International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 1854-1862 www.ijaem.net ISSN: 2395-5252

Assessment of Port Performance in Nigeria

[a]Dere I. Gbolahan, [b]Omoke Victor, [c]Ojekunle J.A. and [d]NwaogbeObioma R.

Department of Transport Management, Federal University of Technology, Minna, Nigeria

Submitted: 10-08-2021 Revised: 25-08-2021 Accepted: 29-08-2021

ABSTRACT: Nigeria projects to be the hub of West African ports as vision 2021 and in meeting the demand, the need for the ports to run efficiently cannot be over emphasized. Efficiency of a port is an important indicator of port performance. An efficient portreduces the cost of transportation, eliminates congestion and brings down turnaround time of vessel. This study focuses on assessing the efficiency of Nigerian ports from 2008 to 2017 by applying Data Envelopment Analysis. Cargo throughputs, labour, berth occupancy, vessel turnaround time and vessel traffic are theSecondary data used, and the data was sourced from Nigeria Port Authority Abstract from 2008 to 2017, for the three sampled seaports (Apapa, Onne and Rivers ports). The findings reveal the operational performance of the Onne port as the most efficient, followed by Apapa and lastly by Rivers Port. Variable Return to Scale (VRS) yielded more efficient results than C0nstant Return to Scale results over the years of the study. The ports operating under constant return to scale are efficient, while the ones operating at increasing return to scale needs to be improved to make them efficient.

Keywords: Assessment, data envelopment analysis, efficiency, constant return to Scaleand variable return to scale.

I. INTRODUCTION

Port costs represent a major portion of marine transport costs. In general, port performance has an enormous effect on these costs. Aside from the board and administration style, port execution could be improved by expanding port limits and exploiting the areas (Perez-Labajos and Blanco 2004), improving ocean and landside port openness (Gekara and Chhetri, 2013) and consolidating data and correspondence innovation (ICT) (Kia, Shayan et al. 2000, Gekara and Fairbrother 2013).

A Seaport is a zone on a coast or shore containing minimum of one harbors where ship/vessel can dock and move people or cargo to or from the land. Port territories are picked to upgrade access to land and navigable water, for business demands, and for spread from wind and waves(Ensslin et al., 2017). Ports are the principal modern and business apparatuses for the financial and social improvement of the nations. The seaport is a multidimensional framework joined between practical capacity, foundation framework, geological space and exchange (Dutra et al., 2015).

The part played via seaports in the maritime logistics chain necessitates that the administration devices utilized (i.e. Performance Evaluation models) are at any rate as effective as those used to decide ocean courses (Dutra et al., 2015). This need has advanced the development of execution pointers, as devices to screen, in a convenient style, explicit seaport qualities. The latest of such instruments assess seaport execution and, paying little mind to the techniques utilized, are established on a lot of markers that permit full observing of sets of attributes, exercises as well as procedures that empower directors to accomplish amazing execution (Ensslin et al., 2017). All things considered, these days, execution estimation is viewed as a fundamental apparatus for modernization.

The utilization of the ocean as methods for transport in Nigeria goes back to the fifteenth century (1485) when the Portuguese cruised into Lagos with their vessels fundamentally to exchange on antiques in Benin City. From the pre-freedom period to date, the Nation's seaport industry is described by the mastery of remote vessels or potentially bearers from the created market economies of Western Europe and America. So as to control this situation, resulting advancements prompted the opening of seaports at Port Harcourt and Apapa, followed by the formation of the Nigerian Ports Authority (NPA) through Ports Act of 1954 (Njoku, 2009).

Nigeria has an aggregate of eleven ports and eight oil terminals sifted through in three zones of Western, Central and Eastern Zones. The Central Zone with its Headquarters in Warri, the Western Zones with Headquarters in Lagos and the Eastern Zone with its Headquarters in Port Harcourt are dominatingly oil terminals. However, Warri, Sapele, Koko, Port Harcourt, Calabar, and the Federal Ocean Terminal are noteworthy general cargo terminals (Chioma, 2011).

The growth in the maritime industry has resulted in the rise in the throughput of cargo, leaving the port operators to the task of meeting up in the clearing of cargo within the shortest period of time. High or increasing congestion, high turnaround time of the ship, delays at the port, and increase in dwell time of ship and low labor productivity are few among the challenges that are rising in Nigerian ports.

