "are overstretched with the attendant inordinate delays in cargo handling and processing. With capacity for 60 million metric tonnes of cargo handling, the ports run at about 100 million metric tonnes and this causes a lot of delay" (Emenyonu, Onyema, Ahmodu, & Onyemechi, 2016). Thus, with almost half and a decade of port reform program, both ship owners and cargo interests were still not wholly satisfied with the manner services were being rendered by Nigerian seaports (The Nigerian Voice, 2011). Similarly, Onwuegbuchunam (2018) "asserted 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 such as higher tariffs, delays in cargo clearance, and cargo inspection bottlenecks are still noticeable". Moreover, 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); especially, with reports indicating in one instance that the gridlock in Apapa delayed the exportation of over eighty five million naira worth of solid minerals for more than three months (Okon, 2018). Thus, business experts estimated that the gridlock in Apapa costs Nigeria's economy a whooping twenty billion naira in daily losses (Dada, 2017).

This paper became necessary in light of operational shortcomings in Nigeria's port industry which may be attributable to infrastructural concerns. Therefore, the objectives of study is to examine the effect of port infrastructure development on performance indicator of service quality in the Nigerian ports. The remaining parts of the paper examined port infrastructural development, port infrastructure and economic growth, methodology, results and discussion as well as concluding remarks.

2. Port Infrastructural Development

Basically sea ports are facilities deliberately designated for receiving and mooring of ships, loading and discharging of cargoes from ships for the purpose of transferring merchandize from sea mode to other landward modes of transport (De Langen, Turró, Fontanet & Caballé, 2018). However, for ports handling similar types of cargoes or engaged in similar activities, the global nature of shipping business requires similar types of infrastructural facilities because the same ships and or ship types with similar designs will call at those ports. The fundamentally international nature of the maritime industry requires uniform standards of operations and regulations across the globe. Because this study focuses on sea ports handling containerized cargoes, emphasis of infrastructural development of sea ports would be on the common facilities necessary for effective and efficient container port operations. Container ports would ordinarily have infrastructure for maritime access, basic port infrastructure, equipment and superstructures, and infrastructure for connection to other modes of inland transport.

Maritime access infrastructure concerns those facilities that enable ships to transverse between the ports habour and the open sea (De Langen, et al., 2018). These include approach channels and berths of significant depth, breakwaters that protect vessels from being hit by waves and swells from the open sea, and locks used to control water levels for ship entry and flood prevention. The development of maritime access port infrastructure involves dredging of the water areas of the port and investment in construction of the fixed facilities. These facilities determine the port's capacity to accommodate certain ship sizes as shallow entry channels will not permit vessels of large tonnages and correspondingly large drafts to enter into the port. For this reason, capital dredging is carried to increase water depth and follow up with regular maintenance dredging is usually effected to ensure that silt buildups and deposits are removed from time to time Bichou (2013). Depending on the weather conditions in the sea port, the use of breakwaters may be necessary to block sea turbulence from extending to the port's harbour and obstructing the delicate navigation involved in port entry and exit by relatively large ocean vessels (De Langen, et al., 2018).

Port infrastructure which are fixed and which enable ships to position for Cargo operations are referred to as basic port facilities (De Langen, et al., 2018). The specific elements of basic port infrastructure include quay walls, quay aprons and floating pontoons or ramps where necessary. Development of these category of infrastructure involves strengthening of quay walls, increasing length of quays and provision/maintenance of floating pontoon ramps. These facilities determine the capacity of the port in terms of the number and sizes of ships that can be accommodated in the port at the same time.

