EVALUATION OF RAIL TRANSPORTATION FOR PETROLEUM PRODUCTS DELIVERY IN NIGERIA

BY

AYABINA EBIKELA BENARD

MSc/ENG/7774/2011-2012

A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA

IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTERS IN OIL AND GAS OPERATIONS MANAGEMENT

DEPARTMENT OF MECHANICAL ENGINEERING

FACULTY OF ENGINEERING

AHMADU BELLO UNIVERSITY, ZARIA

NIGERIA

MARCH, 2014

DECLARATION

I declare that the work in this Project entitled "Evaluation of Rail Transportation for petroleum Products Delivery in Nigeria" has been carried out by me in the department of Mechanical Engineering. The information derived from the Literature has been duly acknowledged in the text and list of references provided. No part of this thesis was previously presented for another degree or diploma at any other institution.

AYABINA Ebikela Benard	…….....	……
Name of Student	Signature	Date

CERTIFICATION

This Project entitled EVALUATION OF RAIL TRANSPORTATION FOR PETROLEUM PRODUCTS DELIVERY IN NIGERIA by Ebikela Benard AYABINA meets the regulations governing the award of master's degree in oil and gas operations management of Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

Dr. M. Dauda

Chairman, Supervisory Committee

Signature……

Date……

Dr. F. O. Anafi

Member, Supervisory Committee

Signature……

Date……

Dr. M. Dauda

Head of Department

Signature……

Date……

Prof. A. J. Adebayo

Dean, School of Postgraduate Studies

Signature……

Date……

DEDICATION

This masters research project is dedicated to God Almighty, the omniscient; the source of my success.

ACKNOWLEDGEMENT

All praise to God Almighty for making my masters research project a reality.
Special thanks to Dr. Dauda, Dr. Anafi and Dr. Yawas for their respective input in this masters project.
To my parents; Mr K. P. Ayabina and Mrs J. A. Ayabina, my profound gratitude goes out to them for equipping me with religion and education from birth.
I sincerely appreciate my siblings; Mrs Ann Tubonimi, Mr Paul Ayabina, Mr Charles Ayabina, Mr James Ayabina and their respective families for their support, advice and guidance.
My warm gratitude goes out to Miss Oriye Atani for her encouragement.
Finally, I humbly acknowledge the support and corporation I received from my colleagues, MSc. Mechanical engineering students; 2011/2012 set. Studying Oil and Gas Operations Management in Ahmadu Bello University had been quite challenging and inspiring, and hence a rewarding experience.

ABSTRACT

The perennial problem of petroleum products scarcity in Nigeria has instigated technocrats and scholars to take a critical look into the distribution system of petroleum products in the country. Seeing that other countries are exploiting the advantage of using railway transportation for distributing petroleum products this research project examines the suitability of distributing petroleum products through railway transportation in Nigeria. By employing the use of questionnaires, feedback was obtained from technocrats in the oil industry. Major stakeholders covered included the Retail outlets, Jetty, Refinery, Product depot and Tanker drivers. The results obtained were compared with those from a study of the Indian and American rail transport systems. It was found that rail transport will play a healthy role in the transport of petroleum products since it is safe and fast and has a potential of buffering the stress on the other modes of transportation and bringing sustained stability in the oil and gas sector of the Nigerian economy. Recommendations were made for the revitalization of the rail transport system and channelling resources into research on areas that will bring about a total overhauling of the system.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Research

Petroleum products can be conveyed and distributed by various means under land and sea transportation, and even air transportation. As advanced countries in Europe, Asia and the United States of America take cost-advantage of every means necessary to convey petroleum products, Nigeria is still lagging behind. Petroleum products are mostly transported in tankers and pipe lines in Nigeria and seldom transported by ferries and rail wagons. It is widely speculated that rail transportation of petroleum products will go a long way to stabilize petroleum products delivery in Nigeria and restructure the entire downstream sector for good.In spite of the huge resources spent on subsidizing petroleum products by the Nigerian government, the country still suffers perennial scarcity of the products. The government will more often blame the scarcity on hoarding of the products. To ensure prompt, adequate and uninterrupted supply of petroleum products, technocrats have argued that the supply chain of Nigerian petroleum downstream sector has to be totally overhauled. Meaning: privatization of existing refineries, setting up more refineries, increasing our current depot capacity, integration of railway transportation into the current delivery system and ensuring a transparent regulatory framework. Whilst there are sufficient grounds to look into cases of corruption, product theft and diversion, pipeline destruction, proponents of deregulation and privatization seem to agree on fully incorporating railway transportation for petroleum products delivery.

