ASSESSMENT OF IMPACT OF CONCESSIONON NIGERIAN THE PRODUCTIVITY OF NIGERIAN SEAPORTS

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CERTIFICATION

This is to certify that this work **"Assessment of the Impact of Concessioning on the Productivity of Nigerian Ports"** was carried out by NZE, OBIAGELI NNEKA (Registration Number 20114771228) in partial fulfillment for the award of the degree Ph.D in Transport Management Technology in the Department of Transport Management Technology of the Federal University of Technology, Owerri, Imo State, Nigeria.

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DEDICATION

To my parents Mr. and Mrs. Green Nze and Ejike Celestine Okezie

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ABSTRACT

This study assessed the productivity of Nigerian ports. The study adopted *ex post facto* design. Using ship traffic, vehicle traffic, berth efficiency, turnaround time as input explanatory variables and output factors as average throughput to compare the pre concession and post concession. The six Nigerian ports: Tincan Island Ports, Apapa Port, Port of Delta Warri, Calabar Port, Rivers Port and Onne Port were sampled. A survey was conducted on 50 stakeholders in the port sector to determine the factors contribute to port's productivity. These factors were examined for each of the ports under study and were analysed with t-test using a hypothesized mean. Secondary data was extracted from National Bureau of Statistics (NBS) Annual Reports, Nigeria Port Authority (NPA) Annual Reports, and Central Bank of Nigeria (CBN) Annual reports.From the t-test, the factors with p-value less than 0.05 were the significant ones. Among the factors influencing the productivity of the ports in Nigeria are predetermined operational problems, frequent congestion of ship, poor inboard services and high cost of documentation etc. Using Data Envelopment Analysis as the fundamental analytical tool to test the most efficient port before and after the concession period. The result reveals that Onne Port and Tin Can Island Port productivity increased significantly after the concession. However, Rivers, Delta, Calabar and Apapa Ports experienced unstable efficiencies in the post concession era. The implication is that concession of Nigerian Ports have favourable effect on Onne Port and Tin Can Island Port and less favourable to Rivers, Delta, Calabar and Apapa Ports. In line with the result, it was recommended that since it was observed that there was element of improvement in the post-concession period of operation at Nigerian Ports, we recommend adequate provision of superstructure for the private operators to utilized them and compliment their infrastructure with them towards the achievement of goals of concession. However, concessioning is a good instrument to improve productivity in Nigerian Ports and requires continuity among Nigeria Ports. We recommend adequate and necessary cargo handling equipment at Ports that experienced fluctuating efficiency.

Keywords: Berth Efficiency, Ship Traffic, Concession, Data Envelopment Analysis (DEA), Port Productivity, Decision making unit (DMU) etc.

CHAPTER ONE

INTRODUCTION

1.1 Background Information

In Nigeria, commercial activities have evolved greatly since 19th Century and the nation has being greatly depending on international transactions. This can also be corroborated by the report made by (Economic Community of West African State, 2010) that Nigeria takes 40% of the transaction trading in West Africa. Currently, Nigeria trade system greatly depends on importation of finished products i.e. takes 65% of the importation of West Africa and also depends on exportation of petroleum representing almost 83% of total Nigeria export revenue (Nigerian Ports Authority, 2005).

Considering economies of scales, Nigerian Seaports have been serving the main purpose of transferability of larger quantities of spatially distributed commodities in Nigeria and other neighboring landlocked countries to designated geographical locations and transferability of required commodities from other countries to Nigeria and other neighboring West African countries i.e. Nigerian Seaport takes 50% of export trade from Nigeria and 70% of the importation to Nigeria(Nigerian Ports Authority, 2015).

With respect to accessibility to high capacity and frequency global maritime freight transport system,(African Bank, 2010) ranked Nigeria 50th position internationally, 4th position in Africa and 1st position in West Africa and over Sub-Sahara African countries with liner shipping connectivity index (LSCI) 13.7, 18.3 and 19.9 in 2007, 2008 and 2009 respectively. Thus, Nigerian Seaports have been playing a vital role towards the growth of Nigerian economy and also West African economy as a whole in the area of international transactions and trade.

Hence, this significant importance of Nigerian seaports warrant adequate and consistent managements of their resources (input mix) for sustainability and the resultants of the managements can be measured via their performances or productivities overtime. Port as a system comprises cascade of operations ranging from land operations to terminal operations and its productivity is not only a concern to individual stakeholder but a mutuality between port authorities, private terminal operators, logistics operators (freight forwarders), and large shippers e.tc. Generally, Port productivity is made of three components namely terminal/berth productivity, yard productivity and land productivity, thus these components have respective indicators of measurement. Therefore, it is crucial to ascertain how port's resources are being utilized in the individual area of productivity just as (Chung, 1993) stated that progressive port manager always desires to know how extensively and intensively port assets are being utilized as well as how well the operations perform financially in terms of port productivity indicators.

In addition, (Journal of Commerce, 2014)also corroborated that the shipping line tends to build its schedule around the terminal's promised productivity aiming at getting its vessels to turn as quickly as possible to maintain its schedules, to maximize slow-steaming and to have its vessel assets deployed most efficiently. Moreover, the shippers go extra miles to make enquiries on the productivities of the concerned ports and make their findings on which Ports could be feasible towards their projected plans/voyages. Consequent to the appraisals, they tend to select the most feasible ports to call at without considering the exogenous and endogenous factors that are influencing the productivities of the underperformedports. Specifically, shippers are always after the terminal/berth productivity of a particular port and one of the prominent productivity indicators the shippers greatly consider is the total turnaround time of their vessels as (De Monie, 1987) stated that a reduction in total turnaround time of ship may improve the overall productivity of ship in port which in turn will boost their revenue. Invariably, someone could deduced that the port productivity is potent information that determines the choice of shipper and knowing that information transmits faster, ports service providers always crave to satisfy every of the shippers and other port users that consume their services.

However, the evolution of containers, larger vessels sizes incorporated with speedy trends in maritime world have been sources of challenges for ports operators to satisfying their consumers thus, compelling ports/terminals operators to expand their capacity by employing updated forms of technologies with expansion of infrastructure and superstructure to accommodate the trending vessel sizes, larger quantities of cargoes and to speedily evacuate cargoes. These trends have been great challenges to many African ports and treats to their productivities as they strive for survival in the maritime markets. As some Ports struggle with their limited resources, they found it challenging to increase their limited capacities. Hence, Nigeria was one of the African countries that were saddled with the responsibilities to increase her Ports' capacities. In other to stay competitive, Nigerian port system witnessed a significant reform which saw most of the Nigerian Ports' terminal concessioned to private operators in 2005/2006. The public–private partnership as corroborated by (Drewry Maritime Research, 2017), is a mechanism to leverage greater private investment participation in port development and most importantly, to access specialized skills, innovations, and new technologies associated with infrastructure development, operation and maintenance. Based on this reform, the least year of contract is 10 years and some terminals were concessioned on 25 years of contractual period (NPA, 2015). This reform has attracted the interest of both internal and external parties on the effects of concession instruments on improved ports' productivities and also the assessment of Nigerian ports' productivities hasbecome a cynosure towards every individual.

1.2 Problem Statement

Nigerian ports have faced different obstacles. They have experienced difficulties during the courses of their production causing low optimization, internal diseconomies and external diseconomies, among such issues are;

i. Inadequate internal funding that brought about commercialization of ports' activities in order to cater and fund the ports without depending on government subsidy;
ii. Port congestions which occur due to policy inconsistency on issues of imports (Ndikom, 2006) incorporated with no intermodalism which prompted some stakeholders to introduce the establishment of Inland Container Depots (ICD) across the six geo-political zones of the nation;
iii. Absurd port charges and other corrupt acts.

Despite the different measures adopted to mitigate or extirpate the issues that bedeviled the ports' systems, the ports' productivity was not still encouraging as terminals could not handle the demands for their services efficiently prompting the shippers who are always technicality and cost conscious to divert their vessels to neighboring ports in order to avoid unnecessary demurrages. This explains the rationality of the shippers i.e. when a port cannot handle the largest ships, shipping companies may prefer to use other major handling ports in order to subdue their operationscosts (Journal of Commerce, 2014). The result of the issues experienced by Nigerian ports prompted the stakeholders to adopt concessioning of ports' terminals on a landlord basis which aimed to achieving the following objectives (Usman, 2016) ;

i. To increase the efficiency of port operation.
ii. To reduce the cost of port services.
iii. To boost economic activities and accelerate development.

iv. To make Nigeria the hub for maritime trade in West and Central Africa.
v. To reduce the out flow of funds from limited government resources.

Consequent to the concessioning, there have been arguments concerning the effects of concession instruments on the productivities of Nigerian ports thus it was claimed by many individuals and scholars that Nigerian ports are on the verge to achieving or have achieved improved productivities. Though, there seems to be improvement through privatization of Nigeria ports' terminals as based on (Nigeria Ports Authority, 2015) records, average cargo throughputs recorded at Nigeria ports during pre-concession years of 2000-2005 is 37,899,224tons while during post-concession years of 2010-2015 is 57,910,116 tons.

But it is mediocre or not adequate to accept the current states of the ports as increases in the throughputs do not really reflect improved productivities of the ports just as (De Monie, 1987) stated that increased production is not necessarily synonymous with improved productivity. Thus, the realization of a specific output, throughput does not critically matter like the relationship between the inputs resources (labour, capital, timee.tc.) used to realize it.

We are burdened on how to ascertain an insight evaluation of productivity of ports in Nigeria through concessioned terminals in spite of the underlying complexities surrounding the systems vis-à-vis their differences in terms of operation, location, structure etc. and how to solve the mediocrity resulting from concessioning. To ascertain the productivities changes that have occurred since the commencement of concession at individual Nigerian port, assessment of the productivities of these ports is required in accordance to the objectives of concessioning. Therefore, this research study aims at ascertaining the improvements that have been witnessed in Nigerian port system so far by assessing the trend and horizontal analysis of Nigerian port's productivities from pre-concession era (year 1985)to post-concession (year 2015).

1.3 Objectives of Study

The major objective of this study is to assess the productivity of Nigerian ports. To achieve this, the following specific objectives were addressed:

i. To examine the trend analysis of productivity of Nigerian ports.
ii. To determine the outcome of horizontal analysis of productivity of Nigerian ports.
iii. To identify the efficient port and the inefficient ports in Nigeria.

iv. To ascertain the degree of sensitivities of Nigerian ports in terms of changes in inputs quantities
v. To identify the significant factors influencing the productivity of respective ports in Nigeria.

1.4 Research Hypothesis

H_0: Increased cargo throughput is the main determinant of improved port productivity.
$H_{1:}$ Increased cargo throughput is not the main determinant of improved port productivity.

1.5 Justification of Study

As a positivist a however the study will assess, evaluate and scrutinize the inefficiency and low productivity issues experienced at the ports and their terminals by laying down some managerial techniques based on the existing ones. Comprehensively, the study creates benefits for all stakeholders, policy makers and other parties within the maritime industry especially shipping lines and other port users because the findings from the research will evaluate the productivity of aggregate Nigerian ports system in cognizance to some differences among the ports and also regardless of the complexities in the systems.

It will also give logical solutions to inefficiencies in port terminals' operations through the adoption of a non-parametric analysis model named Data Envelopment Analysis (DEA) and a parametric analysis model which has not be adopted so far to appraising productivity of aggregate Nigerian Ports over a vast period of time i.e. 20 years of pre-concessioning and 10 years of post-concessioning.

1.6 Scope of Study

The study covers all ports and the amalgamated ports in Nigeria which vis: Lagos, Tin Can Island, Rivers, Onne, Calabar, Delta Port Complexes.
Thus the port operational areas of these ports consist of berthing areas, cargo handling areas, stacking areas and storage facilities areas which are now being managed by the private terminal operators. The study covers all the stated areas and the operations being carried out in the areas. The time scope of the study is basically from operational year 1980 to operational year 2015.

Nigeria is one of the largest countries in Africa, stretching across an area of 923,768km sq. Its long coastline which lies on the Gulf of Guinea in the south, stretches over 853 km and lies between latitude 4º 10' to 6º 20" North and latitude 2º 45' to 8º 35' East. It shares land borders with the Republic of Benin in the West, Chad and Cameroun in the East and Niger in the North.

Nearly 176.46 million people live in Nigeria making it the most populous nation in Africa. She was formerly known to be an agricultural produce exporting nation as agricultural produce such as cotton, corn, millet, palm products, peanuts, sorghum, rubber and cocoa were the country's biggest earners. Agriculture, including forestry and fishing employs nearly 70% of the labour force and contributes about 40% to official Gross Domestic Product (GDP) (Nigeria Port Authority, 2005). Though after the discovery of oil, the concentration and attention given to agricultural sector became less, leaving the economicdeteriorated throughout the notable periods. The complementarity roles of Nigeria Ports cannot be underestimated or ignored as it served as a bridge between these sectors and the international trade system. The role of port in the economic development to the nation cannot be over emphasized as it contributes greatly to the Gross Domestic Product (GDP). In Nigeria, the Lagos Ports Complex, Tin Can Island and others have played major roles in the growth of Lagos and the nation. The ports served the State and the nation in the import and export of goods, as well as raw materials and finished products. Nigeria as a country sharing coast with Atlantic and India Ocean has eight (8) different ports which are categorized into two geographical zones base on their spatial distribution. The geographical zones include:
The Western Zone comprises of;

i. Lagos port complex.
ii. Container Terminal Port (c)
iii. Tin can island port and
iv. RORO port (amalgamated with Tin can island port)

While the Eastern Zone comprises of;

i. Rivers Port Complex
ii. Delta Port Complex
iii. Onne Port Complex and
iv. Calabar Port Complex

1.6.1Apapa Port Complex

The port of Lagos Apapa as it was formerly called is situated in Apapa area of Lagos, South-West Lagos. Apapa port complex occupies a total land area of 200 hectares, a firm, flat terrain and concrete paved land area. The geographical location is within Universal Trans-Mercator (UTM: mostly used military maps) zone 31. Lagos port complex is geographically located at Location: Lat. 06° 25.7N, Long 003° 20.53E and distance from fairway buoy to Bullnose is 2.7 nm (5 km). The volume of maritime trade in Lagos was enormous which made the city a hub for the West and Central African sub region. The concentration of economic activities in Apapa remains a major pull factor for migrants and over the years, inward migration in and around the area has been a major feature. Apapa is Nigeria's largest port and contains a number of wharfs. A range of commodities are handled at Apapa and include dedicated facilities for the discharge and loading of wheat, cement, oil, petroleum, fish, dry cargo and containers. The container terminal is located at the Third Apapa Wharf extension and covers an area of 44 hectares. Maximum capacity of the terminal is 22,000 Twenty Equivalent unit (TEU) and served by 6 designated container berths with a Quay length of 950 metres. There is 6,400m2 of covered storage space. It encompasses of conventional berth facilities to service all types of cargo morphologies. These facilities include:

i. Twenty-four berths for handling dry bulk, general cargoes and fish vessels
ii. Two harbour berths for discharging and loading petroleum products
iii. Thirteen transit sheds with a total storage space of 78,869m sq. and eight warehouses with a total space of 58,042m sq.
iv. Additional support facilities for cargoes on transit to the Economic Community of West African States (ECOWAS), of which Nigeria is a member.

There are also almost 100 devices at the port such as mobile cranes, locomotives and freight lifters. The capacities of these different items range from 3-40 tons, capable of meeting the cargo needs at the port. Private jetties with a range of facilities also offer essential services at Lagos (Nigeria Port Authority, 2005). Table 1.2 encompasses the operational areas of Lagos Port Complex which have been concessioned to different private firms based on landlord basis.

Container Terminal Port

The Container Terminal Port (CTP) is located inside of Apapa wharf and covers an area of 44hectares (ha). Work is ongoing to transform the CTP into a more modern container port with facilities to service various cargo morphologies. Although the terminal already has a capacity of 22,000 twenty-foot equivalent units (TEUs), the upsurge in container imports has put its storage capacity and handling equipment under huge strain. The management at the CTP is procuring more cargo handling plants and equipment to cope with the increased demand at the port. The CTP is served by six designated container berths 15, 16, 16A, 17, 18, 18A as shown in table 1.2 with a total quay length of 1km and an average draught of 11.5m. In addition, there are 135 port appliances of various brands including Kamar, Terex Hyster, and Mercedes Benz truck, with an availability rate of 80%. The port has been merged with Apapa Lagos Port which made up what is now called Lagos Port Complex through the reform program.

Table 1.1: Apapa port Complex Terminals' Descriptions

Terminal	Operators	Quay Area(Ha)	Berths	Berths Capacity m^2	Quay Length (m)	Maximum Draft (m)	Term (years)
A	Apapa Bulk Terminal Limited	5.913	1-3		N/A	11.0	25
B	Apapa Bulk Terminal Limited	5.752	4–5		N/A	9.0	25
C	ENL Consortium limited	11.21	6-10	186,190, 106, 200, 106 and 106	N/A	N/A	10
D	ENL Consortium limited	10.54	11-14	185.7, 106, 132, 106 and 100.59	N/A	N/A	10
E	Greenview Development Nigeria Limited	19.091	19-20		N/A	N/A	25
Bull Nose 1,2,3	Eko Support Services Limited	3.633	21-23	296	400	5.6 and 8	5
Container Terminal (CW)	AP Moller Limited	59.41	15-18	250	N/A	9 and 11	25
Ijora lily pond terminal	Maersk Line		Offshore		N/A		10

Source: Nigeria Port Authority 2015, Open source

***CW: concessioned with**

1.6.2 Tin Can Island Port

Tin Can Island Port is situated in the north west of Apapa wharf, the Tin Can Island Port (TCIP) was built in 1976 and began operations in October 1977. It is geographically located at Lat 06° 25.7N, Long 003° 20.53E and distance from fairway buoy is 5.4 nm (10km) KLT 5.9 nm (11 km). The main port occupies an area of 73ha and compliments the RORO Port, also in Lagos. The TCIP consists of the Kirikiri and Ikorodu lighter terminal, as well as a residential estate and associated private jetties. In terms of berthing facilities the TCIP has a navigable channel 200m wide and 10.5m deep, with total quay length of 2,189m. Berths 1 and 1A are specialized for handling dry and bulk wheat cargo, while others serve general cargo operations. The TCIP has over 75 port devices, including two state of the art Liebherr (LHM 250) cranes, Hyster Spreader type lifters, forklifts, freight lifters, container handlers, mobile cranes, quay tractors and trawlers with capacities ranging from 3-65 tons. Through the reform program, Tin Can and RORO were merged on May, 2006 which result to what is presently known as Tin Can Island Port Complex.

Roll on-Roll off (RORO) Port

The RORO terminal port first started servicing ships in 1977 as part of the TCIP complex. The port is uniquely equipped to handle a large number of vehicles, containers and general cargo – over 80% of vehicles imported into Nigeria pass through the RORO Port. The port consists of berths 9 and 10 plus seven car parks at Tin Can Island. The car parks have a capacity for 7,987 vehicles. Other facilities at the RORO Port include a quay length of 435m and maximum drought of 9.5m. There are also two warehouses of 6,800m^2 each and facilities for holding containers. The port has stacking areas measuring 28,866m^2 with a total capacity of 6,017 tons. The car park is estimated to be 99,869m^2 and the truck terminal 9,300m sq. which can handle all categories of trucks.

1.6.3 Port Harcourt Port

The Rivers Port Complex, or Port Harcourt port, is the third largest port complex in Nigeria and it is geographically located at Lat 04° 46'N, Long 007° 0.7E and its distance from fairway buoy is 48 nm (89 km). It is a natural port, with eight berths. The total quay length is approximately 121km. The average draught along the quays is 8.97m and vessels of up to 15,000 tons deadweight can be berthed. The port has an extensive range of cargo handling plants and equipment and provides a maximum draught of 7.6m. The principal exports and imports include cement, general cargoes, oil well equipment, vegetable oil and grains. The Port Harcourt port has a total storage shed facility in excess of 26,335m^2 and an open stacking area of 38,000m^2. Also belonging to the Rivers ports complex is the Okrika refined petroleum oil terminal, which is situated on the Bonny River, 35 nautical miles from the Fairway buoys. It has an outer jetty capable of berthing ocean-going vessels of up to 15,000 tons. The outer jetty is 193m long with an 8.9m draught, the jetty is dedicated to the government refinery at Eleme. Management of port operators at Port Harcourt itself has been commissioned out to two port operators; Port and Terminal Operators, Bua Ports and Terminal. It is not operated by the NPA like Delta state, River state is a principal petroleum region of Nigeria.

Table 1.2: Port Harcourt Port Complex Terminals' Descriptions

Terminal	Operators	Berth	QuayArea (hectares)	Quay Length (m)	Terms (years)
1, 1A & 2	Josepdam Port Services Limited	1-2	5.767	484	10
3, 4, 4A & 5	Tin Can Island Container Terminal Limited	3-5	24.623	776.90	15
6, 7, 7A & 8	Port and Cargo Handling Services Limited	6-8	17.425	759.54	10
9 & 10	Five Star Logistics Limited	9-10	18.980	437.53	10
11 & 12	Ports and Terminal Multi-services Limited	11-12	12.3 & 8.7	490	25

Source: Nigeria Port Authority 2015, Open source

As a result of these, the various departments and their personnel were also merged in September, 2006. Private Terminal Operators took over on the 10th May, 2006 for Terminal A, C and D while Terminal B was handed over on the 1st June, 2006. Port and Terminal Multiservice Limited (PTML), a Build, Operate and Transfer (BOT) project which commenced operation in September, 2006.

Table 1.3: Port Harcourt Port Complex Terminals' Descriptions

Terminal	Operators	Berth	QuayArea (m^2)	Quay Length (m)	Terms (years)
A	Ports & Terminal Operators Limited.(PTOL)	1	3607.043	158	15
		2	3732.942	158	
		3	4109.750	152	
		4	3012.390	192	
B	BUA Port and Terminals ltd	5	2000.280	128	20
		6	4886.020	135	
		7	4886.020	130	
		8	1217.597	137	
	N/A	Okirika A	N/A	193	
	N/A	Okirika B	N/A	193	
	N/A	Bitumen Jetty	N/A	135	
	N/A	Kidney Island Jetty	N/A	100	
	N/A	Okolobatoru	N/A	288	
	N/A	Ibeto Jetty	N/A	180	
	N/A	Magcobar	N/A	90	

Source: Nigeria Port Authority 2015, Open source

The permissible draft of Port Harcourt channel is 8.5m while for Fairway – Bonny Channel, the draft is 14.3m and channel width is 230m with a stretch of 17.5km

Other Leases within the Port includes:

i. RIVOC Limited
ii. PZ Plc.
iii. Port-Harcourt Flour Mills Limited
iv. Bulk Oil Company Limited
v. Union Dicon Salt Limited
vi. Mobil Nigeria Limited
vii. Dresser Magcober Minerals Limited
viii. Starz Investment Company Limited
ix. Nishan Trans Continental Services Conoil Plc Limited

x. Ibeto Industrial Limited
xi. Zimrich Trading Company Nigeria Limited
xii. Resource improvement and Manufacturing Company Limited
xiii. E.J.R Anthony
xiv. John C. Chediak
xv. Valleumbra Flour Mills Nigeria Limited
xvi. Oando Plc

1.6.4Onne Port Complex

Onne was established as a 'free port zone' (FPZ) to serve as the focal point for the oil and gas industry in West Africa. It is geographically located at Lat. 04°41.0'N, Long 007°10'E and its distance from fairway buoy is 35 nm (64.9 km). Consequent to this unrivalled position, the port provides valuable incentives to investors; examples include simple regulations to enter the Nigerian oil and gas market, minimum bureaucracy and marketing opportunities to the west central African sub-region. The FPZ is positioned at the centre of Nigeria's oil activities and offers excellent business opportunities to investors wishing to participate in both planned and existing projects. The incentives for importers and exporters are comparable to those offered by successful FPZs elsewhere in the world. These include free corporate tax, free import and export duties, free repatriation of capital and profit, 100% foreign ownership, free pre-shipment inspection for imported goods and a free expatriate quota. The Onne FPZ has modern port infrastructure and super structure that can accommodate ocean-going vessels. Also located at the Onne Port Complex are the Federal Ocean Terminal (FOT) and the Federal Lighter Terminal (FLT). The first phase of the FOT was completed in 1996. It is a multi-purpose and modern seaport with a quay length of 790m and it is a Free Trade Zone (FTZ) designed as a transhipment port for west and central African countries and for deep draught ocean-going vessels that cannot berth in other existing conventional ports in the country. The FLT, with a 1,576m long quay, was primarily intended to involve private participation with private terminal operators running the port operations, keeping the facilities owned and maintained by the NPA. The FLT is equipped with 18,000m^2 warehouse and stacking areas measuring 200,000m^2.

1.6.5 Calabar Port Complex

The Calabar port comprises of the old Calabar port and the newer one, which was commissioned on June 9th, 1979. The new port complex consists of the following major operational areas:

i. The Milleno
ii. Jackson wharf
iii. Calcemco wharf for ferry operations to Douala (Cameroon), Libreville (Gabon) and Malabo (Equatorial Guinea)
iv. The crude oil terminal; Eket, Antanadudu
v. The new port; Forms the shipping area
vi. The Aluminum Smelter Company of Nigeria (ALSCON), IkotAbasi.

The port is geographically located at Lat 05° 01N, Long 008° 19E and its distances from fairway buoy are 50 nm (93 km) for New Port and 45 nm (83 km) for the Old Port.

The Calabar port occupies an area of approximately 38 hectares of land and channels. The port also has 11 berthing facilities, as well as six transit sheds and many warehouses, which are permanently allocated to oil companies for storage of their rig and drilling facilities. The new Calabar Port Complex has facilities to accommodate roll-on roll-off vessels. In addition, there are transit sheds for cargo and a large stacking area for containers and other general cargo. There are also port devices of various brands and capacities ranging from 3-50 tons with availability rate of 80%.

1.6.6 Delta Port Complex

Delta Port is home to the ports of Warri, Sapele, Koko and Burutu at the heart of the Niger Delta. Warri Port is the coordinating point for management and administration of other ports in the delta, operating from natural harbours. By virtue of their geographical location, these ports, more than all the others, have land in sufficient quantity for investment purposes. It is geographically located at Lat 05° 31.0N, Long 005° 45.0E and its distances from Warri and Koko fairway buoy are 52 nm (96 km) and 41.5 nm (77 km) respectively. The developed land area consists of 216.19ha and the undeveloped land area takes 136.48ha. The container handling capacity at Delta Port Complex is 333,000 TEU, its quay length is 572 m, access channel depth, one hundred and eight (108) number of buoys, twenty (20) number of berths. The Port is connected to inland waterway, road but not connected to rail. The average turnaround time of vessel at the Port is 3.48 days and the berth occupancy rate is 13%.

Table 1.4: Delta Port Complex Terminals' Descriptions

Terminal	**Operators**	**Berth**	**Quay Area** (m^2)	**Quay Length (m)**	**Terms (years)**
Terminal A, Old port, Warri	Messrs' Integrated Logistics Services (Intels) Nigeria Limited	Okirika A	N/A	193	25years
Terminal B, New Port, Warri	Messrs' Integrated Logistics Services (Intels) Nigeria Limited	Okirika B	N/A	193	
Terminal C, Old Port, Warri	Messrs' Julius Berger Nigeria Limited	Bitumen Jetty	N/A	135	
Terminal B, Old Port, Warri	Messrs' Associated Marine Services				10
Koko Terminal. Koko	Messrs' Green Leigh Nigeria Limited	Kidney Island Jetty	N/A	100	10
	N/A	Okolobatoru	N/A	288	
	N/A	Ibeto Jetty	N/A	180	
	N/A	Magcobar	N/A	90	

Source: Nigeria Port Authority 2015, Open source

CHAPTER TWO
LITERATURE REVIEW

2.1 Conceptual Framework

2.1.1 Concept of productivity

Productivity is comprised of two divisions; total factor productivity (TFP) and partial productivity. Eatwell and Newman (1991) captioned total factor Productivity as multifactor productivity which is required where broad total collection of outputs and inputs are required. Production theory is the basis for analyzing output level changes and the rate of output depends on these factors; the rate at which inputs (technology) are utilized, the amount and types of input resources injected and the level of technology or kind of production process that is employed. Robert and Marc(2009) described productivity as a key to determining the optimal combination of input that should be used to manufacture a given product. Gboyega (2005) further explained the variations in total factor productivity by differences in productivity efficiency, the scale of production and the level of technology while Antle and Capalbo(l988) identified two major approaches of total factor productivity measurement as the growth accounting i.e. Index number and the econometric approach.

According to them, growth accounting approach to TFP measurement is a method for calculating the contribution of various factors to economic growth with the aid of marginal productivity theory – growth accounting decomposes the growth of output into – growth of labour, land, and capital; education; technical knowledge and other miscellaneous sources while econometric approach to TFP measurement is the calculation of specified production function with the intention to creating direct connection of productivity growth to important parameters of either of the functions. Its econometric implementation provides parameters estimates of the production technology in the process of measuring productivity advancement.

Finally, for productivity measurement the main indicator of improved productivity becomes a decreasing ratio of input to output at constant or improved quality this is also be buttressed by Kumar and Suresh (2009) who assests that measuring productivity of different groups of operatives requires different ratios whichare indicative of output/input relationship by citing anexample of the productivity of assembly line work which could be measured as output units per man-hour or alternatively, the value of good produced per cost oflabour on assembly line. The main problem of productivity is clustering and the solution is the reduction of the size of the clustering considering the kind of choice to be implemented between applying parametric and non-parametric productivity measurement.

Udabah(2000) opined that productivity is a very essential tool for rapid economic growth. He further discussed about the two important sectors in Nigeria which could have up-heaved the economic growth of the nation in which he mentioned transportation especially port as one of the sub-sectors which has the potentials to aids these sectors and links them with international trade. Furthermore, he opined that there should be cordial relationship between productivity, economic growth and development.

Productivity can also be described as the process by which varieties of inputs are applied for the processing of a system to obtaining the desired or required outputs at another end. Indeed, productivity is more of an end result of a complex social process involving science, research, analysis, training, technology, management, production plant, trade union and labour among other inter-related influences (Gboyega, 2005).

In studying production functions, Robert and Marc (2009) opined that there are two important relations between inputs and outputs which are crucial. One is the relation between input and variation in all inputs taken together. This is known as return to scale characteristics of a production system. Return to scale plays an important role in managerial decision. They affect the optimal size of a firm and its production facilities. They also affect the nature of competition and thus are important in determining the profitability of investment. It also signals the relation between the quantity of an individual input (or factor of production) employed and the level of output produced.

(Kumar and Suresh, 2009) defined the purposes of studies of productivity for improvement purposes based on the following types of analysis such as trend analysis, horizontal analysis, vertical analysis andbudgetary analysis. Furthermore, they definedtrend analysis as the studying of productivity changes for the firm over a period of time, horizontal analysis as the studying of productivity in comparison with other firms of same size andengaged in similar business, vertical analysis as the studying of productivity in comparison with other industries and other firms of different sizes in the same industry and budgetary analysis as setting up a norm for productivity for a future period as budget, based on studies as above, and planning strategies to achieve it.

2.1.2 Port Production and Capacity

Efficiency of the use of resources or productivity performance is of key interest thus high productivity in transportation, industry, agriculture and other service sectors are necessary for rapid economic growth of any nation. Productivity can be referred to as a matrix of the technical or engineering efficiency of production. As such quantitative metrics of input and sometime output are emphasized. Productivity is distinct from metrics of allocative efficiency which take into account both the value of what is produce and the cost of input used, and also distinct from metric of profitability, which addresses the difference between the revenues obtained from output and the reference associated with consumption (Courbois and Temple, (2001)**;** Kurosawa (2000)**;** Pineda (1999) andSaari (2006)). The activity of converting input resources into service(s)/product(s) can be identified with production and consumption. Thus, production is a process of combining immaterial and material inputs of production so as to produce tools for consumption. The methods of combining the inputs of production in the process of making outputs are called technology. Technology can be depicted mathematically by the production which describes the function between inputs and outputs. The production function depicts production performance and productivity as the metric for it. Measures may be applied with for example, different technology to improve productivity and to raise production outputs. With the help of production function, it is possible to describe the mechanisms of economic growth.

Port production can be described as the conversion of port capacity i.e. labour capacity, cargo equipment, berth capacity, vehicles e.tc to obtain services i.e. throughput or otherwise may be described as the application of certain physical and immaterial resources to the operational areas of the port system in order to achieve a specific output. From the definition of the latter, it is observed that production highly occur at the place of operation i.e. terminal, quay side, gate side e.tc thus this particular definition simply relates the mechanism of port production to the first class of a simple machine named lever as shown in the below diagram.

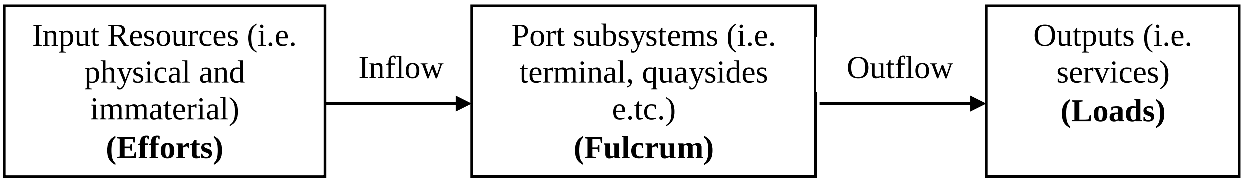

Figure 2.1: Port Production System or Mechanism

Source: The researcher

From Figure 2.1, it is obvious that the resources injected make the port subsystems to function in order to reconcile specific outputs at the other end. Therefore, assessment of productivity of port greatly falls at the central part of a port system i.e. port subsystems.

Furthermore, a port is technically efficient when its output i.e. throughput obtainable given the level of resources i.e. labour, immobile capital e.g. cranes and vehicles are utilized by the port service provider. The technical or functional relationship between the optimal throughput and the level of input resources utilized by the port service provider is the port's economic production function. For instance,

$$Maximum\ port\ throughput = f(port\ resources)$$

If the above expression is fulfilled in a port system then such is technically efficient otherwise it is technical inefficient. Consequently, the port's economic production function with respect to the resources (port labour) is given in the figure below.

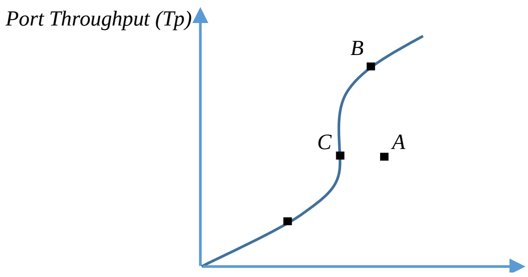

Figure 2.2: Port Cost Minimisation for a Single Port Throughput

It depicts that the port is technically inefficient below the curve with respect to the corresponding amount of labour. For instance at point A the port is technically inefficient since the labour at that point is providing less throughput whereas such level of throughput can be obtained at lower amount of labour at point C. If a point falls on the curve, it depicts that at that point the port is technically efficient and points above the curve reflect that no such throughput has been obtained by the port service provider with the amount of labour.

The maximum throughput (from an engineering perspective) that a port/terminal can physically handle under certain conditions is the port/terminal capacity which means that the magnitude of the port/terminal capacity to the throughput matters a lot to the productivity of a port which can be represented by the berth efficiency which basically reflect the design, preferred and practical capacity. For a given level of maximum port throughput the port economic production function can be solved for various combinations of capital and labour that can provide this minimum level of port throughput. These combinations of capital (K) and labour (L) for the production of maximum port throughput(T_p) are shown below in the figure as isoquant curve T_p. The long-run cost (LTC) incurred by the port in the use of capital and labour resources may be expressed as

$$LTC = P_K * k + P_L * L \qquad 2.1$$

$$where\ P_L\ is\ the\ price\ per\ unit\ of\ capital\ and$$

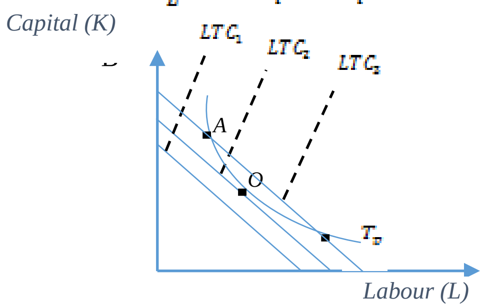

Figure 2.3: Port Cost minimization for a single port throughput

$$P_L\ is\ the\ price\ per\ unit\ of\ labour\ measured\ by\ the\ port\ in\ the\ employment\ of\ capital\ and\ labour\ respectively$$

For a specific level of cost, the equation plots as an isocost line. A cost expenditure of amount LTC_1 (exhibited by isocost line LTC_1 in figure 1.2) is not adequate for the port to run enough resources in order to provide for T_p level of throughput. Similarly, cost expenditure LTC_3 is also sufficient.

At point X, the port is technically efficient on isocost line LTC_3 in the production of T_p level of throughput as quite large amount of capital to labour is being utilised but cost inefficient since there are other combination of resources on isoquant curve T_p that will incur less cost when employ in obtaining T_p level of throughput. At point B, isocost line LTC_2 is apparently a tangent to isoquant curveT_p. In addition, cost expenditure LTC_2 is the minimum expenditure to be incurred by the port in the provision of T_p. At the resource combination at point O, the port is both technically and cost efficient.

2.1.3 Port Productivity and Production Function

Production function is a technical relation which links production factors i.e. inputs and outputs. The law of production can be best used to describe the conversion of the factor inputs into outputs at any particular time period thus it represents the technology of a firm/industry or the whole economy of such firm/industry. Production function also describe the dependency of specific output i.e. for a port/terminal system (throughput is widely used) on the mix or combination of factor inputs i.e. labour, cargo equipment e.tc.

Production function includes all the technically efficient methods of production since it includes the combination of factor inputs required for the production of one unit of output. For instance if terminal X uses less of at least one factor and no more from the other factor to produce the same service output i.e. throughput as compared with terminal Y under the same condition then terminal Y is technically inefficient as compared with X

	X	Y
Labour	3	4
Cargo equipment	4	4

A basic production principle focus only on efficient methods as it considers decision maker rational being.

Production function can be mathematically written as;

$$X = F(L_1, L_2, \ldots, L_n; K_1, K_2, \ldots K_n; M_1 M_2, \ldots M_n) \qquad 2.2$$

Where L1, K1, and M1 represent the various kinds of labour, capital, and materials that are used in the production of product X (services).

Economic growth is a production increase achieved by an economic entity or nation. It is usually expressed as an annual growth indicating real growth of shipping lines' outputs (per entity) or the national products.

Productivity has been widely used in different economic system i.e. port system. The concept has diverse definitions due to different opinions towards it. Eatwell, and Newman (1991) defined productivity as a ratio of some measure of output to some index of inputs used.

Defining productivity is the arithmetic ratio between the amount produce and the amount of any resources in the course of production. This conception of productivity goes to say that productivity is the output per unit input of the efficiency with which resources are utilized (Samuelson and Nordhaus, 1995). Productivity can also be described as the process by which varieties of inputs are applied for the processing of a system to obtaining the desired or required outputs at another end. Indeed, productivity is more of an end result of a complex social process involving science, research, analysis, training, technology, management, production plant, trade union and labour among other inter-related influences (Gboyega, 2005). Productivity can be attained by reducing the cost of the operation that, like any transport operation, it can be divided into two parts: the monetary tariffs and the cost of the time of the operation, which in the case of cargo, can be objectively quantified.

The productive factors necessary for the port operation are a sheltered dock, mechanical equipment for loading (unloading) the ship, physical space and mechanical equipment for handling and distributing the cargo on land after the ship has been unloaded (before loading), and equipment for loading (unloading) the cargo onto terrestrial transport and personnel, both for managing the necessary infrastructure and mechanical resources used and for operating this equipment. The concept of efficiency was adopted from engineering which defines efficiency of a machine/process as output /input = 1. In this approach, efficiency is always less than or equal to unity as some energy loss will always occur during transformation process (Okeudo, 2013).

In a simplified and engineering manner, port productivity may be deduced from the following formula;

$$Mechanical\ Advantage = \frac{Load\ carried}{Effort\ inserted}; \qquad 2.3$$

$$Efficicnecy/Productivity = \frac{Output\ achieved}{Input\ used} \qquad 2.4$$

Just as the mechanical advantage of a first class lever, the efficiency/productivity as it is shown above is always less than or equal to unity as some energy loss will always occur during transformation process (Okeudo, 2013). These conditions determine how efficient a port system is i.e. the rate at which a port produces services, in relation to the magnitude of inputs

2.1.4 Rationale for Productivity

In an increasingly competitive world economy, the importance of productivity enhancement has become even more fundamental. Countries with high productivity tend to become dominant in global markets, while low productivity countries become increasingly marginalized (Oshiomhole, 2006).

In a standard setting, it is important and feasible for firm/industry either private or public to assess their productivity for some cogent reasons which may include.

i. Economic reasons
ii. Technical reasons

In order to ventilate on these mentioned points. It would be viable to deploy them in a well-structured system such as port system.

A. **Economic Reasons:** A port as a significant system and a complex service-oriented business should always strive to avoid unnecessary waste or expenditure of input resources such as time, labour and other assets because of the complexity in the system. In other words, an efficient system must fulfil the three economic reasons which are how much of each product or service is to be produced or rendered? How much of each input resource is to be employed in the production of each product/service? Finally how to distribute the product or service among users? This reasons help to determine the relationship between total costs of inputs and port production which include whether cost of running a port sub-system or the overall system is/are adequate and whether additional input resource(s) to the production process would be feasible. Economically, these questions can be expressed in another angle such as;

i. Is the port making a profit, loss or a break-even when compared to the revenue received?
ii. Secondly can these costs be used for evaluating the balance of the port's level of input resources to profits and losses? and
iii. Thirdly can these costs be analyzed for decision making purposes by the port for example to investigate whether the port exhibits economies of scale and economies of scope?

These questions can only be imminently answered when the input-output analysis is done at the end of the production period.

Economical reason why productivity should be assessed is to check the cost-benefit analysis of using an input resource over another that is whether the port output is produced at the least cost at the given resource prices to be paid by the port operator. A port's economic cost function represents the relationship between the ports' minimize costs to be incurred in handling a given level of output (Talley, 2009).

$$Min\ (Port\ Costs) = g(Port\ Output) \qquad 2.5$$

In order for a port to be cost efficient it must be technically efficient.

B. **Technical Reason:** This is another reason why port productivity should be measured at a definite period. In order to know whether the 4Ps of production that is product, people, process and price are well structured it is necessary to determine the current status of productivity. Evolution in maritime and shipping industry have led to severe technological trends which in turn as resulted to economies of scale for some operators/firm which one way or the other have largely utilised the technologies with respect to the technicality of port/terminal operations as port/terminals that do not upgrade according to the trends end up lagging behind the international standards. Therefore reappraisal of production is a very crucial measure to ascertain through technical aspects of the process how much the port is getting along with the technological trends and how much they utilized the technologies. This can probably be achieved by some computation with the aids of the required input-output models or analytical tools that deal with optimization of production input resources to obtain the best possible units of output(s) for instance, Data Envelopment Analysis.