Paixao and Marlow (2003) propose that ports must adopt a completely new logistic approach and agility to cope with new trends in the market. Expectations of cost and time savings dictate the establishment and use of lean logistics concepts. Industry's expectations of cost and time savings dictate the establishment and use of lean logistics concepts. Lean logistics needs a reliable ocean service, an agile port service and inland transportation, supported by in-time documentation procedures and information. Reducing the number of logistics subjects in supply chains can speed up cargo flow, reduce cost elements and facilitate information flow. The shipping industry is therefore in a phase of dynamic and important changes. With agile port using lean logistics, the seaport will be able to reduce excesses for it to meet up with global standard of efficiency and productivity (Bojan, B., and Elen,T. 2011).

Convention on Business Integrity (2019) noted that the challenges facing Nigerian ports includes rampant excise of discretionary power by ports official, a bouquet of payments made for services not provided, lack of awareness by ports users of grievance mechanisms available for addressing service challenges at the port facilities, poor port infrastructure cost, port users' excessive overruns in terms of extended port processing time and a rise in port charges due to processing delays. These challenges have led to Nigerian ports and terminal being the most expensive in the world and inefficient (CBi, 2019). The effect of operational components had pushed numerous clients to now utilize ports and terminals of neighboring nations, in this way prompting loss of foreign trade profit for Nigeria. The report revealed that port capacity utilization in Nigeria stands at between 38 and 40 percent, adding that 40 percent of the businesses that are located around the seaports communities have either relocated to other neighboring seaports, scaled-down operations or completely closed down in Nigeria.

It has been noted that West African seaports are seriously congested and they are not operating efficiently as compared with the seaports in Asia and Europe. The findings revealed that highly congested ports have direct impacts on the costs of doing business (African Development Bank, 2010).

Leigland and Palsson (2007) state that Nigeria Ports demonstrate very lowlevels of efficiency which results in high turnaround time of the ship, and increased dwell period of containers at the port. Instead of the forty-eight hours international standard needed to load and unload a ship, it takes upto weeks in Nigeria seaports. ApapaPort was ranked 4th among Tema, Abidjan, Dakar, Lome, Cotonou, and Apapa, which are the West African major seaports (Van Dyck, G.K. 2015).

1.2 The Objectives of the study

The objective of the study is to assess theoperational performance of Apapa, Onne and Rivers ports

II. RESEARCH METHODOLOGY

The data used were secondary data sourced from Nigeria Port Authority Abstracts of statistics from 2008 to 2017. The data extracted for the study purpose are cargo throughput, vessel turnaround time, ship/vessel traffic, berth occupancy level and labour/personnel. The study focuses on three ports from the 3 major ports complexes in Nigeria. Apapa port was selected from the Western port complex, Onne port was selected fromthe Eastern port complexand Rivers port was selected fromthe Central port complex. The selected seaports were considered because of their cargo throughputs. Data Envelopment Analysis Program (DEAP) was used for the analysis. Constant Return to Scale (CRS-Model) and Variable Return to scale (VRS-Model) were used to determine the technical efficiency and pure efficiency of the ports. CRS and VRS -Models determine the efficiency of the port by making use of ports' input and output variables. In this study, 4 input variables (labour, turnaround time, berth occupancy, and ship traffic) and one output (cargo throughput) were used.

2.1 Model Formulation

The basic mathematical formulation of DEA has the following form: Suppose n decision-making units (DMUs), where every DMUj, j = 1, 2,... ., n, produces the same s outputs in possibly different amounts, yrj(r = 1, 2,. . ., s), using the same m inputs, xij(i = 1, 2,. . .m), also in possibly different amounts, while u and v are weights that are assigned, respectively, to the outputs and inputs obtained when solving the model. The Basic

Mathematical Formulation of DEA has the accompanying structure:
Maximize
$E_b = \{\sum_{r-1}^{R} u_{rb} y_{rb}\}/\{\sum_{r-1}^{R} v_{rb} x_{rb}\}$
Equation 2.1
Subject to:
$\frac{\sum_{r-1}^{R} u_{rb} y_{rj}}{\sum_{i-1}^{I} v_{ib} x_{ij}} \leq 1, \forall i, j = 1,2 \ldots \ldots \ldots, m$

Equation 2.2
And $u_{rb}, v_{ib} \geq$ call r, i (where $r = 1,2, \ldots \ldots \ldots, R$ and $i = 1,2 \ldots \ldots, m$)
Where
E_b is the efficiency of any unit b;
y_{rj} isthe observed quantity of output I used by unit j =1,2, ... … …, m
x_{ij} is observed quantity of input I used by unit j =1,2, ... … …, m
u_{rb} is the weight (to be determined) given to output r by base unit b
v_{ib} is the weight (to be determined) given to input r by base unit b
c is a very small positive number

u's and v's are the factors of the issue and are obliged to be more noteworthy than or equivalent to some little positive amount c so as to keep away from any output or inputs being completely disregarded in deciding effectiveness. CharnesCooper Rhodes suggested that all the unit ought to be permitted to receive the best arrangement of weights. This activity will end when a portion of the efficiencies becomes 1.

