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A PERFORMANCE EVALUATION OF NIGERIA NATIONAL PETROLEUM CORPORATION JETTIES: A MARITIME TRANSPORT PERSPECTIVE USING DATA ENVELOPMENT ANALYSIS (DEA)

Kenneth Ezebunwa Ndubuisi
Department of Maritime Management Technology, School of Management Technology, Federal University of Technology Owerri, Nigeria
Chinyeaka Nwokodi Nwoloziri
Department of Maritime Management Technology, School of Management Technology, Federal University of Technology Owerri, Nigeria

Abstract

This study is focused on the efficiency evaluation of three NNPC jetties in the Niger Delta. Pre and post 2016 jetty performance over a study period of seven years after a change in the government policy on petroleum product supply was analyzed. The analytical tools used in this study were DEA Model and Ordinary Regression Analysis. The study showed that there is significant relationship between the Output variable (Annual Volume) and Input variables (Max Breadth Extreme, Max LOA and Shore Cargo Tank Capacity). The study also showed that there was more efficient use of the jetties pre 2016 than post period. The study also showed that the NNPC Calabar jetty is the overall most efficient NNPC jetty within the period of study in the Niger Delta Region.

Keywords: NNPC Jetty, R-DEA Model, Efficiency, Petroleum Product supply

1. Introduction

The oil and gas industry is a vital and strategic sector in every country's economy. In Nigeria, this industry is the mainstay of the economy. The oil and gas sector and its numerous infrastructures have been perceived as the indicators of the economic health status of the nation. For the purposes of this study, the oil and gas infrastructure of concern are the tanker vessels (petroleum product tankers), the product import jetties (product jetties), the liquid bulk depots (product tank farms) and the petroleum products (Premium Motor Spirits, Automotive Gas Oil, Dual Purpose Kerosene Etc). These infrastructure forms the basis for all essential economic activities of most countries with its numerous multiplier effects. It is so strategic that it has always been the centre of the international geopolitical and macroeconomic panorama; hence most of the governments maintain careful control of the evolution of the industry or even directly manage the operations in their respective countries (Masseron, 1990). In this period of high globalized production and consumption driven by increase in world population with limited available resources, there is a growing need for efficient and productive supply chain management in oil and gas industries (Hackworth and Shore 2004). This brings to light also the need in the petroleum product supply chain. The petroleum product supply chain which is procurement, transportation, storage, and distribution/marketing has been subject to deliberate drive by corporations to eliminate wastes. For instance, Maritime transportation as a major

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channel of international trade have been subjected to deliberate efforts to improving the efficiency of the sector, hence, there are double bottom very large crude carriers, basically for operators to enjoy economies of scale and also eliminate sea pollution. According to UNCTAD (2009), international sea borne trade, from 1980 to 2008 witnessed an increase of over 120%. According to Umang et al. (2011), this increase was possible due to the steady growth in world population, rapid industrialization, and the depletion of local resources, road congestion, increase in living standard and elimination of trade barriers. He also claimed that since the beginning of the decade, dry bulk, liquid bulk and containerized cargo have registered an impressive tonnage increase of 52%, 48% and 154% respectively. Pertinently, the 48% increase of the liquid bulk traffic was all received through a terminal-jetty which is the link between seagoing tanker vessels and inland transportation systems. Therefore the importance of jetties in the petroleum product supply chain cannot be over emphasized. According to Merk & Dang, (2012), the volume of petroleum product traffic is not only dependent on world oil supply and demand fluctuations, but also influenced by the terminal's efficiency, jetty draught, storage capacity, pipeline suitability. and government policy For instance, the Nigerian National Petroleum Corporation (NNPC) is saddled with the responsibility of providing and ensuring that there is consistent supply of petroleum products nationwide in other to meet the local demand, hence preventing price hike, product diversion and product scarcity.

