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Connectivity of Nigerian seaport Infrastructures to Global Shipping Networks and Port Logistics Performance in Nigeria

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ABSTRACT

Challenges related to port connectivity to global shipping networks have implications on the sustainability of the transportation operations in the affected economies with consequences on the business performance within the economy. The study evaluated the connectivity of Nigerian seaport infrastructures to global shipping networks relative to the logistics performance of the ports. It used used quantitative research design and time series data covering a period of 18 years between 2006 and 2023 on Liner Shipping Connectivity Index (LSCI) of Nigeria, obtained from UNCTAD reports. The findings of the study reveal that about 74% variations in the Liner Shipping Connectivity Index (LSCI) of Nigeria ports is explained by the volume of TEU container shipping export and import trade volumes, the cargo throughput tonnage handled, the ship traffic calls, rates/charges paid by port users, service time experiences of the shippers cum ship-owners, and the delay experienced by the shippers and ship-operators in the ports. The test of significance of the influence of the factors of port logistics performance on the LSCI of Nigerian ports indicate an f-score of 4.192, alpha value of 0.05 and p-value of 0.042. There is a declining trend in the connectivity of Nigerian seaports to global shipping networks while the trend of TEU import and export trade handled in the ports and the cargo throughput tonnage increases over the period. The trend of ship traffic calls to the Nigerian ports is also declining in the same direction as the shipping connectivity index. Recommendations were proffered in line with the findings of the study.

1. Introduction.

Studies by reference [1] defined liner shipping connectivity as the extent to which the seaports in a given Country or trading region is linked to global shipping networks, by which shippers in country or trading region access maritime transport services directly from the linked global shipping networks to the preferred seaports. Liner shipping connectivity provides information of the extent of access that shipper's in a giving Country of trading region have to global shipping services; as a result of the extent of the link between the seaports in the Country and the global shipping networks. The global shipping networks in the context of this study connotes the global liner shipping companies, freight forwarders, global ports, ship-owners, ship-operators and other ports and shipping sector practitioners. By implications, the liner shipping connectivity provides information of the extent of and level of direct connections between and among global ports making it possible for shippers to access direct shipping for example, from port of Shangai China, to Apapa port in Lagos, of Port of Sydney in Australia to Onne port in Nigeria [2; 3]. Seaports that lacking in shipping connectivity often times subject shippers to resort to the use of transshipment services where their shipments are usually transferred to another carrier or vessels than the original career/vessel. The implication is that shippers are subjected to multiple ports of call and careers before their consignments can arrive the desti-

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nation ports. This exposes the shippers to higher port costs and logistical costs with the associated travel time delays.

The World Bank report [4] and reference [5] are in agreement that Liner Shipping Connectivity Index (LSCI) for individual countries provides an understanding of level of connectedness of global seaports and individual countries to the global shipping networks. The LSCI serve as a measure of the extent to which seaports in individual countries are linked to global shipping networks, serving as an indicator of their maritime transport sector's strength. Reference [1] note that the LSCI was developed by the United Nations Conference on Trade and Development reports [6]; [4], based on the number of ships, container-carrying capacity, vessel size, service frequency, direct connections between countries, and shipping companies operating in a country's ports. The LSCI score is determined or generated for each year by comparing individual countries number of ships, container carrying capacity, vessel size, frequency of service, and extent of direct connections to other seaports 100 representing the highest average connectivity in the baseline year [6]. Thus, the LSCI score for a given Country gives an indication of the country's integration into global liner shipping networks, access to global markets (shipping import and export markets), performance of container seaborne trade, extent of ship-ownership (number and shipping tonnage/size), liner shipping frequency, etc.

The Liner Shipping Connectivity Index (LSCI) aims to capture the level of integration into the existing liner shipping network by measuring liner shipping connectivity. It can be calculated at the country and the port level. LSCI can be considered a proxy for accessibility to global trade through the shipping networks. The higher the index, the easier it is to access shipping networks and the greater the extent of access to a high capacity and frequency global maritime freight transport system and effectively participates in international trade. Therefore, LSCI is considered as a measure of both connectivity to maritime transport and extent of facilitation of shipping import and export trade. It serves as an indication extent of market coverage that container shipping lines (liners) by which they seek to maximize revenue. The index is calculated based on six major components: According to reference [6; 4], the LSCI score for ports in given maritime nations is influenced and/or determined by the parameters identified in table1 below:

Table 1: Determinant factors that influence the LSCI.

Factor(s):	Description:
Scheduled ship calls	Connotes the number of ships calling of frequency of services on a weekly basis to ports including exports, imports and transshipment operations.
Deployed capacity	Entails the total shipping capacity of the linked to the frequency of service in the port. The higher the import and export capacity, the greater the potentials to trade on the global markets.
Number of shipping companies and liner services	It indicates the number of carriers or shipping companies servicing the maritime transport needs of the Country or ports.
Average vessel size	Connotes the shipping tonnage or TEUs of existing vessels that serve the needs of the region/country. The higher the scale or size and number of TEUs conveyed to the economy the lower the shipping costs per TEU.
Directly connected ports	It entails the number of ports directly connected to the reference port/economy. a direct connection between ports is an indication of that container shipping trade carried between them cannot be transshipped.

Source: Reference [4].

From the foregoing, it is understandable that the extent of connectivity that a port have to the global shipping network and other ports can influence shipping costs for trading on specific shipping networks or links. For example, shippers in a Country/port with lower shipping may connectivity experience less access frequency of access to liner services as a result of lower frequency of service (schedules) and ship calls; presence of fewer carriers/shipping lines that supply shipping tonnage, and less directly connected ports. The implication is that shipping cost per TEU to such ports will increase and a result of less supply of liner services coupled with the existence of few operators. Similarly, poor or lower direct connectivity to other ports implies that shippers in the economy will resort to the use of transshipment services. This equally increases TEU shipping cost to the ports in economies with poor or lower LSCI. Similarly, the logistics performance of the ports in the economies with lower shipping connectivity index in terms of volume, tonnage and size of shipping import and export, port costs, port service time, among other metrics for assessing logistics performance may witness significant declining trends [7].

The concept of port logistics performance in the context of the study implies the extent of achievement of the objectives of implementation of logistical functions in the port. Since the implementation of logistical functions in a ports to achieve optimized port cost, improved tonnage or size of shipping import and export trade handled in the port, reduced/optimized port service time, improved port revenue, among other things. It implies that the volume of revenue generated by a port, the quantum of shipping import and export facilitated through the port, extent of delay in ship husbandry, extent of delay in cargo processing and delivery time, prevailing levels of port cost encountered by shippers, etc., form veritable proxies for understanding the performance of a given port system, following the implementation of port logistics functions and operations.