2.2 Ports Characteristics

The berth characteristics of Apapa, Rivers, andOnne ports are shown in table 2.1, 2.2 and 2.3 below.

Table 2.1 Apapa port complex berth characteristics

Berth	Quay Length (m)	Area (ha)	Max Depth (m)	Cargo Type	Operator
1 to 5	760	11.66	11.5	Bulk & Gen.	Apapa Bulk
6 to 14	1,720	21.75	9.7	Cargo	Terminal Ltd
15 to18	1,000	59.41	10.5	General Cargo	ENL Consortium Ltd
19 & 20	510	19.09	10.5	Containers	AP Moller
Bull Nose	286	4.15	8	Dry Bulk	Terminals Ltd
Lilypond Inland	NA	13.6	NA	Liquid Bulk	Greenview

Source: NPA Abstract 2017

From table 2.1 above, Apapa berth 1 to 5 has 760m quay length, 11.66ha area, 11.5m max depth, bulk, and general cargo type and operated by Apapa bulk. Berth 6 to 14 has 1,720m quay length, 21.75ha area, 9.7m max depth, cargo type and operated by terminal limited. Berth 15 to 18 has 1,000m quay length, 59.41ha area, 10.5m max depth, general cargo type and operated by ENL consortium limited. Berth 19 & 20 have 510m quay length, 19.09ha area, 10.5m max depth, container cargo type and operated by AP Moller. Berth Bullnose has 286m quay length, 4.15ha area, 8m max depth, dry bulk cargo type and operated by terminals limited. Berth lilypond inland has 13.6ha area, liquid bulk cargo type and operated by Greenviews.

Table 2.2 Rivers Port Complex Berth Characteristics

Berth	Quay Length (m)	Area (ha)	Max Depth (m)	Cargo Type	Operator
1-4	660	3607.043	7.92	Dry Bulk, Liquid Bulk & General Cargo	PTOL
5-8	531	4109.75	7.5	Liquid Bulk & General Cargo	BUA

Source: NPA Abstract 2017

Rivers berth 1 - 4 has 660m quay length, 3607.043ha area, 7.92m max depth, cargo type includes dry bulk, liquid bulk &general cargo and operated by PTOL. Berth 5-8 has 531m quay length, 4109.75ha area, 7.5m max depth, liquid bulk & general cargo type and operated by BUA.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 1854-1862 www.ijaem.net ISSN: 2395-5252

Table 2.3 Onne Port Complex Berth Characteristics

Berth	Quay Length (m)	Area (ha)	Max Depth (m)	Cargo Type	Operator
1-3 FOT	1,320	20	7	General Cargo	INTEL
1-3 FLT	900	33	11	Container & General Cargo	BRAWAL

Source: NPA Abstract 2017

Onne berth 1 – 3 FOT has 1,320m quay length, 20ha area, 7m max depth, general cargo type and operated by INTEL. Berth 13 FLT has 900m quay length, 33ha area, 11m max depth, container bulk & general cargo type and operated by BRAWAL.

III. DATA PRESENTATION AND ANALYSIS

Thissection aimed at the presentation, analysis, and discussion of data for the study.Table 3.1 below shows the output and input descriptive statisticsof the selected Nigerian seaports from 2008 to 2017. The input variables are labour, turnaround time, berth occupancy and ship traffic, while the output variable is cargo throughputs of the three seaports studied.

Table 3.1: Descriptive Statistics for the Sample Seaports Summary

Variables	**Valid Values**	**Missing Values**	**Mini**	**Maxi**	**Average**	**Medium**	**Stddev**	**EstStddev**
Labour	30	0	202	726	422.7	405	173.185	176.145
Turnaround Time	30	0	2.4	10.5	4.90733	3.98	2.53037	2.57363
Berth Occupancy	30	0	18.4	75.36	50.0517	55.6	16.3595	16.6392
Ship Traffic	30	0	121704	4.55438E7	2.1954E7	2.69493E7	1.648E7	1.67617E7
Cargo Throughput	30	0	3.14494E6	2.79689E7	1.58835E7	2.01042E7	9.0281E6	9.18243E6

Source: Author 2019

Table 3.1 above reveals the summary of descriptive statistics for the Three (3) sample seaports in Nigeria which are, Apapa, Onne and Riversseaports considering time series data of 10years.