Apart from the fixed basic port infrastructure there are other surface equipment which are provided in a port to facilitate the key services of cargo operations, cargo marshalling and cargo storage, and these facilities are termed port equipment and superstructures. In a container terminal, specific equipment and super structure would include fixed and gantry cranes fitted to quay sides for loading and discharging of cargo, transtainers, container movers, container stackers and container stacking areas (Liu, Wang, Cheng, 2008). The adequacy and functionality of these equipment's enable efficient internal terminal operations and improves capacity to handle voluminous container cargo traffic. The development of these categories of port infrastructure requires huge investment in procurement and installation of equipment and construction of super structures. Within the port, there is usually heavy traffic of people and vehicles due to the multifarious nature of activities involving several parties, agencies and organizations. To ensure hitch free flow of people, vehicles and goods, certain infrastructure are put in place. These include road networks, parking space and strategic locations of office facilities and other operational shelters such as workshops, stores and outdoor safety equipment (De Langen, et al., 2018). These facilities require careful planning and occasional modifications to suit expansion requirements as the ports core activities expand so that the increased ship and cargo traffic can be effectively handled.

Without these infrastructures in adequate and functional state, cargoes cannot effectively and efficiently get to the ports for export. In the same vein, a lack of port access infrastructure would impede the speedy and efficient conveyance of imports from the ports to their final inland destination. Development of port access infrastructure involves thorough planning and implementation of an integrated multimodal transport system around the port. Planning and implementation of an effective port access infrastructural system would explore all potentials of available transport modes and develop a configuration that optimizes travel time and cost for import and export freight.

Liner Shipping Connectivity Index (LSCI) captures a county's level of integration into the shipping trade and its connectivity to maritime shipping. It is computed by the United Nations Conference on Trade and Development (UNCTAD) based on five components of the maritime transport sector (UNCTAD 2013; Emenyonu, et al., 2016):

containership deployment or number of ships; Container carrying capacity; number of companies that deploy container ships in a country's ports relates to how many shipping companies are servicing the country; number of liner services and average and maximum vessel size.
However, the World Bank index for measuring quality of port infrastructure (QPI) measures business executives' perceptions of their country's port facilities. The index rating ranges from 1 to 7, with a higher score indicating better development of port infrastructure (World Bank 2013).
Besides port infrastructure quality index, one more additional input will be used to contribute to productivity analysis. It is World Bank's Logistic Productivity Index (LPI). LPI measures the effects of the port and the whole supply chain efficiency. Logistics Performance Index includes several other sub-indexes and in overall score reflects perceptions of a country's logistics based on efficiency of following (World Bank 2013); customs clearance process, quality of trade and transport-related infrastructure; ease of arranging competitively priced shipments; quality of logistics services; ability to track and trace consignments; and frequency with which shipments reach the consignee within the scheduled time.
According to Dare, Aubyn and Boumgard (2019), in 2007, the World Bank began logistic performance index (LPI) as an approach to quantify the logistics performance of nations around the globe. The record depends on a study done on organizations that moves products crosswise over nations. It is comprised of six fundamental parts; namely "customs, infrastructure, ease of arranging shipments, quality of logistics services, tracking and tracing and timeliness". Logistic performance index (LPI) is viewed as the most appropriate approach to quantify nations' logistics performance (D'Aleo & Sergi, 2017).

3. Port Infrastructure and Economic Growth

Several studies on port infrastructure have focused on its importance to economic growth. For instance, Nwaogbe, Diugwu, Mohammed, Omoke and Gidado (2016) examined the impact of seaport concession on Nigeria's economic growth with emphasis on infrastructure management and reached a conclusion that provision of port facilities and skilled labour were necessary to improve the port's productivity. Similarly, Emenyonu, Onyema, Ahmodu and Onyemechi (2016) used ANOVA and correlation analysis to examine the impact of seaport development on the economic growth of Nigeria. Using GDP as the dependent variable and trade, logistics performance index (LPI) and liner shipping connectivity (LSCI) as independent variables; the findings show that LSCI has a positive correlation with GDP of Nigeria and will decrease by 0.049% for one percent decrease in LSCI, increase by 3.2% for one percent increase in LPI and increase by 0.012% for one percent increase in trade volume.
Bottasso, Conti, Ferrari and Tei (2014) focusing on the impact of port operations on gross domestic product (GDP) in Europe, indicated that for every 10% increment in port throughput, between 6% and 20% increment in the region's GDP is experienced with a lesser but slightly significant spillover effect on adjoining regions. In the Chinese context, it was revealed in a study that a paltry 1% increase in cargo throughput in seaports can generate a multiplier effect of 7.6% increase in GDP per capita (Shan, Yu & Lee, 2014). Similarly in Asia, Jung (2011) found that sea ports were having declining economic impacts on South Korean and Chinese host economies respectively from an employment creation stand point.
In the United States of America (USA), Yochum and Agarwal (1987) found that due to inadequate port facilities in Hampton and other heartland locations in the USA, severe economic consequences were been suffered by local firms which had to move exports over longer distances to ports in the East or West Coasts and vice versa as it concerns imports. The study by Kinsey (1981) on the port of Liverpool found that there was a declining trend of the