In this competitive and globalizing market it is advisable and ideal for port service provider to check their productivity and production line especially at a fiscal year in order to check mate hiccup(s) in the production process if there is any and also to meet up with the trends.

2.1.5 Concept of Port Productivity

A constant productivity measuring is of vital importance for the port system. Simultaneous and consistent measuring can serve as opportunities in development and optimization. Container handling productivity is directly proportional to the below factors, Beskovnik (2008):

i. Functions of a container terminal
ii. The number and movement rate of berth cranes

iii. The use of yard equipment
iv. Berth and yard occupancy
v. Number of vehicles at the entrance into the terminal
vi. The productivity of workers employed at the operational areas

Beskovnik (2008) conversed that the process of productivity measurement is a complex process because of the interrelationship of the different elements that constitute a terminal thus they have different impacts on each other.

Thus, the most important factors that can influence the productivities of origin-destination type maritime terminals include landsides operation and facilities. Other factors that may also influence their productivities are capacity of terminal gates, efficiency of terminal gates, railway connection, railway services and road network while for transshipment/hub ports, factors such waterside operation and operations of the berth can influence their productivities.

2.1.6 Measurement of Port Performance and Productivity

To effectively measure port performance the following groups of indicators are necessary namely indicators of output and indicators of productivity (De Monie, 1987).

2.1.6.1 Indicators of output: The indicators of output include berth throughput, ship output and gang output.

2.1.6.2 Berth throughput: It measures the total tonnage of cargo handled at a berth in a stated period which is usually expressed on a weekly, monthly or annual basis. It does not provide an indication of how efficiently the facilities have been managed but only has significance measurement if the type of cargo handled, the handling techniques used (e.g. grabs, conveyor belts, conventional gear, container handling equipment), the route followed (direct/or indirect route) and the units of measurement (weight tons, freight tons, measurement tons) are specified. It is basically a measure of "activity" on a facility.

2.1.6.3 Ship output: It measures or indicates how good cargo-handling operations are. These figures also require the same differentiation as mentioned for berth throughput. The more frequently used measures include: tons per ship working hour; tons per ship hour at berth, tons per ship hour in port. Large differences between these values will indicate considerable time losses for the ship at the berth or in the port.

$$\text{ship output per 24 hours in port} = \frac{\text{Tonnes per ship working hour} * \text{working hours}}{\text{Tonnes per ship hour in port}} \qquad 2.6$$

2.1.6.4 Gang output: It measures the average quantity (tons) of cargo handled by a gang in a certain time interval, normally an hour. It is the most important value which measures the performance of labour. It is usually measure in tons per gang-hour thus the effective measurement is influenced by explanatory data on factors such as the gang composition, the cargoes worked, the ship's configuration and many others before any valid conclusions can be arrived at. In addition, some analysts express this indicator in terms of output in man/hours rather than gang/hours, thus eliminating the distorting factor "gang composition". In container terminals, output is measured in "containers per gross or net crane hour", as the notion of a gang in such operations is no longer a realistic one. It is worthy to note that the two latter indicators of output ship output and gang output are also used for the measurement of productivity and performance.

The indicators of port productivity are different from the indicators of output. Indicators of output is the ratio between the actual output achieved and the effort put in expressed in monetary terms. This indicator is termed as cost-effectiveness (less handling cost). Increased production is not necessarily synonymous with improved productivity; hence on a berth it is possible to handle more cargo by employing more men per gang, and more gangs per ship, and by using more equipment and/or storage space. However, although this greater effort will no doubt produce more output, it constitutes no guarantee of higher productivity (i.e. a more cost-effective operation). This port productivity measurement causes compromise or tension between port/terminal operators and shipping lines/shipping agents as they have different pursuit or interest as the latter ones are always after cost-effective service while the port/terminal operators are after cost-efficiency (De Monie, 1987).

The measure of port productivity and cost-effectiveness also involves another important consideration which is the distinction between fixed costs and variable costs are essential. Fixed costs are independent of output (at least up to the full realization of a facility's potential), whilst variable costs increase as output rise. When a port increases berth throughput on a facility i.e. increase in total variable cost like electricity supply, employment of some cargo equipment e.tc it will raise total berth costs (i.e. as a result of no variation in fixed costs). If these costs are, however, expressed per ton of cargo handled, the situation becomes quite different as total cost per ton will then fall with a rise in throughput (due to a decrease of fixed costs per ton and the unchanged variable costs per ton)(De Monie, 1987).

In general cargo berths i.e. conventional, RORO, container or multi-purpose; the labour costs generally represent a major proportion of total cost. As a result, a particularly significant productivity indicator is the one that relates manning with costs, i.e. "labour cost per ton of cargo handled". The nature of the labour-cost element (labour factors) has changed from an exclusively "variable cost" type to a predominantly "fixed cost" one through mechanization and technology leading to higher productivity and lower employment levels. In any event, whenever labour costs become "fixed", they will force the port management, as do the other fixed costs, into a policy of full utilization of existing facilities to achieve maximum productivity (De Monie, 1987).

2.1.7 Indicators of productivity:

Port performance and productivity cannot be determined by only one indicator or by a single all-encompassing value. The complexity of port operations, and in particular the interaction between various essential elements such as the efficiency with which ships, berthing space, equipment and labour are utilized, make it compulsory to rely on a set of indicators if one wants to arrive at an accurate and meaningful evaluation of a port's performance (De Monie, 1987). He further mentioned the secondary indicators that make up the primary or main indicators of poor productivity and performance as:

For conventional break-bulk cargo:

i. Port traffic: This measures the number of ship calls at the port at specific period of time which is also termed as transshipment. This can be inward and outward traffic
ii. Productivity based on port and berth time:
iii. Berth throughput: This particular indicator has been discussed initially in the indicators of output
iv. Labour productivity: this is the incorporation of ship output and gang output which has also been discussed earlier.

v. Ship turnaround time: This is the indicator which measures the time between the time ship calls at the port and the time ship leaves the port.

vi. Berth occupancy: indicates the level of utilization of the berth facilities over a given time period (normally a week, a month or a year), based on an effective occupancy value calculated on an hourly or daily basis). This is calculated as

$$\frac{\text{Working period} - \text{nonworking period}}{\textit{total working period}} * 100\% \qquad 2.7$$

This also indicate the rate at which vessel stays at port for service

For containerized cargo

vii. Container port traffic: This measures the number of container ship calls at the port at specific period of time which is also termed as transshipment. This can be inward and outward container traffic

viii. Productivity based on port and berth time

ix. Container berth throughput

x. Crane productivity: unlike labour productivity this focus on containers per gross or net crane hour.

xi. Ship turnaround time: This is the indicator which measures the time between the time ship calls at the port and the time ship leaves the port

xii. Berth occupancy: This differs from the value obtained for conventional general cargo and liquid cargo.

The process of productivity measurement is a complex process as Beskovnik (2008) said because of the interrelationship of the different elements that make up a terminal and they have different impacts on each other.

Container handling productivity as Beskovnik (2008) viewed is directly proportionate to the transfer functions of a container terminal, the number and movement rate of berth cranes, the use of yard equipment, berth and yard occupancy, number of vehicles at the entrance into the terminal, productivity of workers employed at the operational areas of the terminal which he opined for frequent check-up and adjustment.

There may be different in the case of other types of cargo terminal such as dry cargo terminal, liquid cargo terminal etc.Tongzon and Heng (2005) further described port productivity as a measure of the efficiency of port or terminal operations and consider the amounts of resources usually necessary to perform specific task in a given period of time. They stated that the level of efficiency indicates how quickly containers are handled and how quickly vessels are served and turn around at port. Considering the port (terminal) operation efficiency level, carriers view ships time at ports as an expensive activity thus the speed of container handling and consequent vessel turnaround time is a crucial issue in terms of competitiveness for port authorities and port operators (Peters, 2001). NPA (2012) examined the growth of Lagos Port Complex and Tin Can Island Port as the major development in Apapa, Lagos state and Nigeria in general. The report described the effectiveness of a seaport as a function of the speed and ease by which cargo passes through the port. The study mentioned throughput as one of the measurement of operational effectiveness of the port. This can be in terms of port performance index (PPI), berth performance index (BPI) or cargo performance index (CPI). The time of waiting at berth or port premises can also be used to measure the operational effectiveness of the port. The effectiveness of the port will contribute in no small measure to the economic prosperity of its location and the nation. Thus, apart from the benefits derivable from the port as viable economic base through value chain, its effectiveness is important to optimize the advantages.

Furthermore, Chung (1993) is of the view that exporter/importer basically assess the port’s performance through one indicator of interest which is the dwell time of cargo in port measured in terms of the number of days that a ton of cargo remains in port. A high dwell time is generally an indication that all is not well with the port. It does not identify areas where improvements may be sought since, unlike ship time in port, it does not have a breakdown according to the various procedures that have to be gone through before cargo can be shipped or delivered (e.g., customs clearance, waiting for instructions, waiting for ship, waiting for transport, etc.). The importance of dwell time also obviously varies with the nature of cargo. Hence substantial productivity improvement is general needed to enable ports to meet the strict service requirement of their customers and to obtain competitive advantages. Tongzon and Heng(2005) concluded that the higher the efficiency level of a port or terminal operation, the more port users are likely to select it as their call port which in turn will make the port gain more market share (revenue). They opined that reliability of port operations also influence a ports performance which in turn will affect the choices of shipping lines and shippers. Reliability means a steady and predictable performance adapted to shipping lines schedules. If a port authority or port operator always makes delays during operation process due to strikes, equipment breakdown, weather, e.tc, shipping Lines and shippers will suffer huge losses due to these kinds of unreliability. Apparently, carriers and shippers will not desire to call at this kind of ports even if they provide the most attractive price among their competitors. The differentiation into productivity indices is informative as it helps to identify the source of productivity change for instance; it would be a waste of management focus, effort and resources if a seaport or container terminal which already utilizes its existing production facilities to justify the corrigenda to efficiency deficiencies and unconsciously postpones a technological investment program. However, the offered efficiency and productivity indices should not be interpreted uncritically, as they may be influenced by endogenous and exogenous factors Odeck and Schøyen (2009). He deduced from his findings on the relative efficiency and productivity of Norwegian ports and also productivity comparison with U.K Ports and other Nordic Ports thus throughput is an operational performance indicators which may not be adequate to measure productivity when considering some input variables. This can also complement financial indicator.

Marlow and Paixao (2003) argued that poorly performing ports that are cost inefficient may have to increase their port prices to cover costs and thus to break even (where revenue covers costs), thereby possibly placing the ports on competitive price disadvantage, or else held constant. They further opined that when ports are technically inefficient which could result in ships staying in port longer Shipping lines may have to introduce more ships on a given trade route in order to meet their scheduled port calls on the route and also when cargoes stay at the ports longer, shippers may have to increase their inventories, resulting in higher inventory costs. Ineffective ports may have lower profits as a consequence, thereby having less profit to finance port investments.

Global terminal operators must strive to increase productivity at the ports considering the current market condition where time is essential thus the introduction of much larger vessels will create a big gap in supply and demand (Kavas, 2016). She supported the use of ship arrival and departure from the berth as base for measuring port productivity and argued that increase in productivity at the port and improvement on vessel turnaround time is not solely dependent on automation of cargo handling although it helps to reduce the labour cost to an extent but have not enabled vessel operator to acquire the expected results from the ports. Hence he opined that labour, crane numbers infrastructure, capital management, policies and government agencies' involvements should be considered other than automation.

Golany and Roll (1989) expressed that ports have basically evaluated their performance by comparing their actual and optimum throughputs (measured in tonnage or number of containers handled). He concluded that if a port's actual throughput approached (departs from) its optimum throughput over time, its performance would improve (deteriorated) over time. He defined effectiveness as how well the port utilizes its available resources or concerned with how well the port provides throughput service to its users i.e. carriers (ocean and inland) and shippers thus classified economic operating objectives of a port as either efficiency or effectiveness objectives in which port efficiency operating objectives include the technical efficiency objective of maximizing throughput in the employment of a given level of resources (exhibited by the port's economic production function) and the cost efficiency objective of minimizing cost in the provision of a given level of throughput (exhibited by the port's economic cost function). In order for a port to be effective, it must be efficient i.e. it must be cost efficient which in turn requires that it must be technically efficient. For example, if a port has the effectiveness operating objective of maximizing profits and is cost inefficient, it can obtain greater profits for the same level of throughput service by reducing its costs to become cost efficient. A port can be cost efficient without being effective implies that a port may attract revenue/throughput when it has a reduced or subsidized cost even when it is not effective.

2.1.8 Concept of Labour Productivity

Labour productivity refers to the quantity of labour input required to produce a unit of output. When assessing the productivity of port, labour productivity cannot be ignored just as (Praise et. al.) corroborated that labour productivity cannot be undermined as it constitutes the life wire of any economy and as Labour productivity could be defined as the degree to which an employee's effort results in units of output labour productivity depends on how much value was created by the employee per hour of his work either by producing.

Though, (NBS, 2016) defined labour productivity mathematically as;

$$Labour\ productivity = \frac{GDP_{year\ N}}{Labour_{year\ N}} \qquad 2.8$$

However, developed countries had being having high productivities compared to the developing countries especially Nigeria because of the high dominance of public sectors in commercial activities and their incapability to proffer solutions to labour problems causing low labour productivity.

Based on statistical analysis by (NBS, 2016), it was deduced that as labour forced increased from 2011 to 2016 so does labour productivity alsoincreased but unfortunatetely decclined massively in 2016. However, the massive declination of labour producitivy in this period was attribute to the low volume of private investment and foreign direct investments to the economy system.

Productivity improvement does not just involve the efficient production of products or services, but of products and services that are needed and demanded and bought by very discerning customers while the role of human factor as being embraced as the main determinant of productivity improvement (Oshiomhole, 2006).Dynamism in labour market, however can be technically traced to the labour productivity (NBS, 2016) so does the productivity changes in a system can be basically tribute to labour productivity.

Even in this era of technological advancement, labour factor cannot still be completely preempted as(Oshiomhole, 2006)corroborated that the full potential of technology on productivity improvement cannot be realised in the absence of human resource capable of exploiting this technology. However as the concept of total factor productivity trends, labour still remains the focal actor in productivity incubation. Moreover, the benefits of improved productivity are responsibilities of various stakeholders in society.One of the basic issues faced by managers in the process of introducing technologies in labour-oriented production systems is the mix of labour factor with technologies for improved productivity. However, this will be better explained in the next sub-section of this chapter.

2.2 Pre-Concession Era

The literatures below review the state of productivity of Nigerian ports at pre and post concession era.

2.2.1 Status of productivity of Nigerian Ports in the pre-concession

In the early 1970s, the total capacity of Nigerian ports was only 6.5m tons of general cargo per annum. Yet, in 1974, the government entered into a contract to import 20m tons of pending sharply. New infrastructure developments were suspended, while existing ones were left unmaintained. Nigerian ports were caught in this web of infrastructural neglect and decline. This was compounded by the reduction in port activities, resulting from a sharp fall in the number of ships arriving in Nigeria. This led to the underutilization of existing port facilities (Nigeria Port Authrority, 2005). Also, between the period of 1970 and 1980, Nigeria Ports witnessed54.3% increase in dry cargo traffic 7233468tonsand 100% increase in containerized cargo traffic8871 tons, reflecting the high introduction of containers prior to the containerization era i.e. early 1980s when container services with specialized ships (cellular containerships, first introduced in 1967) became a dominant aspect of international and regional transport systems with the aim to achieve economies of scale by the shippers (Rodrigue, Comtois and Slack, 2006). Subsequent to this, new container terminal and modern cargo handling equipment has been adopted in the ports to speed up the process of loading and discharging vessels in order to reduce turnaround time of ships as the handling of traditional general cargo was usually labour intensive and time-consuming. Pinwa (1999) inferred using container terminal of Lagos that was equipped with gantry cranes and straddle carriers as an epitome of this development in which there was16830.3%increases in TEUS and 47.2% increases in dry cargo traffic at Lagos Port between 1970 and 1980 while other Nigerian Ports there was increase in dry cargo traffic by 168.6% and containerized cargo traffic 25533.6% thus this analysis reflects the attributes of high dependency on importation during this period. Due to the inability of the port to handcuff the issues bedeviling the investment and port performance, the port was commercialized1992changing the name of the organization for Nigeria Port Authority to Port Authority. The Section 7 of the Nigerian Ports Authority Act, No. 38 of 1999, requires the NPA to provide in addition to the statutory function:

i. Commercial status required it to operate as a profit making commercial venture and without subventions from the Federal Government.
ii. Powers to fix rates, prices and charges for goods and services provided, capitalize its assets, borrow money and issue debenture stocks and sue or be sued in its corporate name(Nigeria Port Authrority, 2005).

Among the objectives of the commercialization of the NPA were to attract external fund i.e. private capital, operate on a strictly commercial basis and adopt best practices, modernization of port operations and for the administration to improve efficiency and service delivery. The business agreement between the Nigeria Ports Authority and the private firms which include Nigeria Flour Mills, Dangote Industries at Apapa Port and Intel Nigeria Limited at Onne Portswere mere lease agreement under service port model (Ndikom, 2006). This reform did not achieve its objectives as the port still experienced poor performance and low productivity even more than before. The government's control and ownership of the NPA, despite its commercialization, became a major hindrance to private sector involvement. At the same time, the inability of successive governments to provide the huge amount of capital needed for the smooth and efficient running of Nigeria's seaports, left the NPA unable to perform many of its statutory directives, let alone compete at an international level (Nigeria Port Authrority, 2005). In 1999, the main dock labour management difficulty in Nigeria ports is the problem of replacing the labour force with capital intensive technology in cargo handling as a consequence of containerization in the absence of adequate financial resources from the stevedoring contractors (Pinwa, 1999). The trend in the size of the vessel also called for the involvement of capital intensive technology in cargo handling thus this and other developments are all designed to improve cargo handling, increase productivity and facilitate ship turnaround time. The changes in cargo handling techniques invariably have contributed to labour reduction particularly in container terminals. Pinwa(1999) affirmed that despite the efforts to improve productivity through the mechanization, there was no noticeable effect on the productivity in the Nigerian ports by depicting it with the below tables.

Table 2.1: Labour Productivity in Nigerian Ports from 1993-1996

Year	Tonnage Handled	Gross Tons/hour	Net tons/hour	Gross Net Labour Utilization (%)
1993	4669759	12	18	67
1994	3620707	12	18	67
1995	3083107	19	29	66
1996	2412077	14	20	70

Source: Pinwa (1999)

From the table, three attributes is observed which are fluctuation in labour utilization, increase in gross productivity and net productivity overtime, decrease in throughput over the period thereby depicting wrong input mix which caused technical inefficiency and low productivity of the port. The scenario of technical inefficiency after investment in infrastructure is hard to comprehend as Koutsoyiannis (1979) termed trait like that as the irrational behavior of the firm which are not considered by the theory of production, furthermore he affirmed that no rational firm would employ labour or capital beyond marginal points of the inputs, since an increase in the factors beyond these levels would result in the reduction of the total output of the firm. The challenge of cargo handling technology manifests itself in two major ways which are (Pinwa, 1999).

i. The port authority strategies to introducing advanced technology
ii. The effect of such technology on the entire range of problems associated with human resources including those related to employment, training, attitudes to changes and social security.

One of the most sensitive matters involved in port labour reformation in Nigeria is the need to reduce the labour force to the level required by the new cargo handling methods. During this period of evolution of labour productivity, it was deduced that due to decrease in labour size with increase in new handling devices and system there was increase in throughput which in turn improve productivity and efficiency at the port (Pinwa, 1999). This can be further explained by the theory of production function in which Koutsoyiannis (1979) identified the two technical possible ways of measuring level of production as;

Short term – considers increase one input and keep the other factor constant.

Long term - considers law of returns to scale through the changing all factors by the same proportion or by different proportions. The conditions of law of return to scale are;

i. If change in output remains zero by the increase in the inputs by same proportion k then there are **constant returns to scale.**
ii. If change in output decrease by the increase in the input by same proportion k then there are **decreasing returns to scale** and
iii. If change in output increase by the increase in the input by same proportion k then there are **increasing returns to scale**.

Invariably, this means that Nigerian ports experienced decreasing returns to scale during the period of introduction of technology or mechanization. Furthermore, if the increment can be factored out the production function is termed to be homogeneous whereas if the increment cannot be factored out production function is referred to as homogeneous thus the power raise to the increment is constant return to scale if it's equal to one, decreasing return to scale if it's negative if it's less than one and increasing return to scale if it's greater than one. This also explains the production of Nigeria ports as homogeneous production function.

In this situation, Liu (2010) suggested that checking the infrastructure information during operational years when technical efficiency drops (i.e. efficiency drops after investment in infrastructure is made) will be a milestone to detect the relationship between investment and infrastructure and also solve the low productivity emanating from the problem of input mix.

The proposal to reduce the number of workers was very difficult in Nigeria port as Pinwa (1999) claimed and would strongly be resisted because of the social and economic implications and consequences the nation will face even though he moved the notion of technological impact in reduction of labour and operation level.

He listed factors that influenced productivity between 1992 and 1995 at Nigerian ports as.

i. Poor labour relations: There had been poor labour relations, minimal motivation which resulted in work stoppages. Meanwhile, efforts have been made to ensure cordial rapport to minimize or eliminate conflicts between employers and labour employees.
ii. With the restructuring of the port to the status quo the plants were inadequate. In addition, the employed labour needed some form of training to acquire then necessary skills to work efficiently.
iii. Dilapidated quay apron: dilapidated quay implied slow and unsmooth movement of labour, equipment e.tc during loading and discharging.
iv. Delay caused by ship movement/preparation, labour and equipment breakdown

Beskovnik (2008), acknowledged that difficult labour conditions and more restrictive regulatory have direct impacts on the lower productivity or throughput per terminal space. He suggested the role of productivity quality manager to scrutinize the work and safety rules, workforce motivation, training and handling equipment characteristics in order to achieve balance between labour satisfaction and the productivity as these factors have direct impact on gross labour productivity. Emeghara (2012), accessed the delay factors in Nigeria port operation through an opinion survey conducted with respondents mainly staff of port operators and port users with the aids of questionnaire and it was analyzed with cumulative ranking system and regression model where he concluded that there was deficiency in the ports system in the Nigeria compared to other countries in the industry. He also buttressed the fact with issues of diversion of ships and cargo meant for Nigeria ports to neighboring West-African ports caused by some critical and non-critical delay causative factors which will be mentioned in the preceding topic. Nigerian Ports experienced inefficiencies and inabilities to be user friendly as a result of delays and high cost of using ports in an advantageous or economical positions caused by inadequate cargo handling equipment and other port infrastructure (Emeghara,2012), which in turn discouraged shipper and ship owner to demand for their services thereby causing diversion of markets to neighboring ports. This was buttressed by the research he carried on delay factors evaluation of Nigerian seaports using Apapa Ports Complex, Lagos as a case study multiple regression analysis model to analyze and evaluate the information obtained from the questionnaires distributed to 50 stakeholders of Apapa Port Complex from which he deduced that there is strong correlation between delay time and some critical and non-critical causative factors which subsequent the consideration of lack of enough functional cargo handling equipment as the most critical factor causing delay at the port in spite of the investment of the private operators on cargo handling equipment because of their dependency on the outdated equipment inherited from the NPA. Another critical factors are administrative bottleneck, extortion of money and shallowness of the entry channel which needed to be addressed as there were low inaccessibility encountered from the advent of larger capacity vessels, this can be solved by constant dredging of the channel to suit uptrend size of vessels which short term may serve as difficulties or challenges for developing nations as cost of dredging influences port cost resulting to disadvantages to the developing countries' economies.

When traffic through the port nearly reaches capacity infrastructure efficiency is also high. When the port invests in infrastructure and facilities, capacity increases, so the utilization of the facility drops until the slack is taken up, thus infrastructure efficiency temporarily declines. The demand placed by traffic passing through the port is ever-growing, so the utilization of port infrastructure and facilities also grew to meet the increased capacity. Therefore, the infrastructure efficiency improves until the port once again invests in infrastructure and facilities (Pinwa, 1999)**.** Nigerian Port activities were hindered by inadequate cargo handling plants and equipment, long turnaround time, cargo pilfering and excessive charges (Jaja, 2011), this he deduced inferentially from the research he carried on the assessment of freight traffic at Nigerian seaports through the analysis of cargo throughput recorded at Nigeria Ports from 1990 – 2005 which divided into general cargo traffic; dry cargo traffic; liquid cargo traffic, turnaround time at Nigerian Port and serviceable cargo handling plant and equipment at the Ports. From his findings he analyzed that there was increase in the general cargo inward between 1990 and 1992 but fell by 39.6% in 1994 which he attributed to the reduction in the nation's revenue from oil incorporated with ineffectiveness of port operations and illegal charges on port users which he stated that large share of Nigeria's external trade were being conducted in neighboring countries and smuggled to Nigeria via road. The issues was also experienced on the outward general cargo traffic which increased by 49.3% but fell till 2004 by 74.0% which he attributed to the significant shift from oil export to non-export. Hence from his analysis, the inward cargo increased by 150% between 1990 and 2005 while outward general cargo decreased by 50% showing the attribute of major dependency on importation. Similarly, the statistics of dry cargo traffic also reflected this trend thus liquid cargo traffic reflect similar trend as the inward traffic decreased by 19.1% in the late 90s but increased by 48.1% in 2005. He stated that the huge investment in port development as null since there are anomalies in the Nigeria maritime freight transport which he attributed to the following issues; absence of intermodal connectivity; inadequate cargo handling plant and equipment which he suggested that they should be improved and place in good condition; increased ship turnaround time as his findings indicated that between 1990 and 2005 turnaround time of ships decreased at Apapa Port by 2.2% from initial 9.84days, Tin Can Island Port by 48% from initial 8.88 days, Warri Port by 16.6% from 7.01days, Port Harcourt Port by 40.7% from 17.22days and high pilfering rate. He concluded that these issues have led to regressed national revenue and competitiveness of the ports in the global port system and that concessioning would be suitable to mitigate these anomalies through promoting competition and increasing port operational capacity**.** Vessel delay period has a significant proportion of ports low productivity in terms total cargo throughput and revenue generated which Ndikom (2006) said has 60%. Incorporation of Dilapidated infrastructure facilities and poor state of terminal operational functionality contributes to congestion at the port. He addressed that Nigerian Ports acutely fell below standard in terms of dock labour productivity using 10-15 days to service medium sized vessel with relative to the smaller African Port of Lome and Cotonu Ports. Furthermore, he stated the consequences of this inefficiency on consumers' behaviours or choices to deny the services of Nigerian Ports as the demurrage that could have been saved if Lome and Cotonu Ports were used is US$4,000. Also the issue of high tariff incorporates to impede port productivity which could be solved on a long-term through the review of price and tariff policy if the government desired to make Nigerian's Ports user and customer friendly and Central African Sub region. The maritime industry is a highly technical, professional, competitive industry being capital and labour intensive as well as subjected to international conventions, rules and regulations. Consequent to this, Nigeria Ports could not meet up with the maritime requirements which as a result of this led to poor managerial skills and techniques resulting to loss of revenue to government, inconsistent policies, low efficiency and effectiveness which he attributed to the wrong mismanagement of ports' subsystems which include stevedoring, terminal operations, security, port tariff and charges, importing and exporting e.tc by port stakeholders.

The NPA has taken several corrective measures to improve the state of Nigerian ports and to promote their use. To cope with insufficient capacity, the NPA has embarked on a course of integrated infrastructure development in key operational areas. These efforts have involved the expansion and rehabilitation of some of its ports. For instance, the Lagos Port Complex is currently being rebuilt with respect to their construction of quay line, car park deck and a new administrative building, as well as the main gate and berths 7 to13. The total completion rate as of June 2004, was 80%.Similar rebuilding work has taken place at the Federal Ocean Terminal (FOT) and the Federal Lighter Terminal (FLT) at Onne, where the NPA, in conjunction with Integrated Logistics Services – the major terminal operator at FLT and FOT – has embarked on building an integrated infrastructure and superstructure at the FOT and is constructing an additional570m and 376m extension of the FLT. The ports are dedicated to serving ocean going vessels and tankers of oil and gas for the west and central African sub-region. The adoption of a new maintenance system known as the Manufacture-User Maintenance System has also enabled the NPA to deal with the problem of a lack of functional plants at the ports.

The system has proved successful at the Container Terminal port, where it led to a reduction in turnaround time of vessels and to increased plants availability. Container terminal also experienced redevelopment in which required equipment such as automated cranes to handle container operations were acquired thereby encouraging shippers to call at the port which in turn led to more importation. Consequently, Lagos Apapa Port Complex experienced more traffic congestion due to high storage of containers and cumbersome custom formalities undertook by container shippers/carriers who facilitated the introduction of Inland Container Depots (ICDs) in 2009 to every state where containers are cleared under normal custom formalities and accessed by the carriers at the designated areas**.** From the above literature review it is observed that the operational efficiency and low productivity at the Nigeria ports due to poor investment in port infrastructure and operations was disturbing which requested for viable reforms unlike the ones adopted initially during this period. The notion of Public-Private Participation (PPP) was moved to the system in which Royal Haskonning/Dynamar/Challenge International Associate recommended concessioning of the port on landlord basis which identify the roles of the government from the private concessionaires as (Mohammed, 2009).

Private Sector (Terminal Operators)

i. Cargo Operations
ii. Port Labour
iii. Investment in equipment
iv. Investment in terminal maintenance
v. Insurance of concession assets

Public Sector (NPA)

i. Port Planning, Licensing and Control
ii. Port Development
iii. Technical Regulations
iv. Marine Services
v. Channel Management

2.3 Post-Concession Era

2.3.1 Status of the Productivity of Nigerian Ports in the post- concession

The Federal Government through the Nigerian Ports Authority has continually made efforts to reposition the Nigerian ports in line with global trends in shipping and ports operation. This led to a comprehensive port industry reform in 2006. The aim was to build a robust, responsive and competitive port economy that will have increased private sector participation and be in tune with global best practices (Usman, 2016).

The federal government port's reform programme has been yielding positive results not withstanding inevitable**.** Port reforms are policy measures adopted for the efficiency, productivity and also aimed at attracting investors to the ports, which in turn will lead to providing modern cargo handling plants and equipment to enhance smooth operations at the ports in cognizance to the objective of Bureaucracy Policy Enterprise (BPE) which is to make Nigeria Ports hubs for other western ports and also central ports. The achievement of this objective depends greatly on the challenges posed by mismanagement over the year in increasing the efficiency and productivity of the ports (Ndikom, 2006)**.** He further stated that the socio-economic reasons for the reform and privatization of Nigeria Ports Authority as an approach for government to completely hand over the provision of goods and service provided by private sector, to concentrate on providing enabling environment to develop the port in line with the current trend in the world, to concentrate in the planning and coordination of the development of ports in Nigeria, to attract the private sector in areas of technology, management techniques and provision of specialized services and to develop ports in Nigeria into hubs for West and Central African sub-region thereby reverse the negative trend of cargo diversion to less equipped neighboring ports through forwarding process, computerization of the port system, improved services and abolition of cargo. If proper reform policies are put then the productivity in the ports would improve as port privatization policy and port productivity are proportional. He deduced this findings from his research on critical assessment of port privatization policy and port productivity in Nigerian maritime industry through secondary data of cargo throughput ranges from 1999 to 2009 which he describe as an inference that port productivity has improved since port reform programme and the aids of questionnaires set for 180 ports' stakeholders using Chi-Square method to test and analyze the hypothesis set towards his objectives thus he concluded that the hypothesis that there are no significant relationship between port privatization policy and some port criteria i.e. port optimal performance, efficiency, port revenue generation and service delivery are invalid as majority of the population sample testifies to the positive impacts of port productivity policy on these mentioned criteria in which he suggested that there should be improvement in the policies.

The impact of concessioning was insignificant due to the inconveniencies on private operators which emanates from high port dues, lack of adequate port infrastructure and also the inconsistency of terminal operators themselves (Oghojafor and Alaneme 2012). They adopted the ex-post facto study to examine the problems facing the operations of the Nigerian ports before the concession programme of 2006 and evaluated the impact of the concession exercise on the ports efficiency thus assess the efficiency of Nigeria ports through secondary data using annual reports, as well as interview and media reports to deduce their findings which reflected that better ports' efficiencies was realized at the first concession year (2006) with the overall TEU of 54,641,084 tons, turnaround time of 4.70 days and berth occupancy rate of 47.43% which was conversed declining in the following years with throughput 49,173,324 tons, turnaround time of 6.1 and berth efficiency of 46.93%. Conclusively, the researchers attributed the bottleneck to some managerial factors which include negligence on the part of the authority to provide a conducive environment for port operations and poor infrastructures which is not in consonance to the reform policy. Contrary is the case for Onne Port Complex which has been partially concessioned to some terminal operators since 1996 thus Okeudo (2013) testified that increased cargo throughput, low ship turnaround time, low berth occupancy was experienced at the port as a reflection of significant improvement from the reform programme. He viewed that the reforms have brought a significant improvements in cargo throughput so far as compared to the pre-reform era through the use of two sample t-test to analyze and evaluate the distinct between the status of input and output variables i.e. cargo throughput, ship turnaround time and berth occupancy rate at pre-reform era and port-reform era. From his findings, he deduced that there is no statistical difference between the mean cargo throughput for the pre-reform era and port-reform era at Onne Port is invalid.

To buttress this, Somuyiwa and Ogundele (2015)**,** emphasized on the positive impacts of reform programme on the productivity of Tin Can Island Port as the concessionaires scrutinized and invested on cargo handling equipment, storage capacity, and yard occupancy. Using multiple regression analysis and pearson product moment Correlation coefficient model to analyse fifty (50) plant operators as sampled size based on simple random sampling technique, they deduced that the hypothesis test "there is no significant relationship between the mentioned elements and port productivity" is valid during pre-reform and earlier reform era and invalid during post-reform era which means that there is significant relationship between the cargo handling equipment, storage capacity, yard occupancy and port productivity. They concluded that during pre-reform and earlier reform era the cargo handling equipment were in a bad condition thereby caused high dwell time at the port while during the post-reform era the dwell time of cargo and vessels reduced due to the good condition of these elements.

Table 2.2 Cargo Throughput during Pre-concession and Post-concession Era

Year	Import (million tons)	Export (million tons)	Throughput (million tons)
1999	15,751,331	6,481,605	22,232,936
2000	19,230,496	9,702,384	28,932,880
2001	24,668,791	11,271,901	35,940,692
2002	25,206,380	11,780,861	36,987,241
2003	27,839,293	11,926,652	39,765,945
2004	26,907,075	13,909,872	40,816,947
2005	29,254,761	15,697,312	44,952,073
2006	31,937,804	17,235,520	49,173,324
2007	33,722,488	20,918,560	54,641,048
2008	41,385,973	23,806,946	65,192,919

Source: (Mohammed, 2009)

Table 2.3: Vessel Traffic Pre-Post Concession Era

Year	Ship Traffic	Total Gross Tonnage (Tons)
1999	3,123	32,911,941
2000	3,333	44,432,370
2001	3,745	56,106,345
2002	3,500	53,267,921
2003	3,661	60,622,666
2004	3,606	61,384,221
2005	3,692	60,541,810
2006	3,689	63,267,047
2007	4,646	83,197,856
2008	4,477	89, 597,975

Source: (Mohammed, 2009)

Table 2.4: Overall waiting time, turnaround time and berth occupancy at Nigeria Ports

Year	Waiting time (days)	Turnaround time (days)	Berth occupancy (%)
1995	0.47	6.17	27.76
1996	0.46	6.34	36.68
1997	0.47	6.71	36.73
1998	0.39	7.31	41.39
1999	0.36	6.31	47.09
2000	0.34	7.01	44.76
2001	1.27	7.91	51.78
2002	3.99	11.34	56.58
2003	2.17	7.89	52.75
2004	1.44	6.44	50.93
2005	2.60	7.40	49.70
2006	2.00	6.10	46.93

Source: (Mohammed, 2009)

From the tables 2.3 and 2.4, Mohammed (2009) gave analysis of pre-concession and post –concession era as follows; increased container penetration rate led to annual average growth of 7.8% in the container trade in the 1980s, international container traffic grow by an annual average of 9.5 over the period 1987–2006 which in turn result to serious capacity challenges, capacity utilization rate expected to increase from 72% in 2006 to 97.5% in 2012, stagnation was expected in container volumes in 2009, low and declining charter rates, scarcity of funds for infrastructural development, the current recession faced at the period may affect shipping more than ports, need for harbor expansion still topical, growing cargo volumes due to economic growth, rapid expansion of facilities in the late 70s to early 80s, PPP projects through amortization late 1990s to present, landlord model and BOT in mid-year 2000 (24 concessions and 1 BOT), Repeated incidence of congestion in Lagos area. The ports infrastructure keeps compromising the operations at the concessioned terminals hence according to Onwuegbuchunam (2012), low efficiency recorded in Nigerian ports is due to underutilization of port infrastructure. He was of the view that there is low mechanization of cargo handling in the Nigerian ports as there was low contribution of labour inputs to output of these ports. This findings was based on how he used stochastic frontier analysis to evaluate the three (3) input variables such as number of berth; number of equipment; labour size and one (1) output variable such as throughput for 22years (1989-2009) in order to determine the efficient and inefficient ports in which Apapa Port, Tin Can Island (TCIP), RORO Port, Port-Harcourt Port (PHP) and Onne Ports was considered technically efficient (T.E)as their efficiency values was approximately 1.0 while other Ports like Container Terminal, Warri and Calabar Ports were considered inefficient as they could not make the frontier.

The port concession program has improved the efficiency of the ports through an increase in throughput levels (Nwanosike, 2014). She opined that productivity has declined due to the deterioration in technological progress after concession. She also opined that competition is not a significant contributor to the Nigerian ports' performance, despite concession thus even without inducing intra-port competition, concession improves port operational performance by securing increased throughput through global alliances of GTOs. Her study adopted a positivist approach using quantitative data that involves outputs variables (throughput and turnaround time) and input variables (number of berth, number of staff, number of equipment and storage capacity). Having justified the variables, she analyzed the data using non-parametric DEA and Malmquist Productivity Index to ascertain the efficiency and the productivity change respectively. she deduced a trend analysis of productivity for individual Nigerian Port for the period of 2000 to 2005 and 2006–2011 (12 years) where it was observed that year 2001 only Onne Port was 100% efficient, year 200Onne and PH Port was 100% efficient, year 2003 Apapa and PH Port was 100% efficient, year 2004 Apapa, Calabar and

PH Port was 100% efficient, year 2005 only Onne Port was 100% efficient, year 2006 Apapa, Onne and PH Port was 100% efficient. My contradiction to her research work is on this basis:

i. Turnaround time: According to DEA nature of analysis which is basically derived from Linear Programming Model, inputs' units are meant to be minimized or reduced and/or outputs' units are meant to be maximized or increased if working towards efficiency. Consequent to this, for a port/terminal system to be efficient, turnaround time is meant to be minimized not maximized. Thus this criticized the adoption of this variable in her research work.
ii. Number of Staff: The unit of this variable is difficult to acquire through concessioned terminals as record is still being based on the staff operating in NPA not for terminal concessionaires who handle the main operations.
iii. Number of equipment: the magnitude of this variable varies among ports/terminals. Hence it is not advisable to make comparison based on this variable. Also, the data available is not based on terminals' assets.

2.4 Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) does not impose any particular functional form on the data as it creates flexible piecewise linear function unlike regression. DEA is a good tool to evaluate more performance (Lin, Wu, Chu, and Liu, 2005). They found out the distinctions between DEA and linear regression analysis through the application of these models for the performance efficiency evaluation of the Taiwan's Shipping Industry. In their research, considering 14 shipping companies as Decision Making Units (DMUs) and using the two (2) input variables which include assets; stockholders' equity and also two (2) output variables which include operating revenue and net income. From their analysis he observed U-Ming, YML, WAN HAI and Shanloong as the most efficient with DEA efficiency score 1.0000 while U-Ming was the first efficient shipping company. When considering linear regression analysis of the inputs to the output operating revenue and Taiwan Line was first efficient shipping company when considering linear regression analysis of the inputs to the output net income. The researchers identified the drawbacks of regression as the correlation and relationship of input variables to only one output variable at a time. The differences in the analysis of the DEA and linear regression analysis enabled the researcher to conclude that DEA analysis adopts best performance as the criteria for efficiency computation while regression uses the average performance as the yardstick for computations.

Table 2.5: Sensitivity Analysis of Taiwan Line (Shipping Company in Taiwan)

Variable name	Estimated weight	Value measured	Value if efficient	Slack
Operating revenue	0.5598987	2,357,181	2,357,181	0
Net Income	0.178606	771,641	771,641	0
Assets	0.00000001	5,991,346	5,991,346	0
Equity	0.4242356	4,525,048	4,214,974	310,074

Source: (Lin, Wu, Chu, and Liu, 2005)

From the above analysis, it was observed that by satisfying all the constraints, the estimated weights of the input and output variables are the best possible combination of weight that can produce the relative efficiency of this DMU.

Data Envelopment Analysis (DEA) provides numerous benefits over Cost-Benefit Analysis (CBA) andMulti-Criteria Analysis**(**MCA**)** thus considering this attributes, Caulfield, Bailey, and Mullarkey (2009) recommended DEA as a powerful decision making tool for similar transport investment as they used this analytical tool as a public transport project appraisal tool. The aim of their research was to evaluate and select the best possible mode(s) to be used between Dublin city centre - airport route by employing one (1) input variable Cost which encompass Construction costs; operation costs; maintenance costs and three (3) output variables: number of car trips removed; patronage; travel time saving, all attributed to six (6) possible transportation modes which represent DMUs which include 16, 41, Metro North, BRT Airport, Luas Airport and DART Spur. They explained the reason for selecting the number of input and output variables against the six (6) DMUs as a fact made by Cooper, Seiford and Tone (2000) that if the number of DMUs is less than the combined number of inputs and outputs then a large portion of the DMUs will be identified as efficient and bias will be removed. Subsequently, they deduced from CCR-output oriented analysis that BRT Airport and DART Spur are the most efficient transportation solution for the airport route followed by Lucas with 83% efficiency score and BBC-output oriented analysis (scale efficiency) showed that BRT Airport, DART Spur, Route 16 and Metro North are routes that possess high operating performance relative to their locations. It was conversed that the overall global inefficiency (50%) experienced by route 16 was as a result of inefficient operation rather than scale problems scale problems which he suggested and also concluded that Metro North and Lucas Airport who has 100% BCC score and relatively low scale efficiency of 66% and 83% respectively are suffering from scale size rather than inefficient operation. They recommended that operational efficiencies of these subsequent routes should be improved to meet up with the scale of frontiers (BRT Airport and DART Spur) by reducing costs and infrastructure size.