IV. DISCUSSION OF SUMMARY RESULTS OF T.E (CRS), PURE T.E (VRS), SCALE EFFICIENCY (S.E) AND RETURN TO SCALE (RTS) FOR THE THREE (3) SELECTED SEAPORTS

Table 4.1: Efficiency Summary of T.E (CRS), Pure T.E (VRS), and Scale Efficiency value (S.E) Estimating of the efficiency, Rank and Return to scale (RTS) for the three (3) Selected Seaports.

DMU/Firm	Crste	Crste Rank	%((1-crste) x 100%)	Vrste	Vrste Rank	%((1-Vrste)x 100%)	S.E	Scale(%) ((1-SE)x 100%)	RTS of Seaports
Apapa 2008	0.452	18	54.8	0.532	26	46.8	0.849	15.1	IRS
Onne 2008	0.129	29	87.1	0.997	11	0.3	0.13	87	IRS
Rivers 2008	0.235	22	76.5	0.637	22	36.3	0.368	63.2	IRS
Apapa 2009	0.461	14	53.9	0.529	27	47.1	0.872	12.8	IRS
Onne 2009	0.161	26	83.9	1	1	0	0.161	83.9	IRS
Rivers 2009	0.129	29	87.1	0.587	25	41.3	0.219	78.1	IRS

Apapa 2010	1	1	0	1	1	0	1	0	CRS
Onne 2010	1	1	0	1	1	0	1	0	CRS
Rivers 2010	0.564	11	43.6	1	1	0	0.564	43.6	IRS
Apapa 2011	0.455	17	54.5	0.51	28	49	0.893	10.7	IRS
Onne 2011	0.954	6	4.6	0.99	13	1	0.964	3.6	IRS
Rivers 2011	0.27	20	73	0.852	19	14.8	0.317	68.3	IRS
Apapa 2012	0.405	19	59.5	0.498	29	50.2	0.813	18.7	IRS
Onne 2012	1	1	0	1	1	0	1	0	CRS
Rivers 2012	0.23	23	77	0.964	15	3.6	0.239	76.1	IRS
Apapa 2013	0.471	13	52.9	0.576	26	42.4	0.818	18.2	IRS
Onne 2013	0.866	9	13.4	0.921	17	7.9	0.94	6	IRS
Rivers 2013	0.211	24	78.9	0.995	12	0.5	0.212	78.8	IRS
Apapa 2014	0.572	10	42.8	0.663	20	33.7	0.863	13.7	IRS
Onne 2014	1	1	0	1	1	0	1	0	CRS
Rivers 2014	0.265	21	73.5	0.982	14	1.8	0.27	73	IRS
Apapa 2015	0.55	12	45	0.655	21	34.5	0.84	16	IRS
Onne 2015	0.883	8	11.7	0.884	18	11.6	1	0	CRS
Rivers 2015	0.177	25	82.3	0.925	16	7.5	0.191	80.9	IRS
Apapa 2016	0.461	14	53.9	0.61	23	39	0.755	24.5	IRS
Onne 2016	1	1	0	1	1	0	1	0	CRS
Rivers 2016	0.154	27	84.6	1	1	0	0.154	84.6	IRS
Apapa 2017	0.457	16	54.3	0.592	24	40.8	0.771	22.9	IRS
Onne 2017	0.931	7	6.9	1	1	0	0.931	6.9	IRS
Rivers 2017	0.154	27	84.6	1	1	0	0.154	84.6	IRS
Mean	0.52			0.83			0.643		

Source: Author 2019

Note: CRSte = T.E (CRS-model), VRSte = T.E (VRS-model). Scale = S.E = Crste/Vrste

Table 4.1 above shows the results for the comparison of VRS and CRS for the seaports, the returns to scale, and the scale efficiency in which the seaports are operating under the periods of study.

The Constant Return to Scale Efficiency (T.E) Results of the Seaports

Constant Return to Scaleis useful for controlling the process of production and makingdecisions at various levels includingshort-term tactical operation, daily operation, andlongtermstrategic operation. DEA is used to measure the relative productivity of a DMU by comparing it with other homogeneous units transforming the same group of measurable positive inputs into the same types of measurable positive outputs.

The CRS result indicates that the Onne seaport was efficient in 2010, 2012, 2014 and 2016. Apapa seaport was efficient in 2010 and Rivers seaport was inefficient for all the years. Furthermore, Apapa seaport was not efficient in 2008, 2009, 2011, 2012, 2013, 2014, 2015, 2016 and 2017, Onne was not efficient in 2008, 2009, 2011, 2013, 2015,and 2017 and Rivers port was not operating efficiently from 2008 to 2017.