It is expected that while metrics for port logistics performance can be influenced by the shipping connectivity index of a given port. The extent of influence of these metrics on the LSCI have however not be investigated by available empirical studies. For example, higher port cost induced by increased port charges may influence ship-owner's port choice for ports with lesser charges. This will subsequently affect negative frequency of service, number of operational shipping companies and shipping capacity/tonnage as variables of shipping connectivity index. Similarly, it is in the interest of ports in a given economy to achieve higher connectivity to the global shipping networks of port, shipping companies, freight forwarders, carriers, ship-operators and ship owning companies, etc. This is because it will lead to improved performance of the terms in terms of shipping trade (export and import) handled, port revenue, job opportunity, and over economic development of the sector. However, this cannot be realized without a corresponding improvement in the factors that determine the shipping connectivity index/score as aforementioned. Port costs influenced by port charges, port service time influenced by ship turnaround time and cargo dwell time, shipping export and import trade volumes, etc., also influence the shippers and ship-owners port choice and subsequently the determinant factors of shipping connectivity while the ex-

tent of connectivity to global shipping networks influence the performance of the ports too.

However, the trend of connectivity of Nigeria ports for example to the global shipping networks relative to the trend of shipping export and import handling capacity of Nigerian, trend of port charges that shippers and ship-owners encounter in the ports, trend of service time experiences of shippers and ship-owners and the associated delays in cargo processing and ship-husbandry in Nigeria ports, has not been investigated in any available empirical literature. This specific knowledge is important for the purposes of laying the foundations for the improvement of the connectivity of Nigerian seaports to the global shipping networks. This is because, to achieve improved shipping connectivity, the Nigerian seaports must first address for example the challenges of arbitrarily high uncompetitive port charges with the consequent high port costs, elongated service time and delay in cargo processing and ship husbandry, and unfavorable shipping business environment prevailing in the Nigerian maritime sector. Addressing the above identified challenges will subsequently attract more shippers, ship-operators, carriers, ship-owning companies, increased frequency/schedule of service, improved trade capacity and finally improved connectivity to global shipping networks at the long-run.

This study therefore seeks to provide knowledge and information on the significance and extent of variations in the liner shipping connectivity index of Nigerian ports and the size of the TEU shipping export and import trade, port charges/cost, service time in ports, delay in ship-husbandry operations, delay in cargo/trade processing through the seaports measured by the cargo dwell time as basis over the years. It will also estimate the trend of connectivity of Nigerian seaports associated with trends of shipping import and export capacities, port charges/cost, service time in ports, among other port logistics performance indices. Some of the objectives addressed in the study include:

i. To determine the extent of variations in the connectivity of Nigeria seaports to the global shipping networks as a result of variations the shipping export and import capacities handled in the ports over the years
ii. To estimate the extent of variations in the connectivity of Nigerian seaports to global shipping networks relative to variations in trends of port charges and service time experiences of shippers and ship operators in the ports over the years
iii. To investigate the influences of delay in ship husbandry and cargo processing operations in Nigerian seaports on the extent of connectivity of the Nigerian ports to global shipping networks.
iv. To estimate the trend of connectivity of Nigerian seaports relative to the trend of shipping import cum export trade capacities of the economy and selected port logistics performance indicators.

In line with the objectives of the study, the research questions addressed in the study include:

i. What is the extent of variations in the connectivity of Nigeria seaports to the global shipping networks associated with variations the shipping export and import capacities handled in the ports over the years?
ii. What is the extent of variations in the connectivity of Nigerian seaports to global shipping networks relative to variations in trends of port charges and service time experiences of shippers and ship operators in the ports over the years?
iii. What is the extent of influences of delay in ship husbandry and cargo processing operations in Nigerian seaports on the extent of connectivity of the Nigerian ports to global shipping networks?
iv. What is the trend of connectivity of Nigerian seaports to global shipping networks relative to the trend of shipping import cum export trade capacities of the economy and selected port logistics performance indicators?

These are the questions which the study seeks to provide answers for purposes of laying a sound foundation for the improvement of the connectivity of Nigerian seaports to global shipping networks.

2. Literature Review.

References [8] did a study on determinants of bilateral liner shipping connectivity. The study investigated the relations between the bilateral liner shipping connectivity and its determinants. The study identified a set of possible trade predictors as proxies for connectivity to trade and shipping networks. It used the gravity model/equation of trade to analyze the data obtained [8]. The study determined a set of significant potential components factors that can indicate the bilateral connectivity in liner shipping [8]. The study found that only the liner shipping structure, significantly influence and determine the bilateral liner shipping connectivity index of a port [8]. The study recommends that in order to create a Liner Shipping Bilateral Connectivity Index (LSBCI) in the future, more components that significantly influence connectivity to shipping networks need to be determined focusing more on the route factors such as competition on a shipping route and the effects of barriers and bottlenecks in the shipping networks such as presence of canals on routes between two countries [8; 7].

Reference [9] also did a study on the determinants of liner shipping connectivity. The study examined the determinant of connectivity of about 100 maritime countries to global shipping networks. The study used a double-phase analysis approach employing technical panel estimation to arrive at the determinants. The study used the Mediterranean Sea, Red Sea, North Sea, Arabian Gulf, and the Caribbean Sea maritime regions to implement the study with data obtained from the UNCTAD's database over the period 2007-2014. UNCTAD's Liner Shipping Connectivity Index was used as the endogenous variable [10]. The study used 10 explanatory variables to measure the extent of variations in the Liner Shipping Connectivity Index (LSCI). The container transit time, container transport cost, the

Gross Domestic product (GDP), the containers per capita, ship-turnaround time in port, among other five variables that represent the logistics performance was used as the explanatory variables to explain the LSCI [10]. The findings of the study indicate that all the variables have positive correlation and impact on the LSCI of the regions. However, the impacts of the explanatory variables on the LSCI are disproportionately distributed among the regions just like there exist differences in in the LSCI of the maritime regions worldwide. The findings of the study have implications for decision-making by the stakeholders for prioritizing future investments in the shipping sector [10]

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Reference [11] evaluated liner shipping connectivity as determinant of trade. The study underscores the importance of shipping connectivity as a determinant of bilateral shipping export trade and presented empirical evaluation of relations between container shipping export trade and liner shipping connectivity from 2006 to 2013 [11]. The study used a probed gravity model approach that incorporates maritime distances between ports a explanatory variables for LSCI. The result and findings of the study indicate that the lack of direct sea connection between trading partners (countries) is associated with lower volumes of shipping export trade between the countries. The study further reveals that any additional transshipment operations between ports lead to a 40% lower shipping export trade values. It also shows that the extent of competition among carriers and the container vessel sizes in the economy influence bilateral shipping connectivity [11; 12].