Data Envelopment Analysis and Free Disposal Hull (FOH) allow the measurement of the relative distance that an individual decision making unit lies away from its estimated frontier (Kaisar, Pathomsiri, Haghani and Kourkounakis, 2006). They carried a research on developing measures of U.S ports productivity and performance using two powerful analytical tools named Data Envelopment Analysis (DEA) and Free Disposal Hull (FOH) to analyze and evaluate input variable number of berth, length of berth, total terminal area, storage capacity, number and size of ship shore crane; front and handlers; yard tractors; yard chassis at the ports and output variable TEU of 29 U.S seaports through which they observed that in 1996 eleven (11) out of twenty-nine (29) ports had perfect efficiency score of 1 according to DEA-CCR input-oriented analysis, sixteen (16) ports out of twenty-eight (28) were efficient according to DEA-BCC input-oriented analysis and twenty-four (24) out of twenty-nine (28) ports were efficient according FDH analysis. In 2001, thirteen (13) ports had out of twenty-nine (29) perfect efficiency score of 1 according to DEA-CCR input-oriented analysis, nineteen (19) and twenty-four (24) ports out of twenty-nine ports were efficient according to DEA-BCC input-oriented analysis and FDH analysis respectively. They further test the authentication of these diversified analysis of these analytical tools by employing Spearman's rank order correlation coefficient thus obtained the correlation values between the efficiency derived by DEA-CCR, and DEA-BCC, DEA-CCR and FDH, and DEABCC and FDH methods to be 0.99273, 0.98118, and 0.99730 respectively. The positive and high Spearman's rank order correlation coefficients indicate that the rank of each DMU derived by the three methodologies is similar. Also, the small absolute value of the spearman's rank suggests that the efficiency of ports is not a significant influence by its size.

The application of Data Envelopment Analysis can be seen from the research Van-Dyck and Ismael (2015) carried on the assessment of port efficiency in West Africa using secondary data of input variables total quay length; terminal area; number of quayside cranes; number of yard gantry cranes; number of reach stackers and output variables container throughput for the period 2006-2012 which he deduced that Lagos port has the highest throughput of

1,623,141 ton in 2012 (post-concession era) but suffers from throughput fluctuation over time as other ports except Cotonu Port who experienced stability of throughput during the studied years though Cotonu port has the least average efficiency score of 46% placing them as the last (6th) ports on his efficiency ranking table reflecting the attribute of underutilization of infrastructure at the port which make the writer referred them to as under-achiever, the port of Tema has 91% average efficiency score which placed them first on the efficiency ranking table, the port of Abidjan is the second on the table with efficiency score of 90% followed by port of Lome with efficiency score of 88% then Lagos Apapa Complex as fourth position on the table with 76% irrespective of her unique attributes as a port that has largest size among these West African ports studied and located in a country that has largest economy in Africa which reflects the attributes of low efficiency in the port thus it shows the strength of DEA as an unbiased analytical tools. The port of Dakar precedes Lagos port complex with average efficiency score of 62% even though she exhibit maximum level of efficiency of 72% between 2006 and 2009 but declined in the preceding years to 68%, 56% and 53% and lastly port of Cotonu. He related causes of inefficiencies of ports to smaller customer base and lack of adequate output resulting from the level inputs were being utilized in port operations which he that recommended shipping lines in West Africa should ensure that a potential hub ports exhibits high port efficiency and performance.

The insight of the application of DEA can also be seen in the research carried by Hajizadeh, Nasser, Amer, Homayoun, Mostafa (2016) on relative efficiency analysis of container ports in Middle East using DEA-AP to analyze the input variables berth, berth length, terminal area and quay/yard gantry and output variable throughput for 2011-2013 on twelve (12) ports located in five (5) countries like Islamic Republic of Iran, United Arab Emirates, Saudi Arabia, Oman and Egypt with DEA-BCC output oriented which considered ports of Bushehr, Khorfakkan which has most referenced shadow price, Jebel Ali and Alexandria most efficient ports with efficiency score 1 and port of Oman as the most inefficient. He concluded that managers or operators of these ports experienced increase in output which in turn increased efficiency as a result of expansion of the input capacity. He concluded that three Iranian ports among the ports studied have low relative efficiencies according to the implementation of the BCC model (pure technical efficiency) depicting port inefficient in management of operations. Thus he recommended that managers of inefficient ports should focus on improving management approaches and handling of the operations. The limitation to the application of the model may arise as a result of lack of data unavailability at individual

DMU level which is less experienced when dealing with public sector than with private sector which can lead to flexibility in data interpretation prompting the researcher to move and seek for data from system to sub-systems which might even result to increase in research knowledge through pertinent questions and further justification from responsible officials for whatever inefficiencies are uncovered (Charnes, Cooper, and Rhodes, 1978). The objective is to measure the efficiency of resource utilized in whatever combinations are present in the organization as well as the techniques utilized in whatever combinations are present as well as the technologies utilized and to evaluate the accomplishments or resource conservation possibilities. Considering the fact that competition, free and diverse deployment of resources from one industry to another the introduction of prices or weighting devices, for the evaluation of otherwise non-comparable alternatives. Their measures was not designed for this kind of application but was designed for public sector programs in which the managers of various DMU's are not free to divert resources to other programs merely because they are more profitable or otherwise more attractive.

2.5 Empirical Review

2.5.1 Data Envelopment Analysis

Data envelopment analysis (DEA) is a linear programming based technique that provides an objective assessment of the relative efficiency of similar organizational units (Sarica, and Or, 2007). These similar organizational units are considered to be decision making units (DMU), hence the efficiency of these organizational units are calculated. Thus, efficiency is obtained as productivity where it is a ratio of actual output attained to standard input expected (Sumanth, 1984). Mali (1978), generally express the terms productivity as;

$$\text{Efficiency} = \frac{\text{Output Obtained}}{\text{Input Expected}} = \frac{\text{Performance Achieved}}{\text{Resources Consumed}} = \frac{\text{Effectiveness}}{\text{Effeciency}} \ldots (1) \qquad 2.9$$

Therefore, Sumanth (1984) and Ramanathan (2003) express efficiency:

$$\text{Efficiency} = \frac{\text{output}}{\text{Input}} \ldots (2) \qquad 2.10$$

The equation 2 is applicable for evaluation of simple data. The output and input are diverse significantly. Therefore, equation 2 is not suitable for complex relationship between outputs and inputs. The weight cost approach is the solution for complexities of outputs and inputs as follows. The measure of the efficiency of any DMU is obtained as the maximum of a ratio of weighted outputs to weighted inputs subject to the condition that the similar ratios for every DMU be less than or equal to unity. In more precise form,

$$\text{Efficiency} = \frac{\sum \text{Weighted of Outputs}}{\sum \text{Weighted of Inputs}} \ldots (3) \qquad 2.11$$

Assuming all weights are uniform, mathematically equation 2.11 is:

$$Efficiency\ (e_0) = \frac{\sum_{r=1}^{n} U_r Y_{r0}}{\sum_{s=1}^{n} V_s X_{s0}} \ldots (4) \qquad 2.12$$

Subjected to:

$$Efficiency\ (e_0) = \frac{\sum_{r=1}^{n} U_r Y_{rj}}{\sum_{s=1}^{m} V_s X_{sj}} \leq 1; \text{j} = 1, \ldots, \text{k},$$

$$U_r, V_s \geq \varepsilon; \text{r} = 1, \ldots, \text{n}; \text{s} = 1, \ldots, \text{m}$$

Where $Y_r = Quantity\ of\ Outputs\ r$

$$U_r = Weight\ attached\ to\ Outputs\ r$$

$$X_s = Quantity\ of\ Inputs\ s$$

$$V_s = Weight\ attached\ to\ Inputs\ s$$

An efficient is denoted = 1, therefore efficiency ranges as $0 < Efficiency \leq 1$

Note: The U's and V's are variables of the problem and are constrained to be greater than or equal to some small positive quantity ε in order to avoid any input or output being ignored in computing the efficiency (Bhagavath, 2006).

2.5.2 Technical Efficiency

Data envelopment analysis (DEA) was first introduced by Charnes, Cooper and Rhodes (CCR) in 1978 (Charnes, Cooper, Rhodes, 1978), extended Farrell (1957) idea of estimating technical efficiency with respect to production frontier. The definition of efficiency is referred from the "Extended Pareto-Koopmans and "Relative Efficiency". The CCR is able to calculate the relative technical efficiency of similar decision making units (DMUs) through the analysis with the constant returns to scale basic (CRS).

This is achieved by constructing the ratio of a weighted sum of outputs to a weighted sum of inputs where the weights for both the inputs and outputs are selected so that the relative efficiencies of the DMUs are maximized with the constraint that no DMU can have a relative efficiency score greater than one i.e. DMU > 1.

On the other hand, the DEA-BCC model by Banker, Charnes, and Cooper, 1984) extend from DEA-CCR by assuming variable returns to scale where performance is bounded by a piecewise linear frontier. There are other DEA models but DEA-CCR and DEA-BCC are the most commonly used models.

2.5.3 Scale Efficiency

Since the CCR (1978), the development has introduced the BCC model that is Banker, Charnes and Cooper in 1984. The BCC model relaxes the convexity constraint imposed in the CCR model which allows for the efficiency measurement of DMUs on a variable returns to scale basis. The BCC model results in an aggregate measure of technical and scale efficiency, the CCR model is only capable of measuring technical efficiency. This allows for the separation of the two efficiency measures. The BCC model is an extension of the CCR model, which investigates variable returns to scale.

The development of the Additive model, which involves reduction of inputs with a simultaneous increase in outputs, and Multiplicative models noteworthy advances which, along with further explanations of the DEA technique and its extensions, are outlined in Ali, and Seiford (1993)**,** Charnes, Cooper, Lewin and Seiford, 1994a)**,** Charnes, Cooper and Seiford (1994b) and Lovell (1993). Since the first application of DEA for measuring the efficiency of business student to schools by Charnes, Cooper, Rhodes (1978) the technique has been applied in over 50 industries i.e., healthcare, transportation, hotel, education, computer industry e.t.c.

2.5.4 Model Development

The model is developed from the extension of the ratio technique used in traditional efficiency approaches. The measurement is obtained from DMU as the maximum of a ratio weighted output to weighted input. The numbers of DMUs are not determined outputs and inputs, however, larger DMUs are able to capture higher performance. This would determine the efficiency frontier (Golany, and Roll, 1989). In addition, they opined that the number of DMUs should be at least twice the number of inputs and outputs for the sake of statistical accuracy. The parameters and variables are needed in developing the model.

$$N = number\ of\ DMU\ \{j = 1,2,\ldots n\} \quad 2.13$$

$$y = number\ of\ outputs\ \{y = 1,2,\ldots R\}$$

$$x = number\ of\ inputs\ \{x = 1,2,\ldots S\}$$

$$y_i = Quantity\ of\ output\ rth\ of\ output\ of\ jth\ DMU \quad 2.14$$

$$x_i = Quantity\ of\ input\ sth\ of\ input\ of\ jth\ DMU$$

$$U_r = weight\ of\ rth\ output$$

$$V_s = weight\ of\ sth\ input$$

Therefore, the model is based on the following parameters and variables. Golany, and Roll (1989) describe that homogenous unit is important in choosing DMUs to be compared and identifying the factors affecting DMUs. Therefore, homogenous group of units need to perform similar task and objectives, under same set of market conditions and the factors (inputs and outputs).This concept is using linear programming (LP) formulation to compare the relative efficiency of a set of decision making units (DMUs). Farrell (1957), develops similar approach to compare the relative efficiency of a cross-section sample of agricultural farms. The efficiency measures under constant returns to scale (CRS) are obtained by *N* linear programming problems under (Charnes, Cooper, and Rhodes, 1978) as below:

$$Min_{\psi, \lambda} \psi_j \qquad 2.15$$

$$\sum_{i=0}^{n} \lambda_i y_{ri} \geq y_j; r = 1, \ldots, R$$

$$\sum_{i=0}^{n} \lambda_i y_{si} \geq \psi x_j; s = 1, \ldots, S \qquad 2.16$$

$$\lambda_i \geq 0; \forall_i$$

Where $y_i = y_{1i}, y_{2i}, \ldots y_{Ri}$ is the output vector, $x_i = x_{1i}, x_{2i}, \ldots x_{Si}$ is the input vector. Solving above equation for each one of the *N* container terminals of the sample, *N* weights and *N* optimum solution found. Each optimum solution ψ_j is the efficiency indicator of container terminal *j* and, by construction satisfies $\psi_j \leq 1$.Those container terminals with $\psi_j < 1$ are considered inefficient and $\psi_j = 1$ are efficient. (Charnes, , Cooper, and Rhodes, 1978), model constant returns to scale (CRS) was modified by Banker *et al* (1984) by adding the restriction $\sum_{i=1}^{N} \lambda_i = 1$, this has generalizing model to variable returns to scale (VRS) as below;

$$Min_{\vartheta, \lambda} \vartheta_j \qquad 2.17$$

$$\sum_{i=0}^{n} \lambda_i y_{ri} \geq y_j; r = 1, \ldots, R$$

$$\sum_{i=0}^{n} \lambda_i y_{si} \geq \vartheta x_j; s = 1, \ldots, S \qquad 2.18$$

$$\sum_{i=0}^{n} \lambda_i = 1 \; \lambda_i \geq 0; \forall_i \qquad 2.19$$

Charnes et al. (1978) from DEA-CCR discover the objective evaluation of overall efficiency and identify the resources and estimates the amounts of the identified inefficiencies. Thus it is called constant return to scale (CRS). Albeit, Banker et al, (1984), DEA-BCC remove the constraint from the CCR model by adding $\sum_{i=0}^{n} \lambda_i = 1$thus, BCC is able to distinguish between technical and scale inefficiencies by (i) estimating pure technical efficiency at the given scale of operation and (ii) identifying whether increasing, decreasing or constant return to scale possibilities are present for further exploitation. It is called as variable return to scale. Therefore, for CCR efficient is required both scale and technical efficient, BCC efficient is only required technically efficient.

2.5.5 Strengths and Weaknesses of Data Envelopment Analysis

Data Envelopment Analysis is a very general framework that draws conclusions from the data available and makes very few assumptions of the context where the data came from. Its main strengths and weaknesses are mentioned below (Sottinen, 2009):

Strengths:

i. DEA is simple enough to be modeled with linear programming.
ii. DEA can handle multiple input and multiple outputs.
iii. DEA does not require an assumption of a functional form relating inputs to outputs. In particular, one does not have to think that the outputs are consequences of the inputs.
iv. DMUs are directly compared against a peer or (virtual) combination of peers.
v. Inputs and outputs can have very different units.

Weaknesses:

i. Since a standard formulation of DEA creates a separate linear programming for each DMU, large problems can be computationally intensive.
ii. Since DEA is an extreme point technique, noise (even symmetrical noise with zero mean) such as measurement error can cause significant problems.
iii. DEA is good at estimating relative efficiency of a DMU but it converges very slowly to “absolute” efficiency. In other words, it can tell you how well you are doing compared to your peers but not compared to a “theoretical maximum”.

iv. Since DEA is a nonparametric technique, statistical hypothesis tests are difficult to apply in the DEA context.

DEA is very generous: If a DMU excels in just one output (or input) it is likely to get 100% efficiency, even if it performs very badly in all the other outputs (or inputs). So, if there are many outputs (or inputs) one is likely to get 100% efficiency for all the DMUs, which means that DEA cannot differentiate between the DMUs (it does not mean that all the DMUs are doing well in any absolute sense).

CHAPTER THREE

METHODOLOGY

3.1 Research Design

Primary data: The primary data for each Port were collected from Port users and port stakeholders e.g. Nigeria Port Authority Personnel, Terminal Operators, Ship Owners and Freight Forwarders. The data is expected to cover the possible factors that influence the respective operations of these stakeholders at the Port.

Secondary data: Data from the six (6) Nigerian Ports and their various terminal operators from 1990 - 2015 were collected. The data is expected to show, among other things the ship traffic, vessel traffic, the throughput obtained, the average turnaround time of vessels (day), number of berths and revenue generated at each Nigeria port for the stated years.

3.2 Study Area and Research Population

The areas of study are the Ports and mainly terminals of Nigeria Ports since the port productivity substantially depends on the operations carried out at each concessioned terminal. Therefore the six (6) Nigeria Ports represent decision making units (DMUs). (Golany and Roll, 1989), describe that homogenous unit is important in choosing DMUs to be compared and identifying the factors affecting DMUs. Therefore homogenous group or units need to perform similar task and objective under the same set of market conditions and the factors (inputs and outputs). Larger DMUs are able to capture higher performance the number of DMUs should be at least twice the number of inputs and outputs. (Cooper, Seiford, and Tone, K., 2000), stated that if the number of DMUs is less than the combined number of inputs and outputs then a large portion of the DMUs will be identified efficient and bias will be removed.

Table 3.1: Nigerian Ports and their locations

S/N	Location	DMU	Ownership
1	Western Nigeria	Lagos Port Complex	Landlord concession
2	Western Nigeria	Tin Can Island Port Complex	Landlord concession
3	Eastern Nigeria	Delta Port Complex	Landlord concession
4	Eastern Nigeria	Rivers Port Complex	Landlord concession
5	Eastern Nigeria	Calabar Port Complex	Landlord concession
6	Eastern Nigeria	Onne Port Complex	Landlord concession

Source: NPA, 2015

3.3 Sampling Techniques

The sampling frame describes the list of all population units from which the sample was selected (Cooper and Schindler, 2003). It is a physical representation of the target population and comprises all the units that are potential members of a sample (Kothari, 2004). This study concerns the productivities of ports in Nigeria using ship traffic, vessel traffic, the throughput obtained, the average turnaround time of vessels (day), number of berths and revenue generated at each Nigeria port. However, in collecting the primary data, non-probability sample frame was adopted. Sample is selected from elements of a population that are easily accessible. Fifty (50) copies of the questionnaire were administered in the respective ports studied due to limited number of senior personnel of the ports to be sampled.

3.4Method of Data Collection

The data collection process was done through a systematic sequence of events. The process began by first seeking permission from the Principal Human Resources Development Officer of Nigeria Port Authority at each port in order to avoid any possible stop that might arise from lack of permission to conduct the research at the entry point into the Port Complex. This was followed by seeking permission from the Human resources manager of each terminal operator and also the operation manager of each terminal operator in order to obtain secondary data.

The data collection instrument was annual reports from Nigerian Port Authority. The data from terminals operators were considered and collected through the use of questionnaires.

3.5 Method of Data Analysis

3.5.1 T-test

The primary data was analysed with one-sample t-test for to determine the significant factors that affect the productivity of the ports studied. The one-sample t-test procedure tests whether the mean of a single variable differs from a specified constant. This test assumes that the data are normally distributed; however, this test is fairly robust to departures from normality. The research sample was 50 for the respective ports studied due to limited number of senior personnel of the ports to be sampled and biased. On “Central limit Theorem’ we were allowed to presume the data were normally distributed approximately. A 95% confidence interval for the difference between the mean and the hypothesized test value was supposed. So the hypothesized test value in our study is 3 and it can split respondents into strongly agreed and strongly disagreed respondents and we can specify the null and alternative hypotheses as below.

Null hypothesis H_o: ų ≥ 3

Alternative hypothesis H_a: ų < 3

As noted earlier, we specify the level of sampling error (0.05). The scores for each attributed were then tabulated; the results can be found in the appendix. As shown in most of items, there are negative mean differences and we cannot say that our test value is located in 95% confidence interval of the difference. In another word, in most items, the null hypothesis can be rejected because the calculated value is larger than the critical value.

3.5.2 Test of Reliability

In order to examine the reliability of the number of responses from the questionnaire administered, the data was subjected to a reliability test using the statistical package for social sciences (SPSS) version 17. The Table 3.2 summarized the output of the test:

Table 3.2 Reliability Statistics for Nigerian Ports

Ports	Cronbach's Alpha	Remarks
Onne Port	.760	Accepted
Rivers Port	.855	Accepted
Tincan Port	.761	Accepted
Warri Port	.825	Accepted
Apapa Port	.876	Accepted
Calabar Port	.758	Accepted

Source: Researcher's Analysis

Reliability refers to the consistency, stability, of data collection instruction. A reliable instrument does not respond to chance factors or environmental conditions; it will have consistence results if repeated overtime or if used by two different investigator.

Cronbach's was used as an examination indicator to determine the reliability of the measurement scale. The value of Cronbach's alpha is generally required to be over 0.7 and the calculated results were over, 0.760, 0.855, 0.761, 0.825, 0.876 and 0.758 in Onne Port, Rivers Port, Tincan Port, Warri Port, Apapa Port and Calabar Port productivity factors respectively. The figures representing the output of research survey, it was observed that the reliability of productivity factors in the research sample, in terms of Cronbach's alpha**,** was greater than 0.7. This meant that the research measurement scale, applied in this study, was reliable.

3.5.3 Data Envelopment Analysis

The secondary data obtained was analyzed with data envelopment analysis (DEA) incorporated with technical efficiency (TE), scale efficiency (SE), constant return to scale input-oriented analysis (CRS input-oriented), constant return to scale output-oriented analysis (CRS output-oriented), variable return to scale input-oriented analysis (VRS input-oriented), variable return to scale output-oriented analysis (VRS output-oriented).

3.5.3.1 Relative Efficiency

Relative efficiency is a minute ratio of incommensurate output and input of similar organizational units which implies that for DEA to be deployed, the organizational units which are to be accessed must produce similar goods or service. This similar organizational units are considered to be decision making unit (DMU). DMU manages the operations/processes of production. Efficiency is obtained as productivity, since productivity also deals with the ratio of actual output to standard input expected.

Thus:

$$\text{Efficiency} = \text{Productivity} = \frac{\text{Output Obtained}}{\text{Input Expected}} = \frac{\text{Performance Achieved}}{\text{Resources Consumed}} = \frac{\text{Effectiveness}}{\text{Effeciency}} \qquad 3.1$$

This equation is applicable for simple data

$$\text{Efficiency} = \text{Productivity} = \frac{\text{Output Obtained}}{\text{Input Expected}} \qquad 3.2$$

Apparently, this is not appropriate for complex relationship between input and output i.e. in this study we have six DMUs that produce the similar services but with varieties of outcomes. Thus weight cost approach is used. In order to calculate the relative efficiency the DEA must take into consideration the multiple or incommensurate outputs and inputs data. Since there are complexities of the outputs and inputs the weight cost approach is adopted by the DEA (Kasypi, and Muhammad, 2013) which is as follows:

Assuming all weight are even and uniform, thus it can be mathematically expressed as:

$$\text{Relative Efficiency} = \frac{\sum \text{Weighted of outputs}}{\sum \text{Weighted of Inputs}} \qquad 3.3$$

$$Relative\ Efficiency\ (e_0) = \frac{\sum_{r=1}^{n} U_r Y_{r0}}{\sum_{s=1}^{m} V_s X_{s0}} \qquad 3.4$$

Subject to

$$\frac{\sum_{r=1}^{n} U_r Y_{rj}}{\sum_{s=1}^{m} V_s X_{sj}} \leq 1; j = 1, \dots, k$$

$$r = 1, \dots, n$$

$$s = 1, \dots, m$$

Note: *The (U's) and (V's) are variables of the problem and are constrained to be greater than or equal to some small positive quantity (ε) in order to avoid any input or output being ignored in computing the efficiency* (Bhagavath, 2006).

In this study:

(J) is used to represent selected DMUs which are DMU 1 is Lagos Port Complex, DMU 2 is Tin Can Island Port Complex, DMU 3 is Delta Port Complex, DMU 4 is River Port Complex, DMU 5 is Calabar River Complex, DMU 6 is Onne River Complex

Table 3.3: Outputs and Inputs used

Output	**Input**
Throughput	Ship traffic
Revenue generated at the port	Berth Efficiency
	Turnaround time
	Labour

(n), represents a specified number of outputs used in this study i.e.

Output 1 is throughput at the port and

Output 2 is revenue generated

(m), also represents a specified number of inputs used in this study i.e.

Input 1 is ship traffic;

Input 2 is berth efficiency;

Input 3 is turnaround time and

Input 4 is labour

There are different types of efficiency incorporated in Data Envelopment Analysis but for the sake of this study the following efficiencies will be looked into:

i. Technical Efficiency

ii. Scale Efficiency

3.5.3.2 Technical Efficiency (CCR)

Technical efficiency is the conversion of physical inputs (such as the services of employees and machines) into outputs relative to best practice (Bhagavath, 2006). According to (Microsoft Corporation, 2009), technical efficiency can be defined as the production by a company of a particular quantity of output using the minimum number of inputs. There are two alternative approaches available in DEA to estimate the efficient frontier which are input oriented and output oriented (Zhu, 2003). This study will use dual linear programming problems to envelopment models which is equivalent to the multiplier model to analyze and estimate technical efficiency of DMUs.

Input-Oriented Envelopment Analysis (CCR) Model: This model analyzes and estimates the efficiency of a DMU when its inputs is proportionally minimize and at the same time its outputs are being kept at their current level. The above model (3.0) is an extended nonlinear programming formulation of an ordinary fractional programming problem. It is required to replace these non-convex non-linear formulations with an ordinary linear programming problem (Charnes, Cooper and Rhodes, 1978):

$$\theta_j^* = min\theta_j \qquad 3.5$$

$$subject\ to$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta_j^* x_{i0} \qquad i = 1,2,\ldots,m; \qquad 3.6$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{ro} \qquad r = 1,2,\ldots,s \qquad 3.7$$

$$\lambda_j \geq 0$$

$$j = 1,2,\ldots,n$$

Because of the possible multiple feasible solutions which the model above may not yield all the non-zero slacks. Therefore the dual linear programming model will be further expressed as:

$$max \sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+ \qquad 3.8$$

$$subject\ to$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta_j^* x_{i0} \qquad i = 1,2,\ldots,m;$$ 3.9

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{r0} \qquad r = 1,2,\ldots,s$$ 3.10

$$\lambda_j,\ s_i^-,\ s_i^+ \geq 0 \qquad j = 1,2,\ldots,n$$

Equation 3.1 and 3.2 produced the following equation i.e. a two stage linear programming problem or similarly multiplier model:

$$\min \theta_j - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right)$$ 3.11

$$subject\ to$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta_j^* x_{i0} \qquad i = 1,2,\ldots,m;$$ 3.12

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{r0} \qquad r = 1,2,\ldots,s$$ 3.13

$$\lambda_j,\ s_i^-,\ s_i^+ \geq 0 \qquad j = 1,2,\ldots,n$$

The presence of the non-Archimedean (ε) in the objective function of 3.3 effectively allows the minimization over (θ_j) to override the optimization involving the slacks (s_i^-) and (s_r^+). The two stage process achieve

i. Firstly, the maximal reduction of input via the optimal θ_j

ii. Secondly, the movement onto the efficient frontier via optimizing the slack variables.

DMU 1 (Lagos Complex Port) under evaluation:

$$\min \theta_1 - (max\ s_1^- + s_2^- + s_3^- + s_4^- + s_1^+ + s_1^+)$$ 3.14

$$subject\ to$$

$$\lambda_1 x_{11} + \lambda_2 x_{12} + \lambda_3 x_{13} + \lambda_4 x_{14} + \lambda_5 x_{15} + \lambda_6 x_{16} + s_1^- = \theta_1^* x_{10}.. \qquad (3.5)$$ 3.15

$$\lambda_1 x_{21} + \lambda_2 x_{22} + \lambda_3 x_{23} + \lambda_4 x_{24} + \lambda_5 x_{25} + \lambda_6 x_{26} + s_2^- = \theta_1^* x_{20}.. \quad (3.6)$$ 3.16

$$\lambda_1 x_{31} + \lambda_2 x_{32} + \lambda_3 x_{33} + \lambda_4 x_{34} + \lambda_5 x_{35} + \lambda_6 x_{36} + s_3^- = \theta_1^* x_{30}\ldots (3.7)$$ 3.17

$$\lambda_1 x_{41} + \lambda_2 x_{42} + \lambda_3 x_{43} + \lambda_4 x_{44} + \lambda_5 x_{45} + \lambda_6 x_{46} + s_4^- = \theta_1^* x_{40} \ldots \quad (3.8)$$ 3.18

$$\lambda_1 y_{11} + \lambda_2 y_{12} + \lambda_3 y_{13} + \lambda_4 y_{14} + \lambda_5 y_{15} + \lambda_6 y_{16} - s_1^+ = y_{10} \ldots \quad (3.9)$$ 3.19

$$\lambda_1 y_{21} + \lambda_2 y_{22} + \lambda_3 y_{23} + \lambda_4 y_{24} + \lambda_5 y_{25} + \lambda_6 y_{26} - s_2^+ = y_{20} \ldots \quad (4.0)$$ 3.20

$$\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, s_1^-, s_2^-, s_3^-, s_4^-, s_1^+, s_1^+ \geq 0 \ldots \quad (4.1) \qquad 3.21$$

$where:$

θ_1 *is the input oriented efficiency score (CCR)or technical efficiency score for Lagos Port Complex as DMU 1*

s_1^- *is the excess of ship traffic*

s_2^- *is the excess of vehicle traffic*

s_3^- *is the excess of berth efficiency*

s_4^- *is the excess of turnaround time*

s_1^+ *is shortage of throughput*

s_2^+ *is the shortage of revenue generated*

λ_1 *is the weight Lagos Port Complex*

λ_2 *is the weight of Tin Can Island Port*

λ_3 *is the weight of Delta Port Complex*

λ_4 *is the weight of Rivers Port Complex*

λ_5 *is the weight of Calabar Port Complex*

λ_6 *is the weight of Onne Port Compex*

x_{10} *is the ship traffic at Lagos Port Complex under the specified year*

x_{20} *is the vehicle traffic at Lagos Port Complex under the specified year*

x_{30} *is the berth efficiency at Lagos Port Complex under the specified year*

x_{40} *is the turnaround time at Lagos Port Complex under the specified year*

y_{10} *is the throughput at Lagos Port Complex under the specified year*

y_{20} *is the revenue generated at Lagos Port Complex under the specified year*

x_{11} *is the ship traffic at Lagos Port Complex under the specified year*

x_{12} *is the ship traffic at Tin Can Island Port under the specified year*

x_{13} *is the ship traffic at Delta Port Complex under the specified year*

x_{14} *is the ship traffic at Rivers Port Complex under the specified year*

x_{15} *is the ship traffic at Calabar Port Complex under the specified year*

x_{16} *is the ship traffic at Onne Port Complex under the specified year*

x_{21} *is the vehicle traffic at Lagos Port Complex under the specified year*

x_{22} *is the vehicle traffic at Tin Can Island Port under the specified year*

x_{23} is the vehicle traffic at Delta Port Complex under the specified year
x_{24} is the vehicle traffic at Rivers Port Complex under the specified year
x_{25} is the vehicle traffic at Calabar Port Complex under the specified year
x_{26} is the vehicle traffic at Onne Port Complex under the specified year

x_{31} is the berth efficiency at Lagos Port Complex under the specified year
x_{32} is the berth efficiency at Tin Can Island Port under the specified year
x_{33} is the berth efficiency at Delta Port Complex under the specified year
x_{34} is the berth efficiency at Rivers Port Complex under the specified year
x_{35} is the berth efficiency at Calabar Port Complex under the specified year
x_{36} is the berth efficiency at Onne Port Complex under the specified year

x_{41} is the turnaround time at Lagos Port Complex under the specified year
x_{42} is the turnaround time at Tin Can Island Port under the specified year
x_{43} is the turnaround time at Delta Port Complex under the specified year
x_{44} is the turnaround time at Rivers Port Complex under the specified year
x_{45} is the turnaround time at Calabar Port Complex under the specified year
x_{46} is the turnaround time at Onne Port Complex under the specified year

y_{11} is the throughput at Lagos Port Complex under the specified year
y_{12} is the throughput at Tin Can Island Port under the specified year
y_{13} is the throughput at Delta Port Complex under the specified year
y_{14} is the throughput at Rivers Port Complex under the specified year
y_{15} is the throughput at Calabar Port Complex under the specified year
y_{16} is the throughput at Onne Port Complex under the specified year

y_{21} is the revenue generated at Lagos Port Complex under the specified year
y_{22} is the revenue generated at Tin Can Island Port under the specified year
y_{23} is the revenue generated at Delta Port Complex under the specified year
y_{24} is the revenue generated at Rivers Port Complex under the specified year
y_{25} is the revenue generated at Calabar Port Complex under the specified year
y_{26} is the revenue generated at Onne Port Complex under the specified year

With respect to other Ports (DMUs), the above analysis minimizes the inputs of Lagos Complex Port proportionally while the outputs of this DMU are kept at the current level. In addition it also optimize the slacks variables in order to determine the alternative optimal solution.

Conditions for Lagos Port Complex (DMU 1) to be efficient and on the frontier (isoquant curve):

i. θ_1 *must be equal to one* (1)

ii. $s_1^-, s_2^-, s_3^-, s_4^-, s_1^+, s_2^+$ must be equal to zero (0)

Note: The analysis done for Lagos Port Complex is also applicable to all other Ports under study as DMUs under evaluation.

Output-Oriented Envelopment Analysis Model: Unlike the model mentioned above, this model analyzes and estimates the efficiency of a DMU when its outputs is proportionally maximize and at the same time its inputs are being kept at their current level.

$$\max \phi_j - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right) \qquad 3.22$$

$$subject\ to$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{i0} \qquad i = 1,2,\dots,m; \qquad 3.23$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = \phi_j y_{r0} \qquad r = 1,2,\dots,s \qquad 3.24$$

$$\lambda_j, s_i^-, s_i^+ \geq 0 \qquad j = 1,2,\dots,n$$

In this case ϕ_j^* is calculated first following by the optimization of slacks by fixing the ϕ in the linear programming.

Conditions for Lagos Port Complex (DMU 1) to be efficient and on the frontier (isoquant curve):

i. ϕ_1 *must be equal to one* (1)

ii. $s_1^-, s_2^-, s_3^-, s_4^-, s_1^+, s_2^+$ must be equal to zero (0)

3.5.3.3 Technical Efficiency (VRS) or Pure Technical efficiency

The CCR formulation in model is non-flexible in the sense that it assumes constant returns to scale (CRS) in its stage of production possibilities (Odeck and Schøyen, 2009). In addition, we wanted to explore the assumption of variable returns to scale (VRS). The VRS formulation of (Banker, Charnes and Cooper, 1984) which was later referred to as BCC include the convexity constraint limiting the summation of the multiplier weights (λ) equal to 1 to the technical efficiency - CCR i.e. adding the constraint $\sum_{j=1}^{n} \lambda_j = 1$ to model 3.3 which is as follows:

$$\min \theta_j - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right) \qquad 3.25$$

$$subject\ to$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta_j^* x_{i0} \qquad i = 1,2,\ldots,m; \qquad 3.26$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{r0} \qquad r = 1,2,\ldots,s \qquad 3.27$$

$$\sum_{j=1}^{n} \lambda_j = 1 \qquad j = 1,2,\ldots,n \qquad 3.28$$

$$\lambda_j\ s_i^-,\ s_i^+ \geq 0$$

Note: The above model 4.3 is an input oriented technical efficiency (VRS) while the below model 4.4 is an output oriented technical efficiency (VRS)

This model makes it possible to calculate scale efficiencies.

$$\max \phi_j - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right) \qquad 3.29$$

$$subject\ to$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{i0} \qquad i = 1,2,\ldots,m; \qquad 3.30$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = \phi_j y_{r0} \qquad r = 1,2,\ldots,s \qquad 3.31$$

$$\sum_{j=1}^{n} \lambda_j = 1 \qquad j = 1,2,\ldots \qquad 3.32$$

$$\lambda_j \geq 0$$

For DMU 1 (Lagos Complex Port) under evaluation:

$$\min \theta_j - (max\ s_1^- + s_2^- + s_3^- + s_4^- + s_1^+ + s_2^+)\ldots \qquad 3.33$$

$$subject\ to$$

$$\lambda_1 x_{11} + \lambda_2 x_{12} + \lambda_3 x_{13} + \lambda_4 x_{14} + \lambda_5 x_{15} + \lambda_6 x_{16} + s_1^- = \theta_j^* x_{10} .. \quad (4.6) \qquad 3.34$$

$$\lambda_1 x_{21} + \lambda_2 x_{22} + \lambda_3 x_{23} + \lambda_4 x_{24} + \lambda_5 x_{25} + \lambda_6 x_{26} + s_2^- = \theta_j^* x_{20} .. \quad (4.7) \qquad r = 1,2,\ldots,s$$

$$\lambda_1 x_{31} + \lambda_2 x_{32} + \lambda_3 x_{33} + \lambda_4 x_{34} + \lambda_5 x_{35} + \lambda_6 x_{36} + s_3^- = \theta_j^* x_{30} \ldots (4.8) \qquad 3.35$$

$$\lambda_1 x_{41} + \lambda_2 y_{42} + \lambda_3 y_{43} + \lambda_4 x_{44} + \lambda_5 x_{45} + \lambda_6 x_{46} + s_4^- = \theta_j^* x_{40} \ldots \quad (4.9) \qquad 3.36$$

$$\lambda_1 y_{11} + \lambda_2 y_{12} + \lambda_3 y_{13} + \lambda_4 x_{14} + \lambda_5 x_{15} + \lambda_6 x_{16} - s_1^+ = y_{10} \ldots \quad (5.0) \qquad 3.37$$

$$\lambda_1 y_{21} + \lambda_2 y_{22} + \lambda_3 y_{23} + \lambda_4 x_{24} + \lambda_5 x_{25} + \lambda_6 x_{26} - s_2^+ = y_{20} \ldots \quad (5.1) \qquad 3.38$$

$$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 = 1 \ldots \quad (5.2) \qquad 3.39$$

$$\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6,\ s_1^-,\ s_2^-,\ s_3^-,\ s_4^-,\ s_1^+,\ s_2^+ \geq 0 \ldots \quad (5.3) \qquad 3.40$$

$$where:$$

θ_1 *is the input oriented efficiency score (VRS) or pure technical efficiency score for Lagos Port Complex as DMU* 1

s_1^- *is the excess of ship traffic*

s_2^- *is the excess of vehicle traffic*

s_3^- *is the excess of berth efficiency*

s_4^- *is the shortage of turnaround time*

s_1^+ *is the shortage of throughput*

s_2^+ *is the shortage of revenue generated*

λ_1 *is the weight of Lagos Port Complex*

λ_2 *is the weight of Tin Can Island Port*

λ_3 *is the weight of Delta Port Complex*

λ_4 *is the weight of Rivers Port Complex*

λ_5 *is the weight of Calabar Port Complex*

λ_6 *is the weight of Onne Port Compex*

x_{10} *is the ship traffic at Lagos Port Complex under the specified year*

x_{20} *is the vehicle traffic at Lagos Port Complex under the specified year*

x_{30} *is the berth efficiency at Lagos Port Complex under the specified year*

x_{40} *is the turnaround time at Lagos Port Complex under the specified year*

y_{10} *is the throughput at Lagos Port Complex under the specified year*

y_{20} *is the revenue generated at Lagos Port Complex under the specified year*

x_{11} *is the ship traffic at Lagos Port Complex under the specified year*
x_{12} *is the ship traffic at Tin Can Island Port under the specified year*
x_{13} *is the ship traffic at Delta Port Complex under the specified year*
x_{14} *is the ship traffic at Rivers Port Complex under the specified year*
x_{15} *is the ship traffic at Calabar Port Complex under the specified year*
x_{16} *is the ship traffic at Onne Port Complex under the specified year*
x_{21} *is the vehicle traffic at Lagos Port Complex under the specified year*
x_{22} *is the vehicle traffic at Tin Can Island Port under the specified year*
x_{23} *is the vehicle traffic at Delta Port Complex under the specified year*
x_{24} *is the vehicle traffic at Rivers Port Complex under the specified year*
x_{25} *is the vehicle traffic at Calabar Port Complex under the specified year*
x_{26} *is the vehicle traffic at Onne Port Complex under the specified year*

x_{31} *is the berth efficiency at Lagos Port Complex under the specified year*
x_{32} *is the berth efficiency at Tin Can Island Port under the specified year*
x_{33} *is the berth efficiency at Delta Port Complex under the specified year*
x_{34} *is the berth efficiency at Rivers Port Complex under the specified year*
x_{35} *is the berth efficiency at Calabar Port Complex under the specified year*
x_{36} *is the berth efficiency at Onne Port Complex under the specified year*

x_{41} *is the turnaround time at Lagos Port Complex under the specified year*
x_{42} *is the turnaround time at Tin Can Island Port under the specified year*
x_{43} *is the turnaround time at Delta Port Complex under the specified year*
x_{44} *is the turnaround time at Rivers Port Complex under the specified year*
x_{45} *is the turnaround time at Calabar Port Complex under the specified year*
x_{46} *is the turnaround time at Onne Port Complex under the specified year*

y_{11} *is the throughput at Lagos Port Complex under the specified year*
y_{12} *is the throughput at Tin Can Island Port under the specified year*
y_{13} *is the throughput at Delta Port Complex under the specified year*
y_{14} *is the throughput at Rivers Port Complex under the specified year*

y_{15} *is the throughput at Calabar Port Complex under the specified year*

y_{16} *is the throughput at Onne Port Complex under the specified year*

y_{21} *is the revenue generated at Lagos Port Complex under the specified year*

y_{22} *is the revenue generated at Tin Can Island Port under the specified year*

y_{23} *is the revenue generated at Delta Port Complex under the specified year*

y_{24} *is the revenue generated at Rivers Port Complex under the specified year*

y_{25} *is the revenue generated at Calabar Port Complex under the specified year*

y_{26} *is the revenue generated at Onne Port Complex under the specified year*

3.5.3.4 Scale Efficiency or Scale Effect

This measures how a DMU is able to utilize its production scale(s). This is an alternating and new developed model to determining the return to scale (RTS) nature of a DMU. Thus, when other basic methods i.e. CRS envelopment models and VRS multiplier models failed to test a DMU's RTS nature especially when DEA models have alternate optimal solution (Zhu, 2003), scale efficiency was adopted to solve the issue. This can be deduced mathematically as the ratio of technical efficiency (CCR) to technical efficiency (BCC).

$$\text{Scale Efficiency Score} = \frac{\text{Technical efficiency score (CCR)}}{\text{Pure Technical Efficiency Score (BCC)}} \qquad 3.41$$

$$\text{DMU1}_{\text{SE}} = \frac{\emptyset_{\text{CCR}} \text{ for DMU}}{\emptyset_{\text{BBC}} \text{ for DMU}_1} \qquad 3.42$$

Conditions:

i. If $DMU1_{SE}$ is equal to 1 then Lagos Port Complex is scale efficient else if $DMU1_{SE}$ is less than 1 then Lagos Port Complex is scale inefficient.

ii. If technical efficiencies (CCR) for DMU 1 and other DMUs is equal to one (1) then scale efficiencies will be equal to 1.

iii. If technical efficiency (CCR) is less than 1 and technical efficiency (BCC) is equal to 1 then scale efficiency will be less than 1

3.5.3.5 Return to Scale (RTS)

The laws of return to scale refer to the effects of scale relationship. The term "return to scale" refers to the change in output as all factors change by the same proportion (Koutsoyiannis, 1979). To determine which the nature of RTS, the sum of the weights under the CCR formulation i.e. $\sum_{j=1}^{n} \lambda_j$ must be checked (Odeck J. and Schøyen H., 2009).

$$Let\ W_{s1} = \sum_{j=1}^{n} \lambda_j \qquad 3.43$$

Conditions:

i. If W_{s1} is equal to 1 then return to scale (RTS) nature of Lagos Port Complex is constant return to scale (CRS).

ii. If W_{s1} is greater than 1 then return to scale (RTS) nature of Lagos Port Complex is decrease return to scale (DRS).

iii. If W_{s1} is less than 1 then return to scale nature of Lagos Port Complex is increase return to scale (IRS)

3.5.3.6 Benchmarking

Gap analysis is usually used as the basic method in performance evaluation and benchmarking. This is concerned with one measure at a time (Zhu, 2003). This study makes use of the variable-benchmark models.