Jetties like conventional ports play an important role in the supply chain of the petroleum product and economic development of any nation of the world. The importance of the jetty in Nigeria economy cannot be over emphasized mainly because Nigeria operates a mono-economy driven by petroleum resources (Lambert, and Cooper, 2000). Though according to (Prakash, 2005) who opined that jetties-piers are more than ports and regarded jetties as infrastructure or a complex infrastructure, it should also be noted that some jetties are the most economically viable and relevant than some ports in developing and developed economies of the world. However, it is pertinent to mention that the dysfunction or lack of jetties could cause a negative multiplier effect in the petroleum product supply chain, given that the products loaded and unloaded through these jetties serves as the lifeline of the economic survival of the country. Jetties are also synchronizers between the marine league and inland league of the product supply chain via pipelines. Therefore, policy decisions on the downstream sector of the oil and gas industry internationally and locally are made by critically considering in disaggregated form for all the echelons in the supply chain, mainly for the purposes of overall efficiency of the system which has an international outlook and coloration; hence, the strict interest and implementation of ISPS Code worldwide. In 2016, the Nigeria government introduced a Centralized Petroleum Product Supply System (CPPSS) anchored solely by NNPC to checkmate the issues of product scarcity, hike in price, product diversion and most of all the “subsidy scam”. This policy on the surface could be seen as laudable, but the policy instilled the powers of monopoly to NNPC, created economic stagnation to competitors and investors, and inflicted a high premium of unemployment. This study is poised to empirically evaluate the relative effectiveness of NNPC jetties in handling products owing to the changing phase of the government policies on petroleum product distribution especially for NNPC Jetties located at the Niger Delta region. The

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performance of these jetties will also serve as a reflector of the effect of these policies on the use of government infrastructure-jetty over the study period.

1.2 Problem statement

From early 1990s up to date, it has been the Nigeria government policy to have control over the petroleum sector. The government is the sole importers of petroleum products and saddled with the responsibility to supply the limited quantities of petroleum products to make up for the domestic production shortage of 11% as estimated, however, recently importation has increased from 11% in 1990 to 80% in 2000 and today about 100% as none of the local refineries are effectively in operation. This policy has remained a major drain of our country's foreign reserves, which has been diverted to importation of petroleum products (Musikilu, 2011). However, since 2016, the Nigerian downstream oil and gas sector seeks clarity in the deregulation process. For instance, the supply process of petroleum products in Nigeria since 2016 has been the Centralized Petroleum Products Supply System Policy (CPPSSP) anchored by NNPC (Reginald, 2016). This supply structure is a carefully crafted monopoly that has driven away competition and thereby inflicted the pains of a monopoly on apparent competitors and the populace. This has forced most independent and major marketers and oil jetties terminals to be grossly underutilized. This policy has subjected industry operators to be under threat of losing their investments in the oil and gas industry. The issues of product scarcity and products price hike are also remaining a norm in the polity. The issues concerning subsidy as a scam has also remained a decimal in the political discussion, however, the Centralized Petroleum Products Supply System Policy anchored by NNPC was meant to control the veracity over the exact import quantity, quantity consumption, and actual amount subsidized. These challenges are still prevalent in the country. However, the main aim of this study is to evaluate the performance of the NNPC petroleum product jetties pre and post 2015 to empirically showcase the effect of the policy change in the provision of petroleum products through the three jetties within the Niger Delta Region. Hence, the measurement of the Cargo throughput and the frequency of vessel calls (vessel turnaround time) over these periods are vital. Also, Scholars have used DEA model in analyzing so many industries such as schools, hospitals, banks, ports (Barros & Athanassiou, 2004: Madueke, 2013) etc but none is done on petroleum product jetties in Niger Delta Region.

1.3 Objectives of the study

1. To confirm the influence of input variables on the output variables used in this study.
2. To evaluate the impact of Centralized Petroleum Products Supply System policy on the efficiency of the NNPC jetties.
3. To identify the efficiency levels of the NNPC jetty facilities in Niger Delta Region.

1.4 Research questions

1. How significant is the relationship between the input and output variables used in this study?
2. How has the Centralized Petroleum Products Supply System policy in Nigeria impacted the efficiency of NNPC jetties in the Niger Delta Region?
3. Are the three NNPC jetties under study efficient?

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1.5 Hypothesis

In trying to answer some of the above research questions, the test of the following hypothesis is vital:

1. Ho: There is no significant relationship between the input variables and the output variables.
2. Ho: There is no significant impact in the efficiency of these NNPC jetties in the Niger Delta after the implementation of the Centralized Petroleum Products Supply System policy.
3. Ho: There are no efficient NNPC jetties in Niger Delta.

1.6 Justification of the Study

This study will confirm if this CPPSS policy reflect an improvement on the optimal utilization of the government owned jetties and depots (NNPC). The study will illustrate if there is need for an amendment or sustenance of such policy. It will also serve as a wakeup call to all policy makers concerning the oil and gas downstream sector in Nigeria. This study will also serve as a management decision making tool while it also functions as a guide to industry players in Nigeria and developing economies. Finally, the study will serve as a material of reference to student, stakeholders in the petroleum industry, consultants, corporate organization and the general public.