Reference [13] did an empirical study on Performance measurement of the port logistics system. The study note the prominence of water transport in global economy and an overwhelming contribution to international trade by the carriage of averages of between 80% and 90% of commodity trading in recent time. Under these circumstances, the port acts as logistical center which is crossed each year by major commodity flows. The aim of the study was to determine a set of parameters in order to facilitate the assessment of the performance of port services provided to ships and goods. The study identified a set of parameters suggested by the authors for measuring logistics performance of ports based on their individual ability and need to improve performance of berths operations, especially productivity, by substantially increasing traffic by using facilities, existing human and material resources, possibly with some small-scale investments [13]. The study used mixed research methods comprised of survey and secondary data methods to structure port performance parameters into production parameters, service parameters, resource use parameters and productivity parameters. Port performance parameters were structured as follows: production indicators, service indicators, resource use indicators and productivity indicators. The study note that the quality of port services is an important criterion for port competitiveness and that the measurement of the quality of port services to its users (ship-owners, port operators, shippers, etc.) can be achieved through several parameters. It concluded that quality of port service to port users is the most important port performance measurement criterion and mostly refers to the total residence time of a vessel and trade in port[16]. Starting from the importance that the total residence time of a vessel in port has on dividing the quality of port services and the total cost of transport, the parameter was detailed in the following components: waiting time until operation, stationing time at berth, ship service time, stationing time in port after operation, total waiting time in port. Port practice emphasize that, in order to be meaningful, the above-mentioned components must be determined by type and group of cargoes, by groups of berths or by their specialization and possibly by type of vessel [13]. The average stationing time parameters, even if are determined under the conditions presented above, they provide only general overview of how the analyzed port operates. From the port's point of view, the ratios which are established between these parameters are more relevant and can give indications regarding the way the time of a vessel in port is used [13]. The study notes that these components must be presented in the same unit of measurement (hours or days), preferably in hours, and must be calculated for those vessels that have operated in the analyzed group of berths [13; 12].

The African Development Bank [14] did a report on Port Development in Africa in a view to providing historical perspectives and performance of African ports. The study notes that, approximately 80 percent of world merchandise trade carried by ships, maritime transport remains by far the most common mode of international freight transport. It is the backbone to facilitating international trade, offering the most economical and reliable way to move goods over long distances [14]. It opines that, for all countries, how ports perform is an essential element of overall trade costs. The overall trade cost in this case includes the cost associated with time delays in ports as well as dues and charges paid in the use of ports for trade facilitation [13; 15]. This is especially the case for Africa, as 15 of its countries are landlocked and face severe infrastructural and trade facilitation problems. According to ADB [14], for the landlocked nations, ports together with the inland waterway and land infrastructures (railroads and highways) constitute a crucial link to the outside world and to the global marketplace. As a result, high transport-related costs represent a fundamental constraint to these Landlocked Countries global competitiveness and their sustained economic growth [16; 17]. The study used secondary data sources to find that African ports became more congested following the rise in GDP growth and levels of global trade witnessed in most African countries in the years leading up to the global financial crisis of 2008 [17]. It also found that over the last decade, the cost of transiting trade through major ports in Africa and congestion related costs in Africa's ports has tripled, while containerization is still low and the inland transportation linkages remain weak [14; 17]. The study underscored the need for African governments to demonstrate political will necessary to confront this challenge, in a drive to improve port and other infrastructure [20].

Reference [18] examined container vessel turnaround times across the world in an attempt to investigate how port authorities and terminal administrations in global ports have been able to achieve reduced time of service and trade processing through ports. There exist several studies that have attempted to mea-

sure logistics performance and port efficiency, but curiously enough, these studies have never focused on turnaround times in ports as a component of port logistics performance indicator. Most studies have centered on queuing models of vessels in relation to port entrance channels and berth allocation and productivity, but there is a drastic lack of systematic reporting and analyses of ship turnaround times as port logistics performance indicator. The study by reference [18] aimed to fill this gap, by presenting an overview of time efficiency in world container ports in 1996, 2006, and 2011 [18].

Reference [18] explained that average turnaround time (ATT) of a container ship for example as it calls to a given port; 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. Other measures such as standard deviation could have been used, but the average value better matches the practical reality of port operations [18]. According to [18], the time range of one month was judged to be sufficient to provide a global snapshot of the situation at different years, in the month of May. The study thus used secondary data, descriptive and inferential statistics to determine at Country levels, the average turnaround time performance of global ports as a component of the logistics performance of the ports.

It is observed from [19] report on maritime transport that the distribution of the port LSCI reveals a high concentration level among a small group of highly connected ports that are the gateways and hubs of global trade. The countries with the highest LSCI values show active participation in shipping export trade to other countries. These include countries such as China, Hong Kong, Singapore, United Kingdom, Germany, South Korea, the United States, and Japan. Others are Malaysia, Spain, the United Arab Emirates, Egypt, and Oman which rank high following their roles as transshipment hubs [19].

Reference [1] underscore the justification for continuous assessment of the trends in the maritime markets and the liner shipping connectivity index. This according to reference [1] is to continually provide the empirical information required by maritime nations to improve their region's connectivity to global shipping networks which have implications on their access to global markets, economy and sustainable economic development.. The study opined that the best-connected countries worldwide in terms based on the shipping connectivity index (LSCI) comprised of the seven Asian countries (China, South Korea, Singapore, Japan, Malaysia, Vietnam and Hong Kong), the United States of America, and two European countries.). UNCTAD [7] statistics reveal that while China has the best liner shipping connectivity in the World in 2023, it is followed by South Korea, Singapore, and the U.S.A., in that order. Spain is adjudged to be the best-connected European country and ranks as number eight most connected country globally. Reference [7] reports observed South-Korea's LSCI increased by 6.5% between first quarter of 2024 and first quarter of 2023. Japan and China also had respective of 4.8% and 2.7% increases in LSCI over the same period. Malaysia, Spain, Singapore, and Vietnam each had 1% increase in LSCI between the first quarter of 2023 and first quarter of 2024 while the Netherlands and Hong Kong had respective of 3.3% and 3.5% decreases in liner shipping connectivity between first quarter of 2023 and 2024 [7]. The increase in LSCI of the aforementioned countries is associated with the increasing trend in shipping export and import volumes trading between it and other countries linked to it in bilateral trade relationships, increase in container shipping capacity cum vessel size, improved port logistics performance of the seaports among other factors. This implies that the logistics performances of seaports have influences on the extent of its connectivity to global shipping networks. The report also suggests positive improvement in the connectivity of Sub-Saharan African Countries with the best-connected sub-Saharan African countries experiencing major rise in connectivity. For example, Nigeria's connectivity to shipping networks rose from a lower LSCI score to about 24.6% between the first quarter of 2023 and 2024. Morocco, Egypt, South Africa, Djibouti and Togo have the highest connectivity to global shipping networks in Africa with respective LSCI of 71.5, 70.3, 40.1, 37.0 and 35.9 in 2018 while Nigeria had LSCI score of 18.93 in the same year. Compared with five years ago (2019), the scale of increase in four of the five best-connected countries in sub-Saharan Africa has been impressive [20]

Although the LSCI of Nigeria has improved between 2018 and 2024, it not clear whether the parameters of port logistics performance and volumes of shipping import and export trade of the country followed similar trend of improvement over the years. Similarly, available empirical studies have not be able to provide knowledge of the extent of variations in the connectivity of Nigerian ports to global shipping networks associated with changes in Nigeria's shipping export and import trade volumes and port logistics performance indicators. These are the knowledge gaps which this study is to address in order to provide basic information needed by stakeholders in the shipping and ports sector, for making investment decisions that will ensure sustainable improvement in the connectivity of Nigerian ports to global shipping networks.