A DMU is not just assumed to be a benchmark but must pass through some analysis and comparisons with other DMUs in order to obtain the efficiency gaps between the DMU and other DMUs before it is concluded as a benchmark, such analysis is as follows:

$$min\ \delta_1^{CRS} \qquad 3.44$$

$$subject\ to$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \delta_1^{CRS} x_i^{new} \qquad i = 1,2, \ldots, m; \qquad 3.45$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \leq y_r^{new} \qquad r = 1,2, \ldots, s \qquad 3.46$$

$$\lambda_j \geq 0,\ j \in E^* \qquad j = 1,2, \ldots, n$$

$$max\ \tau_1^{CRS}$$

$$subject\ to$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq x_i^{new} \qquad i = 1,2, \ldots, m; \qquad 3.47$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \leq \tau_1^{CRS} y_r^{new} \qquad r = 1,2,\ldots,s \qquad 3.48$$

$$\lambda_j \geq 0,\ j \in E^* \qquad j = 1,2,\ldots,n$$

The above input variable-benchmark models measures the performance of DMU^{new} i.e. Lagos Port Complex with inputs x_i^{new} and outputsy_r^{new}. The superscript of CRS indicates that the benchmark frontier composed by benchmark DMUs in set E^* exhibit CRS. Model 5.4 and 5.5 yields a benchmark forDMU^{new} $i.e.$ Lagos Port Complex with inputs x_i^{new}.

Conditions for Lagos Port Complex:

If δ_1^{CRS*} is less than 1 or τ_1^{CRS} is greater than 1 then the performance of Lagos Port Complex is dominated by the benchmark

If δ_1^{CRS*} is equal to 1 or τ_1^{CRS} is equal to 1 then the performance of Lagos Port Complex achieve the same performance level of the benchmark.

If δ_1^{CRS*} greater than 1 or τ_1^{CRS} less than 1 then input savings or output surpluses exists in Lagos Port Complex when compared to the benchmark thus making it a new benchmark by overriding the old one.

$\delta^{CRS*} > 1$ *indicates that* DMU^{new} *can increase its inputs to reach the benchmark which in turn indicates that* $\delta^{CRS*} - 1$ *measures the input saving achieved by* DMU^{new}*. Also* $\delta^{CRS*}\tau^{CRS*} < 1$ *indicates that* DMU^{new} *can reduce its outputs to reach the benchmark*

Furthermore, the DEA solver determines the benchmark terminal by comparing the terminal's efficiency with other terminal operators' efficiencies and its efficiency. If the terminal has 1 against itself the DEA efficiency implies it is 100% efficiency.

3.5.3.7 Pearson Correlation

Simple correlation expresses the degree or closeness of the relationship between two variables in terms of a correlation coefficient that provides an indirect measure of the variability of points from the line of best fit (Kumar and Suresh, 2009). The Bivariate Two-Sigma Pearson Correlation Analysis is used to test the proposed hypothesis for objective 5.

3.6 Model Specification and Measurement of Variables Used

The variables had already been measured, aggregated and categorized by Nigeria Port Authority and their respective values were collated separately from each terminal operator from different port: six (6) major geo-political ports. The input variables are ship traffic, vessel traffic, berth efficiency and turnaround time while outputs are throughput obtained and revenue generated.

3.6.1 Outputs Variable

i. *Ship traffic:* This deals with the number of vessels that called at Nigerian ports at a specified period of time. The ship traffic are usually expressed on a weekly, monthly or annual basis. But for the sake of this study we use the annual compilation of ship traffic.

ii. *Cargo throughput:* It measures the total tonnage of cargo handled at a terminals of the ports under study in a stated period. Cargo throughput is usually expressed on a weekly, monthly or annual basis and the unit for it is tons for general and bulk cargo while TEU for containerized cargo. It does not, however, provide an indication of how efficiently the facilities have been managed. Therefore it has to be evaluated against some inputs in order to acquire meaningful result.

3.6.2 Input Variables

i. *Number of berth:* This is an input variable that signify the number of berth at the individual Port. This proxy the capital factor of production.

ii. *Turnaround time:* This is the operational indicator of productivity which measure the time at which a vessel leaves the port completely i.e. the difference between the arrival time of vessel at the port and the departure time of vessel from the port. Apparently, this indicator measures how time efficient a port/terminal is when rendering services to vessels i.e. loading and discharging. (De Monie, 1987), disintegrates total turnaround time into;

Total turn-round time in port as a function of cargo tonnage to be handled during that call.

Total turn-round time in port of a given vessel on a given call (generally expressed in hours)

Total turn-round time in port in the light of cargo composition (traditionally presented by main classes, e.g. bulk liquids, bulk solids, conventional general cargo, containerized cargo

Thus the individual records of the components mentioned above are difficult to acquire at the ports under study because they are not always available at most ports. In addition, the ports handle different types of cargo i.e. River Port handles dry bulk cargo while Tin Can Island Port handles mainly containerized cargo. Consequently, this productivity indicator is not also adequate to conclude productivity as there are variation in cargo compositions. This proxy both the capital and labour factor of production.

iii. *Berth occupancy rate:* This is an input variable which deals with the utilization rate of the berth facilities. This proxy the capital and labour factor of production. This is selected based on the nature of DEA model i.e. minimization of input objective.

Analytical Tools and Models

The Jensen Operations Research (OR) Software for Transportation modelling and problems was used for the analysis. It is a Microsoft Excel add-in programme. SPSS was also used extensively in the research.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Results

4.1.1 Data Presentation

This study applied the average throughput, ship traffic, number of berths, average turnaround time and average idle rate as key variables of productivity in the Nigerian ports. Therefore, the input variables in this study (see Table 4.1, 4.2, 4.3, 4.4, 4.5 and 4.6). Average throughput was defined as the total volume of cargo handled by a port divided by the number of years (TEU), a globally essential indicator of container port output evaluation.

The quantitative variables were obtained from port information books of National Bureau of Statistics (NBS) Annual Report, Nigeria Port Authority (NPA) Annual Report and Central Bank of Nigeria (CBN) Annual report. The efficiency quantitative variable result from the Data Envelopment Analysis index was calculated using terminal quantitative information of throughput, ship traffic, number of berths, average turnaround time and average idle occupancy rate as input variables of DEA model.

Table 4.1: Data for Apapa Port Complex						
DMU	**Total throughput (tonnes)**	**Ship Traffic**	**Number of berth**	**Average turnaround time (days)**	**Average idle occupancy rate %**	**Labour (Net gang per hour)**
1980	3,911,000	1,328	24	23	54	28
1981	3,560,000	1,400	24	19	60	22
1982	4,019,000	1,438	24	26	58	25
1983	4,357,000	1,466	24	23.8	62	20
1984	4,523,000	1,511	24	18.9	50	16
1985	4,849,000	1,568	24	16	61	23
1986	4,897,000	1,400	24	20	53	20
1987	5,169,000	1,523	24	19	44	20
1988	3,321,000	1,498	24	23	55	18
1989	3,959,000	1,402	24	15	46	24
1990	3,071,000	1,259	24	22	40	20
1991	4,369,000	1,316	24	17	57	19
1992	6,260,000	1,139	24	21	35	22
1993	6,342,000	1,200	24	14	49	18
1994	5,059,000	1,100	24	5.21	65	19
1995	5,848,000	1,299	24	11.7	41	23
1996	5,939,468	1,385	26	9.29	41	19
1997	6,319,909	1,363	26	8.5	37	23
1998	7,832,112	1,302	26	8.5	37.4	18
1999	8,281,342	1,195	26	10.4	34.8	22
2000	11,008,278	1,274	26	13	30.1	20
2001	13,898,000	1,218	26	15	24.6	24
2002	12,306,000	1,147	26	23	22.6	22
2003	14,579,318	1,345	26	21	22.3	29
2004	16,152,396	1,376	26	21	18.3	32
2005	18,432,106	1,351	26	14	39.6	37
2006	17,223,340	1,376	27	9	28	19
2007	18,813,072	1,359	27	10	32	10
2008	20,809,226	1,452	28	9	35	11
2009	20,914,876	1,471	28	7	38	12
2010	21,159,707	1,563	28	8	37	10
2011	22,808,352	1,594	29	5	34.9	11
2012	21,065,520	1,421	29	8.1	36.1	15
2013	21,730,426	1,510	29	5.7	43.2	13
2014	20,645,269	1,503	29	5.1	45.9	10
2015	20,594,845	1,410	29	5.1	44.24	11

Source: National Bureau of Statistics (NBS) Annual Report
Source: Nigeria Port Authority (NPA) Annual Report
Source: Central Bank of Nigeria (CBN) Annual report

Table 4.2: Data for Tin Can Island Port						
DMU	**Total throughput (tonnes)**	**Ship Traffic**	**Number of berth**	**Average turnaround time (days)**	**Average berth idle rate %**	**Labour (Net gang per hour)**
1980	1,452,000	477	14	7.7	59	22
1981	1,600,000	483	14	8.1	62.7	30
1982	1,874,000	452	14	8.4	60.9	26
1983	2,244,000	523	14	8.7	56.9	23
1984	2,392,000	549	14	8	61.4	31
1985	2,275,000	555	14	8.1	64	28
1986	2,065,000	542	14	7.9	61	32
1987	1,785,000	509	14	8	59	34
1988	1,892,000	522	14	8.4	55	37
1989	1,660,000	518	14	8.2	53	31
1990	1,814,000	580	14	8.5	51	25
1991	1,522,000	611	14	9.4	58	27
1992	2,493,000	506	14	8	54	21
1993	2,029,000	498	14	8.5	57	23
1994	1,994,000	673	14	7.5	63	26
1995	1,861,000	590	16	9.7	64.8	19
1996	2,175,873	769	16	10.3	61.5	20
1997	2,464,175	655	16	12.5	52	24
1998	7,832,112	540	16	11	43	22
1999	8,281,342	732	16	14	39	17
2000	11,008,278	666	16	12	36	13
2001	13,898,000	718	16	10	38	11
2002	4,755,000	633	16	11	31	16
2003	5,293,000	804	16	9	54.8	14
2004	4,694,000	696	16	8	53	18
2005	5,461,000	671	16	7	42	11
2006	7,400,000	903	18	4	27	14
2007	10,003,300	1185	18	4	33.44	12
2008	13,413,000	1367	18	4	39	16
2009	14,100,000	1488	18	7	40	12
2010	13,076,000	1607	18	5	35	12
2011	15,371,000	1,628	18	5	28.9	15
2012	15,136,436	1,609	18	5	29.2	12
2013	16,134,153	1,615	18	4.5	31.7	16
2014	17,500,804	1,692	18	4.3	35.3	12
2015	16,881,845	1,656	18	4	56.1	15

Source: National Bureau of Statistics (NBS) Annual Report
Source: Nigeria Port Authority (NPA) Annual Report
Source: Central Bank of Nigeria (CBN) Annual Report

Table 4.3: Data for River Port						
DMU	**Total Throughput (tonnes)**	**Ship Traffic**	**Number of Berth**	**Average Turnaround Time (days)**	**Average Berth Idle Rate %**	**Labour (Net Gang per Hour)**
1980	4,000,000	348	8	15	47	22
1981	3,841,000	325	8	18	42	14
1982	3,760,000	373	8	13.4	34	18
1983	4,057,000	381	8	11.9	41.8	20
1984	4,282,000	394	8	16	47.5	17
1985	4,533,100	415	8	18	52	15
1986	4,560,023	392	8	14	44	18
1987	4,716,999	402	8	15	56	13
1988	4,224,300	424	8	14	51	22
1989	5,597,700	420	8	17	49	19
1990	3,445,000	374	8	11	42	24
1991	3,345,000	349	8	9	47	15
1992	3,724,000	389	8	14	50	16
1993	4,453,000	365	8	10	55	13
1994	4,880,000	345	8	8.2	43	11
1995	4,621,000	410	8	7.7	67	21
1996	4,110,962	402	8	9.3	42	11
1997	3,819,966	388	8	10	38	11
1998	4,652,600	428	8	13	30	14
1999	4,369,000	393	8	9	32	16
2000	4,684,000	410	8	11	26	24
2001	5,690,000	432	8	12	20	14
2002	5,302,000	394	8	14	10	15
2003	4,845,000	362	8	17	6	20
2004	4,964,000	212	11	17	28	22
2005	5,347,000	353	11	13	20	28
2006	5,580,000	257	11	12	21	18
2007	4,879,000	339	11	9.99	21	23
2008	4,885,000	412	11	9.57	34	25
2009	5,185,000	465	11	10.4	25	18
2010	5,797,000	471	11	9.7	30	14
2011	7,464,000	566	11	10.2	39	16
2012	5,574,281	461	11	8.9	37.7	15
2013	4,935,944	439	11	7.7	52.1	14
2014	6,225,008	435	11	8.41	53.6	14
2015	4,458,010	373	11	6.9	62.3	17

Source: National Bureau of Statistics (NBS) Annual Report
Source: Nigeria Port Authority (NPA) Annual Report
Source: Central Bank of Nigeria (CBN) Annual report

Table 4.4: Data for Delta Port						
DMU	**Total Throughput (tonnes)**	**Ship Traffic**	**Number of Berth**	**Average Turnaround Time (days)**	**Average Berth Idle Rate %**	**Labour (Net Gang per Hour)**
1980	2,111,000	509	20	6.9	72.6	23
1981	2,045,000	475	20	6.1	71	17
1982	1,973,000	492	20	5.7	82.3	20
1983	1,930,000	401	20	5.9	73	16
1984	1,886,000	397	20	5.4	79	13
1985	1,954,000	409	20	6.6	75	10
1986	1,735,900	429	20	6.3	78	16
1987	1,640,300	412	20	5.5	78.3	19
1988	1,645,400	397	20	5.3	79.1	21
1989	1,658,200	394	20	5.7	80.5	24
1990	1,504,000	390	20	5.9	82	28
1991	1,526,000	410	20	4.8	83.5	18
1992	1,690,000	452	20	6.1	82.2	15
1993	1,957,000	435	20	5.2	84	13
1994	1,822,000	486	20	5.7	83.8	17
1995	1,947,000	450	20	4.4	85	11
1996	1,940,044	524	20	6.47	84.1	19
1997	1,960,736	498	20	6.4	85.7	13
1998	2,107,991	576	20	6.3	83.5	16
1999	1,394,223	398	20	5.7	83	20
2000	1,837,000	331	20	6	83.2	24
2001	1,855,000	414	20	6	84.7	27
2002	2,043,000	386	20	6	83.93	20
2003	1,886,000	327	20	8	89.93	26
2004	1,566,000	298	20	8	90.02	18
2005	2,223,000	361	20	6	91.71	29
2006	1,461,000	257	23	7	91.98	25
2007	1,516,000	272	23	6	83.52	29
2008	4,002,000	301	23	7	90.43	21
2009	7,345,000	328	23	9	91.97	15
2010	9,142,000	337	23	8	89.5	28
2011	8,467,000	362	23	7	89.8	25
2012	6,808,884	357	23	5.7	84.6	20
2013	10,361,746	609	23	3.9	88.8	22
2014	10,199,169	603	23	5.4	84.1	28
2015	7,830,236	528	23	3.5	87	20

Source: National Bureau of Statistics (NBS) Annual Report
Source: Nigeria Port Authority (NPA) Annual Report
Source: Central Bank of Nigeria (CBN) Annual report

Table 4.5: Data for Onne Port Complex						
DMU	**Total Throughput (tonnes)**	**Ship Traffic**	**Number of Berth**	**Average Turnaround Time (days)**	**Average Berth Idle Rate %**	**Labour (Net Gang per Hour)**
1980	4820000	307	6	3.8	72	27
1981	4200000	285	6	4.1	65	25
1982	3759000	264	6	3.5	61	18
1983	3501000	271	6	3.2	70.3	16
1984	3262000	249	6	4.4	65.6	20
1985	3068000	239	6	5.2	62	13
1986	3200000	254	6	5.9	59	14
1987	2340000	201	6	3	53	17
1988	2560000	232	6	3.2	58	19
1989	1880000	221	6	2.8	50	15
1990	3723200	287	6	6.4	65	21
1991	3681000	260	6	4.8	75	19
1992	3856000	227	6	5.3	67	21
1993	3603000	189	6	3.4	92	11
1994	5407000	158	6	3.8	78	33
1995	5195000	254	6	4.7	72	10
1996	5208568	231	6	4.8	63	24
1997	5926219	210	6	3.4	59	32
1998	6440000	260	6	5	52	27
1999	4353428	294	6	4.3	47	15
2000	7166000	310	6	4	51	28
2001	9056487	378	6	4	55.6	17
2002	10182000	423	6	8	29	32
2003	11995000	398	6	3	28	34
2004	13688000	579	6	3	26	33
2005	13809000	585	6	3	29	29
2006	15820000	433	6	2	29	15
2007	21559000	411	7	2	30	17
2008	21419000	457	7	5	66	14
2009	17462000	670	7	5.6	64	15
2010	23302000	785	10	2.7	65	11
2011	26217000	885	10	4	63.2	15
2012	26532187	861	10	2.5	67.6	13
2013	24773387	823	10	2.6	75.4	12
2014	27968861	847	10	2.2	71.5	15
2015	26434660	741	10	2.1	88	18

Source: National Bureau of Statistics (NBS) Annual Report
Source: Nigeria Port Authority (NPA) Annual Report
Source: Central Bank of Nigeria (CBN) Annual report

Table 4.6: Data for Calabar Port

DMU	Average Throughput	Ship Traffic	Number of berth	Average turnaround time	Average Berth Idle Rate	Labour (Net Gang per Hour)
1980	164,578	190	12	4.1	80	15
1981	403,411	257	12	5.7	86.3	19
1982	426,433	303	12	6.2	88	23
1983	263,186	204	12	4.8	79	16
1984	243,155	222	12	4	76	13
1985	575,000	420	12	6.2	85.9	10
1986	716,500	465	12	6.8	89.1	15
1987	695,700	412	12	5.5	92	12
1988	444,700	233	12	3.7	84.6	19
1989	485,000	267	12	4.2	89.6	11
1990	118,446	143	12	3.8	93.5	24
1991	201,000	165	12	4.3	92.8	28
1992	416,261	299	12	4.7	92.1	16
1993	254,000	177	12	4	93.2	24
1994	363,400	244	12	3.4	93.9	23
1995	171,449	226	12	3.9	93	14
1996	101,928	202	12	6.1	94.9	16
1997	90,643	189	12	4.7	96	9
1998	216,308	306	12	5.2	91.3	11
1999	223,943	333	12	4.5	81.3	14
2000	311,765	326	12	3	83.3	17
2001	328,335	357	12	6	85.3	13
2002	409,219	373	12	6	84	20
2003	506,252	480	12	5	82.5	23
2004	798,717	499	12	5	79.1	25
2005	900,624	508	12	2	79.5	21
2006	777,000	611	12	3	79.9	23
2007	1,042,000	682	12	2	75.5	20
2008	1,165,000	622	12	4	72.7	23
2009	1,699,000	198	12	4	76.5	24
2010	1,588,000	199	12	4.6	77.1	27
2011	1,880,000	179	12	5.3	77.3	21
2012	1,738,446	159	12	5.6	75.4	19
2013	1,732,286	373	12	6.8	63.3	23
2014	2,361,477	269	12	5.4	66.5	26
2015	2,127,421	306	12	5.2	77	22

Source: National Bureau of Statistics (NBS) Annual Report
Source: Nigeria Port Authority (NPA) Annual Report
Source: Central Bank of Nigeria (CBN) Annual repot

Table 4.7: Average Port Performance Data for 36 years (1980-2015)

Ports	Average Annual throughput	Average Ship Traffic	Average Number of berth	Average turnaround time	Average berth occupancy rate	Average Labour (Net Gang per Hour)
Lagos Port	10,945,210	1,374	26	14	42	20
Calabar Port	720572	316.61	12.00	4.69	83.53	18.86
Delta Port	3,193,634	417	21	6	84	20
Onne Port	10482444.36	402.19	6.75	3.91	59.01	19.86
Rivers Port	4,744,664	392	9	12	39	17
Tin Can Island Port	6,550,870	840	16	8	49	20

Source: Researcher's Computation

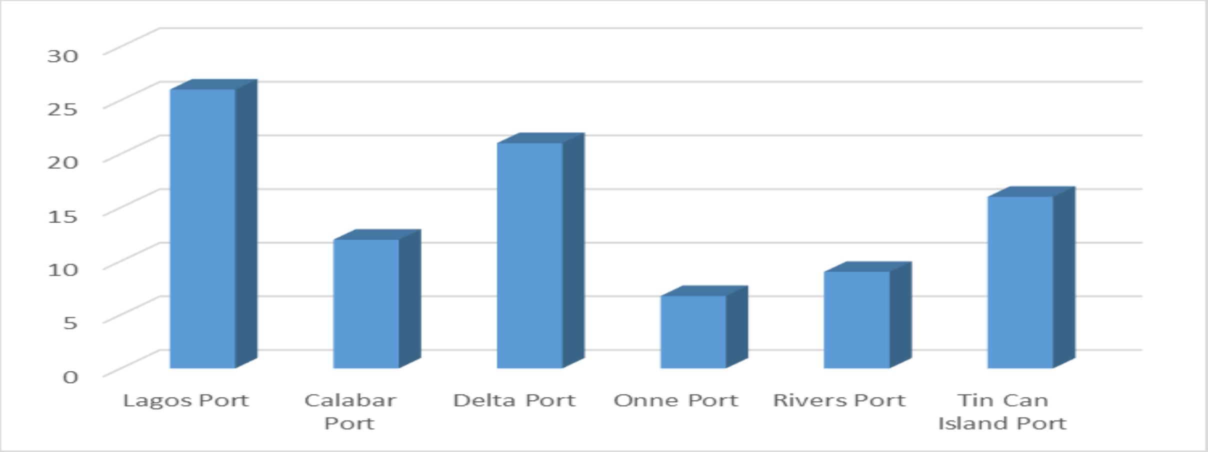

Fig. 4.1: Average Number of berth

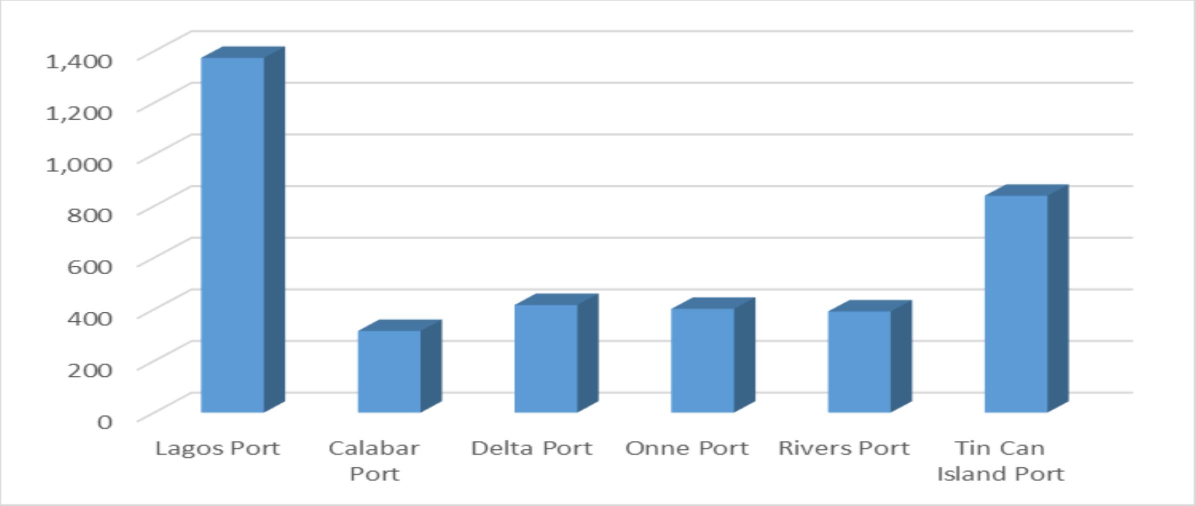

Fig. 4.2: Average Ship Traffic

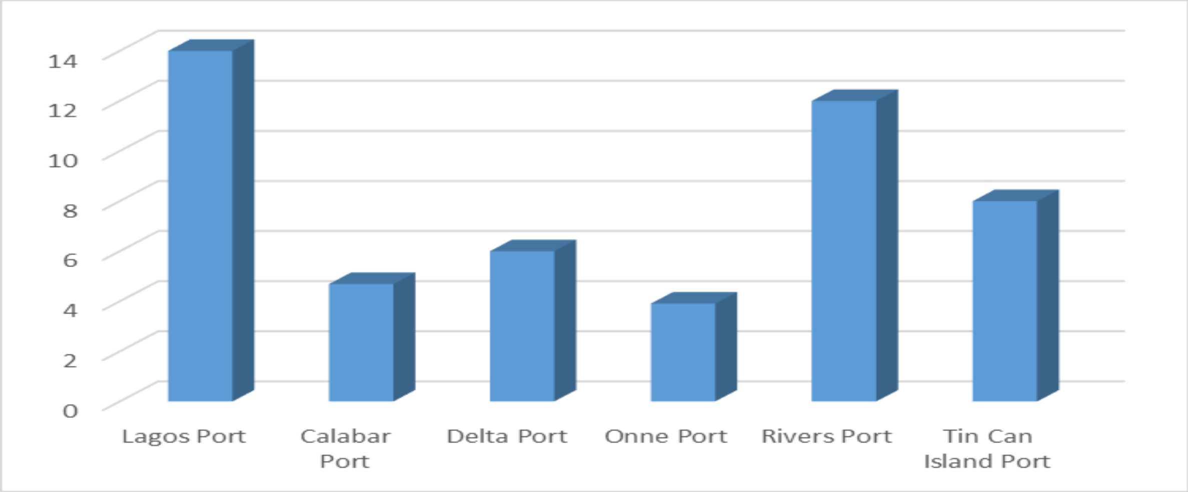

Fig. 4.3: Average turnaround time

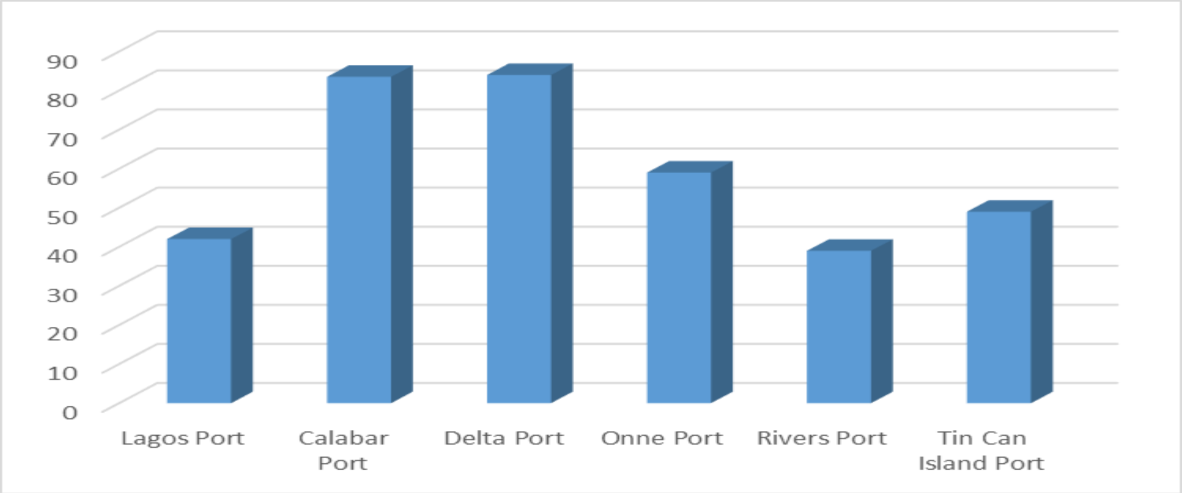

Fig. 4.4: Average berth occupancy rate

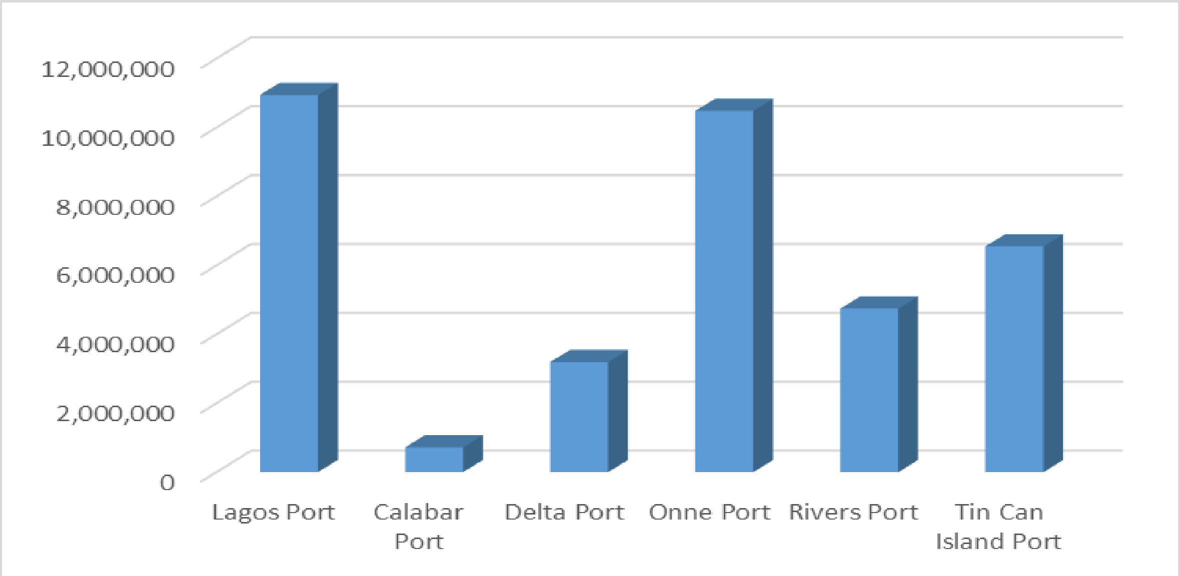

Fig. 4.5: Average Annual throughput

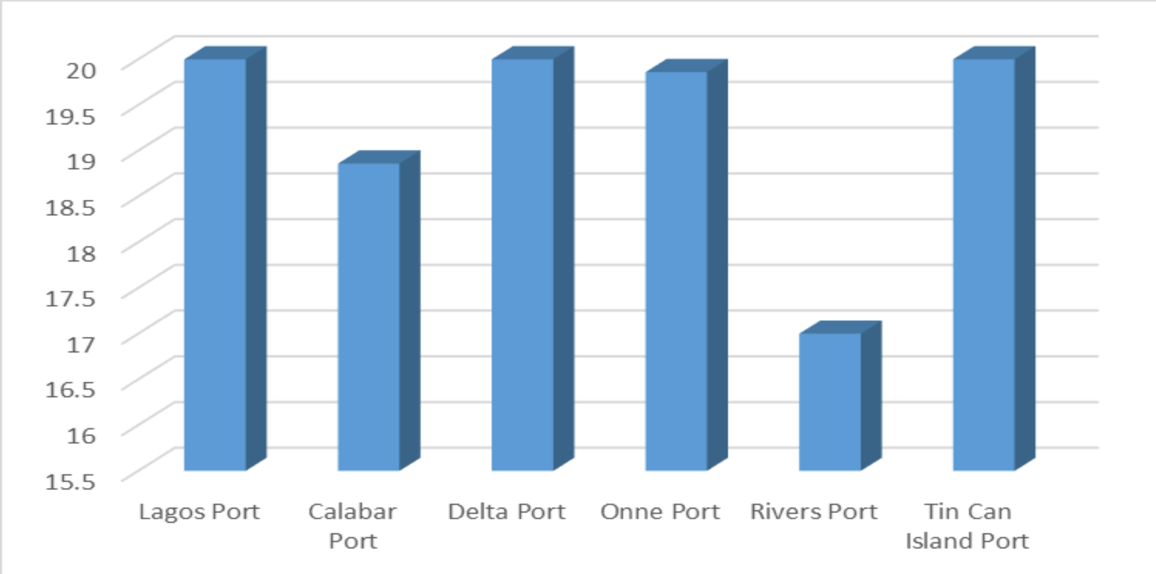

Fig. 4.6: Average Labour (Net Gang per Hour)

4.2To Determine the Trend Analysis of Productivity of Nigerian Ports

4.2.1Trend Analysis of Lagos Port Complex Productivity

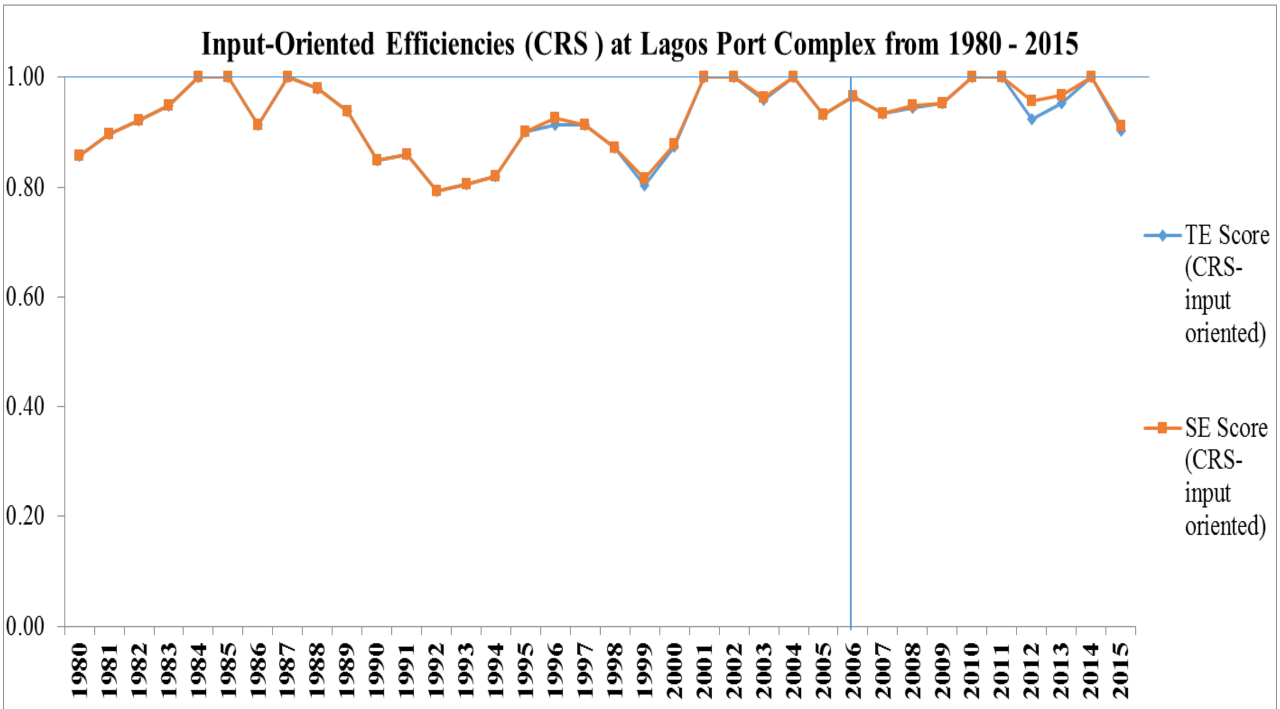

Figure 4.7: CRS – Technical Efficiency (input-oriented) and CRS – Scale Efficiency (input-oriented) at Lagos Port Complex from 1980 – 2015

Source: Researcher Computation

From the table above, it can be deduced that there was fluctuation in both technical and scale efficiencies at Lagos Port Complex throughout the pre-concession era of its operation years (1980-2005). During the 1980s era, higher productivities were recorded in the operation years

1984, 1985 and 1987 with technical efficiency and scale efficiency scores of (1.0) but unfortunately declined steadily to low technical efficiency and scale efficiency scores of (0.79) in 1992 and productivity did not improve beyond TE score of (0.91) and SE score of (0.93) which was attained in operation year 1996 in the 1990s era.

However, the productivity improved with TE and SE scores of (1.0) in 2001 from a low TE and SE of (0.80) and (0.82) respectively in 1999. The port was also efficient in scale and technically efficient in the preceding operation year 2002 and 2004 with TE and SE score of (1.0). Though, the port still had a fluctuating manner of productivity during post-concession era with the most technical and scale efficient operation year in 2010, 2011 and 2014 with TE and SE score of (1.0) and the least technical and scale efficient year in 2015 with TE score of (0.90) and SE score of (0.91).

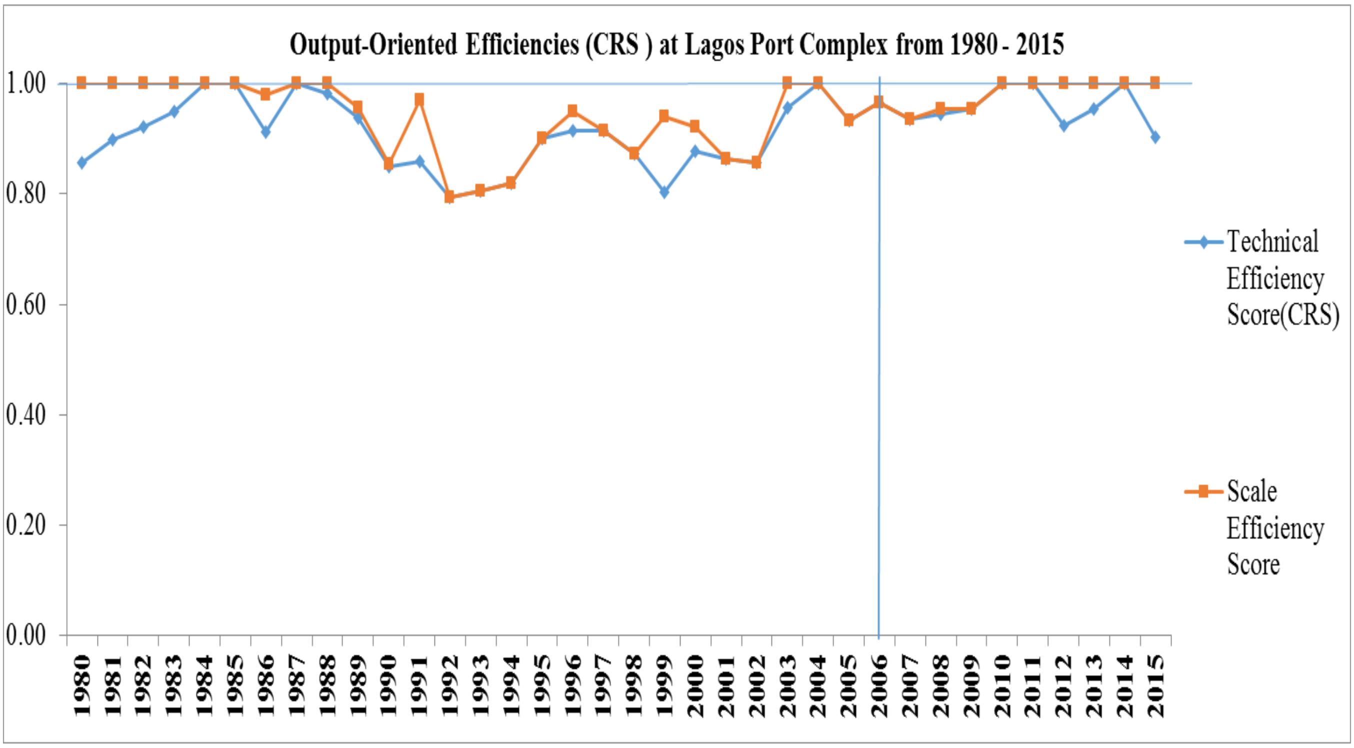

Figure 4.8: CRS – Technical Efficiency (Output-oriented) and CRS – Scale Efficiency (Output-oriented) at Lagos Port Complex from 1980 – 2015

Source: Researcher Computation

From the table above, it is observed that Lagos Port Complex was scale efficient with score (1.0) in the production periods of 1980 to 1985 but technically inefficient in the production period of 1980 to 1983 with TE Scores of (0.86), (0.90), (0.92) and (0.95) respectively. Though, the trend shows that there was technical progress in the production function of this port from year 1980 with TE Score (0.86) to year 1984 and 1985 with TE Score (1.0). Asides these years, the port achieved technical efficient only in 1987 and 2004 pre-concession era while she achieved scale efficient in the production years 1987, 1988, 2003, and 2004. However, there was fluctuation in technical progress all through the production periods at the port. On the contrary, the port eventually operated on a stable optimal scale from 2010 to 2015 post concession era after the later stability in scale efficiency achieved from the beginning of 1980s era till mid-1980s. Thus, this reflect the optimal utilization of superstructure concessioned to the terminal operators while the fluctuating technical efficiency could be as a result of the inabilities of some terminal operators to embrace more technologies in their operations.

Technical efficiency is a pre-requisite for economic efficiency when a firm produces the maximum output with the lowest quantity of inputs required.Scale efficiency or scale effect this measures how a DMU is able to utilize it production scale. This is an alternating and new developed model to determining the return to scale (RTS) nature of a DMU. When other basic methods i.e. CRS envelopment model and VRS multiplier model failed to test a DMU'S RTS nature especially when DEA models have alternate optimal solution, scale efficiency was adopted to solve the issue.