1.7 Brief description of case study - Niger Delta Region and NNPC Jetties

The Niger Delta region is situated in the Gulf of Guinea between longitude 5^0E to 8^0E and latitudes 4^0N to 6^0N, (Opafunso, 2007). ERML (1997) estimated the original Niger Delta region to about 29,900 square kilometers as comprising the area covered by the natural delta of the River Niger and the areas to the east and west, which also produce oil. The natural delta is the Delta of the Niger Delta River sitting directly on the Bight of Biafra (officially Bight of Bonny, in Nigeria) is a bight off the West African coast, in the easternmost part of the Gulf of Guinea, the Atlantic Ocean in Nigeria (*Heerten, & Moses, 2017)*. According to Azaiki (2003), Niger Delta bulged out into the Gulf of Guinea between the Bight (Bay) of Benin and the Bight of Biafra covering more than 10,000 square miles, and has a shoreline of about 200 miles of its 14 main tributaries. The Niger Delta falls under a tropical rain climate, which occurs between 4^0N–10^0N of the equator and at an altitude below 1000 meters. Its mean annual rainfall is always high, although it varies within the region (Azaiki, 2003). The River Niger has a catchment area of approximately 1,150,000km and it natural source is from the Gulf of Guinea while its Delta is in Nigeria. However, the river bifurcates into the Forcados River (western branch) and Nun River (eastern branch). These two rivers further divides into interlinked tributaries, rivers, rivulets and creeks before finally emptying into the Atlantic Ocean. These unique natural features of the Niger Delta region and the perennial vehicular and vessel traffic congestion in the Lagos area of Nigeria have made it the Niger Delta region an investment haven for oil and gas stakeholders. The Niger Delta, as officially defined by the Nigerian government, extends over about 70,000 km^2 (27,000 sq mi) and makes up 7.5% of Nigeria's land mass. It consists of present-day Bayelsa, Delta, and Rivers States. In 2000, however, Obasanjo's regime included the following states - Abia, Akwa-Ibom, Cross River, Edo, Imo and Ondo in the region (Vidal, 2016). Hence, the nine Niger Delta Development Commission (NDDC), states are namely; Abia,

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Akwa Ibom, Bayelsa, Cross Rivers, Delta, Edo, Imo, Ondo and Rivers, and has 185 local government council area, comprising of 800 communities of 12 major ethnic groups endowed with the bulk of crude oil and gas reserves. This region has projected Nigeria in the world map, as the largest producer of oil in Africa, and the fifth largest in OPEC. The region is host to some 42 oil companies prospecting for oil in about 162 oil fields, 275 flow stations, 1,481 oil wells as well as over 7,000km of crude, products and gas pipelines as well as flow lines. The region has also experienced the proliferation of oil terminal and jetties in recent times. According to PPPRA figures of 2018, Nigeria has over 127 product jetties, out of this, the region account for approximately 50 petroleum product jetties. Considerably, the population of this region according to the National Population Commission (NPC) figures of the 2006 census is approximately 30 million people which portends that living standards is expected to be high and rate of unemployment is supposed to below. This is an area that needs to be researched. Though, in this study our interest is on the efficiency of the three NNPC petroleum product jetties within the Niger Delta region namely NNPC JETTY CALABAR, PHRC OKRIKA, and WRPC JETTY WARRI especially before and after the introduction of the Centralized Petroleum Product Supply System policy of the federal government as pioneered by NNPC in 2016**.**

1.8 Nigerian National Petroleum Corporation (NNPC) Petroleum Product Jetties:

The Nigerian National Petroleum Corporation (NNPC) was established under the statutory instrument Decree No. 33 as a result of a merger of Nigerian National Oil Company (NNOC) and the Federal Ministry of Mines and Steel. According to Wikipedia, NNPC was established on 1 April 1977 for the sole responsibility of overseeing the development of the upstream and downstream while also regulating and supervising the oil and gas industry on behalf of the Nigerian Government. Eleven years later the corporation was commercialized into 11 strategic business units, covering the entire spectrum of the industry's operations such as exploration and production, gas development, refining, distribution, petrochemicals, engineering, and commercial investments. Hence, NNPC manages the joint venture contracts between the Nigerian government and the International Oil Corporations (IOCs), which include Royal Dutch Shell, Agip, ExxonMobil, Total S.A, Chevron, and Texaco (now merged with Chevron) to conducts petroleum exploration and production. While in the downstream league of the oil and gas industry, NNPC built refineries, depots and jetties for the smooth distribution of refined petroleum products for local consumption. The jetties were purpose built with synchronized pipelines to depots from the southern to the northern part of the Nigeria. A seven year details of the jetties of study are found in table 1 below.