3. Data and Methods.

In order to achieve the objectives the study, quantitative research design method was used. Time series secondary data on the shipping connectivity index (LSCI) of Nigeria was collected from the UNCATD report on maritime transport [21]. Secondary data on the shipping export trade (TEU) and import trade handled in the seaports between 2007 and 2023 were collected as proxies for the shipping trade capacity of the country over the period between 2006 and 2023 while time series data on ship-turnaround time and cargo dwell time in ports were collected as proxies for service time in ports. The ship turnaround time and cargo dwell time respectively represent the lead time between ship arrival and departure in port; and time between the discharge of cargo in port and the delivery of the cargo away from the port terminal to the shipper's destination after clearing. Ship dues, wharfage and pilotage rates charged by ports over the period between 2006 and 2023 were collected from the Nigerian ports authority as proxies for cost of per unit of service consumed by shippers and ship-operators, when in

Nigerian ports. Each dataset covered a period of period of 18 years from 2007 and 2023. The difference between the ship turnaround time in Nigerian ports and the global cargo standard dwell time benchmark for container vessels was determined as the extent of delay faced by ship-operators in Nigerian ports over the period. Similarly, the difference between the average cargo dwell time period (in days) in Nigerian and the global port sector cargo dwell time standard benchmark of 4 days was determined as the extent of delay experienced by shippers in Nigerian ports in processing container seaborne trade to the shipper's. All of the port charges aforementioned, which indicate the trend of port costs, service time, delay in ship husbandry and trade processing, volume and tonnage of trade handled over the period, etc., serve as indicators of the p\logistics performance of the Nigerian ports sector which are used as explanatory variables for the connectivity of the Nigerian ports to global shipping networks. The Liner Shipping Connectivity Index (LSCI) was used as the dependent variable.

The methods of difference of means and multiple regression analysis were used to analyze the data obtained. Trend analysis was also used to analyze the dataset in order to determine the trend of liner shipping connectivity index in relation to the trend of port logistics performance in Nigeria over the period. The model specifications are as shown below:

$$\begin{aligned} \mathrm{LSCI}_t = {} & \beta_0 + \beta_1 \mathrm{TEUEXP}_t + \beta_2 \mathrm{TEUIMP}_t + \beta_3 \mathrm{PILOTAGE}_t + \beta_4 \mathrm{CARPUT}_t \\ & + \beta_5 \mathrm{SHPTRAFIC}_t + \beta_6 \mathrm{STRT}_t + \beta_7 \mathrm{DELAYSHIPHUSBANDRY}_t \\ & + \beta_8 \mathrm{DELLTIME}_t + \beta_9 \mathrm{DELAYTRADEPROCESSING}_t \end{aligned} \quad (1)$$

Where:

$\boldsymbol{\beta_0}$ **=** regression constant.

$\boldsymbol{\beta_1 - \beta_9}$**=** coefficients of regression.

LSCI$_t$ = Liner shipping connectivity index scores for Nigerian ports over the period.

TEUEXP = Volume of export shipping trade (TEU) handled in Nigerian ports over the period.

TEUIMP = Volume of import shipping trade (YEU) handled in Nigerian ports over the period.

PILOTAGE = pilotage rates paid per meter of pilotage service by ship-operators to the NPA as port charges.

CARPUT = cargo throughput tonnage handled in Nigerian ports over the period.

SHPTRAFIC = ship traffic calls to Nigerian ports over the period.

STRT = ship turnaround time in Nigerian ports as a measure of service time enjoyed by ship-operators in ports over the period.

DELAYSHIHUSBANDRY = extent of delay experienced by ship operators between entry and departure in Nigerian ports over the period.

DELLTIM = cargo dwell time in Nigerian ports as a measure of service time experiences of shippers in Nigerian ports.

DELAYTRADEPROCESSNG = extent of delay experienced by shippers in processing trade in Nigerian ports.

Trend analysis was also used to carry-out further analysis on the dataset obtained. The trend analysis method was used to examine the trend of Nigeria's Liner Shipping Connectivity Index data relative to the trend of each identified explanatory variable. The result of the study provides evidence on whether the LSCI score of Nigerian ports is increasing over the period relative to the trend of the explanatory variables, or otherwise. In trend analysis, time (counting in years) is the explanatory variable while LSCI for example is the dependent variable.

For example, the trend of LSCI over the 18 years period covered in the study is determined using equation (2) below:

$$\mathrm{LSCI}_t = \alpha + b_1 X_1 + e \quad (2)$$

Where:

$\boldsymbol{\alpha}$ = regression constant.

$\mathbf{b}_1$ = coefficients of regression indication the trend and rate of change.

$\boldsymbol{X}$= time in years.

t = period covered in the study = 18 years.

Similarly, the trend of shipping export trade (TEU) handled in Nigerian ports over the period is:

$$\mathrm{TEUEXP}_t = \alpha + b_1 X_1 + e \quad (3)$$

The trends of all the other explanatory variables were also determined and compared with the trend of the connectivity of Nigerian seaports to global shipping networks between 2006 and 2023.

4. Results and Discussion.

Table 2: Average Throughput Tonnages and TEU of Shipping Export and Import Trade cum Connectivity of Nigerian Ports between 2006 and 2023.

	N	Range	Minimum	Maximum	Mean	Std. Deviation
PILOTAGE	18	7.92	71.28	79.20	77.4400	3.38812
SHIPDUES	18	.00	280.80	280.80	280.8000	.00000
HARBOURDUESEXP	18	.00	550.80	550.80	550.8000	.00000
HARBOURDUESIMP	18	.00	672.00	672.00	672.0000	.00000
LSCI	18	28.97	76.18	105.15	87.9228	9.09004
Valid N (listwise)	18					

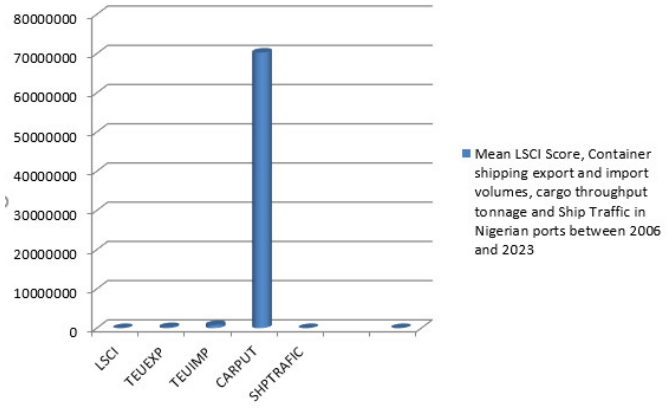
Source: Author's calculation.