4.2.2Trend Analysis of Tin Can Island Port Complex Productivity

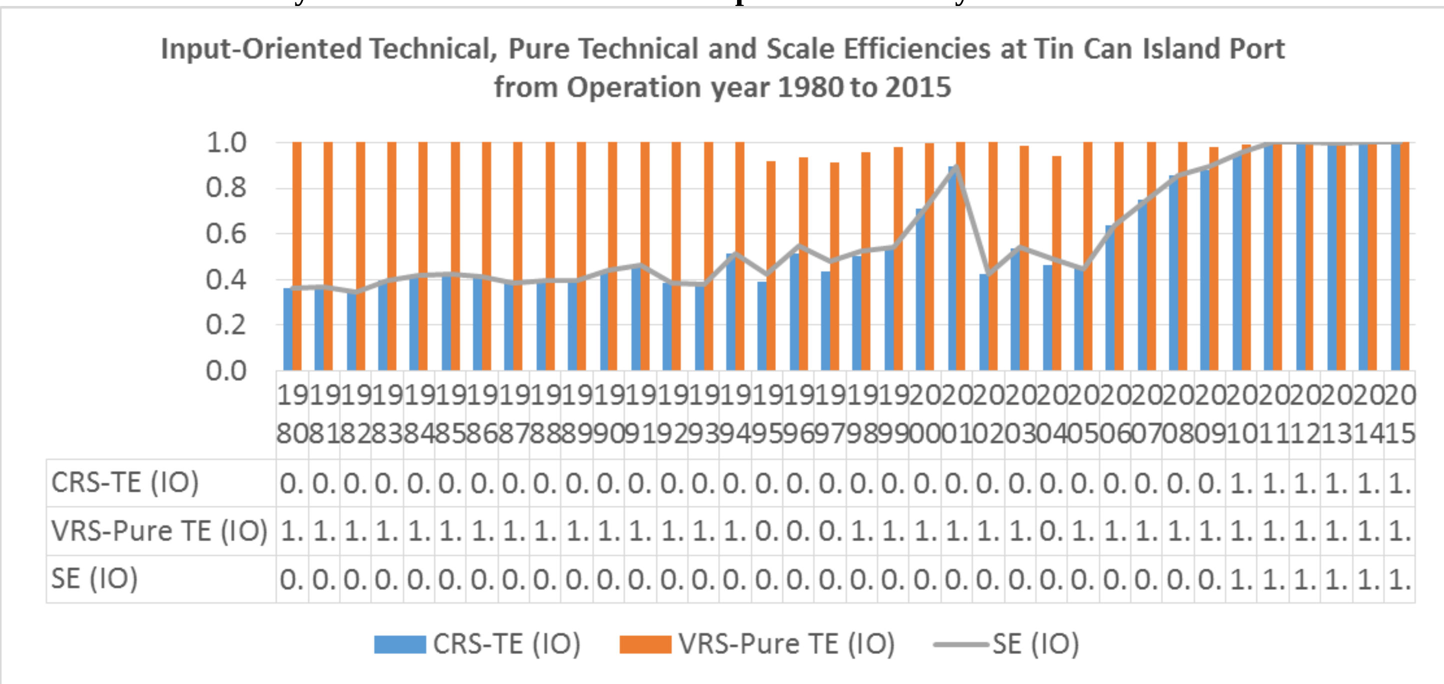

Figure 4.9: CRS – Technical Efficiency (Input-oriented) and CRS – Scale Efficiency (Input-oriented) at Tin Can Island Port Complex from 1980 – 2015

Source: Author's Computation

The figure above depicts the trends of input-oriented technical, pure technical and scale efficiencies at Tin Can Island Port from year 1980 to 2015. The port was technically inefficient in the pre-concession years of 1980 to 2004 with the highest efficiency score of 0.7 achieved in year 2000 and the least efficiency score is 0.4 achieved in year 1980, 1981, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1992 e.t.c. This reflects serious technical problems at the Port during this era. However, the technical efficiency score rose from 0.4 with scale efficiency in the post-concession year of 2007 to efficiency score of 1.0 in operation year 2010. It is observed that the port maintained the efficiency score till 2015.The Port experienced managerial issues in the operation years 1994, 1995, 1996 and 2004.

The port lacked scale optimization all through the pre-concession years but adjusted to scale in year 2011 and maintained till year 2015.

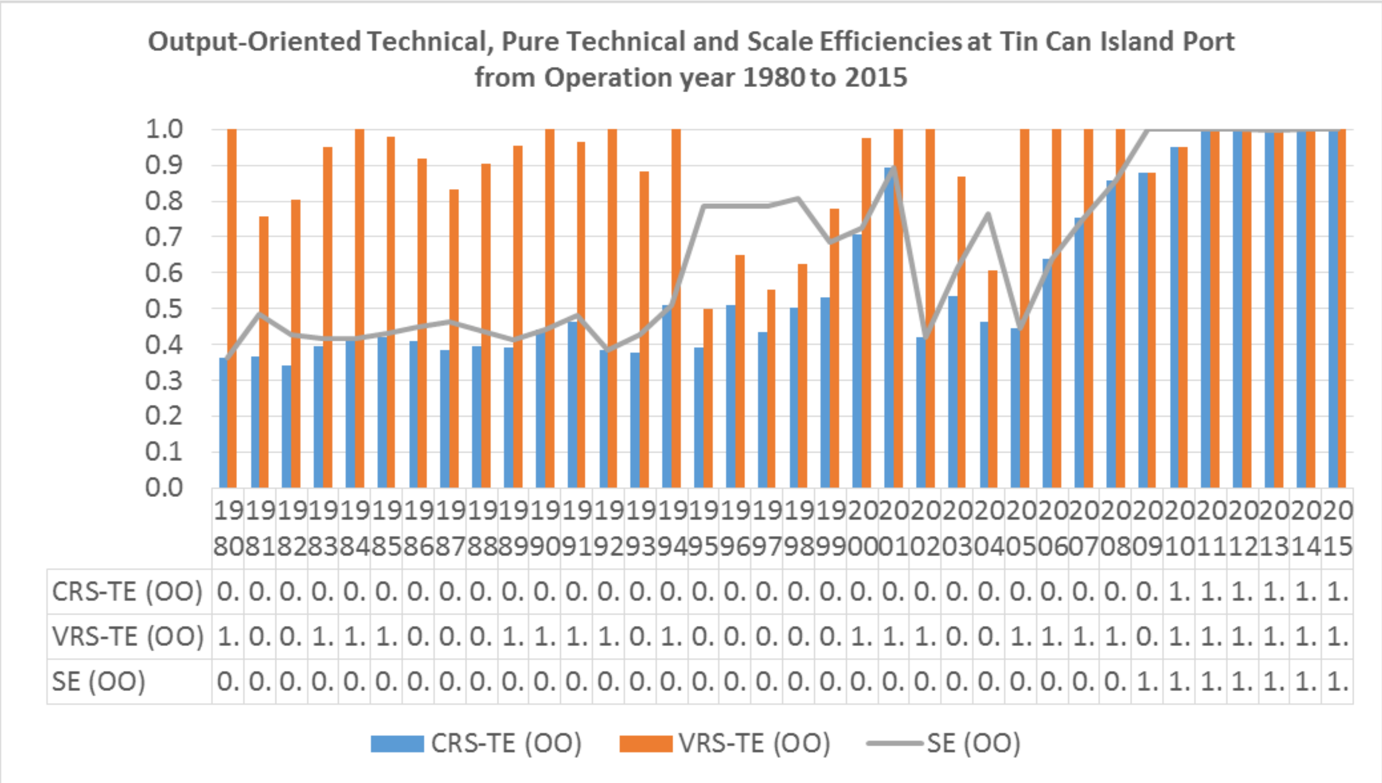

Figure 4.10: CRS–Technical Efficiency (Output-oriented) and CRS–Scale Efficiency (Output-oriented) at Tin Can Island Port Complex from 1980 – 2015

Source: Author's Computation

The figure above shows the trends of output-oriented technical, pure technical and scale efficiencies at Tin Can Island Port from year 1980 to 2015. The port was technically inefficient in the pre-concession years of 1980 to 2009 with the highest efficiency score of 0.9 achieved in year 2001 and the least efficiency score is 3.5 achieved in year 1980 and 1989.

This reflects serious technical problems at the Port during these two years. However, the technical efficiency score together with scale efficiency rose from 0.4 in the post-concession year of 2005 to efficiency score of 1.0 in operation year 2011. It is observed that the Port maintained the efficiency score till 2015.

4.2.3Trend Analysis of Rivers Port Complex Productivity

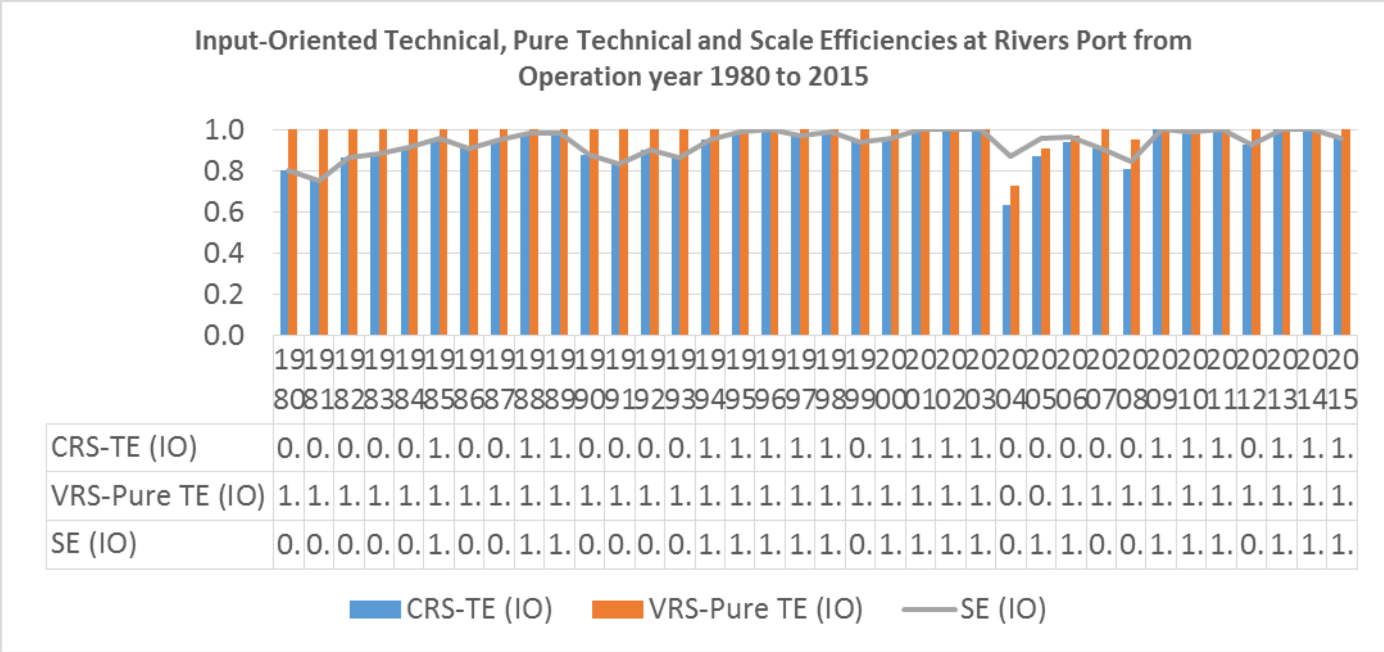

Figure 4.11: CRS – Technical Efficiency (Input-oriented) and CRS – Scale Efficiency (Input-oriented) at Rivers Port Complex from 1980 – 2015

Source: Author's Computation

The trends for technical and scale efficiencies are fluctuating in which out of the 26 pre-concession years, River Port was inefficient for 16 years while out of the 10 post concession years, the port was inefficient for 4 years. In year 2004 and 2005, the Port was not managerially efficient with score 0.7 and 0.9 respectively.

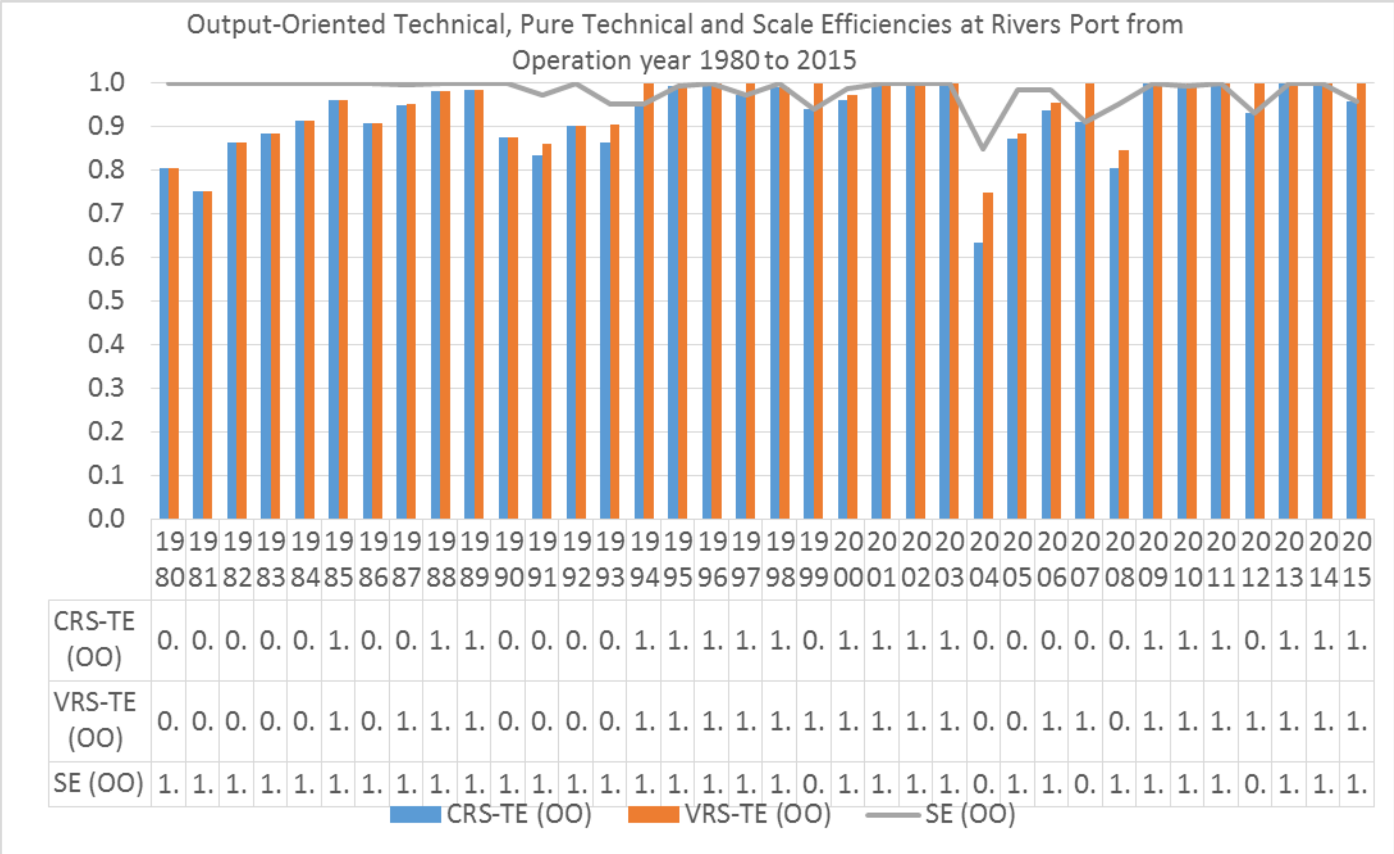

Figure 4.12: CRS – Technical Efficiency (Output-oriented) and CRS – Scale Efficiency (Output-oriented) at Rivers Port Complex from 1980 – 2015

Source: Author's Computation

With respect to output optimization, there was fluctuation in the trend of technical efficiency. Thus, DMU/pre-concession year of 1985, 1988, 1989, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002 and 2003 were technically and managerially efficient in terms of output wise and DMU/post concession year of 2009, 2010, 2011, 2013, 2014 and 2015 were technically efficient. However, the Port experienced managerial inefficiency only during post concession era in year 2008. The Port was scale efficient in all the operation years except year 1999, 2004, 2007 and 2012.

4.2.4Trend Analysis of Delta Port Complex Productivity

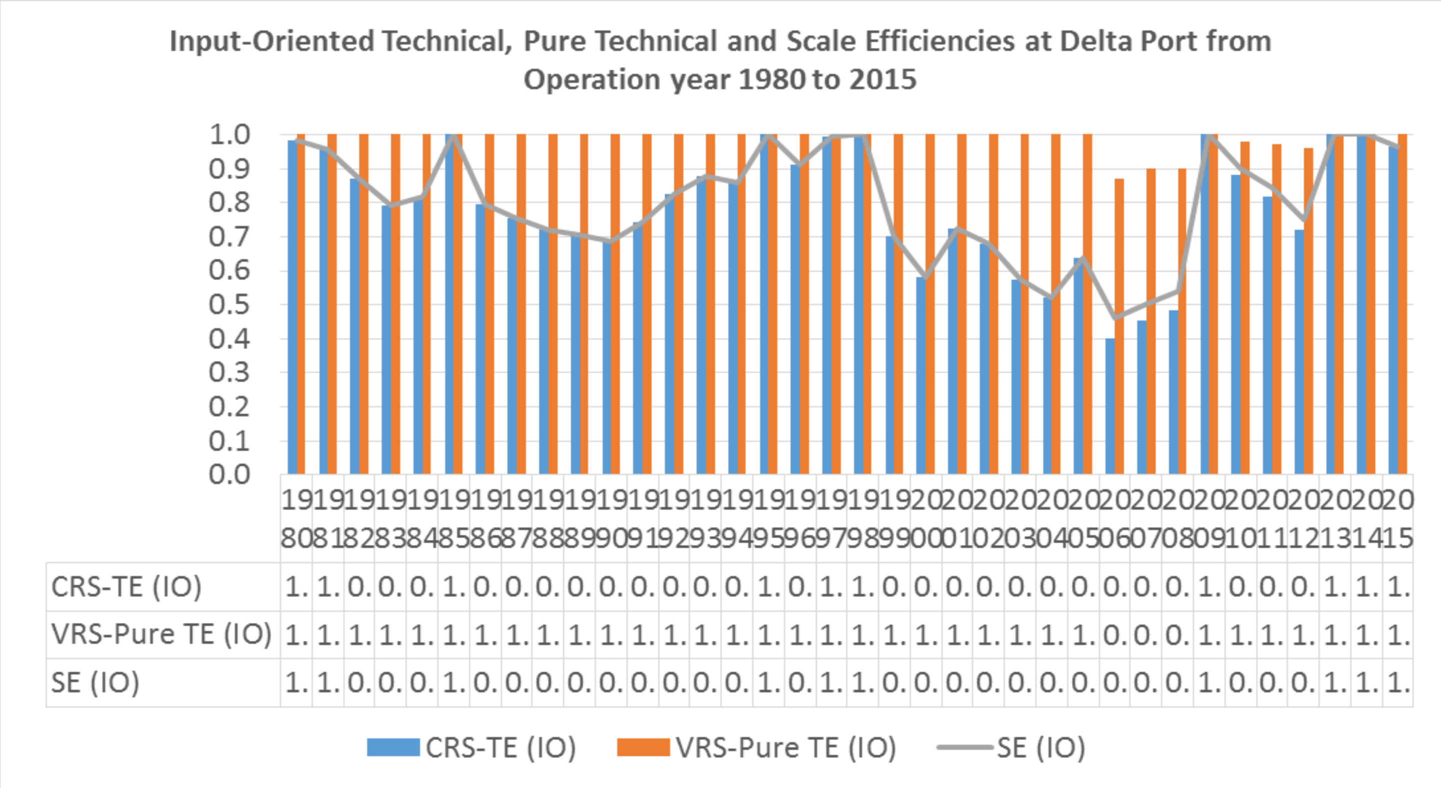

Figure 4.13: CRS – Technical Efficiency (Input-oriented) and CRS – Scale Efficiency (Input-oriented) at Delta Port Complex from 1980 – 2015

Source: Author’s Computation

The figure above depicts the trends of input-oriented technical, pure technical and scale efficiencies at Delta Port from year 1980 to 2015 in which the port maintained technical and scale efficiency score 1.0 in the pre-concession era year of 1980 but dropped to score 0.8 in 1982 and 1983. Fluctuation in technical and scale efficiency occurs all through the pre-concession era. Hence, there was drastic drops in the technical and scale efficiency from score 1.0 ((year 1998) to score 0.4. This drop trend was followed by unsteady and unstable increases in efficiencies between post concession year of 2006 and 2013. Subsequently, stable efficiency was achieved from year 2013 to 2015.

Though, the Port was managerially efficient all through the operation years under study with efficiency score of 1.0

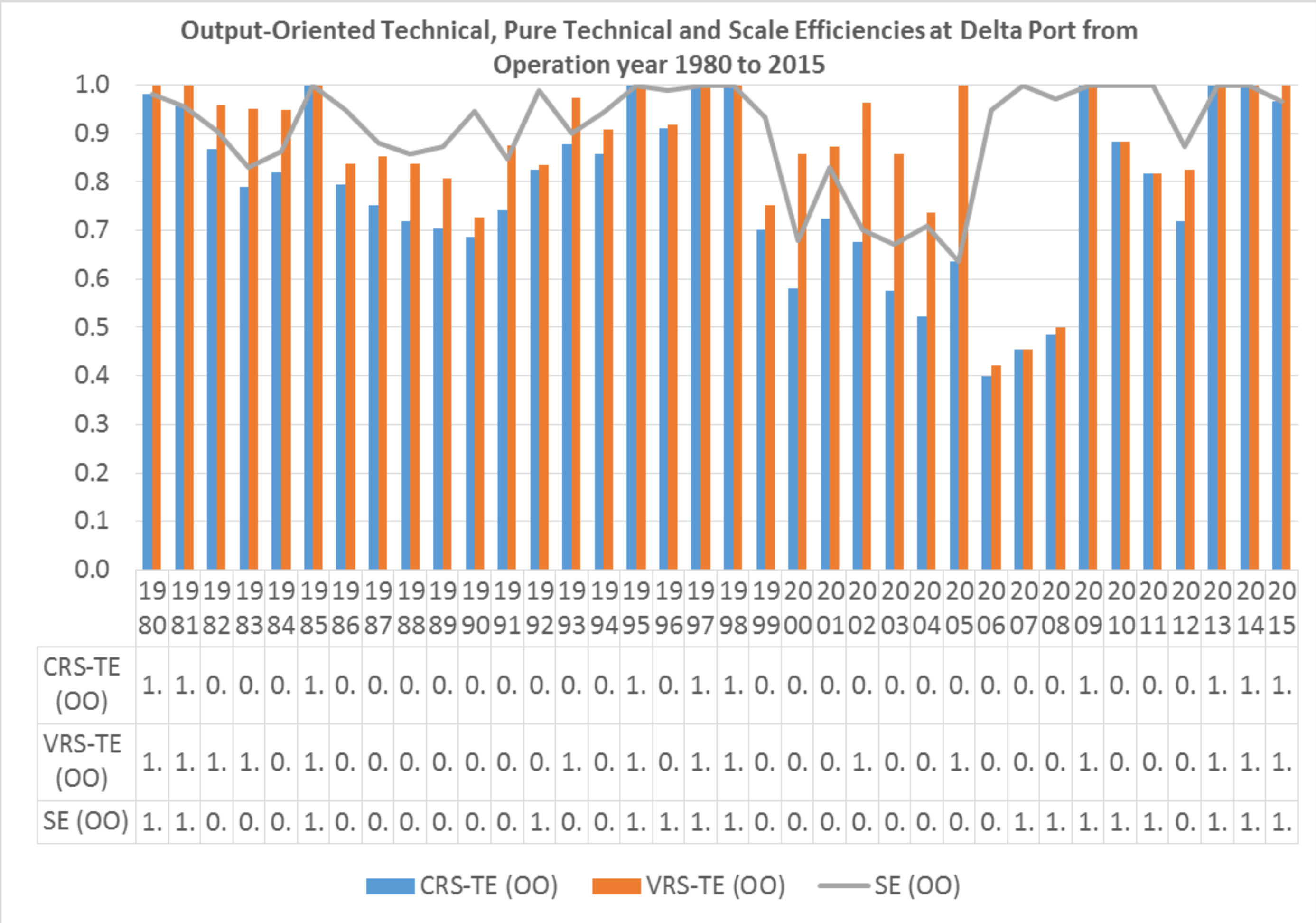

Figure 4.14: CRS – Technical Efficiency (Output-oriented) and CRS – Scale Efficiency (Output-oriented) at Delta Port Complex from 1980 – 2015

Source: Author's Computation

The table above depicts the trends of output-oriented technical, pure technical and scale efficiencies at Delta Port from year 1980 to 2015 in which the port fluctuations in technical and scale efficiency scores over the period. Though the fluctuation in technical and scale efficiency occurs more often during the pre-concession period. The post-concession period in the port is more stable as it concerns technical and scale efficiency scores.

4.2.5Trend Analysis of Onne Port Complex Productivity

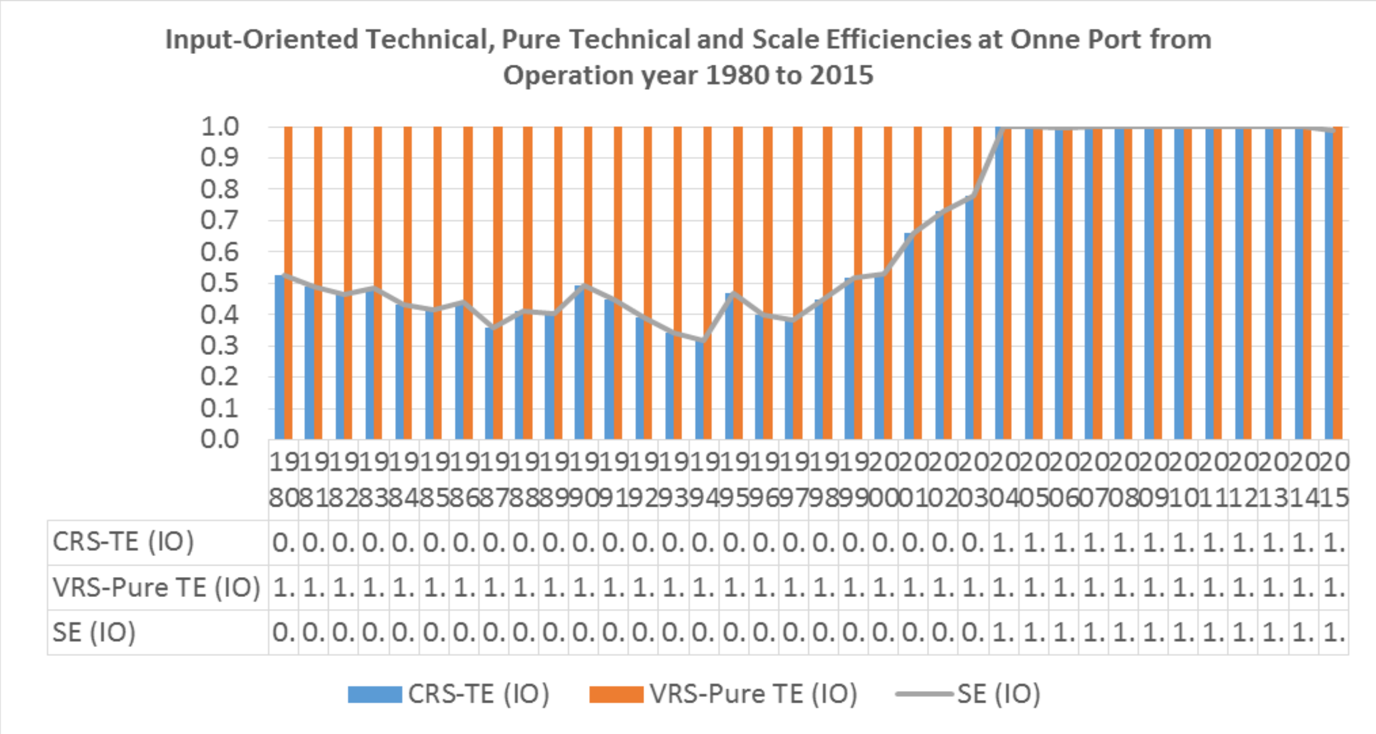

Figure 4.15: CRS – Technical Efficiency (Input-oriented) and CRS – Scale Efficiency (Input-oriented) at Onne Port Complex from 1980 – 2015

Source: Author’s Computation

The figure above depicts the trends of input-oriented technical, pure technical and scale efficiencies at Onne Port from year 1980 to 2015 in which the port was technically and scale inefficient in all the pre-concession year (1980 to 2003) with technical efficiency scores less than 1.0 respectively but she started experiencing technical efficiency from the year 2004 when the Port was concessioned till year 2015 with score 1.0 Hence, the Port was wasteful in terms of input utilization throughout the pre-concession years of operation under study and was technically efficient all through the concessioning period (2004 – 2015). This may be as a result of the involvement of private concessionaires in terminal operations of the port. This consistency and best performance reflect high level of technology employed among these concessionaires and appropriate input mix.

It is also observed that the port experienced managerial efficiency with score 1.0 all through the operation years under study.

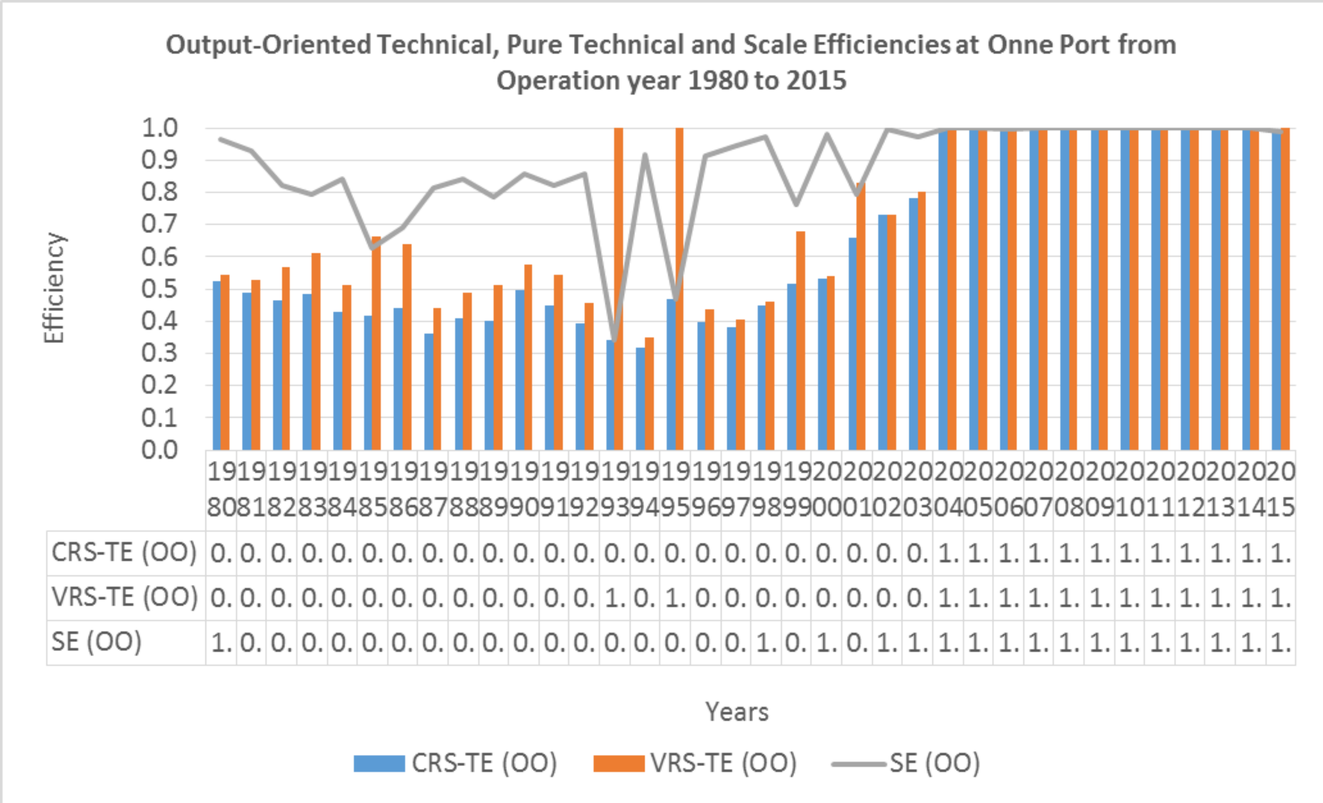

Figure 4.16: CRS – Technical Efficiency (Output-oriented) and CRS – Scale Efficiency (Output-oriented) at Onne Port Complex from 1980 – 2015

Source: Author's Computation

The figure above depicts the output-oriented efficiencies at Onne Port from year 1980 to 2015. Thus, the Port was not technically efficient in terms of output maximization with respect to constant levels of inputs used. The Port was able to maximize her outputs only in the post-concession years 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014 and 2015 and the Port was able to manage their resources optimally in pre-concession years 1993 and 1995 and in the post-concession years 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014 and 2015. The Port had scale efficiency of 1.0 in year 1998, 2000, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014 and 2015.

4.2.6Trend Analysis of Calabar Port Complex Productivity

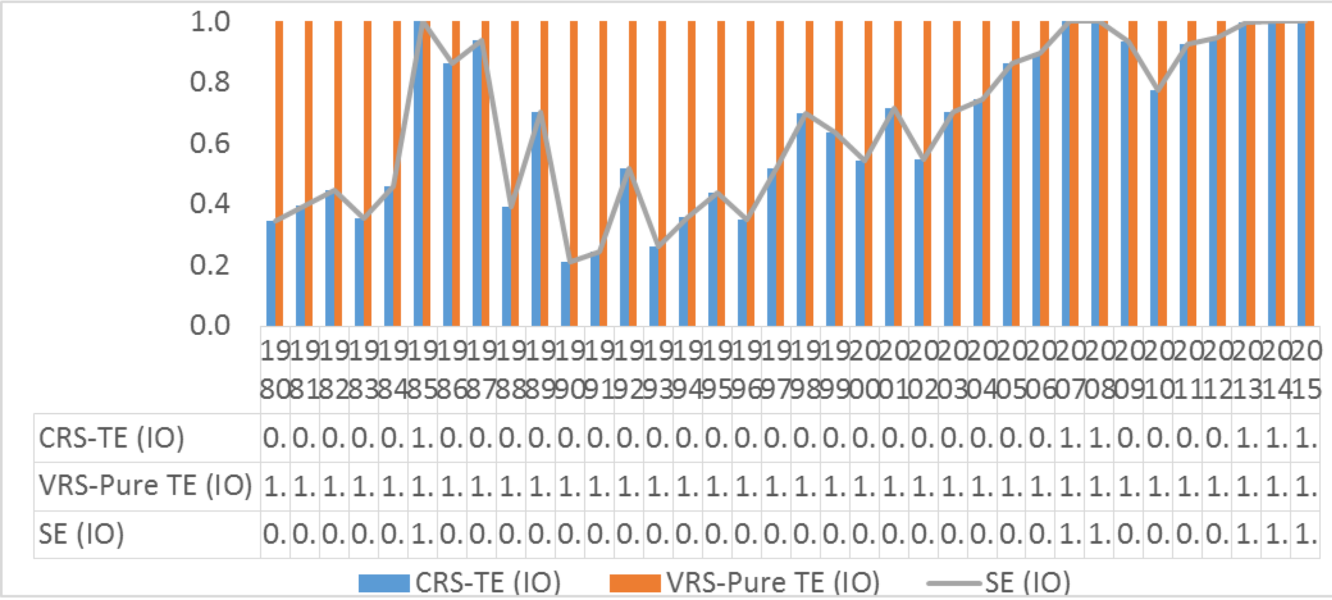

Figure 4.17: CRS – Technical Efficiency (Input-oriented) and CRS – Scale Efficiency (Input-oriented) at Onne Port Complex from 1980 – 2015

Source: Author’s Computation

The table above depicts the trends of input-oriented technical, pure technical and scale efficiencies from year 1980 to 2015 in which the port was technically efficient only in the pre-concession era year of 1985 with technical efficiency score 1.0 and post-concession era year of 2007, 2008, 2013, 2014 and 2015 with technical efficiency score 1.0 while the port had pure technical efficiency or managerial efficiency score of 1.0 all through the operation years. Hence, the Port had been wasteful in terms of input minimization for fifteen (15) years out of the sixteen years (16) under study before concessioning and for four (4) years out of the eight (8) years after concession.

The Port was able to operate on optimal scale size only in the pre-concession year of 1985 with scale efficiency score 1.0 and post-concession era year of 2007, 2008, 2013, 2014 and 2015 with scale efficiency score 1.0. The technical inefficiencies experienced by Calabar Port brought about inefficiencies in inputs’ sizes utilization which implies that inputs used can either be minimized to obtain the realized outputs for the specific inefficient operation years or be used to achieve more outputs.

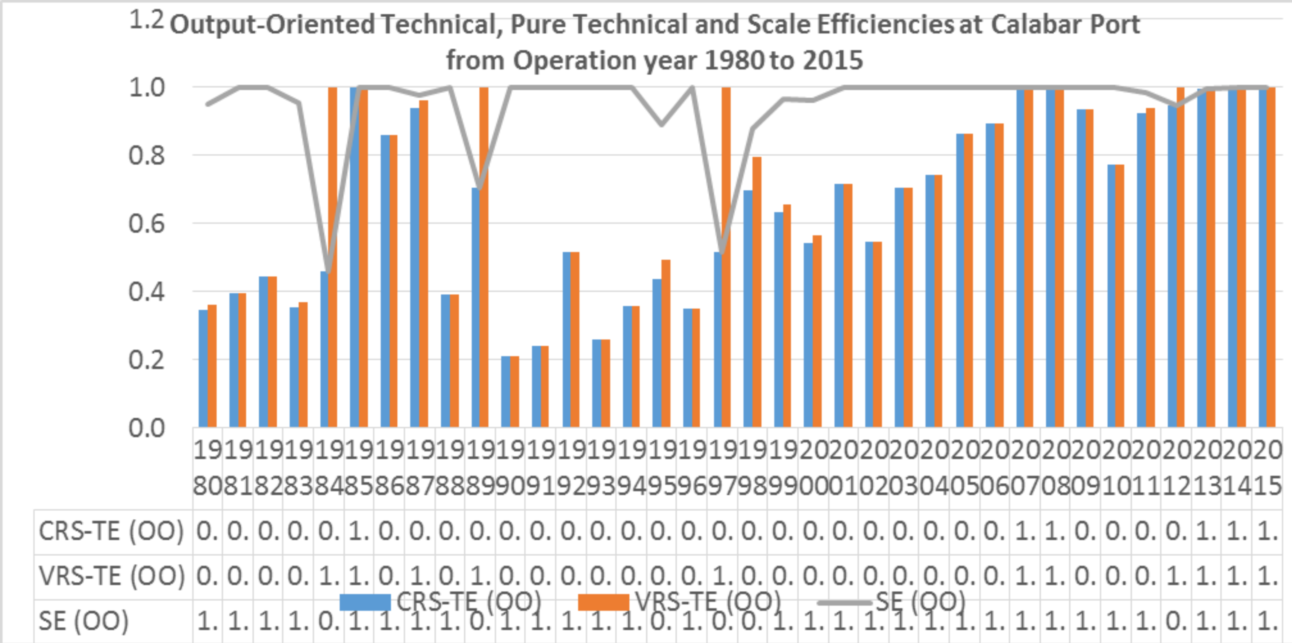

Figure 4.18: CRS – Technical Efficiency (Output-oriented) and CRS – Scale Efficiency (Output-oriented) at Calabar Port Complex from 1980 – 2015

Source: Author's Computation

The figure above depicts the trends of output-oriented technical, pure technical and scale efficiencies at Calabar Port from year 1980 to 2015 in which the port was technically efficient only in the pre-concession year of 1985 with technical efficiency score 1.0 and post-concession years of 2007, 2008, 2013, 2014 and 2015 with technical efficiency score 1.0 thus this is in line with the analysis of figure 4.8 that output can be maximized with the level of inputs resources used in the inefficient years. The port was managerially efficient in pre-concession years 1984 1985, 1987, 1989 and 1997 and in the post-concession years 2007, 2008, 2013, 2014 and 2015 with score of 1.0. This implies that the ship traffic or calls were not managed properly to achieve the required or predetermined throughputs in the managerial inefficient years.

Also, the Port experienced scale inefficiency in terms of output maximization in the pre-concession years of 1984, 1989, 1995, 1997 and 1998 and in the post-concession year of 2012 due to impacts of technical inefficiencies on her operation in the years.

4.3 Horizontal Analysis of Productivity of Nigerian Ports

4.3.1 Horizontal Analysis of Productivity of Ports that handle Bulk, Wet, General and Containerized Cargoes for Lagos, Rivers and Calabar Ports.

Table 4.8: Ports that handle Bulk, Wet, General and Containerized Cargoes.

S/N	DMU	Year	Types of Cargoes
1	Lagos Port Complex (LPC)	Post-Concession 2006 - 2014	Bulk, Wet, General and Containerized Cargo
2	Rivers Port Complex (RPC)	Post-Concession 2006 - 2014	Bulk, Wet, General and Containerized Cargo
3	Calabar Port Complex (CPC)	Post-Concession 2006 - 2014	Bulk, Wet, General and Containerized Cargo

Source: Researcher's Computation

Table 4.9: Input-Oriented Technical Efficiency, Pure Technical Efficiency, Scale Efficiency and Return to Scale for LPC, CPC and RPC Post Concession Era

NO	DMU	Technical Efficiency Score(CRS)	Pure Technical Efficiency Score(VRS)	Scale Efficiency Score	RTS
1	RPC 2006	0.64	1.00	0.64	Increasing
2	RPC 2007	0.56	1.00	0.56	Increasing
3	RPC 2008	0.67	1.00	0.67	Increasing
4	RPC 2009	0.75	1.00	0.75	Increasing
5	RPC 2010	0.77	1.00	0.77	Increasing
6	RPC 2011	0.92	1.00	0.92	Increasing
7	RPC 2012	0.75	1.00	0.75	Increasing
8	RPC 2013	0.71	1.00	0.71	Increasing
9	RPC 2014	0.72	1.00	0.72	Increasing
10	CPC 2006	0.90	0.99	0.91	Increasing
11	CPC 2007	1.00	1.00	1.00	Constant
12	CPC 2008	0.91	0.98	0.94	Increasing
13	CPC 2009	0.29	0.97	0.30	Increasing
14	CPC 2010	0.29	0.96	0.31	Increasing
15	CPC 2011	0.27	0.96	0.28	Increasing
16	CPC 2012	0.24	0.95	0.25	Increasing
17	CPC 2013	0.55	0.94	0.59	Increasing
18	CPC 2014	0.40	0.95	0.42	Increasing
19	LPC 2006	1.00	1.00	1.00	Constant
20	LPC 2007	0.92	0.97	0.96	Increasing
21	LPC 2008	0.94	0.96	0.98	Increasing
22	LPC 2009	0.95	0.96	1.00	Increasing
23	LPC 2010	1.00	1.00	1.00	Constant
24	LPC 2011	1.00	1.00	1.00	Constant
25	LPC 2012	0.92	0.94	0.99	Increasing
26	LPC 2013	0.95	0.96	1.00	Increasing
27	LPC 2014	0.94	0.94	1.00	Increasing
28	LPC 2015	0.94	0.94	1.00	Increasing

Source: Researcher's Computation

From the table above, it is observed that DMU CPC 2007, LPC 2006, LPC 2010 and LPC 2011 were fully efficient with score 1.00 while other DMUs were not fully efficient. Thus this implies that after the comparison of Lagos Port Complex, River Port Complex and Calabar Port Complex only production year 2007 of Calabar Port Complex, production year 2006, 2010 and 2011 of Lagos Port Complex exhibit both technical and scale efficiency. Thus no productive year of River Port Complex are considered efficient and the same years considered to be efficient are also efficient in their respective trend analysis thereby they are inferentially efficient.