The Variable Return to Scale Efficiency (P.T.E) Results of the Sample Seaports

In the Data Envelopment Analysis, Variable Return to scale model is an alternative modified model from the CRS model. From the very beginning of the DEA studies, there have been various extensions of the CRS model and VRS model is one of them. It is an improved or upgraded model of the Constant Return to Scale.

The VRS is an improved version of CRS and this is proven by the results from the study. The table revealed that Onne port was efficient in 2009, 2010, 2012, 2014, 2016 and 2017. Apapa port was efficient in 2010, and Rivers port was

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 1854-1862 www.ijaem.net ISSN: 2395-5252

efficient in 2010, 2016 and 2017. From the results, Apapa was not efficient in the years 2009, 2011, 2012, 2013, 2014, 2015, 2016 and 2017. Rivers port was not efficient in 2009, 2011, 2012, 2013, 2014, and 2015. And Onne port was not efficient in the year 2008, 2011, 2013, and 2015. It is crystal clear that the efficiency result is better or improved as compared to the VRS. From the two results, (CRS and VRS) it is revealed that Onne is still most efficient as compared to Apapa and Rivers. The implication is that the Onne port is well managed and will be the best to be used to benchmark the other ports.

The Return to Scale (R.S)

The return to scale simply shows the seaports operating under constant return to scale/optimal scale and increasing return to scale/below optimal scale. The ports operating at CRS/optimal scale are already efficient and any alternation in the variables either increase or decrease will make them not to operate at optimal scale. While the increasing or decreasing return to scale shows ports that are not efficient or operating below optimal scale and they are needed to be adjusted, so as to be operating at optimal scale.

The return to scale of the seaports as revealed in table 4.1 above. It shows that 80% of the ports' years of study were operating below their optimal scale size and thus, experiencing Increase Return to Scale (CRS). 20% of the Seaports periods under study were experiencing Constant Return to Scale. The policy implication of this finding is that these seaports can enhance efficiency by increasing their size. Thus, downsizing seems to be an appropriate strategic option for these seaports in their pursuit to reduce unit costs and as well as some other inputs so as to increase the efficiency level.

Considering the DMUs of year 2008in table 3.2 above, Apapa port has pure efficiency value of 53.2% and a scale efficiency value of 84.9%. It experienced increasing returns to scale (IRS). By improving the operation of the Apapa port, 46.8% of inputs could be spared. By improving the firm to its optimal size, 15.1% of inputs could be spared. Onne Port has a pure efficiency value of 99.7% and a scale efficiency value of 13%. It experienced increasing returns to scale (IRS). By improving the operation of Onne port, 0.3% of inputs could be spared. By improving the firm to its optimal size, 87% of inputs could be spared. Rivers port has a pure efficiency value of 63.7% and a scale efficiency value of 36.8%. It experienced increasing returns to scale (IRS). By improving the operation of Rivers port, 36.3% of inputs could be spared. By improving the firm to its optimal size, 63.2% of inputs could be spared.

In the Year 2009, Apapa port has a pure efficiency value of 52.9% and a scale efficiency value of 87.2%. It experienced increasing returns to scale (IRS). By improving the operation of the Apapa Port, 47.1% of inputs could be spared. By improving the firm to its optimal size, 12.8% of inputs could be spared. Onne Port has a pure efficiency value of 100% and a scale efficiency value of 16.1%. It is experiencing increasing returns to scale (IRS). Onne port was well managed; it cannot improve its pure efficiency. The only capacity for improvement lies in a scale adjustment, 83.9% of inputs could be spared. Rivers port has a pure efficiency value of 58.7% and a scale efficiency value of 21.9%. It was experiencing increasing returns to scale (IRS). By improving the operation of Rivers port, 41.3% of inputs could be spared. By improving the firm to its optimal size, 78.1% of inputs could be spared.

In the Year 2010**,**Apapa and Onne port have a pure efficiency value of 100% and a scale efficiency value of 100%. They were well managed; hence, their pure efficiency and scale efficiency could not be improved. Rivers port has a pure efficiency value of 99% and a scale efficiency value of 96.4%. It was experiencing increasing returns to scale (IRS). Rivers port has a pure efficiency value of 100% and a scale efficiency value of 56.4%. It was experiencing increasing returns to scale (IRS). Rivers port was well managed;so its pure efficiency could not be improve. The only capacity for improvement lies in a scale adjustment, 43.6% of inputs could be spared.