Table 2 above shows the result of the mean scores of Liner shipping connectivity index (LSCI) of Nigerian ports, the TEU container shipping export (TEUEXP) and import trade (TEUIMP) volumes cum cargo throughput tonnage(CARPUT) handled in Nigerian ports and the ship traffic calls (SHPTRAFIC) to Nigerian ports as indicators of shipping trade capacity of the Nigeria ports over the period.

The result indicates that with TEU shipping export trade, TEU shipping import trade, cargo throughput tonnage and ship traffic call respective averages of 233682.06 TEUs, 785562.83 TEUs, 70246642.50 Tons, and 4515.89 vessels handled in the seaports per annum between 2006 and 2023; the Liner Shipping Connectivity index of Nigerian ports is an average of 87.92 per annum over the same period. The range which indicates the difference between the highest and least values of the parameters indicates that the difference between the highest and least

LSCI score achieved by Nigerian ports over the period is 28.97, when TEU shipping export trade, TEU shipping import trade of Nigerian ports, cargo throughput tonnage and the ship traffic handled in Nigerian ports have ranges of 900342 TEUs, 652761 TEUs, 78207200 tons and 2110 vessels. This implies that variations or differences in volumes of container shipping export and import trade volumes carried by ports, cargo throughput capacity of ports, and ship traffic calls handled by ports actually lead to variations or differences in the connectivity of the seaports to global shipping networks measured by the LSCI. The significance and extent of the variations in the connectivity of seaports to global shipping networks associated with changes in values of the container shipping capacity, cargo throughput tonnage and ship traffic handled in the ports is further examined in subsequent sections of this study. Figure1 below is a bar chart comparing the LSCI score, container shipping export and import trade volumes, cargo throughput tonnage and ship traffic of Nigerian ports per annum between 2006 and 2023.

Figure 1: Mean LSCI Score, Container shipping export and import volumes, cargo throughput tonnage and Ship Traffic in Nigerian ports between 2006 and 2023.



Source: Authors.

Table 3: Average Amounts Charged Per Service Type by the Nigerian Ports Authority Indicating the Trends of Port Cost and the Associated Connectivity of the Ports to Shipping Networks between 2006 and 2023.

	N	Range	Minimum	Maximum	Mean	Std. Deviation
PILOTAGE	18	7.92	71.28	79.20	77.4400	3.38812
SHIPDUES	18	.00	280.80	280.80	280.8000	.00000
HARBOURDUESEXP	18	.00	550.80	550.80	550.8000	.00000
HARBOURDUESIMP	18	.00	672.00	672.00	672.0000	.00000
LSCI	18	28.97	76.18	105.15	87.9228	9.09004
Valid N (listwise)	18					

Source: Author's calculation.

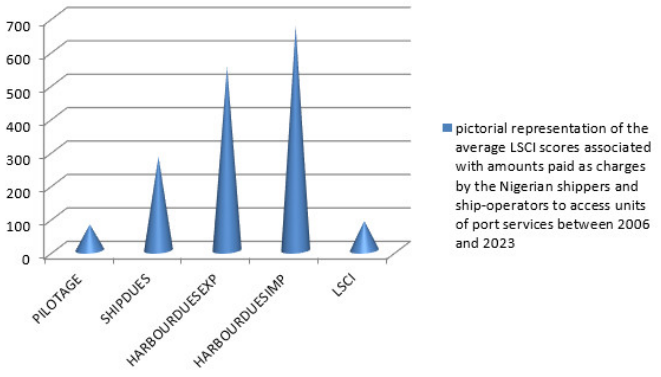
Table3 above shows the average values of port charges paid to shippers and ship-operators to the Nigerian Ports Authority (NPA) per service type and the associated level of connectivity of the Nigerian ports to global shipping network over the period. The result shows that the mean pilotage rates paid by ship operators per meter of pilotage services are 77.44 naira. Similarly, the average amount paid as ship dues per Gross Registered Tonnage (GRT) by ship operators between 2006 and 2023 is 280.80 naira per GRT.

The mean amount paid as harbor dues by shippers per ton of import and export trade delivered through the ports is 672.00/ton and 550.00/ton respectively, while the Liner Shipping Connectivity Index is an average of 87.92 per annum over the period. The range which indicates the difference between the highest and least values of the parameters over the period shows that while the ship dues, harbor dues for import trade and harbor dues for export trade is each 0.00, indicating that each remained constant or unchanged over the period, the pilotage rate has a range of 7.92 naira while the LSCI has a range of 28.97.

The implication is that variations and differences in pilotage rates charged by the NPA to ship operators over the period was associated with variations in the connectivity of the Nigeria seaports to global shipping networks, measured by the Liner Shipping Connectivity Index. The findings of the study also reveal that, when the ship dues and import cum export harbor dues over the period remain unchanged (constant), the Liner Shipping Connectivity Index of the Nigerian ports witnessed variations, indicating that, the changes in volumes of container shipping import and export trade, cargo throughput tonnage handled by ports, ship traffic calls handled in ports, influence the directions of changes/variations in the connectivity of the seaports to global shipping networks more than port charges. Port charges may not necessarily be considered determinant factors of connectivity to global shipping networks.

The extents of the effects of these parameters are presented in subsequent sections of this work. Figure2 below shows the pictorial representation of the average LSCI scores associated with amounts paid as charges by the Nigerian shippers and ship-operators to access units of port services between 2006 and 2023.

Figure 2: Pictorial representation of the average LSCI scores associated with amounts paid as charges by the Nigerian shippers and ship-operators to access units of port services between 2006 and 2023.



Source: Authors.

Table 4: Average Service Time Experiences of Shippers and Ship-operators in Nigerian Ports and the Associated Shipping Connectivity between 2006 and 2023.

	N	Range	Minimum	Maximum	Mean	Std. Deviation
LSCI	18	28.97	76.18	105.15	87.9228	9.09004
STRT	18	2.02	3.63	5.65	4.4903	.47715
DWELLTIME	18	4.70	15.30	20.00	17.7444	1.32497
DELAYSHIHUSBANDRY	18	1.97	2.36	4.33	3.1939	.45985
DELAYTRADEPROCESSING	18	4.70	11.30	16.00	13.7444	1.32497
Valid N (listwise)	18					

Source: Author's calculation.