Nigeria currently delivers most of its petroleum products through tanker trucks and pipelines. The inland water ways and rail systems are rarely used for delivery. With rising cases of road

accidents as well as pipeline destruction in the country the need to explore and probably develop other systems of delivery has come to the fore.

1.2 Statement of the Problem/Research Questions

Rail transport is usually the most suitable mode of transportation for heavy traffic flows when speed is also an advantage because of the lower cost per person per load as the train load increases.

1. Is it possible to replicate this cost advantage in the delivery of petroleum products to consumers in Nigeria?
2. In what ways can railway transportation tackle the lingering issues of petroleum product scarcity?
3. To what extent will railway delivery of petroleum products alleviate/solve the perennial problems of scarcity bearing in mind that railway transportation is not the panacea to this problem?

1.3 Present Research

The present research singles out railway transportation system for petroleum products delivery in Nigeria. Issues involving the gains and setbacks of integrating railway delivery of petroleum products, the intended role of railway transportation in the supply chain of Nigerian petroleum downstream sector and its acceptability will be examined. This research will compare and contrast rail transportation with existing transportation mode of petroleum products in Nigeria and how best it can solve present delivery problems. Finally this research will establish whether or not rail transportation is a viable means of delivering petroleum products to the end users.

1.4 Aim and Objectives of the Study

The aim of this research is to establish whether or not rail transportation is a viable means of delivering petroleum products to the end users in Nigeria.

This research intends to achieve the following objectives:

1. To determine the potential gains of distributing petroleum products through railway transportation.
2. To identify the current problems of petroleum products delivery in Nigeria.
3. To identify the past and present problems of the railway sector vis-à-vis petroleum products delivery.

1.5 Significance of the Study

Nigeria lacks a well-planned petroleum products distribution system which can serve as an area of research interest to the university.

Furthermore the distribution of petroleum products in the Nigerian economy is fraught with complex problems resulting sometimes in petroleum products scarcity and shortages, hording products, inflated prices of products and contentions on the pump price of products. Nevertheless, it remains a lucrative business. Some school of taught argue that scarcity of petroleum products is more often a distribution problem than non-availability of the products themselves. It is hypothesized that the integration of railway in the existing distribution system will address the perennial problem of petroleum products scarcity.

The findings of this research will chart a way forward for private investors and the Nigerian government. It may possibly open up a new business frontier in the distribution of petroleum products and expand railway activities into the petroleum downstream sector. Government policy and regulatory framework on railway as well as the petroleum downstream sector may well be redefined by the findings of this research.

1.6 Research Hypotheses

What are the current problems in the delivery of petroleum products in Nigeria?

How can railway transportation help in resolving these problems?

Is transporting petroleum products by railway cost effective?

Is railway transportation present in the distribution system of petroleum products in Nigeria?

How can railway system be fully integrated in the delivery of petroleum products in Nigeria?

To answer the aforementioned questions, this research is developed based on the hypotheses that railway transportation is a viable means of delivering petroleum products in Nigeria.

1.7 Scope of the Study

1. This research covers both primary and secondary aspects of distribution of petroleum products by railway transportation in the Nigerian downstream sector.
2. For the purpose of this research, petroleum products will be generalized as petrol also known as gasoline. Whatever success is recorded in petrol distribution can be replicated with the other petroleum products.

3. The methodology in this research will exploit the wealth of knowledge of stakeholders in the petroleum downstream sector for opinions bordering railway delivery of petrol through a well-constructed questionnaire.
4. It will also limit itself to assessing the current delivery system of petroleum products through statistical reports of road accidents and pipeline destruction.
5. The research will be limited to the following areas:
    - The downstream sector of the Nigerian petroleum industry.
    - The distribution of the supply chain within the downstream sector.