effect of the port on the economy of the city because the number of jobs which existed as a direct offshoot of the port's operations were reducing.

Meanwhile, these empirical studies on the impact of port operations and infrastructure on economic growth indicates contradictory results that appear to be occasioned by the level of technological advancement of sea port systems. In areas where the port system has embraced advanced technology, there seem to be lesser port operations impact on the economy especially from the angle of job creation. Also, port operations impact appears heavier in countries whose economies depend more on international trade such as China.

4. 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. Data on Nigeria's quality of port infrastructure, liner shipping connectivity index (LSCI) and logistics performance index (LPI) from 2000 to 2019 was obtained from the World Bank's data base as a quantitative measure of port infrastructural development in Nigeria for those periods. Data on cargo dwell time in Nigerian ports was obtained from NPA statistics for the years 2000 to 2019.

The Linear regression methodology was used to model the relationship between infrastructure development needs and port indicator of service quality variables in Nigeria. The model describing the relationship between the dependent variable 'Y' and a set of 'X' independent variables "x_1, x_2 and x_3 can be expressed as follow;

$Y_t = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_2 X_{i3} + e_{ti}$ …………… .(1)

Where; Y is cargoes dwell time (proxy for service quality), X1 is quality of infrastructure index, X2 is liner shipping connectivity index (LSCI), X3 is logistics performance index (LPI), β_0 is the intercept parameter, $\beta 1$- β_3 are the slope parameters and e is error term.

5. Results and Discussion

5.1 Descriptive Statistics

The essence of the descriptive statistics is to ascertain stability of the time series

Table 1: Descriptive Statistics of the Variables

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 Time spent at Berth (CDT)	20	4.36600	1.326513	0.916036	2.821693	0.243937
Liner Shipping Connectivity index (LSCI)	20	14.82800	8.209589	-1.041622	3.788117	0.150460
Logistics Performance Index (LPI)	20	1.96800	1.489301	-0.596143	3.311368	0.190961

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

The descriptive statistics reported in Table 1 indicated that quality of port infrastructure index (QPI) has an approximate mean of 2.069 with the corresponding standard deviation of 1.414. Also, cargoes dwell time which correspond to average time spent at berth (CDT) has an approximate mean of 4.366 with a corresponding standard deviation of 1.327. Similarly, liner shipping connectivity index (LSCI) has an approximate mean of 14.828 with the corresponding standard deviation of 8.210. Logistics performance index (LPI) has an approximate mean of 1.968 with a corresponding standard deviation of 1.489. Meanwhile, the skewness test showed that while quality of port infrastructure index (QPI) and liner shipping connectivity index (LSCI) are negatively sloped, the variables (average time spent at berth and logistics performance index) all have positive values; meaning that they are positively slope. Also, the probability of Jarque-Bera statistics showed that all the four variables passed the null hypothesis of normal distribution. 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.

5.2 Unit Root Test for all the Series

The unit root test was carried out to address the issue of non-stationarity of data which is usually associated with time series data. This is done to forestall the chance of getting spurious or false regression result. Thus, Table 2 showed the outcome of the Augmented Dickey Fuller (ADF) unit root test results.