The result on table 4 above shows the average service time experiences of the shippers and ship owners in Nigerian and the associated liner shipping connectivity index score over the period. The findings suggest that the lead-time between the arrival of vessels in the port and the departure from the port measured by the ship turnaround time (STRT) is an average of 4.5 days per annum over the period with standard deviation of 0.47 while the lead-time between the discharge of cargo (export and import trade) in port terminals and the delivery to the shippers destinations away from the ports after clearance from the customs and authorities is 17.7 days per annum over the period with standard deviation of 1.3.

Similarly, the average delay experienced by ship-owners (ship-operators) and shippers in ship husbandry and trade processing operations in the ports is 3.2 days and 13.7 days respectively with respective standard deviations of 0.46 and 1.32. The associated liner shipping connectivity index of the ports given the average service time experiences of shippers and ship-owners in the port is 87.92. The range of each of the parameter estimates suggests that changes or variations in service time experiences of shippers and ship-owners cum operators in ports also influences the variations in the connectivity of Nigerian seaports to the global shipping networks. The significances, directions and extents of these influences is determined in the subsequent sections of the study.

The findings of the study on table 5 shows the relationship between Liner Shipping Connectivity Index (LSCI) and the TEU container shipping export and import trade, cargo throughput tonnage handled in Nigerian ports, ship traffic calls to Nigerian ports, service time experiences of shippers and ship-owners in Nigerian ports and the delay experiences of shippers and ship-owners in Nigeria ports over the 18 years period covered in the study. The relationship which indicates the influences of Nigerian ports logistics performance measured by the explanatory variables on the LSCI score of Nigeria is:

$$\begin{aligned} \mathrm{LSCI}_t = & -172.696 + 6.420\times10^{-6}\,\mathrm{TEUEXP}_t + 2.926\times10^{-5}\,\mathrm{TEUIMP}_t \\ & + 2.157\,\mathrm{PILOTAGE}_t + 1.583\times10^{-8}\,\mathrm{CARPUT}_t + 0.012\,\mathrm{SHPTRAFIC}_t \\ & + 59.844\,\mathrm{STRT}_t - 62.438\,\mathrm{DELAYSHIPHUSBANDRY}_t \\ & - 39.160\,\mathrm{DELLTIME}_t - 0.516\,\mathrm{DELAYTRADEPROCESSING}_t \end{aligned} \tag{4}$$

The implication is that while a unit increase in TEU container shipping export trade causes a 6.420E-006 increase in liner shipping connectivity of Nigerian port over the period; a unit increase TEU shipping import trade handled in the ports causes a 2.926E-005 units increase in LSCI score of Nigerian ports. A unit increase in the pilotage rates charged by the Nigerian Ports Authority per meter of pilotage services purchased by ship operators causes 2.157 units increase in the LSCI of Nigeria port while a unit increase in the cargo throughput tonnage handled in the ports increased LSCI of the ports by 1.583 units.

Table 5: Extent of Influences of Port Logistics Performance on the Connectivity of Nigerian Ports to Global Shipping Networks.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.860[a]	.739	.508	6.37738	1.138

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	1038.651	8	129.831	4.192	.042[b]
	Residual	366.038	9	40.671		
	Total	1404.689	17			

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-172.696	141.962		-1.216	.255
TEUEXP	6.420E-006	.000	.180	.857	.414
TEUIMP	2.926E-005	.000	.562	1.410	.192
PILOTAGE	2.157	1.594	.804	1.353	.209
CARPUT	1.583E-008	.000	.032	.143	.889
SHPTRAFIC	.012	.004	.763	2.942	.016
STRT	59.844	65.712	3.141	.911	.386
DELAYSHIHUSBANDRY	-62.438	68.827	-3.159	-.907	.388
DELLTIME	-39.160[b]	3.581	-.067	-1.112	.298
DELAYTRADEPROCESSNG	-.516	1.762	-.075	-.293	.774

Source: Author's calculation.

Similarly, as the ship traffic size handled in the ports increase by a unit, the connectivity of the ports to global shipping networks increased by 0.012 units while the connectivity of the ports to global shipping networks increases by 59.84 units with a unit increase in service time experiences of the ship-owners, measured by the ship turnaround time. A unit increase in delay experienced by ship-owners in the ports leads to a 62.438 units decrease in liner shipping connectivity index (LSCI) while a unit delay in the time of processing shipping export and import trade in ports leads to about 0.517 units decline in LSCI of Nigerian seaports. Lastly, a unit's increase in cargo dwell as a measure of service time experiences of shippers in the ports leads a 59.160 units decline in the connectivity of Nigerian seaports to global shipping networks over the period covered in the study.

The coefficient of R which measures the extent of correlation between the LSCI, and maritime/shipping trade handled in the Nigerian ports, service time experiences of shippers cum ship-operators in ports and the charges paid by the shippers cum ship-operators as indicators of port logistics performance is 0.860. This implies the existence of about 86% positive correlation between LSCI of Nigerian ports and maritime/shipping trade handled in the Nigerian ports, service time experiences of shippers cum ship-operators in ports and the charges paid by the shippers cum ship-operators as indicators of port logistics performance. This corroborates the findings of reference [1] that the shipping capacity of a region and her ship-ownership

strength cum capacity of vessels owned by shipping companies operating in the region influence the trend of liner shipping connectivity of the region.

The R-square coefficient which measures the explanatory power of the model is 0.739. This indicates that about 74% variations in the Liner Shipping Connectivity Index (LSCI) of Nigeria ports is caused or explained by the volume of TEU container shipping export and import trade of the ports, the cargo throughput tonnage of the ports, the ship traffic calls to the ports, the port rates/charges (pilotage charges) paid by port users, the service time experiences of the shippers cum shipowners measured by the cargo dwell time and ship turnaround time, the delay experienced by the shippers and ship-operators in the ports. Since these parameters form the basis for assessing and understanding port logistics performance, it is inferred that about 74% variations in LSCI of Nigerian ports is influenced by the variables of port logistics performance in the Nigerian port sector.

The test of significance of the influence of the variables of port logistics performance on the LSCI of Nigerian ports indicate an f-score of 4.192, alpha value of 0.05 and p-value of 0.042. Since the alpha value is greater than the p-value (0.05>0.042), the study infers that port logistics performance measured using the volumes of TEU shipping export and import trade handled in the ports, the cargo throughput tonnage handled in the ports, ship calls to the Nigerian ports, pilotage rates charged by the NPA, ship turnaround time cum cargo dwell time in the time, delay in ship husbandry operations in the port and delay associated with trade processing in the ports. The test of the extent of significance of the effects of trade parameters such as the volumes of TEU shipping export and import trade handled in the port, cargo throughput tonnage and ship traffic calls to the ports on the connectivity of the ports to global shipping networks indicates that only ship traffic calls (SHPTRAFIC) to Nigerian ports have t-score of 2.942 and p-value of 0.016. Since 0.016<0.05; it is inferred that ship traffic calls to Nigerian ports is the only trade related parameter that significantly influence the trend of Nigeria's LSCI. For port pricing parameters the t-score for pilotage rate charged by port operators is 1.35 with p-value of 0.209; since the p-value is greater than the alpha value of 0.05 (0.209>0.05), it is inferred that pilotage rates paid by ship-operators does not significantly influence the LSCI.