1.8 Definition of Terms

Petroleum products distribution is concerned with the movement of refined petroleum from the refinery to the final consumers across various locations of delivery in the country (Ehinomen and Adeleke, 2012).

The following are terms frequently used in the discus of the oil economic sector vis-à-vis petroleum products and their transportation.

The Upstream Sector: Is concerned with exploration and production of petroleum (crude oil).

The Downstream Sector: Is concerned with refining petroleum, distribution of petroleum products, and marketing and sales of petroleum products.

Primary Distribution of petroleum products involves delivery of refined products from the refinery or loading terminals to the depots (also known as wholesale marketers)

Secondary Distribution involves the transportation of petroleum products from depot points to retail outlets (also known as service points or petrol stations).

Supply-Chain Link in the Oil and Gas Industry

Exploration → Production (Storage) → Refining → Marketing (Distribution) → Consumer

Refinery: A facility which produces products from petroleum.

Product Depot: A facility which stores petroleum products in large volumes for wholesales purposes to retail outlets and others.

Retail outlets: Are facilities which store petroleum products for sales to the final consumer.

Jetty: A facility located on the docks for loading and offloading of petroleum products to ships for transportation.

Tanker truck: A vehicle used for conveying petroleum products on land.

Transportation is an essential part of human activity, and in many ways form the basis of all socio-economic interactions. Indeed, no two locations will interact effectively without a viable means of movement.

Rail Transport: Is a means of conveying passengers and goods by way of wheeled vehicles running on rail tracks. In contrast to road transport, where vehicles merely run on a prepared surface, rail vehicles are also directionally guided by the tracks on which they run. Track usually consists of steel rails installed on sleepers/ties and ballast, on which the rolling stock, usually fitted with metal wheels, moves. However, other variations are also possible, such as slab track where the rails are fastened to a concrete foundation resting on a prepared subsurface.

Tank wagon: A type of railroad car or rolling stock designed to transport liquid and gaseous commodities.

NNPC: Nigerian National Petroleum Company. This is the national oil company (NOC) for Nigeria, involved in both upstream and downstream petroleum operations.

DPR: Department of Petroleum Resources. This is the nation's regulatory agency for the petroleum industry.

NRC: Nigeria Railway Corporation. This agency manages the entire railway transportation in Nigeria.

GDP: Gross Domestic Product. This is the market value of all officially recognized final goods and services produced within a country in a year, or over a given period of time.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This review covers three areas: The distribution network of the Nigerian petroleum downstream sector, Railway activities in Nigeria, and Transport statistics. A review of previous research shows that this topic is quite unique.

2.2 Petroleum Distribution Network of the Downstream Sector

The country now has a new refinery, aside the four situated at Port Harcourt, Warri and Kaduna. The refinery, according to the DPR is owned by a marginal field player, Niger Delta Petroleum Resources, and is currently refining 1,000 barrels of crude per day.It also put the number of petrochemical plants in the country at 3; lubricant blending plants at 35; depots at 121; jetties at 62; tankers at 25,000; retail outlets at 24,500; and terminals at 27 (DPR Reports, 2012).

2.2.1 Petroleum Products Transportation

Refined petroleum products are transported from the refineries through pipelines, coastal (marine) vessels, road trucks and rail wagons to the 21 regional storage / distribution depots, spread across the country, from where the marketing companies obtain their supplies. These distribution depots, with a total capacity of 1,422,000 cubic metres, and the transportation system are owned and managed by NNPC through its subsidiary, the Pipelines and Products Marketing Company Limited (PPMC). The depots are linked to the refineries and port terminals by a 3,001 km network of pipelines in five systems (Ubani, 2005 and USAID, 1999).

It should be noted that rail wagon transportation of petroleum products only just recommenced early 2013 after a protracted absence.