Table 2: Unit Root Test Result at First Difference

Variables	ADF Test @ 5% Value	ADF Test @ 1st Difference	Status
Quality of Port Infrastructure Index (QPI)	-4.572024	-3.040391	Stationary
Liner Shipping Connectivity index (LSCI)	-10.46839	-3.040391	Stationary
Logistics Performance Index (LPI)	-4.027838	-3.040391	Stationary
Average Time spent at Berth (CDT)	-4.037943	-3.040391	Stationary

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

The unit root test of stationarity for each of the series via the ADF test as presented in Table 2. The result showed that the variables were not stationary at level. But they were all differenced once and became stationary at first difference. 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 multiple regression analyzed.

5.3 Linear Regression Analysis Result Output

The objective of the study is to examine the effect of port infrastructure development on port performance indicator of service quality in the Nigerian ports. Here the key port performance indicator was identified as cargoes dwell time or average time awaiting berth was regressed against quality of port infrastructure index and other associated infrastructural development variables such as liner shipping connectivity index (LSCI) and logistics performance index (LPI). The estimated result is presented in the table below.

Table 3: Multiple Regression Analysis Output

Dependent Variable: Cargo Dwell Time (CDT)				
Variables	**Coefficients**	**t-statistics**	**Probability**	**P-Value @ 5%**

QPI	-0.048518	-0.212129	0.0347	0.05
LSCI	-0.120971	-3.117431	0.0066	0.05
LPI	-0.110784	-0.515317	0.6134	0.05
Constant	6.478162	21.72970	0.0000	0.05
R-Squared	0.81806	Durbin Watson Stat	1.53027	Prob(f-stat)=0.000004

Note: *CDT is Cargo Dwell Time (Ports Service Quality), QPI is Quality of ports infrastructural, LSCI is Liner Shipping Connectivity Index and LPI is Logistics performance index*
Source: *Researcher's Computation from E-view 10*

The regression analysis carried out in Table 3 estimated the effect of the independent variables (quality of port infrastructure index, liner shipping connectivity and logistics performance) on the dependent variable (Cargo Dwell Time). The finding from the estimated result showed that there is an indirect and significant relationship between quality of port infrastructure index and port performance indicator of service quality in the Nigerian ports. In specific term, a unit improvement in port infrastructure index will lead to a reduction in is the period vessels stays at berth to discharge cargo by about 4.8%; The implication of this finding is that service quality in the Nigerian ports has improved to some extent as a result of the drastic measures taken by the federal government to concessed the ports in the year 2006 in order to bring about improvement in the service delivery and hence productivity of the ports. Thus, during the post-concession, the contribution of the Nigerian Ports Authority to the national output has increase substantially. In line with the finding, Oghojafor, Kuye and Alaneme, (2012) while assessing the importance of port infrastructure to Nigeria's port operations and the economy at large averred that one of the motivations for the port concession programme implemented by the Federal Government in the mid-2000s is to boost productivity output and the growth of the economy at large.

Moreover, an examination of the results in Table 3 equally showed that liner shipping connectivity has an indirect and significant relationship cargo dwell time (an indicators of service quality) in the Nigerian ports. Meaning that a unit improvement in liner shipping connectivity will lead to a reduction in is the period vessels stays at berth to discharge cargo by about 12.1%. Also, the results showed that logistics performance index has an indirect relationship with cargo dwell time (an indicators of service quality) in the Nigerian ports. Thus, an improvement in logistics performance will lead to a reduction in is the period vessels stays at berth to discharge cargo by about 11.1%.

Meanwhile, the f-statistic p-value of 0.00001 which is less than critical p-value of 0.005, showed that the model has significant explanatory power and therefore reliable. Also, based on the high value of coefficient of determination (0.818) 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 variables is about 82%. This showed that the model is a good fit. The finding corroborates the empirical work of Emenyonu, Onyema, Ahmodu and Onyemechi (2016) who analyzed the impact of seaport development on the economic growth of Nigeria and averred that logistics performance and liner shipping connectivity has a significant impact on economic growth. Thus, most empirical studies on the impact of port operations and infrastructure on the economy indicated that in areas where the port system has embraced advanced technology, there seem to be greater port operations impact on the economy.