For the purpose of this study, a jetty is defined as "a pier projecting out into the waterway and with facilities for mooring ships at its head or along its flank"(www.piping-engineering.com). They are structural connection between the land with deep water farther away from shore for the purposes of docking ships and unloading cargo. They are also referred to as piers. (https://www.nationalgeographic.org/encyclopedia/jetty).

Literally, jetties are like "bus stops" but built on the waterways for loading and offloading of refined petroleum product from tanker vessels synchronized with pipelines connected to storage

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tanks termed depots – they are industrial facilities made up of storage tanks, pumps and meters for the storage of oil and/or petroleum products, from which these products are distributed to end users through the Bulk Road Vehicles (BRVs) serviced by loading gantries. NNPC has about 22 depots nationwide. (Table 1, shows the characteristics of the three NNPC jetties.)

In the Niger Delta Region of Nigeria, NNPC has three petroleum product jetties: Okirika jetty Port Harcourt, WRPC jetty Warri and NNPC jetty Calabar. The first two NNPC jetties are connected to the refinery and can supply refined petroleum products to inland depots while the Calabar jetty is not connected to the refinery but can only receive refined petroleum products from marine vessels through the jetty. The Okrika PHC jetty is connected to Port Harcourt depot, Aba depot, Enugu depot, Makurdi depot, Bonny Export Terminal (BET) but supplies Calabar depot through vessel voyage to Calabar jetty from Port-Harcourt or through direct importation which is the case as at today. The Warri jetty is connected to Warri depot, Benin depot, Abudu pump station, Auchi pump station, Lokoja pump station and Escravous PPMC Terminal. These infrastructures were built to achieve the objective of equal distribution of product pan Nigeria at the lowest possible cost. This architecture identified NNPC to be the best nucleus of the refined products distribution in Nigeria. In a bid to identify if these jetties owned and operated by the NNPC are operating efficiently in the phase of inconsistent policies, this study interest was muted. The results will amongst other things, provide NNPC with insights on the impact of the policies of centralized petroleum product supply system on NNPC jetties utilization.

Table 1: Characteristics of NNPC jetties in Niger Delta Region (2012 to 2018)

	NNPC jetties	CALABAR jetty	OKRIKA jetty	WARRI jetty
Input Variables	Jetty draft	6.5	9.2	10
	Max LOA	277	173.68	277
	Max Breadth Extreme	48	31.03	48
	Shore Cargo Tank Capacity	52,496,080	876,950,000	187,450,000
	No of Shore Cargo Tanks	5	11	14
2012 Output Variable	Annual Volume	134,773,206	243,787,365	238,411,032
	Ship Call Freq	16	15	18
2013 Output Variable	Annual Volume	199,331,834	352,647,013	70,362,756
	Ship Call Freq	21	12	4
2014 Output Variable	Annual Volume	19,679,614	512,370,833	151,243,824
	Ship Call Freq	2	16	13
2015 Output Variable	Annual Volume	204,958,378	466,194,714	293,005,436
	Ship Call Freq	19	13	21
2016 Output Variable	Annual Volume	115,412,113	171,501,208	147,722,040
	Ship Call Freq	11	5	11
2017 Output Variable	Annual Volume	126,365,006	54,605,994	9,368,805
	Ship Call Freq	13	3	1
2018 Output Variable	Annual Volume	166,852,205	586,296,505	70,361,932
	Ship Call Freq	15	16	4

Source: Researchers compilation from NPA yearbook, PPPRA publications, NNPC bulletins and websites

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1.8 Limitations to the Study

The study is limited to the operational evaluation of the performance of the three NNPC petroleum product jetties in CALABAR, OKRIKA and WARRI, all in Niger Delta Region of Nigeria. The dynamism of the study area and the inconsistency of the reports by the government agencies, made the study to be subject to steady editing due to confirmation and reconfirmation of data to avoid stale information. This study is not intended to be a comprehensive analysis of NNPC jetties efficiency evaluation. However for a more thorough examination, the reader is referred to the sources cited in the bibliography/references in this study and more.