2.2.2 Petroleum Products

According to Ehinomen and Adeleke (2012), petroleum and its bye products may include but not limited to the following:

1. Premium motor spirit (PMS OR PERTOL)
2. Automotive Gas Oil (AGO or Diesel)
3. Household Kerosene (HHK)
4. Aviation Turbine Kerosene (ATK or jet-Al)
5. Industry Fuel:
6. High pour Fuel Oil (HPFO)
7. Low pour Fuel Oil (LPFO)
8. Liquefied petroleum Gas (LPG)
9. Bitumen
10. Base oil

2.2.3 Delivery Process

To purchase petrol in Nigeria, motorists typically drive to a Fuel Station. The fuel attendant pumps the requested quantity and payment is made in cash, electronically (value card, top card, etc.) or otherwise.

The Fuel station typically receives its supply from road tankers which have been loaded at an NNPC or other fuel depots. The NNPC depots receive their supply from local refineries through

pipelines. Imported petroleum products are evacuated from ocean-going tankers to local depots which then supply to Fuel stations by road tankers.

Local refineries receive their feed Crude oil through pipelines from oil terminals. The Crude oil is produced by oil companies from wells in their OMLs (Oil Mining Lease). The Federal Government of Nigeria (FGN) is the senior partner in Joint Venture (JV) oil producing companies. The NNPC manages FGN investments in the JVs. Production Sharing Contracts (PSCs) are a different relationship from Joint Ventures. This determination is based on JV production which represents most of the Nigerian production. PSC production can be similarly treated.

2.3 Railway Activities in Nigeria

Railway is the oldest of all the conventional and contemporary land transport modes in Nigeria. It came into being in 1898. Rail construction work started in Lagos with the single-track system of 1067 mm (3'6") gauge. As at today, the Railway system is made up of 4332km total network and 3505 route kilometers of narrow gauge. There is also 277 km standard gauge rail line under construction to link the Iron and Steel Company Ajaokuta to Delta Steel Company Aladja near Warri. The project is almost completed and will serve the steel industry. Such can equally be replicated in the petroleum downstream sector for competitive advantage by investors. The primary reason for constructing the railways in Nigeria was to open up the hinterland for the exploitation of agricultural and mineral resources, as well as to provide leverage for strengthening colonial political administration (Jaekel, 1997). In fact, the motive for constructing the railway was partly administrative, in order to provide a link between the northern and southern parts of Nigeria, and partly economic, so as to enhance the evacuation of mineral resources and agricultural products from

the hinterland to the seaports, for onward shipment to overseas markets in Europe (Elechi, and Jakpa, 1981). The flow of goods to the hinterland was also facilitated by the railway (Olanrewaju, 1986).

The existing Nigerian Railway Corporation (NRC) was created by the enabling Act of 1955 (as amended in 1990), after starting as a Government Department in 1898. The responsibilities of the NRC as spelt out in the Act establishing it include 'carriage of passengers and goods in a manner that will offer full value for money, meet the cost of operations, improve market share and quality of service, ensure safety of operations and maximum efficiency, meet social responsibility in a manner that will meet the requirements of rail users, trade, commerce, industry and the general public'(Olanrewaju, 1986).

The Nigerian railways during its heyday, contributed significantly to the export of products such as cotton, groundnut, hides and skin, tin and columbite, coal and so on, and all of the promote growth and development in the areas where they were produced (Onakomaiya, 1978). As a result of the oil boom of the early 1970s, the Nigerian Railway Corporation benefited from the patronage of Peugeot Automobile of Nigeria, Inland Containers Limited, Steel Rolling Mills, West African Portland Cement (now Lafarge), Flour Mills, Nigerian National Petroleum Corporation and Cattle traders among others (Ayodele, 2000 and Adesanya, 2002). In addition, a sizeable proportion of the goods movement to and from the Nigerian seaports was by rail transport. More significantly, the rail transport sector contributed partly to industrial growth as well as interregional trade and commerce. It also facilitated passenger movement and generated employment, while also contributing reasonably to National GDP.