6. Concluding Remarks

With the current competition in today's port environment, service quality has become an inevitable factor for port success as it determines the retention of customers and growth of customer base. But the appalling state of infrastructures and quality service in the Nigerian ports have been worrisome. Also, it will be noted that port productivity of Nigerian ports are occasioned by delay in cargo throughput which was caused by lack of infrastructural facilities, port managerial problems and Poor planning amongst others. In lieu of the above, the research involved the estimation of the effect of port infrastructural development on service quality in Nigerian ports by using Ordinary Least Square 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 development has a significant effect service quality in the Nigerian ports. Also, both liner shipping connectivity and logistics performance significantly affect service quality of the Nigerian ports.

Based on the findings, it was recommended that; (i) Since port infrastructure development in the post-concession era significantly affects service quality in Nigerian ports, government should develop better concession policies to address the bottle neck such as grid lock in the major ports in Nigeria to allow free flow of traffic and discharge of cargoes. Also, the liner shipping connectivity and logistics performance are very important determinants of bilateral trade costs. Thus, it is imperative for government to carry out more development programmes that will improve the shipping connectivity in the Nigeria ports to avoid losing foreign earning which will boost gross domestic product to other regional ports.

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Appendix 1

Data for the Research

Year	Quality of Port Infrastructure Index	Average Time spent at Berth (Days)/ Cargoes Dwell Time	Liner Shipping Connectivity index	Logistics Performance Index
YEAR	QPI	CDT	LSCI	LPI
2000	0.00	6.67	0.00	0.00
2001	0.00	6.67	0.00	0.00
2002	0.00	7.35	0.00	0.00
2003	0.00	5.72	0.00	0.00
2004	0.00	5.00	12.83	0.00
2005	0.00	4.80	12.79	0.00
2006	3.05	4.26	13.02	0.00
2007	2.69	3.39	13.69	2.69
2008	2.62	3.58	18.30	2.89
2009	2.80	4.6	19.89	2.82
2010	2.98	4.27	18.28	3.10
2011	3.31	4.27	19.85	3.01
2012	3.55	4.04	21.81	2.92
2013	3.44	3.8	21.35	3.01
2014	3.16	2.9	22.91	3.46
2015	2.98	2.8	21.44	3.25
2016	2.80	3.0	20.85	3.04
2017	2.80	3.7	20.53	3.05
2018	2.50	3.2	18.96	3.07

2019	2.70	3.3	20.06	3.05

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

Appendix 2
Descriptive Statistic

MEASUREMET	QPI	CDT	LSCI	LPI
Mean	2.069000	4.366000	14.82800	1.968000
Median	2.750000	4.150000	18.63000	2.905000
Maximum	3.550000	7.350000	22.91000	3.460000
Minimum	0.000000	2.800000	0.000000	0.000000
Std. Dev.	1.413960	1.326513	8.209589	1.489301
Skewness	-0.759105	0.916036	-1.041622	-0.596143
Kurtosis	1.741916	2.828127	2.546307	1.402473
Jarque-Bera	3.239778	2.821693	3.788117	3.311368
Probability	0.197921	0.243937	0.150460	0.190961
Sum	41.38000	87.32000	296.5600	39.36000
Sum Sq. Dev.	37.98638	33.43308	1280.550	42.14232
Observations	20	20	20	20

OLS Regression Results

Dependent Variable: CDT
Method: Least Squares
Date: 11/21/20 Time: 00:56
Sample: 2000 2019
Included observations: 20

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.478162	0.298125	21.72970	0.0000
QPI	-0.048518	0.228718	-0.212129	0.0347
LSCI	-0.120971	0.038805	-3.117431	0.0066
LPI	-0.110784	0.214982	-0.515317	0.6134

R-squared	0.818060	Mean dependent var	4.366000
Adjusted R-squared	0.783946	S.D. dependent var	1.326513
S.E. of regression	0.616584	Akaike info criterion	2.047613
Sum squared resid	6.082821	Schwarz criterion	2.246760
Log likelihood	-16.47613	Hannan-Quinn criter.	2.086489
F-statistic	23.98033	Durbin-Watson stat	1.530272
Prob(F-statistic)	0.000004		