Table 4.10: Output-Oriented Technical Efficiency, Pure Technical Efficiency, Scale Efficiency and Return to Scale for LPC, CPC and RPC Post Concession Era

NO	DMU	Technical Efficiency Score(CRS)	Pure Technical Efficiency Score(VRS)	Scale Efficiency Score	RTS
1	RPC2006	0.64	1.00	0.64	Increasing
2	RPC 2007	0.56	1.00	0.56	Increasing
3	RPC 2008	0.67	0.85	0.79	Increasing
4	RPC 2009	0.75	1.00	0.75	Increasing
5	RPC 2010	0.77	1.00	0.77	Increasing
6	RPC 2011	0.92	1.00	0.92	Increasing
7	RPC 2012	0.75	1.00	0.75	Increasing
8	RPC 2013	0.71	1.00	0.71	Increasing
9	RPC 2014	0.72	1.00	0.72	Increasing
10	CPC 2006	0.90	0.90	1.00	Constant
11	CPC 2007	1.00	1.00	1.00	Constant
12	CPC 2008	0.91	0.92	0.99	Increasing
13	CPC 2009	0.29	0.57	0.52	Increasing
14	CPC 2010	0.29	0.44	0.67	Increasing
15	CPC 2011	0.27	0.44	0.61	Increasing
16	CPC 2012	0.24	0.38	0.62	Increasing
17	CPC 2013	0.55	0.56	0.98	Increasing
18	CPC 2014	0.40	0.54	0.74	Increasing
19	LPC2006	1.00	1.00	1.00	Constant
20	LPC 2007	0.92	0.95	0.98	Increasing
21	LPC 2008	0.94	0.95	1.00	Increasing
22	LPC 2009	0.95	0.96	1.00	Increasing
23	LPC 2010	1.00	1.00	1.00	Constant
24	LPC 2011	1.00	1.00	1.00	Constant
25	LPC 2012	0.92	0.92	1.00	Constant
26	LPC 2013	0.95	0.95	1.00	Constant
27	LPC 2014	0.94	0.94	1.00	Decreasing
28	LPC 2015	0.94	0.94	1.00	Decreasing

Source: Researcher's Computation

From the above table, it is observed that based on output orientation the analysis has similar efficient DMUs with that of input orientation analysis. The difference is that year 1992, 1999, 2001, 2002, 2003, 2004 have higher technical and scale efficiency score than the ones in input orientation reflecting output scale size problems but not as bad as the input scale size problems.

4.3.2 Horizontal Analysis of Productivity of Ports that handle Bulk, Wet, Heavy and Containerized Cargoes for Delta, Onne and Tin can Island Ports.

Table 11: Ports that handle Bulk, Wet, heavy and Containerized Cargoes

S/N	DMU	Year	Types of Cargoes
1	Delta Port Complex (DPC)	Post-Concession 2006 - 2014	Bulk, Wet, heavy and Containerized Cargo
2	Onne Port Complex (OPC)	Post-Concession 2006 - 2014	Bulk, Wet, heavy and Containerized Cargo
3	Tin Can Island Port Complex (TPC)	Post-Concession 2006 - 2014	Bulk, Wet, heavy and Containerized Cargo

Source: Researcher's Computation

Table 4.12: Input-Oriented Technical Efficiency, Pure Technical Efficiency, Scale Efficiency and Return to Scale for DPC, OPC and TPC Post Concession Era

NO	DMU	Technical Efficiency Score(CRS)	Pure Technical Efficiency Score(VRS)	Scale Efficiency Score	RTS
1	OPC 2006	0.98	1.00	0.98	Increasing
2	OPC 2007	1.00	1.00	1.00	Constant
3	OPC 2008	1.00	1.00	1.00	Constant
4	OPC 2009	1.00	1.00	1.00	Constant
5	OPC 2010	0.90	0.93	0.98	Increasing
6	OPC 2011	1.00	1.00	1.00	Constant
7	OPC 2012	1.00	1.00	1.00	Constant
8	OPC 2013	0.95	0.96	0.99	Increasing
9	OPC 2014	1.00	1.00	1.00	Constant
10	TPC 2006	0.64	0.93	0.69	Increasing
11	TPC 2007	0.75	0.91	0.83	Increasing
12	TPC 2008	0.87	0.92	0.94	Increasing
13	TPC 2009	0.88	0.89	0.99	Increasing
14	TPC 2010	0.95	0.96	0.99	Increasing
15	TPC 2011	1.00	1.00	1.00	Constant
16	TPC 2012	0.99	0.99	1.00	Increasing
17	TPC 2013	0.99	1.00	0.99	Increasing
18	TPC 2014	1.00	1.00	1.00	Constant
19	DPC 2006	0.12	0.31	0.39	Increasing
20	DPC 2007	0.13	0.34	0.37	Increasing
21	DPC 2008	0.14	0.31	0.45	Increasing
22	DPC 2009	0.17	0.30	0.55	Increasing
23	DPC 2010	0.18	0.31	0.60	Increasing
24	DPC 2011	0.19	0.31	0.60	Increasing
25	DPC 2012	0.18	0.35	0.50	Increasing
26	DPC 2013	0.40	0.53	0.75	Increasing
27	DPC 2014	1.00	1.00	1.00	Constant
28	DPC 2015	1.00	1.00	1.00	Constant

Source: Researcher's Computation

From the table above, it is observed that DMU OPC 2007, OPC 2008, OPC 2009, OPC 2011, OPC 2012, OPC 2014, TPC 2011, TPC 2014, DPC 2014 were fully efficient with score 1.00 while other DMUs were not fully efficient. Thus this implies that after the comparison of Lagos Port Complex, River Port Complex and Calabar Port Complex only production year 2007 of Calabar Port Complex, production year 2006, 2010 and 2011 of Lagos Port Complex exhibit both technical and scale efficiency. Thus no productive year of River Port Complex are considered efficient and the same years considered to be efficient are also efficient in their respective horizontal analysis thereby they are inferentially efficient.

Table 4.13: Output-Oriented Technical Efficiency, Pure Technical Efficiency, Scale Efficiency and Return to Scale for DPC, OPC and TPC Post Concession Era

NO	DMU	Technical Efficiency Score(CRS)	Pure Technical Efficiency Score(VRS)	Scale Efficiency Score	RTS
1	OPC 2006	0.98	1.00	0.98	Increasing
2	OPC 2007	1.00	1.00	1.00	Constant
3	OPC 2008	1.00	1.00	1.00	Constant
4	OPC 2009	1.00	1.00	1.00	Constant
5	OPC 2010	0.90	0.91	1.00	Increasing
6	OPC 2011	1.00	1.00	1.00	Constant
7	OPC 2012	1.00	1.00	1.00	Constant
8	OPC 2013	0.95	0.95	1.00	Increasing
9	OPC 2014	1.00	1.00	1.00	Constant
10	TPC 2006	0.64	0.80	0.80	Increasing
11	TPC 2007	0.75	0.80	0.94	Increasing
12	TPC 2008	0.87	0.88	0.99	Increasing
13	TPC 2009	0.88	0.88	1.00	Decreasing
14	TPC 2010	0.95	0.95	1.00	Constant
15	TPC 2011	1.00	1.00	1.00	Constant
16	TPC 2012	0.99	0.99	1.00	Constant
17	TPC 2013	0.99	1.00	0.99	Increasing
18	TPC 2014	1.00	1.00	1.00	Constant
19	DPC 2006	0.12	0.15	0.78	Decreasing
20	DPC 2007	0.13	0.16	0.78	Decreasing
21	DPC 2008	0.14	0.20	0.69	Decreasing
22	DPC 2009	0.17	0.30	0.56	Decreasing
23	DPC 2010	0.18	0.35	0.53	Decreasing
24	DPC 2011	0.19	0.34	0.55	Decreasing
25	DPC 2012	0.18	0.29	0.60	Decreasing
26	DPC 2013	0.40	0.47	0.86	Decreasing
27	DPC 2014	1.00	1.00	1.00	Constant
28	DPC 2015	1.00	1.00	1.00	Constant

Source: Researcher's Computation

From the table 4.15, it is observed that based on output orientation the analysis has similar efficient DMUs with that of input orientation analysis. The difference is that year 1992, 1999, 2001, 2002, 2003, 2004 have higher technical and scale efficiency score than the ones in input orientation reflecting output scale size problems but not as bad as the input scale size problems.

4.4 Analysis of the Technical Efficiency Benchmarking for the Ports

Table 4.14: Input-Oriented Technical Efficiency Benchmarking for Lagos Port Complex

NO	DMU	IO-CRS TE Score	OO-CRS TE Score	Times as Benchmark	Benchmark (Lambda)
1	2015	1.0	1.0	6	2015(1.000000)
2	2014	1.0	1.0	14	2014(1.000000)
3	2013	1.0	1.0	15	2011(0.430697); 2014(0.543627)
4	2012	1.0	1.0	1	2012(1.000000)
5	2011	1.0	1.0	5	2011(1.000000)
6	2010	1.0	1.0	22	2012(0.046823); 2014(0.905238)
7	2009	0.9	0.9	1	2014(0.879433)
8	2008	0.9	0.9	1	2014(0.585795); 2015(0.226953)
9	2007	0.8	0.8	1	2014(0.681287); 2015(0.019483)
10	2006	0.6	0.6	1	2011(0.307586); 2014(0.237736)
11	2005	0.4	0.4	1	2014(0.396572)
12	2004	0.5	0.5	1	2014(0.411348)
13	2003	0.5	0.5	0	2014(0.475177)
14	2002	0.4	0.4	0	2011(0.024906); 2014(0.350150)
15	2001	0.9	0.9	0	2014(0.794135)
16	2000	0.7	0.7	0	2014(0.629016)
17	1999	0.5	0.5	0	2014(0.473198)
18	1998	0.5	0.5	0	2014(0.447529)
19	1997	0.4	0.4	0	2014(0.387116)
20	1996	0.5	0.5	0	2014(0.454492)
21	1995	0.4	0.4	0	2014(0.348700)
22	1994	0.5	0.5	0	2014(0.397754)
23	1993	0.4	0.4	0	2014(0.294326)
24	1992	0.4	0.4	0	2014(0.299054)
25	1991	0.5	0.5	0	2014(0.361111)
26	1990	0.4	0.4	0	2014(0.342790)
27	1989	0.4	0.4	0	2014(0.306147)
28	1988	0.4	0.4	0	2014(0.308511)
29	1987	0.4	0.4	0	2014(0.300827)
30	1986	0.4	0.4	0	2014(0.320331)
31	1985	0.4	0.4	0	2014(0.328014)
32	1984	0.4	0.4	0	2014(0.324468)
33	1983	0.4	0.4	0	2014(0.309102)
34	1982	0.3	0.3	0	2014(0.267139)
35	1981	0.4	0.4	0	2014(0.285461)
36	1980	0.4	0.4	0	2014(0.281915)

Source: Author's Computation

It is observed that year 2014 is the most efficient year out of the 36 operation years in terms of output maximization with constant levels of inputs under the study period with score 1.0 respectively serving as 32 times benchmark for other years.

Table 4.15: Input-Oriented Technical Efficiency Benchmarking for Tin Can Island Port Complex

NO	DMU	IO-CRS TE Score	OO-CRS TE Score	TAB	Benchmark (Lambda)
1	1985	1	1	0	1985(1.000000)
2	1995	1	1	0	1995(1.000000)
3	1998	1	1	0	1998(1.000000)
4	2009	1	1	0	2009(1.000000)
5	2013	1	1	0	2013(1.000000)
6	2014	1	1	0	2014(1.000000)
7	1997	1	1	0	1995(0.597122); 1998(0.398082)
8	1980	1	1	0	1998(0.097475); 2014(0.751002)
9	2015	1	1	0	2013(0.866995)
10	1981	1	1	0	1998(0.538428); 2014(0.273409)
11	1996	0.9	0.9	0	1998(0.906816); 2013(0.002749)
12	2010	0.9	0.9	17	2013(0.882284)
13	1993	0.9	0.9	0	1985(0.019394); 1995(0.520622); 1998(0.308713); 2013(0.024580)
14	1982	0.9	0.9	0	1998(0.689436); 2013(0.155805)
15	1994	0.9	0.9	0	1998(0.681028); 2013(0.153905)
16	1992	0.8	0.8	0	1985(0.058243); 1995(0.068991); 1998(0.689466)
17	1984	0.8	0.8	0	1985(0.144669); 1995(0.245484); 1998(0.356600); 2013(0.036060)
18	2011	0.8	0.8	7	2013(0.817140)
19	1986	0.8	0.8	0	1998(0.671055); 2014(0.070435)
20	1983	0.8	0.8	0	1998(0.556132); 2014(0.133778)
21	1987	0.8	0.8	0	1998(0.432905); 2013(0.028129); 2014(0.241320)
22	1991	0.7	0.7	0	1998(0.359684); 2013(0.333041)
23	2001	0.7	0.7	3	1998(0.650024); 2013(0.065002)
24	2012	0.7	0.7	0	2009(0.088755); 2013(0.594203)
25	1988	0.7	0.7	0	1998(0.367580); 2013(0.103169); 2014(0.203058)
26	1989	0.7	0.7	0	1998(0.480576); 2013(0.042916); 2014(0.151000)
27	1999	0.7	0.7	0	1998(0.557714); 2013(0.126037)
28	1990	0.7	0.7	0	1998(0.564613); 2013(0.051841); 2014(0.055078)
29	2002	0.7	0.7	0	1998(0.588193); 2013(0.077506)
30	2005	0.6	0.6	0	1998(0.509496); 2013(0.110887)
31	2000	0.6	0.6	0	1998(0.493320); 2013(0.076926)
32	2003	0.6	0.6	0	1998(0.478102); 2013(0.084751)
33	2004	0.5	0.5	4	1998(0.455558); 2013(0.058454)
34	2008	0.5	0.5	0	1998(0.145511); 2013(0.356382); 2014(0.000248)
35	2007	0.5	0.5	0	2014(0.451078)
36	2006	0.4	0.4	0	1998(0.304084); 2014(0.135734)

Source: Author's Computation

It is observed from the table above that Tin Can Island Port was technically efficient in the operation years of 1980, 1981, 1985, 1995, 1997, 1998, 2009, 2013, 2014 and 2015 with score 1.0. However, the most efficient operation years are 1998 and 2013 while the most inefficient year is with efficiency score 1.0. The post-concession years that the port was technically inefficient are 2006, 2007, 2008, 2010, 2011 and 2012.

Table 4.16: Input-Oriented Technical Efficiency Benchmarking for Rivers Port Complex

NO	DMU	Score	Times as benchmark	Benchmark (Lambda)
1	2004	1.0	3	2004(1.000000)
2	2005	1.0	21	2005(1.000000)
3	2007	1.0	2	2007(1.000000)
4	2008	1.0	1	2008(1.000000)
5	2009	1.0	21	2009(1.000000)
6	2010	1.0	1	2010(1.000000)
7	2011	1.0	3	2011(1.000000)
8	2012	1.0	9	2012(1.000000)
9	2013	1.0	0	2010(0.500000); 2012(0.500000)
10	2014	1.0	5	2014(1.000000)
11	2006	1.0	0	2004(0.170087); 2007(0.375328); 2011(0.146621); 2012(0.058653)
12	2015	1.0	0	2014(0.945146)
13	2003	0.8	0	2004(0.475560); 2007(0.179719); 2014(0.057599)
14	2002	0.7	0	2004(0.187042); 2005(0.502885); 2014(0.024221)
15	2001	0.7	0	2005(0.187616); 2009(0.355808); 2012(0.034673)
16	2000	0.5	0	2005(0.497653); 2009(0.028169)
17	1980	0.5	0	2005(0.460814); 2009(0.055856)
18	1999	0.5	0	2005(0.092397); 2009(0.279594); 2011(0.059458)
19	1990	0.5	0	2005(0.249737); 2009(0.210305)
20	1981	0.5	0	2005(0.368133); 2009(0.103943)
21	1983	0.5	0	2005(0.143550); 2009(0.158212); 2012(0.094101)
22	1995	0.5	0	2009(0.104098); 2011(0.208197)
23	1982	0.5	0	2005(0.175613); 2009(0.173248); 2012(0.052486)
24	1991	0.4	0	2005(0.171066); 2009(0.238696)
25	1998	0.4	0	2005(0.233919); 2009(0.183817)
26	1986	0.4	0	2005(0.031271); 2009(0.351801)
27	1984	0.4	0	2005(0.190280); 2009(0.205502)
28	1985	0.4	0	2005(0.003682); 2009(0.353501)
29	1988	0.4	0	2005(0.186553); 2009(0.108470); 2012(0.058294)
30	1989	0.4	0	2005(0.110521); 2009(0.092386); 2012(0.109694)
31	1996	0.4	0	2005(0.274121); 2009(0.105431)
32	1992	0.4	0	2005(0.197527); 2009(0.166338)
33	1997	0.4	0	2005(0.027314); 2009(0.183983); 2014(0.083533)
34	1987	0.4	0	2005(0.131471); 2009(0.089066); 2012(0.074815)
35	1993	0.3	0	2005(0.005237); 2009(0.167406); 2012(0.085685)
36	1994	0.3	0	2008(0.029971); 2014(0.170370)

Source: Author's Computation

It is observed that the preceding year 2005 and year 2009 are the most efficient years out of the 36 operation years for both input and output orientation under the study period with score 1.0 respectively serving as 21 times benchmark for other years while year 1993 and 1994 are the least inefficient years with score 0.3.

Table 4.17: Input-Oriented Technical Efficiency Benchmarking for Delta Port Complex

NO	DMU	IO-CRS TE Score	OO-CRS TE Score	Times as benchmark	Benchmark (Lambda)
1	1996	1.0	1.0	1	1996(1.000000)
2	2001	1.0	1.0	20	2001(1.000000)
3	2002	1.0	1.0	4	2002(1.000000)
4	2003	1.0	1.0	0	2003(1.000000)
5	2009	1.0	1.0	1	2009(1.000000)
6	2011	1.0	1.0	17	2011(1.000000)
7	2013	1.0	1.0	2	2013(1.000000)
8	2014	1.0	1.0	0	2014(1.000000)
9	1995	1.0	1.0	0	2001(0.061078); 2011(0.677764)
10	2010	1.0	1.0	0	2001(0.119014); 2002(0.090646); 2011(0.678218)
11	1998	1.0	1.0	0	2001(0.990741)
12	1989	1.0	1.0	0	2001(0.983779)
13	1988	1.0	1.0	0	2001(0.981481)
14	1997	1.0	1.0	0	1996(0.717020); 2011(0.176251)
15	1985	1.0	1.0	0	2001(0.960648)
16	2000	1.0	1.0	0	2001(0.749647); 2011(0.152213)
17	2015	1.0	1.0	0	2011(0.240105); 2013(0.540092)
18	1994	1.0	1.0	0	2011(0.653805)
19	1987	0.9	0.9	0	2001(0.547783); 2011(0.292151)
20	1999	0.9	0.9	0	2001(0.324073); 2011(0.446997)
21	2006	0.9	0.9	0	2002(0.535552); 2011(0.367163)
22	2012	0.9	0.9	0	2011(0.697652); 2013(0.150635)
23	1984	0.9	0.9	0	2001(0.912037)
24	2007	0.9	0.9	0	2002(0.359774); 2011(0.398108)
25	1986	0.9	0.9	0	2001(0.907407)
26	1992	0.9	0.9	0	2001(0.900463)
27	1983	0.9	0.9	0	2001(0.863584); 2011(0.014014)
28	1990	0.9	0.9	0	2001(0.683825); 2011(0.138848)
29	2005	0.9	0.9	0	2002(0.594306); 2011(0.294211)
30	1982	0.9	0.9	0	2001(0.863426)
31	1993	0.9	0.9	0	2001(0.486101); 2011(0.273860)
32	1991	0.8	0.8	0	2001(0.287790); 2011(0.396952)
33	2008	0.8	0.8	0	2009(0.141396); 2011(0.611751)
34	1980	0.8	0.8	0	2001(0.805556)
35	1981	0.8	0.8	0	2001(0.752315)
36	2004	0.6	0.6	0	2001(0.872408)

Source: Author's Computation

From the table above, it is observed that the DMUs that fall on the frontier are DMU 1985, 1988, 1989, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002, 2003, 2009, 2010, 2011, 2013, 2014, 2015which means that Delta Port was efficient with respect to input minimization and output maximization in the aforementioned years while the inefficient DMUs are DMUs 1980, 1981, 1982, 1983, 1984, 1986, 1987, 1990, 1991, 1992, 1993, 1999, 2004, 2005, 2006, 2007, 2008, 2012. It is observed that DMU/operation year 2001 is the most efficient DMU/operation year serving as benchmark for other twenty-one (21) DMUs/years and the least efficient years are DMU/operation year 2004 with efficiency score of 0.6.

Table 4.18: Input-Oriented Technical Efficiency Benchmarking for Onne Port Complex

NO	DMU	Score	Score	Times as benchmark	Benchmark (Lambda)
1	2004	1.0	1.0	3	2004(1.000000)
2	2005	1.0	1.0	21	2005(1.000000)
3	2007	1.0	1.0	2	2007(1.000000)
4	2008	1.0	1.0	1	2008(1.000000)
5	2009	1.0	1.0	21	2009(1.000000)
6	2010	1.0	1.0	1	2010(1.000000)
7	2011	1.0	1.0	3	2011(1.000000)
8	2012	1.0	1.0	9	2012(1.000000)
9	2013	1.0	1.0	0	2010(0.500000); 2012(0.500000)
10	2014	1.0	1.0	5	2014(1.000000)
11	2006	1.0	1.0	0	2004(0.170087); 2007(0.375328); 2011(0.146621); 2012(0.058653)
12	2015	1.0	1.0	0	2014(0.945146)
13	2003	0.8	0.8	0	2004(0.475560); 2007(0.179719); 2014(0.057599)
14	2002	0.7	0.7	0	2004(0.187042); 2005(0.502885); 2014(0.024221)
15	2001	0.7	0.7	0	2005(0.187616); 2009(0.355808); 2012(0.034673)
16	2000	0.5	0.5	0	2005(0.497653); 2009(0.028169)
17	1980	0.5	0.5	0	2005(0.460814); 2009(0.055856)
18	1999	0.5	0.5	0	2005(0.092397); 2009(0.279594); 2011(0.059458)
19	1990	0.5	0.5	0	2005(0.249737); 2009(0.210305)
20	1981	0.5	0.5	0	2005(0.368133); 2009(0.103943)
21	1983	0.5	0.5	0	2005(0.143550); 2009(0.158212); 2012(0.094101)
22	1995	0.5	0.5	0	2009(0.104098); 2011(0.208197)
23	1982	0.5	0.5	0	2005(0.175613); 2009(0.173248); 2012(0.052486)
24	1991	0.4	0.4	0	2005(0.171066); 2009(0.238696)
25	1998	0.4	0.4	0	2005(0.233919); 2009(0.183817)
26	1986	0.4	0.4	0	2005(0.031271); 2009(0.351801)
27	1984	0.4	0.4	0	2005(0.190280); 2009(0.205502)
28	1985	0.4	0.4	0	2005(0.003682); 2009(0.353501)
29	1988	0.4	0.4	0	2005(0.186553); 2009(0.108470); 2012(0.058294)
30	1989	0.4	0.4	0	2005(0.110521); 2009(0.092386); 2012(0.109694)
31	1996	0.4	0.4	0	2005(0.274121); 2009(0.105431)
32	1992	0.4	0.4	0	2005(0.197527); 2009(0.166338)
33	1997	0.4	0.4	0	2005(0.027314); 2009(0.183983); 2014(0.083533)
34	1987	0.4	0.4	0	2005(0.131471); 2009(0.089066); 2012(0.074815)
35	1993	0.3	0.3	0	2005(0.005237); 2009(0.167406); 2012(0.085685)
36	1994	0.3	0.3	0	2008(0.029971); 2014(0.170370)

Source: Author's Computation

It is observed that the preceding year 2005 and year 2009 are the most efficient years out of the 36 operation years for both input and output orientation under the study period with score 1.0

respectively serving as 21 times benchmark for other years while year 1993 and 1994 are the least inefficient years with score 0.3.

Table 4.19: Input-Oriented Technical Efficiency Benchmarking for Calabar Port Complex

NO	DMU	IO-TE Score	OO-TE Score	Times as benchmark	Benchmark (Lambda)
1	1985	1.0	1.0	16	1985(1.000000)
2	2007	1.0	1.0	28	2007(1.000000)
3	2008	1.0	1.0	1	2008(1.000000)
4	2013	1.0	1.0	0	2008(0.359033); 2014(0.556437)
5	2014	1.0	1.0	4	2014(1.000000)
6	2015	1.0	1.0	7	2015(1.000000)
7	1986	0.9	0.9	0	1985(0.434381); 2007(0.404845); 2015(0.021097)
8	1987	0.9	0.9	0	1985(0.737189); 2007(0.118927); 2015(0.069518)
9	2005	0.9	0.9	0	2007(0.864322)
10	2006	0.9	0.9	0	2007(0.895894)
11	2009	0.9	0.9	0	2007(0.384778); 2014(0.549682)
12	2011	0.9	0.9	0	2015(0.883699)
13	2012	0.9	0.9	0	2015(0.817161)
14	2010	0.8	0.8	0	2007(0.182177); 2014(0.592075)
15	1989	0.7	0.7	0	1985(0.384105); 2007(0.127195); 2015(0.061860)
16	1998	0.7	0.7	0	1985(0.551613); 2007(0.108977)
17	2001	0.7	0.7	0	1985(0.501203); 2007(0.214801)
18	2003	0.7	0.7	0	2007(0.703812)
19	2004	0.7	0.7	0	2007(0.724328); 2014(0.018619)
20	1999	0.6	0.6	0	1985(0.375435); 2007(0.257064)
21	1984	0.5	0.5	0	1985(0.238003); 2007(0.178943)
22	1992	0.5	0.5	0	1985(0.207207); 2007(0.310811)
23	1997	0.5	0.5	0	1985(0.378781); 2007(0.043859)
24	2000	0.5	0.5	0	1985(0.135958); 2007(0.394278)
25	2002	0.5	0.5	0	2007(0.546921)
26	1981	0.4	0.4	0	1985(0.041348); 2007(0.347718); 2015(0.008139)
27	1982	0.4	0.4	0	2007(0.444282)
28	1983	0.4	0.4	0	1985(0.136784); 2007(0.214884)
29	1988	0.4	0.4	0	1985(0.050244); 2007(0.285815); 2015(0.055461)
30	1994	0.4	0.4	0	2007(0.357771)
31	1995	0.4	0.4	0	1985(0.210822); 2007(0.201546)
32	1980	0.3	0.3	0	1985(0.167750); 2007(0.175286)
33	1993	0.3	0.3	0	2007(0.259531)
34	1996	0.3	0.3	0	1985(0.139986); 2007(0.209979)
35	1990	0.2	0.2	0	2007(0.209677)
36	1991	0.2	0.2	0	2007(0.241935)

Source: Author's Computation

From the table above, it is observed that the DMUs that fall on the frontier are DMU 1985, 2007, 2008, 2013, 2014 and 2015 which implies that Calabar Port was efficient with respect to input minimization and output maximization in the aforementioned years while the inefficient DMUs are DMU 1986 to DMU 2006, DMU 2009, DMU 2010, DMU 2011 and DMU 2012. However, the most efficient DMU/year is DMU/year 2008 serving as benchmark for other twenty-eight (28) DMUs/years and the least efficient years are 1990 and 1991.

4.5 Analysis of sensitivity of Nigerian Portswith respect to input quantities

Table 4.20: Input Quantities for Lagos Port Complex

NO	DMU	Score	(Number of berth)	(Average turnaround time)	(Average berth occupancy rate)	(Average throughput)	(Ship Traffic)
1	1990	0.94	-1	-1.3	-2	0	0
2	1991	0.98	0	-0.3	-1	0	0
3	1992	0.85	-4	-3.1	-5	0	0
4	1993	0.90	-3	-1.5	-5	0	0
5	1994	0.83	-4	-0.9	-11	0	0
6	1995	0.97	-1	-0.4	-1	0	0
7	1996	0.95	-1	-0.4	-2	0	0
8	1997	0.94	-2	-0.5	-2	0	0
9	1998	0.90	-3	-0.9	-4	0	0
10	1999	0.82	-5	-1.8	-6	0	0
11	2000	0.89	-3	-1.5	-3	0	0
12	2001	1.00	0	0.0	0	0	0
13	2002	0.96	-1	-0.9	-1	0	0
14	2003	0.96	-1	-0.8	-1	0	0
15	2004	1.00	0	0.0	0	0	0
16	2005	0.93	-2	-0.9	-3	0	0
17	2006	0.97	-1	-0.3	-1	0	0
18	2007	0.92	-2	-0.8	-3	0	0
19	2008	0.94	-2	-0.5	-2	0	0
20	2009	0.95	-1	-0.3	-2	0	0
21	2010	1.00	0	0.0	0	0	0
22	2011	1.00	0	0.0	0	0	0
23	2012	0.92	-2	-0.6	-3	0	0
24	2013	0.95	-1	-0.3	-2	0	0
25	2014	0.94	-2	-0.3	-3	0	0

Source: Author's Computation

From the Table 4.20, the level of inputs required for each DMU to be efficient is given i.e. for DMU 2014 to be efficient input-wise, the number of berth may be reduced by two units as a result of idleness of this two (2) berths, the average turnaround time may be reduced by 3 hours and the berth occupancy may be reduced by 3%. Since a fixed asset such as berth cannot be reduced therefore technically and complimentarily the turnaround time and berth occupancy rate need to be decreased more than 5hours and 3% respectively by allocating the queue ship at the over-utilized berth to the idle berths which in turn will mitigate underutilization of this berths been required to be reduced or alternatively the Port should embrace more cargo handling technology to enhance fast loading and discharging of cargoes thus attracting more vessels to the port.

Table 4.21: Input quantities for Tin Can Island Port Complex

DMU	Score	Actual (NOB)	Project. (NOB)	Actual (ATT)	Project. (ATT)	Actual (ABIR)	Project. (ABIR)	Actual (NG/H)	Projection (NG/H)	Actual (AT)	Project. (AT)	Actual (ST)	Project. (ST)	DMU
1	2015	1.0		18		4.0		56.1		15.0		16881845		1656
2	2014	1.0		18		4.3		35.3		12.0		17500804		1692
3	2013	1.0		18		4.5		31.6		13.0		16134153		1621
4	2012	1.0		18		5.0		29.2		12.0		15136436		1609
5	2011	1.0		18		5.0		28.9		15.0		15371000		1628
6	2010	1.0		17		4.1		33.3		11.4		16551117		1607
7	2009	0.9		16		3.8		31.0		10.6		15390778		1488
8	2008	0.9		15		3.4		33.4		10.4		14083276		1367
9	2007	0.8		13		3.0		25.1		8.5		12251964		1185
10	2006	0.6		10		2.6		17.3		7.5		8888482		903
11	2005	0.4		7		1.7		14.0		4.8		6940331		671
12	2004	0.5		7		1.8		14.5		4.9		7198912		696
13	2003	0.5		9		2.0		16.8		5.7		8315985		804
14	2002	0.4		7		1.6		13.1		4.6		6510729		633
15	2001	0.9		14		3.4		28.0		9.5		13898000		1344
16	2000	0.7		11		2.7		22.2		7.5		11008278		1064

Table 4.21 Continued

17	1999	0.5		9		2.0		16.7		5.7		8281342		801
18	1998	0.5		8		1.9		15.8		5.4		7832112		757
19	1997	0.4		7		1.7		13.7		4.6		6774838		655
20	1996	0.5		8		2.0		16.0		5.5		7953971		769
21	1995	0.4		6		1.5		12.3		4.2		6102526		590
22	1994	0.5		7		1.7		14.0		4.8		6961017		673
23	1993	0.4		5		1.3		10.4		3.5		5150946		498
24	1992	0.4		5		1.3		10.6		3.6		5233692		506
25	1991	0.5		7		1.6		12.7		4.3		6319735		611
26	1990	0.4		6		1.5		12.1		4.1		5999094		580
27	1989	0.4		6		1.3		10.8		3.7		5357811		518
28	1988	0.4		6		1.3		10.9		3.7		5399184		522
29	1987	0.4		5		1.3		10.6		3.6		5264722		509
30	1986	0.4		6		1.4		11.3		3.8		5606050		542
31	1985	0.4		6		1.4		11.6		3.9		5740512		555
32	1984	0.4		6		1.4		11.5		3.9		5678452		549
33	1983	0.4		6		1.3		10.9		3.7		5409527		523
34	1982	0.3		5		1.1		9.4		3.2		4675156		452
35	1981	0.4		5		1.2		10.1		3.4		4995797		483
36	1980	0.4		5		1.2		10.0		3.4		4933737		477

Source: Author's Computation

The table above depicts the actual level of inputs used and projected level of inputs to be used to achieve the specific level of outputs at Tin Can Island Port. Thus, it is observed that the Port was most technically efficient (DMU/year 2014) when specific levels of outputs were achieved i.e. 1692 Ship calls and reconciled throughput of 17,500,804 tons with optimized levels of inputs i.e. 18 working berths, average turnaround time of 4.3, average berth idle rate of 35.3 and labour rate of 12 gang per hour.

Table 4.22: Input quantities for Delta Port Complex

DMU	IO-CRS TE Score	Actual (NOB)	Project (NOB)	Actual (ATT)	Project (ATT)	Actual (ABIR)	Project (ABIR)	Actual (NG/H)	Project (NG/H)	Actual (AT)	Project (AT)	Actual (ST)	Project (ST)
1985	1.0	20	20	6.6	6.6	75.0	75.0	10	10.0	1,954,000	1954000	409	409
1995	1.0	20	20	4.4	4.4	85.0	85.0	11	11.0	1,947,000	1947000	450	450
1998	1.0	20	20	6.3	6.3	83.5	83.5	16	16.0	2,107,991	2107991	576	576
2009	1.0	23	23	9	9.0	92.0	92.0	15	15.0	7,345,000	7345000	328	328
2013	1.0	23	23	3.9	3.9	88.8	88.8	22	22.0	10,361,746	10361746	609	609
2014	1.0	23	23	5.4	5.4	84.1	84.1	28	28.0	10,199,169	10199169	603	603
1997	1.0	20	20	6.4	5.1	85.7	84.0	13	12.9	1,960,736	2001749	498	498
1980	1.0	20	19	6.9	4.7	72.6	71.3	23	22.6	2,111,000	7865076	509	509
2015	1.0	23	20	3.5	3.4	87.0	77.0	20	19.1	7,830,236	8983583	528	528
1981	1.0	20	17	6.1	4.9	71.0	68.0	17	16.3	2,045,000	3923546	475	475
1996	0.9	20	18	6.47	5.7	84.1	76.0	19	14.6	1,940,044	1940044	524	524
2010	0.9	23	20	8	3.4	89.5	78.3	28	19.4	9,142,000	9142000	337	537
1993	0.9	20	18	5.2	4.5	84.0	73.7	13	11.4	1,957,000	1957000	435	435
1982	0.9	20	17	5.7	5.0	82.3	71.4	20	14.5	1,973,000	3067733	492	492
1994	0.9	20	17	5.7	4.9	83.8	70.5	17	14.3	1,822,000	3030321	486	486
1992	0.8	20	16	6.1	5.0	82.2	67.8	15	12.4	1,690,000	1701521	452	452
1984	0.8	20	16	5.4	4.4	79.0	64.7	13	10.6	1,886,000	1886000	397	397
2011	0.8	23	19	7	3.2	89.8	72.6	25	18.0	8,467,000	8467000	362	498

Table 4.22 Continued

1986	0.8	20	15	6.3	4.6	78.0	62.0	16	12.7	1,735,900	2132958	429	429
1983	0.8	20	14	5.9	4.2	73.0	57.7	16	12.6	1,930,000	2536741	401	401
1987	0.8	20	15	5.5	4.1	78.3	58.9	19	14.3	1,640,300	3665290	412	412
1991	0.7	20	15	4.8	3.6	83.5	59.6	18	13.1	1,526,000	4209096	410	410
2001	0.7	20	14	6	4.3	84.7	60.0	27	11.8	1,855,000	2043782	414	414
2012	0.7	23	16	5.7	3.1	84.6	60.9	20	14.4	6,808,884	6808884	357	391
1988	0.7	20	14	5.3	3.8	79.1	56.9	21	13.8	1,645,400	3914887	397	397
1989	0.7	20	14	5.7	4.0	80.5	56.6	24	12.9	1,658,200	2997800	394	394
1999	0.7	20	14	5.7	4.0	83.0	57.8	20	11.7	1,394,223	2481621	398	398
1990	0.7	20	14	5.9	4.1	82.0	56.4	28	11.7	1,504,000	2289111	390	390
2002	0.7	20	14	6	4.0	83.9	56.0	20	11.1	2,043,000	2043000	386	386
2005	0.6	20	13	6	3.6	91.7	52.4	29	10.6	2,223,000	2223000	361	361
2000	0.6	20	12	6	3.4	83.2	48.0	24	9.6	1,837,000	1837000	331	331
2003	0.6	20	12	8	3.3	89.9	47.4	26	9.5	1,886,000	1886000	327	327
2004	0.5	20	10	8	3.1	90.0	43.2	18	8.6	1,566,000	1566000	298	298
2008	0.5	23	11	7	2.3	90.4	43.8	21	10.2	4,002,000	4002000	301	301
2007	0.5	23	10	6	2.4	83.5	37.9	29	12.6	1,516,000	4600620	272	272
2006	0.4	23	9	7	2.6	92.0	36.8	25	8.7	1,461,000	2025379	257	257

Source: Author's Computation

The table above depicts the actual level of inputs used and projected level of inputs to be used to achieve the specific level of outputs at Delta Port. The Port was most technically efficient year 1998 and 2013 when 576 Ship calls and reconciled throughput of 2,107,991tons was achieved with optimized levels of inputs i.e. either 20 working berths, average turnaround time of 6.3, average berth idle rate of 83.5 and labour rate of 16.0 gang per hour or in year 2013 when the Port achieved 609 Ship calls and reconciled throughput of 10,361,746 tons was achieved with optimized levels of inputs i.e. either 23 working berths, average turnaround time of 3.9, average berth idle rate of 88.8 and labour rate of 22.0 gang per hour.

Table 4.23: Input Quantities for Rivers Port Complex

NO	DMU	IO-CRS TE Score	Actual (NOB)	Project. (NOB)	Actual (ATT)	Project. (ATT)	Actual (ABIR)	Project. (ABIR)	Actual (NG/H)	Project. (NG/H)	Actual (AT)	Project. (AT)	Actual (ST)	Project. (ST)
1	1996	1.0	8	8	9.3	9.3	42	42.0	11	11.0	4,110,962	4,110,962	402	402
2	2001	1.0	8	8	12	12.0	20	20.0	14	14.0	5,690,000	5,690,000	432	432
3	2002	1.0	8	8	14	14.0	10	10.0	15	15.0	5,302,000	5,302,000	394	394
4	2003	1.0	8	8	17	17.0	6	6.0	20	20.0	4,845,000	4,845,000	362	362
5	2009	1.0	11	11	10.4	10.4	25	25.0	18	18.0	5,185,000	5,185,000	465	465
6	2011	1.0	11	11	10.2	10.2	39	39.0	16	16.0	7,464,000	7,464,000	566	566
7	2013	1.0	11	11	7.7	7.7	52.1	52.1	14	14.0	4,935,944	4,935,944	439	439
8	2014	1.0	11	11	8.41	8.4	53.6	53.6	14	14.0	6,225,008	6,225,008	435	435
9	1995	1.0	8	8	7.7	7.6	67	27.7	21	11.7	4,621,000	5,406,363	410	410
10	2010	1.0	11	9	9.7	9.6	30	29.7	14	13.9	5,797,000	6,220,014	471	471
11	1998	1.0	8	8	13	11.9	30	19.8	14	13.9	4,652,600	5,637,315	428	428
12	1989	1.0	8	8	17	11.8	49	19.7	19	13.8	5,597,700	5,597,700	420	425
13	1988	1.0	8	8	14	11.8	51	19.6	22	13.7	4,224,300	5,584,630	424	424
14	1997	1.0	8	8	10	8.5	38	37.0	11	10.7	3,819,966	4,263,178	388	388
15	1985	1.0	8	8	18	11.5	52	19.2	15	13.4	4,533,100	5,466,088	415	415
16	2000	1.0	8	8	11	10.5	26	20.9	24	12.9	4,684,000	5,401,608	410	410
17	2015	1.0	11	9	6.9	6.6	62.3	37.5	17	11.4	4,458,010	4,458,010	373	373
18	1994	1.0	8	7	8.2	6.7	43	25.5	11	10.5	4,880,000	4,880,000	345	370
19	1987	0.9	8	8	15	9.6	56	22.3	13	12.3	4,716,999	5,297,504	402	402
20	1999	0.9	8	8	9	8.4	32	23.9	16	11.7	4,369,000	5,180,363	393	393
21	2006	0.9	11	8	12	11.2	21	19.7	18	13.9	5,580,000	5,580,000	257	419
22	2012	0.9	11	9	8.9	8.3	37.7	35.1	15	13.3	5,574,281	5,950,803	461	461
23	1984	0.9	8	7	16	10.9	47.5	18.2	17	12.8	4,282,000	5,189,491	394	394
24	2007	0.9	11	7	9.99	9.1	21	19.1	23	11.8	4,879,000	4,879,000	339	367

Table 4.23 Continued

25	1986	0.9	8	7	14	10.9	44	18.1	18	12.7	4,560,023	5,163,148	392	392
26	1992	0.9	8	7	14	10.8	50	18.0	16	12.6	3,724,000	5,123,634	389	389
27	1983	0.9	8	7	11.9	10.5	41.8	17.8	20	12.3	4,057,000	5,018,391	381	381
28	1990	0.9	8	7	11	9.6	42	19.1	24	11.8	3,445,000	4,927,321	374	374
29	2005	0.9	11	8	13	11.3	20	17.4	28	13.6	5,347,000	5,347,000	353	401
30	1982	0.9	8	7	13.4	10.4	34	17.3	18	12.1	3,760,000	4,912,894	373	373
31	1993	0.9	8	7	10	8.6	55	20.4	13	11.2	4,453,000	4,810.001	365	365
32	1991	0.8	8	7	9	7.5	47	21.2	15	10.4	3,345,000	4,600,373	349	349
33	2008	0.8	11	8	9.57	7.7	34	27.4	25	12.3	4,885,000	5,299,245	412	412
34	1980	0.8	8	6	15	9.7	47	16.1	22	11.3	4,000,000	4,583,611	348	348
35	1981	0.8	8	6	18	9.0	42	15.0	14	10.5	3,841,000	4,280,671	325	325
36	2004	0.6	11	7	17	10.5	28	17.4	22	12.2	4,964,000	4,964,000	212	377

Source: Author's Computation

The table above depicts the actual level of inputs used and projected level of inputs to be used to achieve the specific level of outputs at Rivers Port. Thus, it is observed that the Port was most technically efficient (DMU/year 2001) when specific levels of outputs were achieved i.e. 432 Ship calls and reconciled throughput of 5,690,000 tons with optimized levels of inputs i.e. 8 working berths, average turnaround time of 12 days, average berth idle rate of 20%, and labour rate of 14 net gang per hour.