2. Related literature review

Alaba & Agbalajobi (2013) evaluates the performance of private refineries and depots in distribution of petroleum products in Nigeria by randomly distributing ninety (90) questionnaires to the selected five major and ten independent private depots while sixty (60) questionnaires were distributed to the public within Lagos metropolis. The data collected were tabulated and analyzed by using statistical graphs and charts. The results show that 90% of the public make use of petroleum products in their daily activities while 77% of the respondents agreed that the establishment of private refineries and depots have improved distribution of petroleum products across the country. 70% of petroleum products used in Nigeria was imported into the country due to low performance of local refineries while 85% of the respondents rejected total deregulation of downstream sector without putting the local refineries in good condition. 75% of the respondents rated the performance of private depots above average while 65% demand for more in order to ensure steady supply and distribution of petroleum products to the teaming population of Nigeria.

Okeudo (2013) studied the impact of reforms on port performance using the Onne and Rivers ports as a reference point by analyzing the pre and post reform eras of the ports in terms of their performance. Secondary Data such as Ship traffic, Cargo throughput, Ship turn round time, Berth occupancy and personnel were used as variables for the assessment for the period of 2001 to 2010 and analyzed using Data Envelopment Analysis to assess the efficiency of the port. The analysis revealed a continuous improvement in the overall efficiency of both Ports, since 2006 when the new measure was introduced. Average Ship turn-around time improved in the ports due to modern and fast cargo handling equipment and more cargo handling space which were provided and also the Ship traffic calling at the ports increased, resulting in increased cargo throughput and berth occupancy rate at ports of Onne and Rivers. The reform also led to more private investment in the ports existing and new facilities and the introduction of a World Class service in port operation. This study concludes that the Ports of Onne and Rivers are performing better under the reform programme of the Federal Government of Nigeria.

Madueke (2013) examined the Measuring and Benchmarking of Efficiency and Productivity Levels of Liquid Bulk Terminal Operations Using a DEA AND OEE Approach Considering Nigeria's Atlas Cove Jetty and Depot Facility while focusing on the atlas cove jetty of the product and pipeline marketing company of Nigeria as its target terminal by using the DEA model to compare the relative efficiency of 4 terminals shortlisted from a panel of 84 terminals

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on the basis of the class of product handled by evaluating the Average Vessel Turnaround Time, the Berth Occupancy, and the Average Pump Rate. The result of the linear program to minimize of the objective function with the goal of identifying if our target terminal was performing at levels relatively inefficient was inconclusive. As an extension to this approach, the OEE approach was also used to compare performance level of equipments and sub-processes within our target terminal and our benchmark terminal with conclusive outcomes that inferred that our target terminal indeed has potential technical efficiency gains to be exploited. Onwuegbuchunam (2012) studied the productivity and efficiency of Nigerian seaports using the stochastic frontier framework. The panel data analyzed consists of the records of the coastal ports with output and multiple input variables for a 22 year period. The result reveals that the capital input variables significantly contribute to port productivity while the labour input variables were statistically insignificant. Ahmed, et al (2006) investigated the efficiency of 22 seaports in the Middle East and East African region using two separate analyses based on data collected for 6 years (2000–2005), Standard Data Envelopment Analysis (DEA) method was used in the first analysis and DEA window analysis was used in second analysis. By using both methods, better insight into the efficiency situation at hand is gathered; the advantages and disadvantages of the methods are highlighted.

2.1 Data Envelopment Analysis (DEA)

The basic concept of efficiency measurement is the ratio of total outputs to total inputs. However a more improved model was discovered by Charnes et al. (1994), who first introduced the DEA as a multi-factor productivity analysis module for measuring the relative efficiencies on decision making units (DMUs). DEA literally is Data Envelopment Analysis model; it is a non-parametric (i.e. deterministic (certainty)) model for measuring the efficiency of Decision Making Units (DMU) with multiple inputs and or multiple outputs (Yao et al. 2007), as one of its strong characteristics over linear programming application. The DEA is normally employed in the analysis of the cross sectional data. DEA as initially developed by Charnes et al. (1994), and Banker et al. (1984), in order to evaluate the relative efficiency of similar economic production systems which have evolved in application in the area of pure science given to its flexibility (Cooper, et al. 2003), and that can be applied under different underlying economic assumptions and the returns to scale (Charnes et al, 2012) yielding different DEA models (Bowlin, 1998). The DEA analysis shows how inputs and output have to be changed in order to maximize the efficiency levels of the target Decision Making Unit (Graham & Hardakar, 2000; Yan, et al. 2002).