Lastly, the test of significance also indicates that service time in the ports measured by the ship-turnaround time; cargo dwell time, delay in ship husbandry operations and delay in trade processing each have no significant effects on the trend of Liner Shipping Connectivity in Nigerian ports. These corroborates the findings of [11]; [12] and [5] who found that ship calls cum size of ships in terms of Gross Registered tonnages (GRT) constitute a major determinant of liner shipping connectivity index.

The trend of liner Shipping Connectivity Index (LSCI) in Nigeria relative to the trend of volumes of TEU shipping export and import trade handled in the ports, cargo throughput tonnage, ship traffic size, ship turnaround time, cargo dwell time, pilotage rates charged by the NPA, delay in ship husbandry and delay in trade processing is shown in table 6.

Table 6: Rate of Change Coefficients indicating the Trend of Liner Shipping Connectivity of Nigerian Ports to Global Shipping Networks Relative to the Trends of Port Logistics Performance Indicators between 2006 and 2023.

Parameter/variable(s)	Constant term(s)	Regression/Rate of change coefficient(s) over time (T)	t-score	p-value/sign
CARPUT (Cargo throughput tonnage)	52564494.87	1872227.396	2.533	.022
TEUEXP (TEU container export shipping trade)	16395.57	23006.804	2.174	.045
TEUIMP (TEU container shipping import trade)	526439.99	27436.537	5.956	.000
SHPTRAFIC (ship calls to Nigerian ports)	5217.888	-74.329	-3.586	.002
PILOTAGE (pilotage charge per meter)	73.061	.464	4.186	.001
STR (ship turnaround time)	4.385	.011	.499	.624
DWELLTIME	15.811	0.205	5.654	.000
DELAYTRADEPROCESSING	11.811	0.205	5.654	.000
DELAYSHIHUSBANDRY	3.103	0.010	.446	.661
LSCI (Liner Shipping Connectivity Index)	94.176	-.662	-1.668	.115

Source: Author's calculation.

The result and findings of the study shown on table 6 indicate that the coefficient of the rate change of Liner Shipping Connectivity Index of Nigerian seaports over the 18 years period covered in the study is -0.662. The negative coefficient of the average rate of change indicates that there is a declining trend in the connectivity of Nigerian seaports to global shipping networks. It implies that the connectivity of Nigerian ports to global shipping networks declines by an average of 0.662 per year over the period. The equation depicting the trend of connectivity of Nigerian seaports to global shipping networks is:

$$\mathrm{LSCI}_t = 94.176 - 0.662\,X_t \tag{5}$$

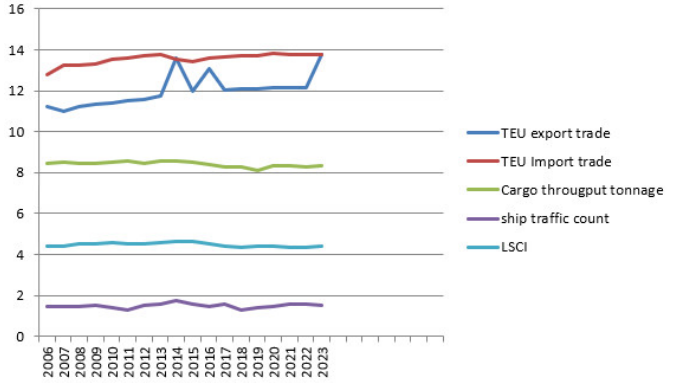
This implies that a unit increase in time (yearly) between 2006 and 2023, the LSCI of Nigerian ports decreases by 0.662 units. However, the t-score of 1.67 and p-value of 0.115 at alpha value of 0.05 indicates that the rate of decline in the trend of LSCI over the period is not significant.

The rate of change coefficients of cargo throughput tonnage, volumes of TEU shipping import and export trade and ship traffic calls to Nigerian ports are 1872227.396, 27436.54, 23006.804 and -74.33 respectively. The positive coefficients of cargo throughput tonnage of the ports, volumes of TEU shipping export and import trade indicates that these is increasing trend in cargo throughput tonnage, volumes of TEU export and import trades handled in the ports over the period. Therefore, as the trend of TEU import and export trade handled in the ports and the cargo throughput tonnage increases, the associated trend of liner shipping connectivity index is increasing over the same period. While the LSCI is decreasing, though not significantly at the average rate of 0.662 per annum over the period, the TEU shipping export trade, import trade, and cargo throughput tonnage increases significantly at respective average rates of 23006.804, 27436.54 and 1872227.396 per annum over the same period.

However, the trend of ship traffic calls to the ports is decreasing significantly at an average of 74.33 units per annum. The implications is that as ship traffic calls to Nigerian seaports experiences declining trend, the liner shipping connectivity in-

dex of Nigerian ports also experiences a declining trend in the same direction with the ship traffic calls. The trend lines potted for each variable by transforming the raw data into natural log equivalents in order to achieve a common scale of measurement is shown in figure 3:

Figure 3: The trend lines of TEU shipping export trade, import trade, cargo throughput tonnage, ship traffic count and liner shipping connectivity index of Nigerian ports.



Source: Authors.

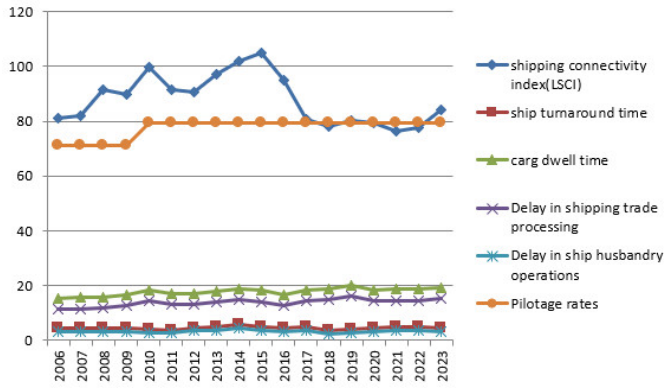
The result and findings of the further reveal that coefficient of average rate of change of pilotage charges paid per meter of pilotage services consumed by ship-operators in Nigeria ports over the period is 0.464. This indicates that the trend of trend of pilotage rates charged by the NPA over the period covered in the study increased by an average of 0.464 naira per meter of pilotage services rendered to ship-operators while the trend of LSCI decreased over the same period. The equation depicting the trend of pilotage rates charged by the NPA over the period is:

$$\text{PILOTAGE}_t = 73.061 + 0.464\,X_2 \qquad (6)$$

The coefficients of average rate of change of ship turnaround time, cargo dwell time, delay in ship husbandry and delay in trade processing which indicates the trends of each of the parameters of shippers and ship-owners service experiences in the port are 0.011, 0.205, 0.010 and 0.205 respectively. This implies that while each of ship turnaround time, cargo dwell time, delay in ship husbandry and delay in trade processing as parameters of service time experiences of shippers and ship-owners in the Nigerian seaports is increasing over the period, the liner shipping connectivity index of Nigeria ports is decreasing. This implies that increasing trend in the service time spent by shippers and ship-owners cum operators in ports is associated with decreasing trend in the connectivity of the seaports to global shipping networks. The policy implications is that to achieve higher connectivity to global shipping networks, port authorities and terminal operators must develop and implement policies that limit the amount of time spent in ports by shippers and ship-owners in order to optimize the service time experiences of the port users. Delays in ship husbandry and trade processing must also be addressed by the use of port policies.