In the Year 2011**,**Apapa port has a pure efficiency value of 51% and a scale efficiency value of 89.3%. It experienced increasing returns to scale (IRS). By improving the operation of the Apapa port, 49% of inputs could be spared. By improving the firm to its optimal size, 10.7% of inputs could be spared. Onne port has a pure efficiency value of 99% and a scale efficiency value of 96.4%. It experienced increasing returns to scale (IRS). By improving the operation of Onne port, 1% of inputs could be spared. By improving the firm to its optimal size, 3.6% of inputs could be spared. Rivers port has a pure efficiency value of 85.2% and a scale efficiency value of 31.7%. It experienced increasing returns to scale (IRS). By improving the operation of Rivers port, 14.8% of inputs could be spared. By improving the firm to its optimal size, 68.3% of inputs could be spared.

The year 2012, Apapa port has a pure efficiency value of 49.8% and a scale efficiency value of 81.3%. It experienced increasing returns to scale (IRS). By improving the operation of the Apapa Port, 50.2% of inputs could be spared. By improving the firm to its optimal size, 18.7% of inputs could be spared. Onne port has a pure efficiency value of 100% and a scale efficiency value of 100%. It was experiencing constant returns to scale (CRS). Onne was well managed; its pure efficiency and scale efficiencybe could not improved. Rivers port has a pure efficiency value of 92.1% and a scale efficiency value of 94%. It was experiencing increasing returns to scale (IRS). By improving the operation of Rivers port, 7.9% of inputs could be spared. By improving the firm to its optimal size, 6% of inputs could be spared

In 2013, Apapa had a pure efficiency value of 57.6% and a scale efficiency value of 81.8%. It was experiencing increasing returns to scale (IRS). By improving the operation of the Apapa port, 42.4% of inputs could be spared. By improving the firm to its optimal size, 18.2% of inputs could be spared. Onne port has a pure efficiency value of 92.1% and a scale efficiency value of 94%. It was experiencing increasing returns to scale (IRS). By improving the operation of Onne port, 7.9% of inputs could be spared. By improving the firm to its optimal size, 6% of inputs could be spared. Rivers port has a pure efficiency value of 99.5% and a scale efficiency value of 21.2%. It was experiencing increasing returns to scale (IRS). By improving the operation of Rivers port, 0.5% of inputs could be spared. By improving the firm to its optimal size, 78.8% of inputs could be spared.

In the year 2014, Apapa port has a pure efficiency value of 66.3% and a scale efficiency value of 86.3%. It is experiencing increasing returns to scale (IRS). By improving the operation of the Apapa port, 33.7% of inputs could be spared. By improving the firm to its optimal size, 13.7% of inputs could be spared. Onne port has a pure efficiency value of 100% and a scale efficiency value of 100%. It is experiencing constant returns to scale (CRS) and Onne port was well managed, it cannot improve its pure efficiency nor scale efficiency. Rivers port has a pure efficiency value of 98.2% and a scale efficiency value of 27%. It is experiencing increasing returns to scale (IRS). By improving the operation of Rivers port, 1.8% of inputs could be spared. By improving the firm to its optimal size, 73% of inputs could be spared.

The year 2015, Apapa port has a pure efficiency value is 65.5% and a scale efficiency value is 84%. It is experiencing increasing returns to scale (IRS). By improving the operation of the Apapa port, 34.5% of inputs could be spared. By improving the firm to its optimal size, 16% of inputs could be spared. Onne port pure efficiency value is 88.4% and a scale efficiency value of 100%. It is experiencing increasing returns to scale (IRS). By improving the operation of Onne port, 11.6% of inputs could be spared. Its scale efficiency cannot be increased. Rivers port has a pure efficiency value of 92.5% and a scale efficiency value of 19.1%. It is experiencing increasing returns to scale (IRS). By improving the operation of Rivers port, 7.8% of inputs could be spared. By improving the firm to its optimal size, 80.9% of inputs could be spared.

In 2016, Apapa had a pure efficiency value of 61% and a scale efficiency value of 75.5%. It experienced increasing returns to scale (IRS). By improving the operation of the Apapa Port, 39% of inputs could be spared. By improving the firm to its optimal size, 24.5% of inputs could be spared. Onne port had a pure efficiency value of 100% and a scale efficiency value of 100%. It experienced constant returns to scale (CRS) and Onne Port was well managed, its pure efficiency and scale efficiency could not be improved. Rivers port has a pure efficiency value of 100% and a scale efficiency value of 15.4%. It was experiencing increasing returns to scale (IRS). Rivers port was well managed;hence its pure efficiency could not be improved. The only capacity for improvement lies in a scale adjustment, 84.6% of inputs could be spared.