According to Cooper et al (2004), The performance of a DMU is efficient if and only if it is not possible to improve any input or output without worsening any other input or output, while the performance of a DMU is inefficient if and only if it is possible to improve some input or output without worsening some other input and output. (Pareto-Koopmans Definition of Efficiency)

Charnes, et al (1994), developed several formulations as an approach to DEA. In this research the main question is with respect to minimization of inputs what firms are capable of. In this way an approach has been chosen which are Input-oriented Model, Constant Return to Scale (CRS)

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and Variable Return to Scale (VRS) analysis. This approach is adopted due to the severe competitive lobby of oil companies to access products from NNPC as the only product supplier in Nigeria since 2016 as explained in the introduction of this research.

3. Methodology

The study data were mainly secondary data gotten from the websites of Nigeria Ports Authority (NPA), Petroleum Product Pricing Regulatory Agency (PPPRA), Journals, NPA Bulletin and Handbook. These data were also reconfirmed by direct observation and random questions to cargo surveyors and vessel pilots operating in the Niger Delta region. The secondary data comprises of input variables (Jetty draft, Max Length Overall (LOA), Number of Product Tanks, Total Tank Capacity of terminal,) and output variables (Yearly Cargo Throughput, Yearly Tanker Calls). These data were collected for a seven-year period from 2012 to 2018.

The data collected on this study were analyzed using DEA. DEA is used in this study because of its suitability in analyzing efficiency of transit services which petroleum product jetty is. In this paper, we propose the output-oriented DEA model to maximize the output while the inputs variables remain the same.

Where,

X= input vector used in the DMUs.

Y= output vector produced by DMUs.

Є=is a constant non- Archimedean (infinitesimal of the order of 10-6) that insures no input or output is given a zero weight while s+ and s- are the slack vectors for output and input respectively.

Θ=represents the proportional reduction of the input in relation to the amount of the projected input. The optimal value of λ forms a composite unit outperforming the DMU under analysis and providing targets for this DMU to identify sources of its inefficiency.

Thus:

F= {(Y, X)/X can produce Y}

Where in this study n= NNPC jetty Warri, NNPC jetty Calabar, NNPC jetty Okrika PHC

Y= Terminal Storage Tank Capacity, Jetty Draft, Max LOA, Max Breadth Extreme, Number of Storage Tanks

X= Ship Calls, Cargo Throughput,

Therefore a production technology can be represented by a set of DMUs that satisfies Pareto efficiency conditions. DMU is the production units (oil jetties) that transform inputs into outputs.

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4. Data presentation, analysis of results and discussion

Table 2: Summary of Input and Output Variables

	Annual Volume	Ship Call Freq	Jetty Draft	Max LOA	Max Breadth Extreme	Shore Cargo Tank Capacity	No of shore Cargo Tanks
YEAR	CALABAR JETTY						
2012	134,773,206	16	6.5	277	48	52,496,080	5
2013	199331834	21	6.5	277	48	52,496,080	5
2014	19,679,614	2	6.5	277	48	52,496,080	5
2015	204,958,378	19	6.5	277	48	52,496,080	5
2016	115412113	11	6.5	277	48	52,496,080	5
2017	126,365,006	13	6.5	277	48	52,496,080	5
2018	166,852,205	15	6.5	277	48	52,496,080	5
	OKRIKA JETTY						
2012	243,787,365	15	9.2	173.68	31	187,450,000	11
2013	352,647,013	12	9.2	173.68	31	187,450,000	11
2014	512,370,833	16	9.2	173.68	31	187,450,000	11
2015	466,194,714	13	9.2	173.68	31	187,450,000	11
2016	171,501,208	5	9.2	173.68	31	187,450,000	11
2017	54,605,994	3	9.2	173.68	31	187,450,000	11
2018	586,296,505	16	9.2	173.68	31	187,450,000	11
	WARRI JETTY						
2012	238,411,032	18	10	277	48	876,950,000	14
2013	70,362,756	4	10	277	48	876,950,000	14
2014	151,243,824	13	10	277	48	876,950,000	14
2015	293,005,436	21	10	277	48	876950000	14
2016	147,722,040	11	10	277	48	876950000	14
2017	9,368,805	1	10	277	48	876950000	14
2018	70,361,932	4	10	277	48	876950000	14

Source: Researchers, compilation of data collected from NPA, NNPC, PPPRA, online journals

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Fig 1: Graphical representation of NNPC Jetties Annual Volume