The findings reveal that while each of ship turnaround time, cargo dwell time, and delay in trade processing and delay in ship husbandry increased by respective averages of 0.011, 0.205, 0.205 and 0.010 per annum over the period while the connectivity of the Nigerian seaports to global shipping networks declines by an average of 0.662 per annum. The cargo dwell time and delay in the processing of shipping trade in the ports had significantly increasing trends with p-values of 0.00 each while ship turnaround time and delay in ship husbandry operations had non-significant increases in trend. Figure 4 shows the trend lines of parameters of service time experiences of shippers and ship-owners in Nigerian ports over the period and the associated liner shipping connectivity index.

Figure 4: Trend lines of parameters of service time experiences of shippers and ship-owners in Nigerian ports over the period and the associated liner shipping connectivity index.



Source: Authors.

The result and findings of the study corroborates the findings of references [1; 5; and 20] that elongated service time experiences of shippers, ship-owners and ship-operators in Nigerian ports and the port cost discourage shippers and ship-owners cum operators from assessing and using Nigerian ports.

Conclusions.

In answer to the research questions and the objectives of the study, the study concludes in line with the findings that the extent of correlation between the LSCI and maritime/shipping trade handled in the Nigerian ports, service time experiences of shippers cum ship-operators in ports and the charges paid by the shippers cum ship-operators as indicators of port logistics performance is 0.860. This implies that there exist 86% positive correlation between LSCI of Nigerian ports and maritime/shipping trade handled in the Nigerian ports, service time experiences of shippers cum ship-operators in ports and the charges paid by the shippers cum ship-operators as indicators of port logistics performance.

The R-square coefficient of the model of relationship between LSCI and port logistics performance indicators is 0.739; which indicates that 74% variations in the Liner Shipping Connectivity Index (LSCI) of Nigeria ports is explained by the volume of TEU container shipping export and import trade of the

ports, the cargo throughput tonnage of the ports, the ship traffic calls to the ports, the port rates/charges (pilotage charges) paid by port users, the service time experiences of the shippers cum ship-owners measured by the cargo dwell time and ship turnaround time, the delay experienced by the shippers and ship-operators in the ports. Since these parameters form the basis for assessing and understanding port logistics performance, it is inferred that about 74% variations in LSCI of Nigerian ports is influenced by the variables of port logistics performance in the Nigerian port sector.

The test of significance of the influence of the variables of port logistics performance on the LSCI of Nigerian ports indicate an f-score of 4.192, alpha value of 0.05 and p-value of 0.042. Since the alpha value is greater than the p-value (0.05>0.042), it infers that port logistics performance measured using the volumes of TEU shipping export and import trade handled in the ports, the cargo throughput tonnage handled in the ports, ship calls to the Nigerian ports, pilotage rates charged by the NPA, ship turnaround time cum cargo dwell time in the time, delay in ship husbandry operations in the port and delay associated with trade processing in the ports.

The coefficient of the rate change of Liner Shipping Connectivity Index of Nigerian seaports over the 18 years period covered in the study is -0.662. This indicates that there is a declining trend in the connectivity of Nigerian seaports to global shipping networks. It implies that the connectivity of Nigerian ports to global shipping networks declines by an average of 0.662 per year over the period. By implication, per unit increases in time (yearly) between 2006 and 2023, the LSCI of Nigerian ports decreases non-significantly by 0.662 units.

The trend of TEU import and export trade handled in the ports and the cargo throughput tonnage increases over the period while the associated trend of liner shipping connectivity index is decreasing over the same period. While the LSCI is decreasing, at the average rate of 0.662 per annum over the period, the TEU shipping export trade, import trade, and cargo throughput tonnage increases significantly at respective average rates of 23006.804, 27436.54 and 1872227.396 per annum over the same period.

The trend of ship traffic calls to the ports over the period is decreasing significantly at an average of 74.33 units per annum while the trend of liner shipping connectivity index of Nigerian ports is also declining in the same direction.

The trend of pilotage rates charged by the NPA over the period covered in the study increased by an average of 0.464 naira per meter of pilotage services rendered to ship-operators while the trend of LSCI is declining over the same period.

The coefficients of average rate of change of ship turnaround time, cargo dwell time, delay in ship husbandry and delay in trade processing which indicates the trends of each of the parameters of shippers and ship-owners service experiences in the port are 0.011, 0.205, 0.010 and 0.205 respectively. This implies that while each of ship turnaround time, cargo dwell time, delay in ship husbandry and delay in trade processing as parameters of service time experiences of shippers and ship-owners in the Nigerian seaports is increasing over the period, the liner shipping connectivity index of Nigeria ports is decreasing.

Recommendations.

It is recommended in line with the findings of the study that:

i. The performance of the ports in the variables/parameters of port logistics performance such as volumes of TEU container imports and exports handled, cargo throughput capacity, ship traffic calls, service time in ports, extents of delay in vessel husbandry cum trade processing and port charges jointly have significant influence on the connectivity of the Nigerian ports to the global shipping networks. It is therefore recommended that the port operations policies must be tailored towards improving these parameters of port logistics performance in order to improve the connectivity of the ports to the global shipping networks.

ii. The ship traffic calls to the Nigerian ports is observed to have the most individual significant influence of the liner shipping connectivity index of Nigerian ports. It is recommended in line with the findings of the study that port operations policies and port traffic models that aim at attracting higher ship traffic calls to the ports must be developed and implemented in order to improve the connectivity of the Nigerian ports to the global shipping networks.

iii. Since increasing trend in delay in ship husbandry operations experienced by ship-owners and operators in Nigerian ports is associated with declining trend in the connectivity of the ports to global shipping networks, it is recommended that port authorities and terminal operators should deploy port automation systems to eliminate and/or reduce delay in ship husbandry operations in Nigerian ports.

iv. Lastly, port authorities and terminal operators should implement port automation systems in cargo clearing processes in the ports in order to reduce the delay usually experienced by shippers in processing trade in Nigeria seaports. This is because the increasing trend in delay in trade processing in the ports over the years is associated with declining trend in the connectivity of the Nigerian ports to global shipping networks.

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