Table 4.24: Input Quantities for Onne Port Complex

DMU	Score	Actual (NOB)	Project (NOB)	Actual (ATT)	Project (ATT)	Actual (ABIR)	Project (ABIR)	Actual (NG/H)	Projection (NG/H)	Actual (AT)	Project (AT)	Actual (ST)	Project (ST)
2004	1.0	6	6	3	3.0	26	26.0	33	33.0	13,688,000	13,688,000	579	579
2005	1.0	6	6	3	3.0	29	29.0	29	29.0	13,809,000	13,809,000	585	585
2007	1.0	7	7	2	2.0	30	30.0	17	17.0	21,559,000	21,559,000	411	411
2008	1.0	7	7	5	5.0	66	66.0	14	14.0	21,419,000	21,419,000	457	457
2009	1.0	7	7	5.6	5.6	64	64.0	15	15.0	17,462,000	17,462,000	670	670
2010	1.0	10	10	2.7	2.7	65	65.0	11	11.0	23,302,000	23,302,000	785	785
2011	1.0	10	10	4	4.0	63.2	63.2	15	15.0	26,217,000	26,217,000	885	885
2012	1.0	10	10	2.5	2.5	67.6	67.6	13	13.0	26,532,187	26,532,187	861	861
2013	1.0	10	10	2.6	2.6	75.4	66.3	12	12.0	24,773,387	24,917,093	823	823
2014	1.0	10	10	2.2	2.2	71.5	71.5	15	15.0	27,968,861	27,968,861	847	847
2006	1.0	6	6	2	2.0	29	28.9	15	15.0	15,820,000	15,820,000	433	433
2015	1.0	10	9	2.1	2.1	88	67.6	18	14.2	26,434,660	26,434,660	741	801
2003	0.8	6	5	3	1.9	28	21.9	34	19.6	11,995,000	11,995,000	398	398
2002	0.7	6	4	8	2.1	29	21.2	32	21.1	10,182,000	10,182,000	423	423
2001	0.7	6	4	4	2.6	55.6	30.6	17	11.2	9,056,487	9,723,855	378	378
2000	0.5	6	3	4	1.7	51	16.2	28	14.9	7,166,000	7,363,972	310	310
1980	0.5	6	3	3.8	1.7	72	16.9	27	14.2	4,820,000	7,338,745	307	307
1999	0.5	6	3	4.3	2.1	47	24.3	15	7.8	4,353,428	7,716,975	294	294
1990	0.5	6	3	6.4	1.9	65	20.7	21	10.4	3,723,200	7,120,952	287	287
1981	0.5	6	3	4.1	1.7	65	17.3	25	12.2	4,200,000	6,898,611	285	285
1983	0.5	6	3	3.2	1.6	70.3	20.6	16	7.8	3,501,000	7,241,691	271	271
1995	0.5	6	3	4.7	1.4	72	19.8	10	4.7	5,195,000	7,276,059	254	254
1982	0.5	6	3	3.5	1.6	61	19.7	18	8.4	3,759,000	6,842,858	264	264
1991	0.4	6	3	4.8	1.8	75	20.2	19	8.5	3,681,000	6,530,362	260	260
1998	0.4	6	3	5	1.7	52	18.5	27	9.5	6,440,000	6,440,000	260	260

Table 4.24 Continued

1986	0.4	6	3	5.9	2.1	59	23.4	14	6.2	3,200,000	6,574,965	254	254
1984	0.4	6	3	4.4	1.7	65.6	18.7	20	8.6	3,262,000	6,216,049	249	249
1985	0.4	6	2	5.2	2.0	62	22.7	13	5.4	3,068,000	6,223,688	239	239
1988	0.4	6	2	3.2	1.3	58	16.3	19	7.8	2,560,000	6,016,894	232	232
1989	0.4	6	2	2.8	1.1	50	16.5	15	6.0	1,880,000	6,049,853	221	221
1996	0.4	6	2	4.8	1.4	63	14.7	24	9.5	5,208,568	5,626,384	231	231
1992	0.4	6	2	5.3	1.5	67	16.4	21	8.2	3,856,000	5,632,251	227	227
1997	0.4	6	2	3.4	1.3	59	18.5	32	4.8	5,926,219	5,926,219	210	210
1987	0.4	6	2	3	1.1	53	14.6	17	6.1	2,340,000	5,355,748	201	201
1993	0.3	6	2	3.4	1.2	92	16.7	11	3.8	3,603,000	5,268,958	189	189
1994	0.3	6	2	3.8	0.5	78	14.2	33	3.0	5,407,000	5,407,000	158	158

Source: Author's Computation

The table above depicts the actual and projected level of inputs to be used to achieve the specific level of outputs. Thus, it is observed that the most efficient level of operation is either when the Port operated on 6 berths, average turnaround time of 3 days, average berth idle rate of 29%, labour rate of 29 ng/h to achieve throughput of 13,809,000 tons and 585 ship calls or when she operated on 7 berths, average turnaround time of 5.6 days, average berth idle rate of 64%, labour rate of 15 ng/h to achieve throughput of 17,462,000 and ship calls of 670.

However, in year 1994 which is the least year the Port was supposed to operate on 2 berths instead of 6 berths, average turnaround time of 0.5 days instead of 3.8 days, average berth idle rate of berth idle 14.2% instead of 78%, labour rate of 3ng/h instead of 33ng/h to achieve throughput of 5,407,000 tons and ship calls of 158. In other words, berth idle rate would have been minimized if the 4 idle berths were utilized thereby reflecting scale optimization. Hence turnaround was supposed to be reduced if necessary, cargo equipment were put in place with the appropriate average labour rate of 3ng/h instead of 33ng/h used. This reflects huge waste at the Port at pre-concession era.

Table 4.25: Input Quantities for Calabar Port Complex

NO	DMU	IO-CRS TE Score	Actual (NOB)	Project (NOB)	Actual (ATT)	Project (ATT)	Actual (ABIR)	Project (ABIR)	Actual (NG/H)	Project (NG/H)	Actual (AT)	Project (AT)	Actual (ST)	Project (ST)
1	1985	1.0	12	12	6.2	6.2	85.9	85.9	10	10.0	575,000	575,000	420	420
2	2007	1.0	12	12	2.0	2.0	75.5	75.5	20	20.0	1,042,000	1,0420,00	682	682
3	2008	1.0	12	12	4.0	4.0	72.7	72.7	23	23.0	1,165,000	1,165,000	622	622
4	2014	1.0	12	12	5.4	5.4	66.5	66.5	26	26.0	2,361,477	2,361,477	269	269
5	2015	1.0	12	12	5.2	5.2	77	77.0	22	22.0	2,127,421	2,127,421	306	306
6	2013	1.0	12	11	6.8	4.4	63.3	63.1	23	22.7	1,732,286	1,732,286	373	373
7	2012	0.9	12	10	5.6	4.2	75.4	62.9	19	18.0	1,738,446	1,738,446	159	250
8	1987	0.9	12	11	5.5	5.2	92	77.7	12	11.3	695,700	695,700	412	412
9	2009	0.9	12	11	4.0	3.7	76.5	65.6	24	22.0	1,699,000	1,699,000	198	410
10	2011	0.9	12	11	5.3	4.6	77.3	68.0	21	19.4	1,880,000	1,880,000	179	270
11	2006	0.9	12	11	3.0	1.8	79.9	67.6	23	17.9	777,000	933,522	611	611
12	2005	0.9	12	10	2.0	1.7	79.5	65.3	21	17.3	900,624	900,624	508	589
13	1986	0.9	12	10	6.8	3.6	89.1	69.5	15	12.9	716,500	716,500	465	465
14	2010	0.8	12	9	4.6	3.6	77.1	53.1	27	19.0	1,588,000	1,588,000	199	284
15	2004	0.7	12	9	5.0	1.5	79.1	55.9	25	15.0	798,717	798,717	499	499
16	2001	0.7	12	9	6.0	3.5	85.3	59.3	13	9.3	328,335	512,015	357	357
17	1989	0.7	12	7	4.2	3.0	89.6	47.4	11	7.7	485,000	485,000	267	267
18	2003	0.7	12	8	5.0	1.4	82.5	53.1	23	14.1	506,252	733,372	480	480

Table 4.25 Continued

19	1998	0.7	12	8	5.2	3.6	91.3	55.6	11	7.7	216,308	430,732	306	306
20	1999	0.6	12	8	4.5	2.8	81.3	51.7	14	8.9	223,943	483,735	333	333
21	2002	0.5	12	7	6.0	1.1	84	41.3	20	10.9	409,219	569,891	373	373
22	2000	0.5	12	6	3.0	1.6	83.3	41.4	17	9.2	311,765	489,014	326	326
23	1997	0.5	12	5	4.7	2.4	96	35.8	9	4.7	90,643	263,500	189	189
24	1992	0.5	12	6	4.7	1.9	92.1	41.3	16	8.3	416,261	443,009	299	299
25	1984	0.5	12	5	4.0	1.8	76	34.0	13	6.0	243,155	323,310	222	222
26	1982	0.4	12	5	6.2	0.9	88	33.5	23	8.9	426,433	462,941	303	303
27	1995	0.4	12	5	3.9	1.7	93	33.3	14	6.1	171,449	331,234	226	226
28	1981	0.4	12	5	5.7	1.0	86.3	30.4	19	7.5	403,411	403,411	257	257
29	1988	0.4	12	5	3.7	1.2	84.6	30.2	19	7.4	444,700	444,700	233	233
30	1994	0.4	12	4	3.4	0.7	93.9	27.0	23	7.2	363,400	372,798	244	244
31	1983	0.4	12	4	4.8	1.3	79	28.0	16	5.7	263,186	302,560	204	204
32	1996	0.3	12	4	6.1	1.3	94.9	27.9	16	5.6	101,928	299,290	202	202
33	1980	0.3	12	4	4.1	1.4	80	27.6	15	5.2	164,578	279,104	190	190
34	1993	0.3	12	3	4.0	0.5	93.2	19.6	24	5.2	254,000	270,431	177	177
35	1991	0.2	12	3	4.3	0.5	92.8	18.3	28	4.8	201,000	252,097	165	165
36	1990	0.2	12	3	3.8	0.4	93.5	15.8	24	4.2	118,446	218,484	143	143

Source: Author's Computation

The table above depicts the actual and projected level of inputs to be used to achieve the specific level of outputs. Thus, it is observed that the Port was most technically efficient (DMU/year 2007) when specific levels of outputs were achieved i.e. 682 Ship calls and reconciled throughput of 1,042,000 tons with optimized levels of inputs i.e. twelve (12) working number of berths, average turnaround time of 2.0, average berth idle rate of 75.5 and labour rate of 20 gang per hour. However, the practice(s) adopted in the year 2007 is the best practice for other operation years in Calabar Port. The best practice DMU was a year after the concessioning of the said Port thus, the best performance may be as a result of the involvement of the concessionaires and the zeal deployed by these private concessionaires towards the terms of lease.

It is inferentially observed that the Port lacked technicality in the pre-concession years which had negative impacts on the scale size of the Port i.e. in year 1990 which is one of the least inefficient operation years at Calabar Port with score 0.2, the Port should have achieved 143 Ship calls and throughput of 118,446 tons with minimized inputs of three (3) berths, 0.4 days average turnaround time, 15.8% average berth idle rate and 4.2ng/h labour rate. Since berth is a fixed asset and cannot be reduced or minimized on a short run however, ship traffic should have been allocated to the underutilized berths to reduce idle rate of berth and cost of underutilization. Hence, it seems there were very low market or ship call at this port which may be as a result of underutilization or marginalization of the port in Nigerian Port industry.

4.6 Analysis of Factors that affect the productivity of the ports

Here we explore the significant factors influencing port's productivity. The Table 4.26depicts the relationship of the variables used in this study. The notion is to justify the variables in term of positivity and isotonicity property of the variable. As it is seen from the data that all values are positive and the above reflect the adherence of variables to isotonicity property.

Table 4.26: Correlation of the Factors of Ports Productivity

		Throughput	Ship Traffic	Number of Berth	Average Turnaround Time	Average Berth Vacancy Rate
Throughput	Pearson Correlation	1	.643**	.239**	-.014	-.456**
	Sig. (2-tailed)		.000	.003	.867	.000
	N	150	150	150	150	150
Ship Traffic	Pearson Correlation	.643**	1	.665**	.272**	-.500**
	Sig. (2-tailed)	.000		.000	.001	.000
	N	150	150	150	150	150
Number of Berth	Pearson Correlation	.239**	.665**	1	.307**	-.049
	Sig. (2-tailed)	.003	.000		.000	.555
	N	150	150	150	150	150
Average Turnaround Time	Pearson Correlation	-.014	.272**	.307**	1	-.505**
	Sig. (2-tailed)	.867	.001	.000		.000
	N	150	150	150	150	150
Average Berth Vacancy Rate	Pearson Correlation	-.456**	-.500**	-.049	-.505**	1
	Sig. (2-tailed)	.000	.000	.555	.000	
	N	150	150	150	150	150

Source: Author's Computation

Below are the factors that were employed during the analysis.

Factors affecting or influencing the productivity of ports in Nigeria

A1 Predetermined Operational problems?

A2 Frequent congestion of ship?

A3 Poor inboard services?

A4 High cost of documentation?

A5 Prompt attention to ship specification needs.

A6 Both/berthing facility availability

A7 Having other port related partners e.g. intra transport facility and inter-modal facility

A8 Image of shipping line/shippers about the terminal/port.

A9 Technical qualities success to complete local/unloading

A10 Having sound loyalty programme to recognize frequent shipping line.

A11 Easy access to documentation.

A12 Terminal operations instill confidence to shippers

A13 Safety performance of terminal operations.

A14 Security/security facility availability.

A15 Import/Export rate

A16 Sincere and responsive attitude to shipping/shippers complaints.

A17 Capable to respond to emergency situations.

A18 Transfer services and efficiency at approach channels.

A19 Attitude and uniforms of port agencies and government officials

A21 Provision of information per and post changes in the port and documentation.

A21 Prompt response of port/terminal operations to shippers request or complaint.

A22 Does a holidays/National work free day affect port productivity?

A23 Does reliability of terminal operations/operations affect port/shipping operations?

A24 Delays due to loading/unloading

Factors affecting the level of productivity of terminal operation in relation to berth utilization

B1 Age of ship vessel

B2 Ship/vessel specification

B3 Good business strategies of terminal operation does enhance ship/vessel port productivity

B4 Average carrying capacity of cargo handling equipment.

B5 Does total operating cost affect ship utilization in relation to productivity for the port?

B6 Berthing cancellation causing congestion.

B7 Load factor i.e. the ration of capacity of payload affects berth utilization.

B8 Average turnaround times

B9 Mishandled/damaged cargoes.

B10 Loading and unloading.

Factors affecting individual port productivity

C1 Ship size and weight rules

C2 Decisions on water levels

C3 Support for specialized vessels

C4 Approval for tolls and other charges

C5 Fuel standards

C6 Discharge rules for vessels

C7 Ship background check

C8 Parking restriction

C9 Local taxes

C10 Port fees (i.e. FTEU fees) and gate pricing

C11 Port dray truck rule

C12 Vessel speed limits

C13 Vessel killing limits

C14 Special load limits

C15 Land use planning requirement for stacking cargoes temporality

Effects of Port Concessioning

D1 Port generally

D2 Cargo utilization

D3 Cargo handling

D4 Labour (stevedoring)

D5 Experts for globalizing

D6 Berthing

D7 Berthing facilities

D8 Port change/documentation

D9 Speeding operations

Factors That Affects Throughput

E1 Infrastructural access restrictions

E2 Truck parking limits and truck restrictions

E3 Vessel speed limits

E4 Local taxes

E5 Access roads

E6 Port dray trucks

E7 Cargo handling equipment availability

In accordance with the methodology proposed in a research by Ng (2006), the relevant factors for port productivity in this study were collected from the port service provider's perspective.

Specifically, we analyzed the information collected through a survey of a group of fifty (50) port stakeholders in each of Rivers Port, Tincan Port, Warri Port, Onne Port, Calabar Port and Apapa Port. We analyzed the factors that determine the productivity of ports by means of surveys addressed to directors and agents in the six ports in Nigeria on a five-point Likert scale, with one indicating strongly disagree and five Strongly Agreed. These scores were then calculated to form an average significance score for each factor. In this study, similar attributes and ranking scales have been used to investigate the opinions of port service providers. As noted by Ng (2006), these factors were identified with reference to existing literature and in-depth discussions with various stakeholders within the port and shipping industries. Thus, this study serves as an extension of the research work by Ng (2006) which investigates the factors of port productivity.

However, we attempt to examine the factors that affect the productivity of the ports. Many factors contribute to port's productivity. Broadly, we grouped into five: factors affecting or influencing the productivity of ports in Nigerian, factors affecting the level of productivity of terminal operation in relation to berth utilization, factors affecting individual port productivity, effects of port concessioning and factors that affects throughput. These factors were examined for each the ports under study. The questionnaires distributed at each of the ports were analysed with t-test using a hypothesized mean. The factors with p-value less than 0.05 were the significant ones (see appendix four).

Table 4.27: Factors Affecting or Influencing the Productivity of Ports in Nigeria

	Rivers Port	**Tincan Port**	**Warri Port**	**Onne Port**	**Calabar Port**	**Apapa Port**
A1	Significant.	Significant.	Significant	Significant	Significant	Significant
A2	Significant	Significant.	Significant	Significant.	Insignificant	Significant
A3	Insignificant	Significant.	Significant	Significant.	Significant	Significant
A4	Significant	Significant.	Significant	Significant.	Insignificant	Significant
A5	Significant	Insignificant	Insignificant	Significant.	Insignificant	Insignificant
A6	Insignificant	Significant	Significant	Significant.	Insignificant	Insignificant
A7	Insignificant	Significant	Significant	Significant.	Insignificant	Insignificant
A8	Insignificant	Significant	Significant	Significant.	Insignificant	Insignificant
A9	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
A10	Significant	Insignificant	Significant	Significant.	Insignificant	Insignificant
A11	Insignificant	Insignificant	Significant	Significant.	Insignificant	Insignificant
A12	Significant	Significant	Insignificant	Insignificant	Insignificant	Insignificant
A13	Insignificant	Insignificant	Significant	Significant.	Insignificant	Insignificant
A14	Insignificant	Significant	Insignificant	Significant.	Insignificant	Insignificant
A15	Insignificant	Insignificant	Significant	Insignificant	Insignificant	Insignificant
A16	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
A17	Insignificant	Insignificant	Significant	Insignificant	Insignificant	Insignificant
A18	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
A19	Insignificant	Insignificant	Insignificant	Significant.	Insignificant	Insignificant
A21	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
A21	Insignificant	Insignificant	Insignificant	Significant.	Insignificant	Insignificant
A22	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
A23	Insignificant	Significant	Insignificant	Significant.	Significant	Insignificant
A24	Significant	Significant	Significant	Significant.	Significant	Significant

Source: Author's Computation

Among the factors influencing the productivity of the ports in Nigeria, A1-A4 (A1-Predetermined Operational problems, A2-Frequent congestion of ship, A3-Poor inboard services and A4 High cost of documentation) and A24 were significant for Apapa ports while others were insignificant; for Calabar only A1, A3, A23 (reliability of terminal operation) and A24 (Delays due to loading/unloading) were significant; A1-A8 (A5-Prompt attention to ship specification needs, A6-Both/berthing facility availability, A7-Having other port related partners e.g. intra transport facility and inter-modal facility and A8-Image of shipping line/shippers about the terminal/port), A10 (Having sound loyalty programme to recognize frequent shipping line), A11 (Easy access to documentation), A13 (Safety performance of terminal operations), A14 (Security/security facility availability), A23 and A24 were significant for Onne ports; A1-A4, A6-A8, A10, A11,, A13, A15 (Import/Export rate), A17 (Capable to respond to emergency situations) and A24 were significant for Warri ports. Tincan ports has the following significant factors A1-A4, A6-A8, A12 (Terminal operations instill confidence to shippers), A14 Security/security facility availability), A23 and A24. A1, A2, A4, A5, A10, A12 and A24 were significant for Rivers ports.

In addition, predetermined operational problems, frequent congestion of ship, poor inboard services, high cost of documentation and delays due to loading/unloading are common factors influencing the productivity of ports in Nigeria. Hence, this is in line the findings to simultaneously leverage port productivity and prevent congestion of facilities, port managers, supported by local authorities, try to encourage traffic growth by expanding and improving infrastructure (Haralambides 2002; Malchow and Kanafani, 2004). Port managers should invest more in infrastructure mainly because of (1) their views of factors determining the port capability to attract traffic, and (2) their lack of capability to act on other factors that, regardless of their significance, are beyond their control. In the first case, factors include port infrastructure improvement, modernization of equipment, granting of terminal use to large shipping lines, identification and development of alternative routes, establishing competitive fees, and fostering efficiency in service delivery. In the second case, factors would include, for example, location and accessibility (Sanchez, Ricardo, Adolf, and Garcia-Alonso, 2011)

Table 4.28: Factors That Affect the Level of Productivity of Terminal Operation In Relation To Berth Occupancy

	Rivers Port	Tincan Port	Warri Port	Onne Port	Calabar Port	Apapa Port
B1	Significant	Significant	Significant	Significant	Significant	Significant
B2	Significant	Significant	Significant	Significant	Insignificant	Significant
B3	Significant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
B4	Insignificant	Significant	Significant	Significant	Significant	Significant
B5	Insignificant	Significant	Significant	Significant	Significant	Significant
B6	Significant	Significant	Significant	Significant	Significant	Insignificant
B7	Significant	Significant	Significant	Significant	Insignificant	Insignificant
B8	Insignificant	Significant	Insignificant	Insignificant	Insignificant	Insignificant
B9	Insignificant	Significant	Insignificant	Insignificant	Insignificant	Insignificant
B10	Insignificant	Significant	Significant	Insignificant	Insignificant	Insignificant

Source: Author's Computation

B1 (Age of ship vessel), B2 (Ship/vessel specification), B4 (Average carrying capacity of cargo handling equipment), and B6 (Berthing cancellation causing congestion) are common factors that are significant in determining level of productivity of terminal operation in relation to berth occupancy. Almost all the factors were significant for Tincan Port. Overall results seem to confirm that, despite existing differences of opinions, there are no significant variations among the studied ports regarding the major factors that determine port productivity. According to Sanchez, Ricardo, Adolf, and Garcia-Alonso (2011) respondents from all countries regard time efficiency, delays, and accessibility of ports as the core factors of port productivity. Most respondents seem to regard factors directly related to the public administrations, notably customs procedures and port authority policy and regulations, as significantly more important.

Table 4.29: Factors Affecting Individual Port Productivity

	Rivers Port	Tincan Port	Warri Port	Onne Port	Calabar Port	Apapa Port
C1	Significant	Significant	Significant	Significant	Significant	Significant
C2	Significant	Significant	Significant	Significant	Insignificant	Significant
C3	Significant	Insignificant	Insignificant	Significant	Insignificant	Insignificant
C4	Significant	Significant	Significant	Significant	Significant	Significant
C5	Significant	Significant	Significant	Significant	Significant	Significant
C6	Significant	Insignificant	Significant	Significant	Insignificant	Insignificant
C7	Significant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
C8	Significant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
C9	Significant	Significant	Insignificant	Insignificant	Insignificant	Insignificant
C10	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
C11	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
C12	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
C13	Insignificant	Significant	Insignificant	Insignificant	Insignificant	Insignificant
C14	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
C15	Insignificant	Significant	Insignificant	Insignificant	Insignificant	Insignificant
C16	Insignificant	Insignificant	Insignificant	Significant	Insignificant	Insignificant

Source: Author's Computation

C1 (Ship size and weight rules), C2 (Decisions on water levels), C4 (Approval for tolls and other charges), C5 (Fuel standards) are commonly significant for all the ports. C1-C9 are significant for Rivers ports and C1-C6 are significant for Onne port. Ports activities is characterized by increasing ship size, high geographical coverage, and frequent restructuring of shipping networks. Such development has intensified inter-port competition, highlighting the importance for ports to sustain and improve service quality, and thus productivity, to port service users. While the major attributes in determining port productivity from the perspectives of users, notably shipping lines and shippers, have been widely studied, the perspective from service suppliers, that is, port operators and authorities themselves, has been, so far, largely overlooked (Sanchez, Ricardo, Adolf, and Garcia-Alonso, 2011).

Table 4.30: Effects of Port Concessioning

	Rivers Port	Tincan Port	Warri Port	Onne Port	Calabar Port	Apapa Port
D1	Significant	Significant	Significant	Significant	Significant	Significant
D2	Significant	Significant	Significant	Insignificant	Insignificant	Significant
D3	Significant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
D4	Insignificant	Significant	Significant	Significant	Insignificant	Significant
D5	Insignificant	Significant	Significant	Significant	Insignificant	Significant
D6	Significant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
D7	Significant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
D8	Insignificant	Insignificant	Insignificant	Insignificant	Significant	Insignificant
D9	Significant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant

Source: Author's Computation

D1 (Port generally). D2 (Cargo utilization), D4 (Labour (stevedoring), and D5 (Experts for globalizing) are the common factors impacted by port concessioning. Empirical results from Sanchez, Ricardo, Adolf, and Garcia-Alonso (2011) indicate that the countries and the port stakeholders concerned share similar views patterns regarding port productivity factors in determining port productivity. At the country level, time efficiency, delays, and port accessibility serve as the core factors in determining port productivity. Quality of port infrastructure, port superstructure, and speed in responding to liners' new demands and requests have middle rankings, indicating that these attributes should not be ignored. For stakeholders, time efficiency, delays, port accessibility, and quality of port infrastructure and superstructures serve as the major factors in determining port productivity, while the speed in responding to liners' new demands and requests is another significant factor. A major difference is that national port authorities do not seem to regard monetary costs as an important factor. Rather, they regard port authority policy and regulations (e.g. port concessioning) as a factor that cannot be overlooked. Their views, however, does not seem to be shared by other port stakeholders.

Table 4.31: Factors That Affect Throughput

	Rivers Port	Tincan Port	Warri Port	Onne Port	Calabar Port	Apapa Port
E1	Significant	Significant	Significant	Significant	Significant	Significant
E2	Significant	Significant	Significant	Significant	Insignificant	Significant
E3	Significant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
E4	Insignificant	Significant	Significant	Significant	Significant	Significant
E5	Insignificant	Significant	Significant	Significant	Significant	Significant
E6	Insignificant	Insignificant	Significant	Significant	Insignificant	Significant
E7	Insignificant	Insignificant	Significant	Significant	Significant	Significant

Source: Author's Computation

E1 (Infrastructural access restrictions), E2 (Truck parking limits and truck restrictions), E4 (Local taxes) and E5 (Access roads) were significant for all the ports. Almost all the factors are significant for Warri, Onne, Calabar and Apapa ports. For users, port accessibility is the most valued, while for port authorities there is a diversity of views. It should be noted that rank port accessibility third in importance, almost the same level as speed in responding to liners' new demands and requests (Sanchez, Ricardo, Adolf, and Garcia-Alonso, 2011). The variables identified as most relevant by port service providers are IT and advanced technology and monetary costs, both of which are noticeably less valued than the other attributes by users. Also port service providers believe that monetary costs and geographic location issues are less important than the quality of the port infrastructure and IT and advanced technology (Sanchez, Ricardo, Adolf, and Garcia-Alonso, 2011).

The results of this study point out the need to go deeper in the knowledge of maritime business and how port clients evaluate their port service providers. This study also highlights the significance of authorities in port development and in contributing to the countries' economies. Indeed, this study is one of the few in which the same author employs a similar, thus comparable, methodology in investigating the attributes affecting port productivity. Thus, the survey and analysis presented here provide invaluable comparative reference between port service users and providers. Last but not least, by offering an alternative view on the views of port productivity factors, this article can provide constructive insights into port productivity. By exposing the potential perceptual diversification between different stakeholders (both port service providers and users) on port productivity factors, this study has also laid down a decent foundation for further research on port productivity and competition.

For example, Malchow and Kanafani (2004) distinguished four key factors in each one of these two aspects. Cost aspects are affected by overland distance from place of origin to port, port fees, maritime distance from port of departure to cargo destination and average size of vessel. In terms of transit time associated with each port, distance from place of origin to port, time needed to transfer cargo from land to vessel, time needed for berthing of vessel in transit ports, and maritime distance to destination port are relevant. Finally, Lirn et al. (2004) summarized five effective conditioning factors of port traffic, including (1) handling cost of containers, (2) proximity to main navigation routes, (3) proximity to import/export areas, (4) basic infrastructure condition, and (5) existing feeder networks. Even until now, researchers cannot generally agree on the decisive factors from the port user perspective. Nevertheless, as knowledge about the key factors of interport competition is broadening, a certain consensus has been reached about monetary costs, specifically port fees, as a factor that has lower impacts on the initially assumed port productivity decision. As Preston (2004) argued, due to the very nature of decision making, the more structural and "humanistic" aspects could not be ignored when researchers attempted to understand this issue. Hence, factors that are not closely related to maritime transport service cost (qualitative factors) are being credited with the significance initially assigned to those factors more related to monetary cost itself (quantitative factors). However, the inclusion of the qualitative factors in the empirical models was rather complex. Moreover, some aspects of these multiple goals might conflict with each other, thus requiring decision makers to include the interaction of several standards, relative weight of which varies with the circumstances surrounding the decisions (Guy and Urli 2006).

4.7 Test of Hypothesis

H_0 Increased cargo throughput is not a determinant of improved port productivity.

Table 4.32 Descriptive Statistics

	Mean	Std. Deviation	N
Throughput	6106232.3	6396905.1	216
Efficiency	0.75	0.24	216

Table 4.33 Correlations

		Throughput	Efficiency
Throughput	Pearson Correlation	1	0.5**
	Sig. (2-tailed)		.000
	N	216	216
Efficiency	Pearson Correlation	0.5**	1
	Sig. (2-tailed)	.000	
	N	216	216

Correlation is significant at the 0.01 level (2-tailed).

From the table above, it is observed that there is strong positive significant association between throughput and efficiency with p = 0.5 and n = 0.00. However, increase in throughput leads to increase in efficiency and increase efficiency leads to increase in throughput. Therefore, the null hypothesis is rejected, and the alternate hypothesis i.e. increased cargo throughput is a determinant of improved port productivity.

4.8 Discussion of findings

The study was able to assess only the trend analysis of productivity at individual Nigerian port i.e. the studying of productivity of Nigerian ports changes for the firm over a period because of many factors which are not limited to variation in cargo operations, geographical location e.tc. The tables and figures in the data analysis and presentation depicts the trend of technical, scale and managerial efficiency at individual for 36 years, from year 1980 to 2015. The efficient and inefficient years were also well represented by the tables. Also, the benchmark year (s) for individual Port and return to scale well represented by tables.

Hence, the impacts of concessioning was really felt at Onne Port and Tin Can Island Port because the level of technical and scale efficiencies were very unacceptable in the pre-concession period as it was recorded that the only highest level of efficiency (0.8) the Port achieved in the pre-concession was in year 2003 while Tin Can Island Port achieved technical and scale efficiency of

0.9 only in pre-concession year 2001. However, they were able to utilize their input resources consistently to the optimal level to produce adequate or required outputs' quantities for more than five (5) consecutive post concession years with technical, scale and managerial efficiency score of 1.0 respectively. They were able to use their scale size optimally in the post concession years with scale efficiency score of 1.0 respectively.

Rivers, Delta, Calabar and Lagos Port experienced unstable efficiencies in the post concession era. However, Delta Port experienced the least efficiency score in the pre-concession era in year 2006, 2007 and 2008 with score 0.4, 0.5 and 0.5 respectively in terms of input minimization and output maximization. The most efficient operation year in Lagos Port Complex is year 2011 and the least inefficient operation years are year 1992, 1993, 1994 and 1999 with efficiency score of year 0.8. The most efficient operation year in Tin Can Island Port is year 2014 and the least inefficient year is 1982 with efficiency score of 0.3.

The most efficient operation year in River Port is year 2001 while the least inefficient year is 2004 with efficiency score of 0.6. The most efficient operation year in Delta Port is year 2013 and the least inefficient operation year in Delta Port is 2006 with efficiency score 0.4. The most efficient operation year in Calabar Port is year 2007 and the least inefficient year is year 1991 with score 0.2. The most efficient years in Onne Port are year 2005 and 2009 while the least inefficient year are 1993 and 1994. Hence, all Nigerian Ports achieved the highest level of efficiency in the post concession year except River Port that had the highest level of efficiency in year 2001.

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In Summary,

i. It can be deduced that there was fluctuation in both technical and scale efficiencies at Lagos Port Complex throughout the pre-concession era of its operation years (1980-2005). The port still had a fluctuating manner of productivity during post-concession era with the most technical and scale efficient operation year in 2010, 2011 and 2014. Tincan Island port was technically inefficient in the pre-concession years of 1980 to 2004 with the highest efficiency score of 0.7 achieved in year 2000. The port lacked scale optimization all through the pre-concession years but adjusted to scale in year 2011 and maintained till year 2015. River Port was inefficient for 16 years while out of the 10 post concession years, the Port was inefficient for 4 years. Delta Port from year 1980 to 2015 maintained technical and scale efficiency score 1.0 in the pre-concession era year of 1980 but dropped to score 0.8 in 1982 and 1983.This drop trend was followed by unsteady and unstable increases in efficiencies between post concession year of 2006 and 2013. Subsequently, stable efficiency was achieved from year 2013 to 2015. Onne Port from year 1980 to 2015 was technically and scale inefficient in all the pre-concession year (1980 to 2003). Hence, the Port was wasteful in terms of input utilization throughout the pre-concession years of operation under study and was technically efficient all through the concessioning period (2004 – 2015). Calabar Port had been wasteful in terms of input minimization for fifteen (15) years out of the sixteen years (16) under study before concessioning and for four (4) years out of the eight (8) years after concession.

ii. After the comparison of Lagos Port Complex, River Port Complex and Calabar Port Complex only production year 2007 of Calabar Port Complex, production year 2006, 2010 and 2011 of Lagos Port Complex exhibit both technical and scale efficiency. Thus no productive year of River Port Complex are considered efficient and the same years considered to be efficient are also efficient in their respective horizontal analysis thereby they are inferentially efficient.

iii. It is observed that year 2014 is the most efficient year out of the 36 operation years in terms of output maximization with constant levels of inputs under the study period with score 1.0 respectively serving as 32 times benchmark for other years. It is observed from that Tin Can Island Port was technically efficient in the operation years of 1980, 1981, 1985, 1995, 1997, 1998, 2009, 2013, 2014 and 2015 with score 1.0. However, the most efficient operation years are 1998 and 2013 while the most inefficient year is with efficiency score 1.0. The post-concession years that the port was technically inefficient are 2006, 2007, 2008, 2010, 2011 and 2012.

iv. The level of inputs required for each DMU to be efficient is given i.e. for DMU 2014 to be efficient input-wise, the number of berth may be reduced by two units as a result of idleness of this two (2) berths, the average turnaround time may be reduced by 3 hours and the berth occupancy may be reduced by 3%. Since a fixed asset such as berth cannot be reduced therefore technically and complimentarily the turnaround time and berth occupancy rate need to be decreased more than 5hours and 3% respectively by allocating the queue ship at the over-utilized berth to the idle berths which in turn will mitigate underutilization of this berths been required to be reduced or alternatively the port should embrace more cargo handling technology to enhance fast loading and discharging of cargoes thus attracting more vessels to the Port.

v. Many factors contribute to port's productivity. Broadly, we grouped into five: factors affecting or influencing the productivity of ports in Nigerian, factors affecting the level of productivity of terminal operation in relation to berth utilization, factors affecting individual port productivity, effects of port concessioning and factors that affects throughput.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In the pre-concession era, all Nigerian Ports had trouble achieving a reasonable outputs quantities with minimal inputs' quantities. However, there were improvements in the productivities of these Ports in the post concession era even though only Onne Port had significant improved productivity from the year of concessioning year 2004 through increased efficiency and maintained the change till year 2015. This reflects the well-being of the Port after the concession and the positive impacts of the private operators on the productivity of the Port in terms of technology and inputs mix. This is corroborated by (Okeudo, 2013) that Onne Port had improved Port efficiency due to concession.

Calabar Port had been under-utilized towards the achievement of the required results. On the contrary, Rivers Port requires technical touches in her operations. As a liquid bulk port, the time of loading and discharging of commodities are often more than any other types of port and the turnaround time at this port are often more. Scale optimization is also required in Rivers Port. Inferentially, Lagos Port has been operating on optimal scale size but fluctuating managerial efficiency were experienced in the operation years which could be as a result of exogenous factors which some scholars mentioned to have been necessary superstructure, political factors, port dues e.t.c.

As a matter of findings, Tin Can Island has similar trend to that of Onne Port with low productivities in the pre-concession period which improved consistently in the post-concession year of 2010 till year 2015. It was also observed that Tin Can Island Port operated on under-utilization of inputs resources in the pre-concession periods till the post-concession year 2010. This reflect element of wastefulness with respects to both inputs and outputs quantities. Delta Port experienced fluctuating scale and technical efficiency trend in both pre and post concession years. Hence, it is observed that productivities' trends vary among the concessioned Nigerian Ports. These could be as a result of influence of varied exogenous and endogenous factors on individual Port.

5.2Recommendation

Since it was observed that there was element of improvement in the post-concession period of operation at Nigerian Ports,

i. We recommend adequate provision of superstructure for the private operators to utilized them and compliment their infrastructure with them towards the achievement of goals of concession.
ii. However, concessioning is a good instrument to improve productivity in Nigerian Ports and requires continuity among Nigeria Ports.
iii. There should be adequate and necessary cargo handling equipment at ports that experienced fluctuating efficiency. Facilities should be made available and in good working condition for efficient operation.
iv. The Federal Government should design a legal/regulatory framework that would guarantee the attainment of policy objective of privatization.
v. The federal government should create the environment that would guarantee the training and retraining of the maritime labour force in line with international trend to make them specialist to be able to face the new challenges in the industry.

Productivity is bedrock or a check for performance/efficiency enhancement and development to meet up with global challenges and practices so suggest frequent assessment using many more of input/output analyzes to stay in business. However, the acquisition of data is quite difficult, and combination of independent and dependent which utilized in this study also has to be adjusted. If the management of each major port could correct comprehensive and detailed data with regard to its operations, that will not help only the operator increasing berth productivity efficiency, both also serve as a consultation for investigation with respect to ongoing improvement in academic research.

Finally, for the sake of getting the further research result which indicate how relatively inefficient ports can improve their efficiency on which aspect, a study should compared the regression analytical report between Nigeria ports. According to the result of this study, talking advantage of large yard area and long berth length, Nigeria container ports should pay attention to increase the efficiency of yard crane and quay crane. Regarding to berth length, it is necessary to be cautiously interpreted and be kept on optimal size instead of excessive investment. There is also some weakness existing in the research.

5.3Contribution to Knowledge

This research disaggregated the productivity of the individual ports in Nigeria using Data Envelopment Analysis (DEA). It provided insight evaluation of productivity of ports in Nigeria through concessioned terminals in spite of the underlying complexities surrounding the systems vis-à-vis their differences in terms of operation, location, structure etc. and how to solve the mediocrity resulting from concessioning. With cognizance to some differences among the ports and complexities in productivity measurement, the research tries to identify and evaluate productive issues in terms of technical efficiencies (managerial efficiency) and scale efficiencies (managerial and allocative efficiency) experienced at individual Nigeria ports. It equally provided a technical benchmark for assessing the overall efficiencies of the respective ports in Nigeria during the pre-concessioned and post-concessioned era.

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APPENDIX ONE

FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI
POST-GRADUATE SCHOOL
P.M.B 1526 IMO STATE.
DEPARTMENT OF TRANSPORT MANAGEMENT TECHNOLOGY
Questionnaire for a Research thesis on the assessment of productivity of Nigeria Port using Data envelopment Analysis (DEA).

The purpose of this questionnaire is for the assessment of productivity of the Nigerian ports using DEA and the thesis is part of the requirements to be satisfied for the award of Doctor in philosophy (PHD) of the federal University of Technology, Owerri. So your co-operation is highly solicited. The information to be supported is strictly for academic purpose.

Please kindly complete the questionnaire according to specification.

1. Sex: male ☐ Female ☐

S/N	**A**	**Strongly Agreed**	**Agreed**	**Neutral**	**Disagree**	**Strongly disagree**
	What are the factors affecting or influencing the productivity of ports in Nigerian.	5	4	3	2	1
1	Predetermined Operational problems?					
2	5frequent congestion of ship?					
3	Poor inboard services?					
4	High cost of documentation?					
5	Prompt attention to ship specification needs.					
6	Both/berthing facility availably					
7	Having other port related partners e.g. intra transport facility and inter-modal facility					
8	Image of shipping line/shippers about the terminal/port.					
9	Technical qualities success to complete local/unloading					
10	Having sound loyalty programme to recognize frequent shipping line.					
11	Easy access to documentation.					
12	Terminal operations instill confidence to shippers					
13	Safety performance of terminal operations.					
14	Security/security facility availability.					
15	Import/Export rate					
16	Sincere and responsive attitude to shipping/shippers complaints.					