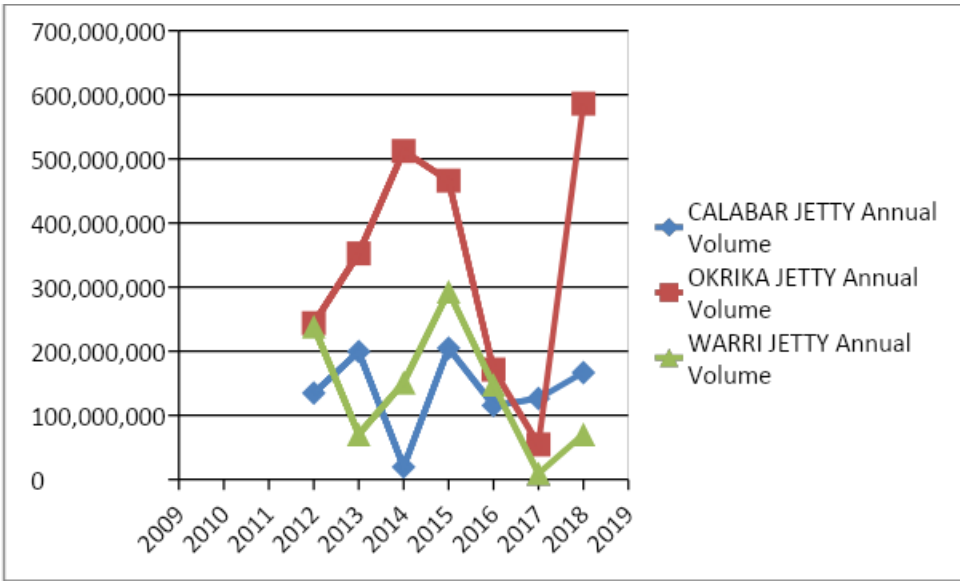

Fig2: Graphical representation of NNPC Jetties Ship Call Frequency

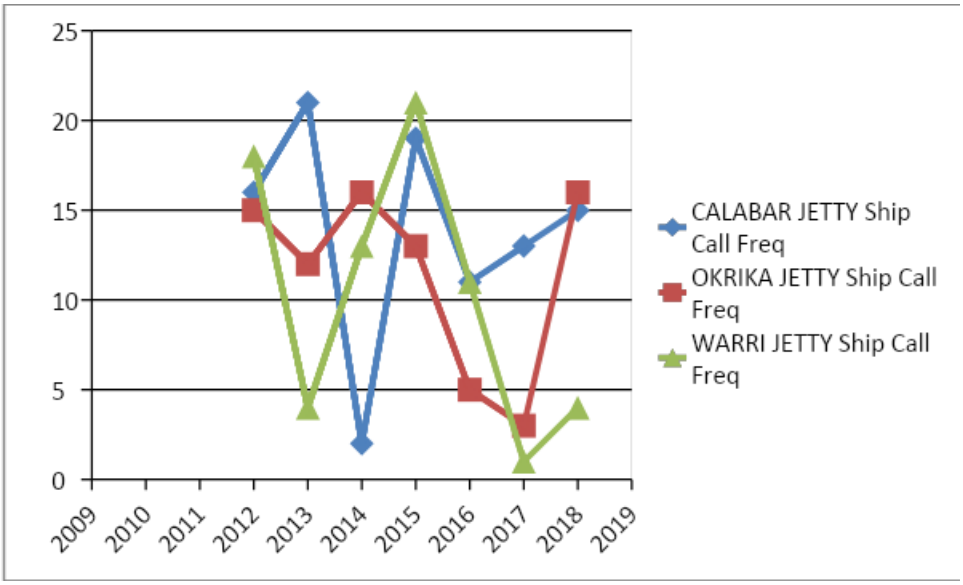

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Table 3A: Analysis of relationship between output variables and input variables

Variables	Annual Volume	Ship Call Frequency
Constant	6.78E+08** (0.0014)	15.7136* (0.0922)
Max LOA	-1951352*** (0.0043)	0.0005 (0.9877)
No of Shore Cargo Tanks	207991.6 (0.9790)	-0.3968 (0.3143)
Shore Cargo Tank Capacity	0.2609*** (0.0033)	-1.45E-09 (0.7149)
F	11.54	0.56
D.W	2.2	2.3

Source: Research findings from eView version 8

Table 3B: Analysis of relationship between output variables and input variables

Variables	Annual Volume	Ship Call Frequency
Constant	7.04E+08** (0.017)	21.413 (0.1217)
Jetty Draft	534835.5 (0.979)	-1.0204 (0.3143)
Max Breadth Extreme	-11869037*** (0.005)	-0.019 (0.9181)
F	5.54	0.56
D.W	2.2	2.3

Source: Research findings from eView version 8

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Table 4A: DEA test result on NNPC jetties efficiency levels pre 2016 CPPSS policy