In the year 2017**,** Apapa Port had a pure efficiency value of 59.2% and a scale efficiency value of 77.1%. It was experiencing increasing returns to scale (IRS). By improving the operation of the Apapa Port, 40.8% of inputs could be spared. By improving the firm to its optimal size, 22.9% of inputs could be spared. Onne port has a pure efficiency value of 100% and a scale efficiency value of 93.1%. It was experiencing increasing returns to scale (IRS). Onne port was well managed;so its pure efficiency could not be improved. The only capacity for improvement lies in a scale adjustment, 6.9% of inputs could be spared. Rivers port has a pure efficiency value of 100% and a scale efficiency value of 15.4%. It was experiencing increasing returns to scale (IRS). Rivers port was well managed; its pure efficiency could not be improved. The only capacity for improvement lies in a scale adjustment, 84.6% of inputs could be spared.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 1854-1862 www.ijaem.net ISSN: 2395-5252

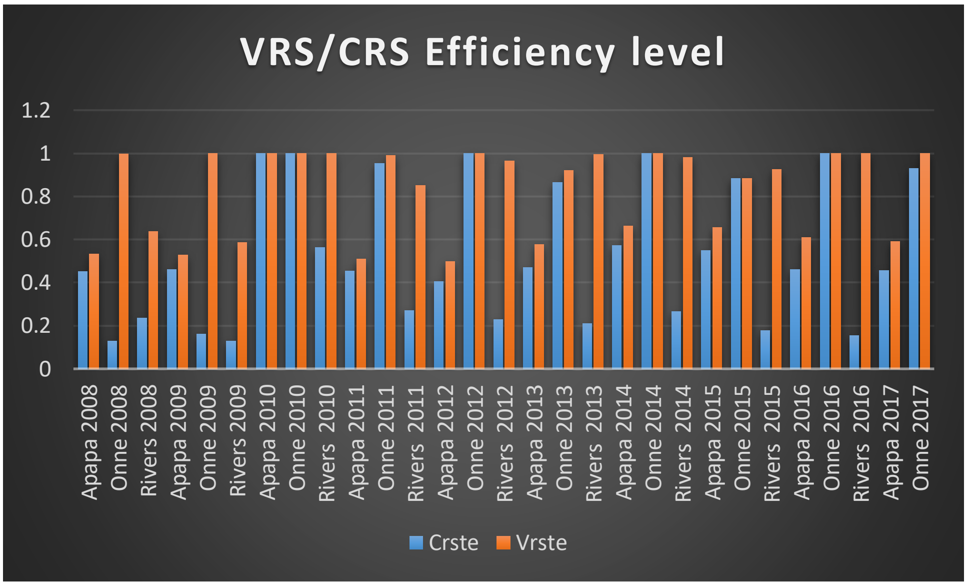

Figure 3.1:VRS and CRS efficiency slope

Source: Author 2019

Figure 3.1 shows the efficiency results of the three significant seaports that are on the production frontier. Their respective years of appearance are: Onne (2009, 2010, 2012, 2014, 2016 and 2017), Apapa (2010), and Rivers(2010, 2016 and 2017).On the efficiency frontier, it means they were operating at a technical efficiency degreeof 100%, while subsequent years of the seaports were below the frontier. OnnePort in 2008 and Rivers port 2009 were the least efficient as shown in the frontier curve with an inefficiency value of 0.129. From the curve, pure efficiency (VRS) was majorly operated at 100% compared to Technical Efficiency (CRS).

V. CONCLUSION

The study is aimed at assessing seaport performance in Nigeria. From the analysis, we conclude that the empirical findings of the study show various significant results from the DEA model used to analyze the time-series data and contextual variables during the analysis. The findings indicate that higher and lower efficiency values of the seaports were obtained and require different actions in order to keep on with high service standards.

The efficiency indices inclined from 0.129 to 1 for the CRS-model result and 0.498 to 1 for VRS-model. The findings reveal that at least 2 seaports were considered to be technically efficient from the CCR-model analysis result for the 10 years period. The seaports were Apapa in the year 2010 and Onne in the year 2010, 2012, 2014 and 2016. Also the VRS results show that the seaports were efficient in the following years: Apapa (2010), Onne (2009,2010, 2012, 2014,2016 and 2010) and Rivers (2010, 2016 and 2017). From the VRS results, it becomes clear that there is an improvement in the level of the seaport efficiency as compared to the CRS.