17	Capable to respond to emergency situations.					
18	Transfer services and efficiency at approach channels.					
19	Attitude and uniforms of port agencies and government officials					
20	Provision of information per and post changes in the port and documentation.					
21	Prompt response of port/terminal operations to shippers request or complaint.					
22	Does a holidays/National work free day affect port productivity?					
23	Does reliability of terminal operations/operations affect port/shipping operations?					
24	Delays due to loading/unloading					
	B					
	What factors affect the level of productivity of terminal operation in relation to berth utilization					
1	**Age of ship vessel**					
2	Ship/vessel specification					
3	Good business strategies of terminal operation does enhance ship/vessel port productivity					
4	Average carrying capacity of cargo handling equipment.					
5	Does total operating cost affect ship utilization in relation to productivity for the port?					
6	Berthing cancelation causing congestion.					
7	Load factor i.e. the ration of capacity of payload affects berth utilization.					
8	Average turnaround times					
9	Mishandled/damaged cargoes.					
10	Loading and unloading.					
	C					
	What are the factors affecting individual port productivity.					
1	Ship size and weight rules					
2	Decisions on water levels					
3	Support for specialized vessels					
4	Approval for toils and other					

	charges					
5	Fuel standards?					
6	Discharge rules for vessels					
7	Ship background check					
8	Parking restriction					
9	Local taxes					
10	Port fees (i.e. FTEU fees) and gate pricing					
11	Port dray truck rule					
12	Vessel speed limits					
13	Vessel killing limits					
14	Special load limits					
15	Land use planning requirement for stacking cargoes temporality					
	D					
	Concession has brought improvement on					
1	**Port generally**					
2	Cargo utilization					
3	Cargo handling					
4	Labour (stevedoring)					
5	Experts for globalizing					
6	Berthing					
7	Berthing facilities					
8	Port change/documentation					
9	Speeding operations					
	E					
I	Vehicular traffic (in/out of port)					
1	Infrastructural access restrictions					
2	Truck parking limits and truck restrictions					
3	Vessel speed limits					
4	Local taxes					
5	Access roads					
Ii	**Intra transportation**					
1	Port dray trucks					
2	Cargo handling equipment availability					

APPENDIX TWO

THROUGHPUT					
Port	**1990**	**1991**	**1992**	**1993**	
Lagos Port Complex	4,605,667	4,369,000	6,260,000	6,342,000	5394166.75
Tin Can Island Port Complex	2,357,000	1,522,000	2,493,000	2,029,000	2014666.667
River Port Complex	3,445,000	3,345,000	3,724,000	4,453,000	3741750
Onne Port	723,200	681,000	856,000	603,000	715800
Calabar Port	118,446	201,000	416,261	254,000	247426.75
Delta Port	1,504,000	1,526,000	1,690,000	1,957,000	1669250
					#DIV/0!
SHIP TRAFFIC					#DIV/0!
Lagos Port Complex	1,259	1,316	1,139	1,200	1228.5
Tin Can Island Port Complex	580	611	506	498	548.75
River Port Complex	374	349	389	365	369.25
Onne Port	287	260	227	189	240.75
Calabar Port	143	165	299	177	202.3333333
Delta Port	390	410	452	435	421.75
					#DIV/0!
VEHICLE TRAFFIC					#DIV/0!
Lagos Port Complex					#DIV/0!
Tin Can Island Port Complex					#DIV/0!
River Port Complex					#DIV/0!
Onne Port					#DIV/0!
Calabar Port					#DIV/0!
Delta Port					#DIV/0!
					#DIV/0!
BERTH OCCUPANCY					#DIV/0!
Lagos Port Complex	60	43	65	51	54.75
Tin Can Island Port Complex	49	42	46	43	45
River Port Complex					#DIV/0!
Onne Port	35	25	33	8	25.25
Calabar Port					#DIV/0!
Delta Port	18	16.5	17.8	16	17.075
					#DIV/0!
TURNAROUND TIME					#DIV/0!
Lagos Port Complex	22	17	21	14	18.5
Tin Can Island Port Complex	8.5	9.4	8	8.5	8.6
River Port Complex	11	9	14	10	11
Onne Port	6.4	4.8	**5.3**	**3.4**	4.975
Calabar Port	3.8	4.3	4.7	4	4.2
Delta Port	5.9	4.8	6.1	5.2	5.5
					#DIV/0!

REVENUE GENERATED					#DIV/0!
Lagos Port Complex	1,040,216,000	1,000,010,00	863,600,000	1,201,000,000	1034938667
Tin Can Island Port Complex	610,020,500	419,130,000	360,517,400	588,432,999	494525224.8
River Port Complex					#DIV/0!
Onne Port			15,649,415	**33,639,560**	24644487.5
Calabar Port					#DIV/0!
Delta Port					#DIV/0!
					#DIV/0!
EXPENDITURE INCURRED					#DIV/0!
Lagos Port Complex					#DIV/0!
Tin Can Island Port Complex					#DIV/0!
River Port Complex					#DIV/0!
Onne Port			0	**17027879**	8513939.5
Calabar Port					#DIV/0!
Delta Port					#DIV/0!
					#DIV/0!
OPERATING SURPLUS					#DIV/0!
Lagos Port Complex					#DIV/0!
Tin Can Island Port Complex					#DIV/0!
River Port Complex					#DIV/0!
Onne Port				**16611681**	16611681
Calabar Port					#DIV/0!
Delta Port					#DIV/0!

APPENDIX THREE

THROUGHPUT					
Port	**1994**	**1995**	**1996**	**1997**	
Lagos Port Complex	5,059,000	5,848,000	5939468	6319909	5791594.25
Tin Can Island Port Complex	1,994,000	1,861,000	2,175,873	2,464,175	2123762
River Port Complex	4,880,000	4,621,000	4,110,962	3,819,966	4357982
Onne Port	5,407,000	5,195,000	5,208,568	5,926,219	5434196.75
Calabar Port	363,400	171,449	101,928	90,643	181855
Delta Port	1,822,000	1,947,000	1,940,044	1,960,736	1917445
					#DIV/0!
SHIP TRAFFIC					#DIV/0!
Lagos Port Complex	1100	1299	1385	1363	1286.75
Tin Can Island Port Complex	673	590	769	655	671.75
River Port Complex	345	410	402	388	386.25
Onne Port	158	254	231	210	213.25
Calabar Port	244	226	202	189	224
Delta Port	486	450	524	498	489.5
					#DIV/0!
VEHICLE TRAFFIC					#DIV/0!
Lagos Port Complex					#DIV/0!
Tin Can Island Port Complex					#DIV/0!
River Port Complex					#DIV/0!
Onne Port					#DIV/0!
Calabar Port					#DIV/0!
Delta Port					#DIV/0!
					#DIV/0!
BERTH OCCUPANCY					#DIV/0!
Lagos Port Complex	35	59	59	63	54
Tin Can Island Port Complex	37	35.2	38.5	48	39.675
River Port Complex	57	33	58		49.33333333
Onne Port	22	28	37	41	32
Calabar Port		6.96	5.11	4.03	5.366666667
Delta Port	16.2	15	15.9	14.3	5.7425
TURNAROUND TIME					
Lagos Port Complex	5.21	11.7	9.29	8.47	8.6675
Tin Can Island Port Complex	7.5	9.7	10.3	12.5	10
River Port Complex	8.2	7.7	9.3	10	8.8

Onne Port	3.8	4.7	4.8	3.4	4.175
Calabar Port	3.4	3.9	6.1	4.7	4.525
Delta Port	5.7	4.4	6.47	6.4	#REF!
					#DIV/0!
REVENUE GENERATED					#DIV/0!
Lagos Port Complex	1,159,323,885	1,115,743,012	1,129,222,626	959,309,521	1090899761
Tin Can Island Port Complex	384,239,000	617,240,000	530,900,000	486,268,340	504661835
River Port Complex					#DIV/0!
Onne Port	36,124,250	101,106,331	151,145,663	153,246,164	110405602
Calabar Port					#DIV/0!
Delta Port		117,221,600	133,322,000	153,718,300	134753966.7
					#DIV/0!
EXPENDITURE INCURRED					#DIV/0!
Lagos Port Complex	131394609	127504767	150998649	106568976	129116750.3
Tin Can Island Port Complex					#DIV/0!
River Port Complex					#DIV/0!
Onne Port	29021310	71276565	75926181	76746639	63242673.75
Calabar Port					#DIV/0!
Delta Port					#DIV/0!
					#DIV/0!
OPERATING SURPLUS					#DIV/0!
Lagos Port Complex					#DIV/0!
Tin Can Island Port Complex					#DIV/0!
River Port Complex					#DIV/0!
Onne Port	7102940	29829766	75219482	76499525	47162928.25
Calabar Port					#DIV/0!
Delta Port					#DIV/0!

River Port Complex						#DIV/0!
Onne Port						#DIV/0!
Calabar Port						#DIV/0!
Delta Port						#DIV/0!
						#DIV/0!
BERTH OCCUPANCY						#DIV/0!
Lagos Port	62.6	65.23	69.89	75.45		70.19

Complex						
Tin Can Island Port Complex	57	61	64	62		62.33333333
River Port Complex						#DIV/0!
Onne Port	48	53	49	44.44		48.81333333
Calabar Port	8.66	18.71	16.75	14.71		16.72333333
Delta Port	16.5	17	16.8	15.3		16.36666667
						#DIV/0!
TURNAROUND TIME						#DIV/0!
Lagos Port Complex	8.45	10.44	13	15		12.81333333
Tin Can Island Port Complex	11	14	12	10		12
River Port Complex	13	9	11	12		10.66666667
Onne Port	5	4.3	4	4		4.1
Calabar Port	5.2	4.5	3	6		4.5
Delta Port	6.3	5.7	6	6		5.9
						#DIV/0!
REVENUE GENERATED						#DIV/0!
Lagos Port Complex	1,000,082,515	1,006,930,698	1,780,641,964	1,354,621,702		1380731455
Tin Can Island Port Complex	893,555,409	602,950,356	906,922,110	1,001,375,000		837082488.7
River Port Complex						#DIV/0!
Onne Port	255,300,000	260,000,000	237,810,000	402,920,570		300243523.3
Calabar Port						#DIV/0!
Delta Port	111,116,200	169,125,000	263,549,000	461,594,000		298089333.3
						#DIV/0!
EXPENDITURE INCURRED						#DIV/0!
Lagos Port Complex	97,024,512	121,487,512	2,004,847,023.62			1063167268
Tin Can Island Port Complex						#DIV/0!
River Port Complex						#DIV/0!
Onne Port						#DIV/0!
Calabar Port						#DIV/0!

Delta Port						#DIV/0!
						#DIV/0!
OPERATING SURPLUS						#DIV/0!
Lagos Port Complex						#DIV/0!
Tin Can Island Port Complex						#DIV/0!
River Port Complex						#DIV/0!
Onne Port						#DIV/0!
Calabar Port						#DIV/0!
Delta Port						#DIV/0!

River Port Complex						#DIV/0!
Onne Port						#DIV/0!
Calabar Port						#DIV/0!
Delta Port						#DIV/0!
BERTH OCCUPANCY						
Lagos Port Complex	77.43	77.74	81.69	60.44	72	72.9675
Tin Can Island Port Complex	69	45.22	47	58	73	55.805
River Port Complex	90	94	72	80	79	81.25
Onne Port						#DIV/0!
Calabar Port	15.98	17.47	20.91	20.47	20.1	19.7375
Delta Port	16.07	10.07	9.98	8.29	**8.02**	9.09
TURNAROUND TIME						
Lagos Port Complex	23	21	21	14	9	19.75
Tin Can Island Port Complex	11	9	8	7	4	7.8
River Port Complex	14	17	17	13	12	14.75
Onne Port	8	3	3	3	2	2.75

Calabar Port	6	5	5	2	3	3.75
Delta Port	6	8	8	6	7	7.25
						#DIV/0!
REVENUE GENERATED						#DIV/0!
Lagos Port Complex	**3470952440**	2,153,954,158	3,203,441,549	2,054,390,000	1,202,736,748	2153522766
Tin Can Island Port Complex	**1127103972**	1,373,491,600.00	1,500,000,000	2,160,000,000	2,070,000,000	1775872900
River Port Complex	**1609625313**	1,701,797,951	1,389,970,000	1,694,847,626	1,966,777,262	1688348210
Onne Port	**672800546**	900,207,010	1,204,956,333	856,300,000	923,607,298	971267660.3
Calabar Port	**500130126**	600,823,013	495,884,005	500,002,100	601,705,030	549603537
Delta Port	**450032300**	749,134,200	558,377,000	613,367,100	550,567,400	617861425
			8,352,628,887			8352628887
EXPENDITURE INCURRED						#DIV/0!
Lagos Port Complex					1251055463	1251055463
Tin Can Island Port Complex			1,260,000,000	2,100,000,000	1810000000	1723333333
River Port Complex						#DIV/0!
Onne Port						#DIV/0!
Calabar Port						#DIV/0!
Delta Port						#DIV/0!
OPERATING SURPLUS						
Lagos Port Complex	1780641964	1354621702	3203441549	2054390000	-48318715	1641033634
Tin Can Island Port Complex	1127103972	1373491600	240000000	60000000	260000000	483372900
River Port Complex	1609625313	1701797951	1389970000	1694847626	1966777262	1688348210
Onne Port	672800546	900207010	1204956333	856300000	923607298	971267660.3
Calabar Port	500130126	600823013	495884005	500002100	601705030	549603537
Delta Port	450032300	749134200	558377000	613367100	550567400	617861425

Tin Can Island Port Complex	165,970	100,760	192,042	267675	152924
River Port Complex					#DIV/0!
Onne Port					#DIV/0!
Calabar Port					#DIV/0!
Delta Port					#DIV/0!
					#DIV/0!
BERTH OCCUPANCY					#DIV/0!
Lagos Port Complex	**68**	**65**	**62**	**63**	64.5
Tin Can Island Port Complex	**66.56**	**61**	**60**	**65**	63.14
River Port Complex	**79**	**66**	**75**	**70**	72.5
Onne Port	**70**	**34**	**36**	**35**	43.75
Calabar Port	**24.5**	**27.35**	**23.54**	**22.95**	24.585
Delta Port	**16.48**	**9.57**	**8.03**	**10.5**	11.145
					#DIV/0!
TURNAROUND TIME					#DIV/0!
Lagos Port Complex	10	9	7	8	8.5
Tin Can Island Port Complex	4	4	7	5	5
River Port Complex	9.99	9.57	10.4	9.7	9.915
Onne Port	2	5	5.6	2.7	3.825
Calabar Port	2	4	4	3	3.25
Delta Port	6	7	9	8	7.5
					#DIV/0!
REVENUE GENERATED					#DIV/0!
Lagos Port Complex	1,669,709,178	1,923,001,400	2,207,338,000	2,046,189,030	1961559402
Tin Can Island Port Complex	688,000,000	870,000,000	892,539,000	938,216,000	847188750
River Port Complex	952,205,612	731,817,795	706,990,000	695,005,758	771504791.3
Onne Port	775,002,831	706,811,098	803,091,777	800,992,545	771474562.8
Calabar Port	405,352,602	360,000,000	348,117,900	509,128,341	405649710.8
Delta Port	314,039,300	230,639,200	624,647,100	737,633,100	476739675
EXPENDITURE INCURRED					#DIV/0!

Lagos Port Complex	583,007,782				583007782
Tin Can Island Port Complex	1,140,000,000	1,230,000,000			1185000000
River Port Complex					#DIV/0!
Onne Port					#DIV/0!
Calabar Port					#DIV/0!
Delta Port					#DIV/0!
					#DIV/0!
OPERATING SURPLUS					#DIV/0!
Lagos Port Complex	1,086,701,396	1923001400	2207338000	2046189030	1815807457
Tin Can Island Port Complex	-452,000,000	-360,000,000	892539000	938216000	254688750
River Port Complex	952,205,612	731,817,795	706990000	695,005,758	771504791.3
Onne Port	775002831	706811098	803091777	800992545	771474562.8
Calabar Port	405352602	360000000	348117900	509128341	405649710.8
Delta Port	314,039,300	230,639,200	624,647,100	737,633,100	476739675

THROUGHPUT					
Port	**2011**	**2012**	**2013**	**2014**	
Lagos Port Complex	22,808,352	21,065,520	21,730,426	20,645,269	21562391.75
Tin Can Island Port Complex	15,371,000	15,136,436	16,134,153	17,500,804	16035598.25
River Port Complex	7,464,000	5,574,281	4,935,944	6,225,008	6049808.25
Onne Port	26,217,000	26,532,187	24,773,387	27,968,861	26372858.75
Calabar Port	1,880,000	1,738,446	1,732,286	2,361,477	1928052.25
Delta Port	8,467,000	6,808,884	10,361,746	10,199,169	8959199.75
SHIP TRAFFIC					
Lagos Port Complex	1,594	1,421	1,510	1503	1507
Tin Can Island Port Complex	1,628	1,609	1,615	1,692	1636
River Port Complex	566	461	439	435	475.25
Onne Port	885	861	823	847	854
Calabar Port	179	159	373	269	245
Delta Port	362	357	609	603	482.75
VEHICLE TRAFFIC					
Lagos Port Complex	3,468	16,050	12,240	14,000	11439.5
Tin Can Island Port Complex	227,376	58,758	278,803	**320,398**	221333.75
River Port Complex	-	-	-		#DIV/0!
Onne Port	204	204	223		210.3333333
Calabar Port	-	-	-		#DIV/0!
Delta Port	375	662	558		531.6666667
BERTH OCCUPANCY					
Lagos Port Complex	65.1	63.9	56.8	54.1	59.975
Tin Can Island Port Complex	71.1	70.8	68.3	64.7	68.725

River Port Complex	61	62.3	47.9	46.4	54.4
Onne Port	36.8	32.4	24.6	28.5	30.575
Calabar Port	22.7	24.6	36.7	33.5	29.375
Delta Port	10.2	15.4	11.2	8.41	11.3025
TURNAROUND TIME					
Lagos Port Complex	5	8.1	5.7	5.1	5.975
Tin Can Island Port Complex	5	5	4.52	4.3	4.705
River Port Complex	10.2	8.9	7.7	8.41	8.8025
Onne Port	4	2.5	2.6	2.2	2.825
Calabar Port	4	5.6	6.8	5.4	5.45
Delta Port	7	5.7	3.9	5.4	5.5
					#DIV/0!
REVENUE GENERATED					#DIV/0!
Lagos Port Complex	2,481,890,655	2,710,209,111	2,825,813,555	2,641,300,000	2664803330
Tin Can Island Port Complex	1,209,999,105	1,283,740,222	1,107,003,000	1,522,060,309	1280700659
River Port Complex	564,520,961	963,306,522	850,000,000	1,003,207,192	845258668.8
Onne Port	755,445,814	913,402,042	1,007,313,000	994,000,000	917540214
Calabar Port	660,008,330	499,216,350	709,035,577	822,149,290	672602386.8
Delta Port	900,000,000	1,040,029,000	1,111,438,000	970,321,456	1005447114
					#DIV/0!
EXPENDITURE INCURRED					#DIV/0!
Lagos Port Complex					#DIV/0!
Tin Can Island Port Complex					#DIV/0!
River Port Complex					#DIV/0!
Onne Port					#DIV/0!
Calabar Port					#DIV/0!
Delta Port					#DIV/0!
					#DIV/0!
OPERATING SURPLUS					#DIV/0!
Lagos Port Complex					#DIV/0!
Tin Can Island Port Complex					#DIV/0!

River Port Complex					#DIV/0!
Onne Port					#DIV/0!
Calabar Port					#DIV/0!
Delta Port					#DIV/0!

APPENDIX FOUR: DISSERTATION WORK PLAN

Dissertation proposed titled-Assessment of productivity of Nigerian ports using Data envelopment analysis

PART 1			
Project plan	Activities	Means of verification	Time lag
Abstract Background -State of the art (key reference) -Objectives (hypothesis, problem statement, -Research questions Literature Reviews	Information Gathering	Key reference	28th Sept 2016-31st Oct, 2017
PART TWO			
Methods (Research Methodology)		Field work (primary data from the port (s) and collection of data from the web	31st oct, 2017-Dec 2017
Expected outcomes (data analysis		The use of scientific models in analysis of data	Jan. 2018
Scientific contributions and Recommendation			Jan, 2018

APPENDIX FIVE

RELIABILITY STATISTICS:

Reliability Statistics for Onne Port

Cronbach's Alpha	N of Items
.760	66

Reliability Statistics for Rivers Port

Cronbach's Alpha	N of Items
.855	66

Reliability Statistics for Tincan Port

Cronbach's Alpha	N of Items
.761	66

Reliability Statistics for Warri Port

Cronbach's Alpha	N of Items
.825	66

Reliability Statistics for Apapa Port

Cronbach's Alpha	N of Items
.876	66

Reliability Statistics for Calabar Port

Cronbach's Alpha	N of Items
.758	65

RIVERS PORT

Factors affecting or influencing the productivity of ports in Nigeria

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
A1	16.066	49	.000	1.720	1.50	1.94
A2	11.699	49	.000	.900	.75	1.05
A3	-.573	49	.569	-.060	-.27	.15
A4	-6.473	49	.000	-.880	-1.15	-.61
A5	-3.428	49	.001	-.720	-1.14	-.30
A6	-.109	49	.914	-.020	-.39	.35
A7	-1.241	49	.221	-.260	-.68	.16
A8	1.851	49	.070	.280	-.02	.58
A9	.785	49	.436	.120	-.19	.43
A11	.121	49	.904	.020	-.31	.35
A11	-1.335	49	.188	-.220	-.55	.11
A12	-2.478	49	.017	-.460	-.83	-.09
A13	-.326	49	.746	-.060	-.43	.31
A14	.685	49	.497	.120	-.23	.47
A15	-1.218	49	.229	-.260	-.69	.17
A16	-.428	49	.671	-.080	-.46	.30
A17	-.244	49	.808	-.040	-.37	.29
A18	.676	49	.502	.120	-.24	.48
A19	1.121	49	.268	.200	-.16	.56
A21	.343	49	.733	.060	-.29	.41
A21	-.531	49	.598	-.080	-.38	.22
A22	-1.377	49	.175	-.220	-.54	.10
A23	-1.630	49	.110	-.240	-.54	.06
A24	-2.266	49	.028	-.420	-.79	-.05

Factors that affect the level of productivity of terminal operation in relation to berth occupancy

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
B1	9.137	49	.000	1.240	.97	1.51
B2	8.411	49	.000	.960	.73	1.19
B3	2.979	49	.004	.460	.15	.77
B4	1.950	49	.057	.360	-.01	.73
B5	.686	49	.496	.140	-.27	.55
B6	3.497	49	.001	.540	.23	.85
B7	3.280	49	.002	.540	.21	.87
B8	.795	49	.431	.140	-.21	.49
B9	.984	49	.330	.160	-.17	.49
B10	1.699	49	.096	.320	-.06	.70

Factors affecting individual port productivity

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
C1	12.390	49	.000	1.420	1.19	1.65
C2	2.943	49	.005	.520	.16	.88
C3	3.093	49	.003	.560	.20	.92
C4	3.055	49	.004	.560	.19	.93
C5	2.692	49	.010	.500	.13	.87
C6	3.904	49	.000	.620	.30	.94
C7	2.843	49	.007	.540	.16	.92
C8	3.215	49	.002	.560	.21	.91
C9	2.676	49	.010	.460	.11	.81
C11	1.399	49	.168	.280	-.12	.68
C11	1.170	49	.248	.220	-.16	.60
C12	.187	49	.852	.040	-.39	.47
C13	.949	49	.347	.600	-.67	1.87
C14	1.289	49	.203	.260	-.15	.67
C15	.922	49	.361	.180	-.21	.57
C16	2.591	49	.013	.540	.12	.96

Effects of port concessioning

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
D1	9.977	49	.000	1.360	1.09	1.63
D2	7.233	49	.000	.980	.71	1.25
D3	4.455	49	.000	.700	.38	1.02
D4	1.843	49	.071	.360	-.03	.75
D5	1.518	49	.135	.320	-.10	.74
D6	3.313	49	.002	.620	.24	1.00
D7	4.452	49	.000	.720	.40	1.04
D8	2.165	49	.035	.420	.03	.81
D9	4.810	49	.000	.840	.49	1.19

Factors that affects throughput

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
E1	8.121	49	.000	1.240	.93	1.55
E2	6.659	49	.000	.940	.66	1.22
E3	3.553	49	.001	.520	.23	.81
E4	.000	49	1.000	.000	-.34	.34
E5	-.704	49	.485	-.160	-.62	.30
E6	1.346	49	.185	.280	-.14	.70
E7	.455	49	.651	.100	-.34	.54

TINCAN
Factors affecting or influencing the productivity of ports in Nigeria

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
A1	23.584	45	.000	1.783	1.63	1.93
A2	3.228	45	.002	.457	.17	.74
A3	-2.010	45	.050	-.261	-.52	.00
A4	-4.786	45	.000	-.696	-.99	-.40
A5	-1.875	45	.067	-.435	-.90	.03
A6	-2.876	45	.006	-.435	-.74	-.13
A7	-2.514	45	.016	-.370	-.67	-.07
A8	3.360	45	.002	.587	.24	.94
A9	1.925	45	.061	.304	-.01	.62
A11	1.269	45	.211	.196	-.11	.51
A11	-.813	45	.420	-.130	-.45	.19
A12	-2.136	45	.038	-.261	-.51	-.01
A13	-1.295	45	.202	-.196	-.50	.11
A14	-2.817	45	.007	-.435	-.75	-.12
A15	-1.729	45	.091	-.283	-.61	.05
A16	-1.756	45	.086	-.239	-.51	.04
A17	1.354	45	.183	.196	-.10	.49
A18	.000	45	1.000	.000	-.31	.31
A19	-.292	45	.772	-.043	-.34	.26
A21	-.306	45	.761	-.043	-.33	.24
A21	-.256	45	.799	-.043	-.39	.30
A22	-1.855	45	.070	-.304	-.63	.03
A23	-2.119	45	.040	-.239	-.47	-.01
A24	-6.511	45	.000	-1.022	-1.34	-.71

Factors that affect the level of productivity of terminal operation in relation to berth occupancy

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
B1	13.665	45	.000	1.761	1.50	2.02
B2	6.487	45	.000	.739	.51	.97
B3	-.903	45	.371	-.065	-.21	.08
B4	-10.724	45	.000	-1.000	-1.19	-.81
B5	-13.694	45	.000	-1.696	-1.95	-1.45
B6	8.778	45	.000	1.435	1.11	1.76
B7	2.901	45	.006	.500	.15	.85
B8	-2.017	45	.050	-.326	-.65	.00
B9	-2.697	45	.010	-.522	-.91	-.13
B10	-2.798	45	.008	-.674	-1.16	-.19

Factors affecting individual port productivity

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
C1	11.167	45	.000	1.609	1.32	1.90
C2	4.610	45	.000	.630	.35	.91
C3	-1.912	45	.062	-.239	-.49	.01
C4	-3.681	45	.001	-.630	-.98	-.29
C5	-6.725	45	.000	-1.217	-1.58	-.85
C6	1.869	45	.068	.413	-.03	.86
C7	.922	45	.362	.196	-.23	.62
C8	-.423	45	.675	-.087	-.50	.33
C9	-2.048	45	.046	-.435	-.86	.00
C11	-.396	45	.694	-.087	-.53	.35
C11	-.092	45	.927	-.022	-.50	.45
C12	.000	45	1.000	.000	-.45	.45
C13	-2.222	45	.031	-.457	-.87	-.04
C14	.590	45	.558	.130	-.31	.58
C15	-1.736	45	.089	-.413	-.89	.07
C16	1.451	45	.154	.261	-.10	.62

Effects of port concessioning

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
D1	6.564	45	.000	1.304	.90	1.70
D2	3.284	45	.002	.565	.22	.91
D3	-.172	45	.864	-.022	-.28	.23
D4	-6.348	45	.000	-.804	-1.06	-.55
D5	-3.253	45	.002	-.783	-1.27	-.30
D6	1.277	45	.208	.283	-.16	.73
D7	2.228	45	.031	.413	.04	.79
D8	-.581	45	.564	-.109	-.49	.27
D9	.573	45	.569	.130	-.33	.59

Factors that affects throughput

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
E1	6.731	45	.000	1.304	.91	1.69
E2	4.225	45	.000	.609	.32	.90
E3	-.286	45	.776	-.043	-.35	.26
E4	-4.531	45	.000	-.761	-1.10	-.42
E5	-3.200	45	.003	-.783	-1.28	-.29
E6	.170	45	.866	.043	-.47	.56
E7	3.228	44	.002	.873	.33	1.42

WARRI PORT

Factors affecting or influencing the productivity of ports in Nigeria

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
A1	16.361	49	.000	1.660	1.46	1.86
A2	8.510	49	.000	.780	.60	.96
A3	-2.156	49	.036	-.260	-.50	-.02
A4	-2.080	49	.043	-.380	-.75	-.01
A5	-1.881	49	.066	-.320	-.66	.02
A6	-2.011	49	.050	-.300	-.60	.00
A7	-2.364	49	.022	-.320	-.59	-.05
A8	2.979	49	.004	.460	.15	.77
A9	1.219	49	.229	.180	-.12	.48
A11	3.207	49	.002	.460	.17	.75
A11	-2.614	49	.012	-.380	-.67	-.09
A12	-.286	49	.776	-.040	-.32	.24
A13	-2.190	49	.033	-.380	-.73	-.03
A14	-.444	49	.659	-.060	-.33	.21
A15	.000	49	1.000	.000	-.32	.32
A16	-.219	49	.828	-.040	-.41	.33
A17	.000	49	1.000	.000	-.31	.31
A18	1.033	49	.306	.160	-.15	.47
A19	.125	49	.901	.020	-.30	.34
A21	-.853	49	.398	-.140	-.47	.19
A21	.000	49	1.000	.000	-.26	.26
A22	-1.184	49	.242	-.160	-.43	.11
A23	-1.791	49	.079	-.260	-.55	.03
A24	-5.840	49	.000	-.980	-1.32	-.64

Factors that affect the level of productivity of terminal operation in relation to berth occupancy

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
B1	16.082	49	.000	1.820	1.59	2.05
B2	26.000	49	.000	1.040	.96	1.12
B3	-1.071	49	.290	-.080	-.23	.07
B4	-13.404	49	.000	-1.100	-1.26	-.94
B5	-6.576	49	.000	-1.240	-1.62	-.86
B6	7.137	49	.000	1.160	.83	1.49
B7	3.581	49	.001	.660	.29	1.03
B8	-1.359	49	.180	-.260	-.64	.12
B9	-.282	49	.779	-.060	-.49	.37
B10	2.064	49	.044	.400	.01	.79

Factors affecting individual port productivity

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
C1	24.000	49	.000	1.920	1.76	2.08
C2	7.230	49	.000	.800	.58	1.02
C3	-.896	49	.374	-.100	-.32	.12
C4	-6.567	49	.000	-.860	-1.12	-.60
C5	-7.000	49	.000	-1.300	-1.67	-.93
C6	4.427	49	.000	.800	.44	1.16
C7	1.040	49	.303	.180	-.17	.53
C8	-2.319	49	.025	-.380	-.71	-.05
C9	-.480	49	.634	-.100	-.52	.32
C11	1.177	49	.245	.260	-.18	.70
C11	.000	49	1.000	.000	-.42	.42
C12	-.308	49	.759	-.060	-.45	.33
C13	-.100	49	.921	-.020	-.42	.38
C14	.375	49	.709	.080	-.35	.51
C15	.280	49	.781	.060	-.37	.49
C16	2.271	49	.028	.400	.05	.75

Effects of port concession

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
D1	70.015	49	.000	1.960	1.90	2.02
D2	5.775	49	.000	.720	.47	.97
D3	-1.265	49	.212	-.140	-.36	.08
D4	-7.847	49	.000	-.920	-1.16	-.68
D5	-6.812	49	.000	-1.220	-1.58	-.86
D6	3.208	49	.002	.640	.24	1.04
D7	2.561	49	.014	.440	.09	.79
D8	-.105	49	.917	-.020	-.40	.36
D9	.916	49	.364	.160	-.19	.51

Factors that affects throughput

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
E1	26.600	49	.000	1.900	1.76	2.04
E2	4.037	49	.000	.620	.31	.93
E3	.622	49	.537	.060	-.13	.25
E4	-10.149	49	.000	-.960	-1.15	-.77
E5	-3.968	49	.000	-.920	-1.39	-.45
E6	-5.721	49	.000	-1.160	-1.57	-.75
E7	9.215	49	.000	1.420	1.11	1.73

ONNE PORT

Factors affecting or influencing the productivity of ports in Nigeria

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
A1	14.694	49	.000	1.620	1.40	1.84
A2	4.440	49	.000	.620	.34	.90
A3	-2.333	49	.024	-.300	-.56	-.04
A4	-4.086	49	.000	-.720	-1.07	-.37
A5	-2.190	49	.033	-.380	-.73	-.03
A6	-2.049	49	.046	-.300	-.59	.00
A7	-3.710	49	.001	-.500	-.77	-.23
A8	2.641	49	.011	.360	.09	.63
A9	.961	49	.341	.140	-.15	.43
A10	2.391	49	.021	.360	.06	.66
A11	-2.995	49	.004	-.420	-.70	-.14
A12	-1.095	49	.279	-.140	-.40	.12
A13	-3.500	49	.001	-.600	-.94	-.26
A14	-2.399	49	.020	-.340	-.62	-.06
A15	.559	49	.579	.100	-.26	.46
A16	-1.085	49	.283	-.180	-.51	.15
A17	-.270	49	.789	-.040	-.34	.26
A18	.607	49	.547	.100	-.23	.43
A19	-3.011	49	.004	-.440	-.73	-.15
A20	-.312	49	.757	-.060	-.45	.33
A21	-2.374	49	.022	-.280	-.52	-.04
A22	-1.794	49	.079	-.300	-.64	.04
A23	-2.087	49	.042	-.280	-.55	-.01
A24	-5.235	49	.000	-.920	-1.27	-.57

Factors that affect the level of productivity of terminal operation in relation to berth occupancy

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
B1	11.613	49	.000	1.700	1.41	1.99
B2	9.839	49	.000	.900	.72	1.08
B3	-1.400	49	.168	-.100	-.24	.04
B4	-11.667	49	.000	-1.000	-1.17	-.83
B5	-6.619	49	.000	-1.300	-1.69	-.91
B6	7.039	49	.000	1.080	.77	1.39
B7	3.130	49	.003	.600	.21	.99
B8	-1.273	49	.209	-.240	-.62	.14
B9	-1.017	49	.314	-.220	-.65	.21
B10	1.218	49	.229	.260	-.17	.69

Factors affecting individual port productivity

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
C1	18.187	49	.000	1.800	1.60	2.00
C2	5.140	49	.000	.680	.41	.95
C3	-4.516	49	.000	-.520	-.75	-.29
C4	-6.261	49	.000	-.800	-1.06	-.54
C5	-5.802	49	.000	-1.120	-1.51	-.73
C6	4.461	49	.000	.760	.42	1.10
C7	.853	49	.398	.140	-.19	.47
C8	-2.050	49	.046	-.360	-.71	.00
C9	-.305	49	.762	-.060	-.46	.34
C10	1.568	49	.123	.340	-.10	.78
C11	.092	49	.927	.020	-.42	.46
C12	-.214	49	.832	-.040	-.42	.34
C13	-.104	49	.918	-.020	-.41	.37
C14	-.704	49	.485	-.160	-.62	.30
C15	1.518	49	.135	.320	-.10	.74
C16	3.066	49	.004	.520	.18	.86

Effects of port concessioning

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
D1	16.082	49	.000	1.820	1.59	2.05
D2	2.824	49	.007	.420	.12	.72
D3	-1.589	49	.119	-.260	-.59	.07
D4	-4.086	49	.000	-.720	-1.07	-.37
D5	-3.816	49	.000	-.840	-1.28	-.40
D6	2.017	49	.049	.420	.00	.84
D7	1.974	49	.054	.360	.00	.73
D8	.207	49	.837	.040	-.35	.43
D9	2.228	49	.030	.460	.05	.87

Factors that affects throughput

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
E1	12.430	49	.000	1.760	1.48	2.04
E2	2.107	49	.040	.360	.02	.70
E3	-1.565	49	.124	-.200	-.46	.06
E4	-8.091	49	.000	-.920	-1.15	-.69
E5	-3.323	49	.002	-.800	-1.28	-.32
E6	-4.163	49	.000	-.900	-1.33	-.47
E7	4.781	49	.000	1.040	.60	1.48

CALABAR PORT

Factors affecting or influencing the productivity of ports in Nigeria

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
A1	6.542	49	.000	1.040	.72	1.36
A2	1.237	49	.222	.200	-.12	.52
A3	-2.641	49	.011	-.360	-.63	-.09
A5	-1.371	49	.177	-.240	-.59	.11
A6	-1.273	49	.209	-.240	-.62	.14
A7	-1.070	49	.290	-.180	-.52	.16
A8	1.278	49	.207	.200	-.11	.51
A9	.759	49	.452	.120	-.20	.44
A11	-.496	49	.622	-.080	-.40	.24
A11	-1.974	49	.054	-.360	-.73	.01
A12	1.444	49	.155	.280	-.11	.67
A13	-1.589	49	.119	-.280	-.63	.07
A14	-.756	49	.453	-.140	-.51	.23
A15	.000	49	1.000	.000	-.36	.36
A16	-1.695	49	.096	-.260	-.57	.05
A17	.629	49	.533	.120	-.26	.50
A18	.880	49	.383	.140	-.18	.46
A19	.489	49	.627	.080	-.25	.41
A21	.929	49	.358	.160	-.19	.51
A21	-.880	49	.383	-.140	-.46	.18
A22	.942	49	.351	.180	-.20	.56
A23	-.387	49	.700	-.060	-.37	.25
A24	-3.697	49	.001	-.680	-1.05	-.31

Factors that affect the level of productivity of terminal operation in relation to berth occupancy

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
B1	4.096	49	.000	.860	.44	1.28
B2	1.500	49	.140	.260	-.09	.61
B3	1.950	49	.057	.240	.00	.49
B4	-3.182	49	.003	-.500	-.82	-.18
B5	-2.734	49	.009	-.600	-1.04	-.16
B6	3.887	49	.000	.720	.35	1.09
B7	1.528	49	.133	.300	-.09	.69
B8	.532	49	.597	.100	-.28	.48
B9	-1.107	49	.274	-.200	-.56	.16
B10	-.459	49	.649	-.100	-.54	.34

Factors affecting individual port productivity

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
C1	3.654	49	.001	.820	.37	1.27
C2	1.500	49	.140	.260	-.09	.61
C3	-1.219	49	.229	-.200	-.53	.13
C4	-3.157	49	.003	-.520	-.85	-.19
C5	-3.669	49	.001	-.760	-1.18	-.34
C6	1.512	49	.137	.940	-.31	2.19
C7	.106	49	.916	.020	-.36	.40
C8	-2.372	49	.022	-.440	-.81	-.07
C9	-1.207	49	.233	-.260	-.69	.17
C11	.382	49	.704	.080	-.34	.50
C11	-.590	49	.558	-.120	-.53	.29
C12	-.942	49	.351	-.160	-.50	.18
C13	.805	49	.424	.140	-.21	.49
C14	.760	49	.451	.180	-.30	.66
C15	.709	49	.482	.160	-.29	.61
C16	.224	49	.823	.040	-.32	.40

Effects of port concessioning

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
D1	3.848	49	.000	.840	.40	1.28
D2	-.214	49	.832	-.040	-.42	.34
D3	.387	49	.700	.060	-.25	.37
D4	-2.137	49	.038	-.360	-.70	-.02
D5	-2.615	49	.012	-.560	-.99	-.13
D6	1.807	49	.077	.400	-.04	.84
D7	.885	49	.381	.180	-.23	.59
D8	2.055	49	.045	.380	.01	.75
D9	-1.093	49	.280	-.200	-.57	.17

Factors that affects throughput

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
E1	3.101	49	.003	.720	.25	1.19
E2	-.841	49	.405	-.160	-.54	.22
E3	-1.495	49	.141	-.240	-.56	.08
E4	-3.436	49	.001	-.620	-.98	-.26
E5	-2.080	49	.043	-.480	-.94	-.02
E6	-1.912	49	.062	-.420	-.86	.02
E7	3.412	48	.001	.796	.33	1.26

APAPA PORT

Factors affecting or influencing the productivity of ports in Nigeria

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
A1	4.803	48	.000	1.061	.62	1.51
A2	5.060	48	.000	.571	.34	.80
A3	-2.304	48	.026	-.408	-.76	-.05
A4	-2.054	48	.045	-.347	-.69	.00
A5	-.305	48	.762	-.061	-.46	.34
A6	1.287	48	.204	.286	-.16	.73
A7	.233	48	.816	.041	-.31	.39
A8	1.656	48	.104	.306	-.07	.68
A9	-1.257	48	.215	-.204	-.53	.12
A11	-.423	48	.674	-.082	-.47	.31
A11	.759	48	.452	.122	-.20	.45
A12	.667	48	.508	.143	-.29	.57
A13	.414	48	.680	.122	-.47	.72
A14	.102	48	.920	.020	-.38	.42
A15	-1.144	48	.258	-.224	-.62	.17
A16	-.413	48	.681	-.082	-.48	.32
A17	1.000	48	.322	.204	-.21	.61
A18	1.543	48	.129	.265	-.08	.61
A19	-1.868	48	.068	-.347	-.72	.03
A21	-.685	48	.497	-.122	-.48	.24
A21	1.460	48	.151	.204	-.08	.49
A22	.000	48	1.000	.000	-.38	.38
A23	-1.640	48	.108	-.265	-.59	.06
A24	-4.215	48	.000	-.837	-1.24	-.44

Factors that affect the level of productivity of terminal operation in relation to berth occupancy

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	*df*	*Sig. (2-tailed)*	*Mean Difference*	*Lower*	*Upper*
B1	*4.330*	*48*	*.000*	*1.041*	*.56*	*1.52*
B2	*6.828*	*48*	*.000*	*.796*	*.56*	*1.03*
B3	*.206*	*48*	*.837*	*.020*	*-.18*	*.22*
B4	*-5.268*	*48*	*.000*	*-.878*	*-1.21*	*-.54*
B5	*-2.949*	*48*	*.005*	*-.714*	*-1.20*	*-.23*
B6	*1.884*	*48*	*.066*	*.388*	*-.03*	*.80*
B7	*1.568*	*48*	*.123*	*.347*	*-.10*	*.79*
B8	*-.423*	*48*	*.674*	*-.082*	*-.47*	*.31*
B9	*.559*	*48*	*.579*	*.102*	*-.27*	*.47*
B11	*1.131*	*48*	*.264*	*.286*	*-.22*	*.79*

Factors affecting individual port productivity

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
C1	3.527	48	.001	.898	.39	1.41
C2	4.276	48	.000	.571	.30	.84
C3	-2.574	48	.013	-.469	-.84	-.10
C4	-3.567	48	.001	-.551	-.86	-.24
C5	-4.750	48	.000	-.959	-1.37	-.55
C6	1.157	48	.253	.224	-.17	.61
C7	.545	48	.588	.102	-.27	.48
C8	-1.377	48	.175	-.224	-.55	.10
C9	.000	48	1.000	.000	-.51	.51
C11	-.202	48	.841	-.041	-.45	.37
C11	-1.235	48	.223	-.306	-.80	.19
C12	-.125	48	.901	-.020	-.35	.31
C13	-1.734	48	.089	-.388	-.84	.06
C14	-.831	48	.410	-.204	-.70	.29
C15	1.075	48	.288	.286	-.25	.82
C16	1.639	48	.108	.388	-.09	.86

Effects of port concessioning

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
D1	4.427	48	.000	1.000	.55	1.45
D2	4.403	48	.000	.694	.38	1.01
D3	-.409	48	.685	-.061	-.36	.24
D4	-3.882	48	.000	-.673	-1.02	-.32
D5	-4.249	48	.000	-.939	-1.38	-.49
D6	1.732	48	.090	.429	-.07	.93
D7	-.775	48	.442	-.143	-.51	.23
D8	-.643	48	.523	-.143	-.59	.30
D9	-1.079	48	.286	-.245	-.70	.21

Factors that affects throughput

	Test Value = 3					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
E1	4.836	48	.000	1.082	.63	1.53
E2	2.153	48	.036	.347	.02	.67
E3	-1.572	48	.122	-.245	-.56	.07
E4	-3.087	48	.003	-.510	-.84	-.18
E5	-3.344	48	.002	-.776	-1.24	-.31
E6	-4.315	48	.000	-.878	-1.29	-.47
E7	3.947	47	.000	.917	.45	1.38