		EFFICIECNCY SCORES	
NNPC JETTIES	CALABAR	OKRIKA	WARRI
Input Oriented with Variable RTS	1.0000000	1.0000000	1.0000000
Output Oriented with Variable RTS	1.0000000	1.0000000	0.8171887
Input Oriented with Constant RTS	1.0000000	1.0000000	0.784727
Output Oriented with Constant RTS	1.000000	1.000000	0.784727

Source: Research Analysis using R-DEA as compiled by researcher

Table 4b: DEA test result on NNPC jetties efficiency levels in post 2016 CPPSS policy

		EFFICIECNCY SCORES	
NNPC JETTIES	CALABAR	OKRIKA	WARRI
Input Oriented with Variable RTS	1.0000000	1.0000000	1.0000000
Output Oriented with Variable RTS	1.0000000	1.0000000	0.4791277
Input Oriented with Constant RTS	1.0000000	1.0000000	0.4581749
Output Oriented with Constant RTS	1.0000000	1.0000000	0.4581749

Source: Research Analysis using R-DEA as compiled by researcher

Table 5: DEA test result on most efficient NNPC jetty in NIGER DELTA REGION

		EFFICIECNCY SCORES	
NNPC JETTIES	CALABAR	OKRIKA	WARRI
Input Oriented with Variable RTS	1.0000000	1.0000000	1.0000000
Output Oriented with Variable RTS	1.0000000	1.0000000	0.8171887
Input Oriented with Constant RTS	1.000000	1.000000	0.784727
Output Oriented with Constant RTS	1.000000	1.000000	0.784727

Source: Research Analysis using R-DEA as compiled by researcher

Discussion of findings

From Table 3a above, Jetty Draft has a positive and insignificant relationship with the Annual Volume while it is negative and insignificant to Ship Call Frequency.

Maximum Breadth Extreme reports a negative and highly significant relationship with the Annual Volume while the relationship is negative and insignificant with the Ship Call Frequency.

Table 3b, Maximum Length Overall (LOA) shows a negative and highly significant relationship with the Annual Volume while it is positive and insignificant to Ship Call frequency.

Number of Shore Cargo Tanks shows a positive relationship with the Annual Volume and a negative relationship with Ship Calls Frequency and both are not significant.

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The Shore Cargo Tank Capacity indicates a positive and highly significant relationship with the Annual Volume while it is negative and insignificant to Ship Call Frequency. The discussions in table 3a and 3b answers research question 1.

Durbin- Watson (DW) is significant (2.2, 2.3), hence, the estimated equation can be relied upon in making inference about the influence of the input variables on the output variables of NNPC jetties under study.

Table 4a, above shows that in Pre 2016, NNPC Calabar, Okrika and Warri jetties were all operating efficiently under Input Oriented Variable Return to Scale. However, NNPC Warri Jetty under Output Oriented Variable Return to Scale, Input Oriented Constant Return to Scale, and Output Oriented Constant Return To Scale was inefficient while Calabar and Okrika jetties remained efficient under these conditions.

Table 4b, above shows that in Post 2016, NNPC Calabar, Okrika and Warri jetties were all operating efficiently under Input Oriented Variable Return to Scale. However, NNPC Warri Jetty under Output Oriented Variable Return to Scale, Input Oriented Constant Return To Scale, and Output Oriented Constant Return To Scale was inefficient while Calabar and Okrika jetties remained efficient under these conditions. The inefficiency rates as shown in table 4a for Warri jetty is better than the rate shown in table 4b for the same Warri jetty. The discussion from tables 4a and 4b answers research question 2.

Table 5 shows that NNPC Calabar, Okrika and Warri jetties were all efficient under input oriented variable return to scale, which answer research question 3.

5. Conclusion and recommendation

This study investigated the efficiency of NNPC Petroleum product jetties in the Niger Delta Region of Nigeria over a period of seven years that experienced changes in oil and gas sector policy. The ordinary regression model and r-DEA were used to test for significance and efficiency of the variables and decision making units respectively.

In accordance with the research findings, the study concludes that there is a significant relationship between the input and output variables as reported by annual volume.

The centralized petroleum product supply system policy anchored and implemented by NNPC did not reflect in the efficient operation of the NNPC Jetties in the Niger Delta Region.

Therefore, we recommend that in policy formulation, a vast and holistic approach be taken to accommodate the optimum functionality of all stakeholders in the oil and gas sector so as to avert under utilization, increase in unemployment rate, and dispersion of investors.

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