The study shows clearly that Nigerian ports are improving in their level of efficiency. However, Onne port performed most efficiently in the comparative analysis results. Apapa is also efficient in 2010 and not efficient in the remaining years of study and Rivers port performs generally inefficiently over the periods of the study as revealed in the CRS result. The VRS results show that Onne performed betterthan Apapa and Rivers ports. Rivers Port also performed better when compared to Apapa. The competitiveness among the ports also affects their relative performances. Apapa and Rivers port should be privatized to improve their efficiency level and Onne port should be used to benchmark other Nigerian ports.

VI. RECOMMENDATIONS

1. From the correlations matrix of the CRS and VRS DEA-model analysis, there is a need to improve the inputs so as to increase the efficiency level of the seaports.
2. Onne port should be used to benchmark other Nigerian ports due to its level of efficiency as compared to the other ports.
3. Apapa and Rivers port should be privatized to improve their efficiency levels
4. The government should improve accessibility in and around the port by providing better road

and rail networks. Doing so will help to ease the operational activities within ports and the efficiency will also improve.

5. The Government should ensure workers/labor strikes are prevented and that excessive holidays of NPA staff are avoided to improve the efficiency of the ports.

REFERENCES

[1]. AFDB (2010). Gowing Forward: Developing Regional Hubs in Africa. http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/African%20Develpment%20Report%202010_CH%206.pdf

[2]. African-Line, O.T. (2009). Trade Watch, West African trade and transport report.http://www.otal.com: The official webpage of OT African line-Nigeria

[3]. Bojan, B., &Elen, T. (2011). Agile Port and Intermodal Transport Operations Model to Secure Lean Supply Chains Concept. Traffic&Transportation, 23(2),105-112

[4]. CBi, (2019). Port Reforms: Why Nigerian Ports Lose Money; Understanding the Economics of Inefficiency and Sleaze. https://www.proshareng.com/news/Doing-Business-in Nigeria/Port-Reforms--Why-Nigerian-Ports-Lose-Mo/47340

[5]. Chioma, O.A. (2011). Freight traffic at Nigerian seaports; problem and Prospect. MedwellJournals. 6 (1), 250-258.

[6]. Dutra, A., Ripoll-Feliu, V.M., Fillol, A.G., Ensslin, S.R., &Ensslin, L. (2015). Theconstruction of knowledge from the scientific literature about the theme seaport performance evaluation. International Journal of Productivity and PerformanceManagement 64 (2): 243–269.

[7]. Ensslin, L., Ensslin, S.R., Dutra, A., & Reis, C. (2017). BPM governance: A literature analysis of performance evaluation. Business Process Management Journal 23 (1): 71–86.

[8]. Gekara, V.O., &Chhetri, P. (2013). "Upstream transport corridor inefficiencies and the implications for port performance: a case analysis of Mombasa Port and the NorthernCorridor." Maritime Policy and Management**40**(6): 559-573.

[9]. Gekara, V. O., & Fairbrother, P. (2013). "Managerial Technologies and Power Relations: astudy of the Australian Waterfront." New Technologies, Work and Employment**28**(1):14.

[10]. Ghashat, H., & Cullinane, K. (2013). Port Devolution in Libya: Identifying a Roadmap forSuccess. International Journal of Governance. 3 (2).

[11]. Leighland, J., &Palsson, G. (2007). Public-private infrastructure advisoryfacility. Washington, DC.

[12]. Njoku, I. (2009). Evaluation of Transport Infrastructural Development in Nigeria & its Effecton the National Economy. An unpublished M.Sc Thesis at the Federal University of Technology, Owerri.

[13]. Nigerian Ports Authority, (2017). Annual Reports. Nigerian Ports Authority Annual Reports.

[14]. Paixao, A. C., & Marlow, P. B. (2003): Fourth generation ports - a question on an agility?,International Journal of Physical Distribution and Logistics Management, 33(4).335-376

[15]. Perez-Labajos, C., & Blanco, B. (2004). Competitive policies for commercial sea ports in theEU. Marine Policy, 28**,** 553-556.

[16]. Peter, W., Obioma, R. N., &Zhongfei, C. (2017): Efficiency in Nigerian ports: imprecise datawith a two-stage fuzzy approach, Maritime Policy and Management, DOI: 10.1080/03088839.2017.1410588

[17]. Kia, M., Shayan, E., &Ghotb, F. (2000). "The importance of information technology in portterminal operations" International Journal of Physical Distribution and Logistics Management30(3/4): 331-344.

[18]. Van dyck, G.K. (2015). The Drive for a Regional Hub Port for West Africa: GeneralRequirements and Capacity Forecast. International Journal of Business and EconomicsResearch, 4, 36-44.