To a considerable extent, the Nigerian railways met some of its responsibilities, in terms of their contribution to economic growth as well as promoting interregional and international trade, especially in the first half of the twentieth century (Robinson et al, 1961 and Onakomaiya, 1978). In the early 1970s, which coincided with the first phase of oil boom in Nigeria, petroleum products and containers became important components of rail traffic. In addition, a sizeable proportion of the goods movement to and from the Nigerian seaports was by rail transport up the mid-1970s, the rail transport sector did not only stimulate industrial growth as well as interregional trade and commerce, it played a key role in passenger movement, in employing people as well as contributing substantially to the GDP. Given limited rail expansion activities, as at today, only a few state capitals are connected by the railways. Besides, only the Apapa and Port Harcourt major seaports are served by the railways (Okanlawon, 2006). In short, just 19 out of the existing 36 states are connected by the railway (Edward,2001).

2.3.1 Railway Technology

Rail transport is usually the most suitable mode of transportation for heavy traffic flows when speed is also an advantage because of the lower cost per person per load as the train load increases. Nigeria's single-narrow-gauge railway line constructed in the colonial period was for many years the only mode of freight movement between the northern and southern parts of the country. Although rail has always contributed a tiny proportion of value-added in transportation, its share of value-added continues to decline because road transport (freight and passenger) has virtually taken over all the traffic previously conveyed by rail. This setback in Nigerian rail transport has left little room for integration into the value chain of the petroleum downstream sector (Ismaila*et al, 2012*).

Rolling stock in railway transport systems generally has lower frictional resistance when compared with highway vehicles and the passenger and freight cars (carriages and wagons) can be coupled into longer trains. The operation is carried out by a railway company, providing transport between train stations or freight customer facilities. Power is provided by locomotives which either draw electrical power from a railway electrification system or produce their own power, usually by diesel engines. Most tracks are accompanied by a signaling system. Railways are a safe land transport system when compared to other forms of transport. Railway transport is capable of high levels of passenger and cargo utilization and energy efficiency, but is often less flexible and more capital-intensive than highway transport when lower traffic levels are considered (Vamsi and Yugandhar, 2013).

2.3.2 Current State of Nigerian Railway

Because Nigeria's railways are in a parlous condition, the government is trying to rectify the situation by privatizing the Nigerian Railway Corporation.Railways in Nigeria are operated by the Nigerian Railway Corporation (UNESCO, 2010).

As of 2003, Nigeria's rail system had 3,557 kilometres of track, 19 kilometres of which were dual gauge and the remainder, standard gauge. The country has two major rail lines: one connects Lagos on the Bight of Benin and Nguru in the northern state of Yobe; the other connects Port Harcourt in the Niger Delta and Maiduguri in the north-eastern state of Borno. As of March 2006, Nigeria and Niger expected to move forward with plans to establish a rail link between the two countries. Nigeria is also seeking a rail link with Cameroon, but discussions are more contentious in the aftermath of the International Court of Justice's October 2002 verdict in favour of Cameroon on the issue of control of the Bakasi Peninsula. In order to remedy the poor

condition, efficiency, and profitability of the nation's railways, the government is seeking to privatize the Nigerian Railway Corporation. Under the privatization plan, three separate concessions of 25–30 years would be granted to private-sector companies to run train services in the western, central, and eastern regions (UNESCO, 2010).

Years of neglect of both the rolling stock and the right-of-way have seriously reduced the capacity and utility of the system. A project to restore Nigeria's railways is now underway. A project to convert the gauge of the system to 1435 mm has also somewhat stalled. Couplings of the chopper kind, vacuum brakes and non-roller bearing plain axles are also obsolete (UNESCO, 2010). Figure 2.1 below shows the current Nigerian Railway network.

Figure 2.1: The Nigerian Railway map (UNESCO, 2010).

2.4 Road Accidents Statistics

In Nigeria, the facts are bare, and show that the country loses about 3 percent of its Gross Domestic Product (GDP) earnings to road traffic crashes and about 17 percent of its current national reserves. A further analysis reveals that in 2007, the average number of deaths from road traffic crashes was 4,000. By 2008, it rose to 6,000 and only reduced by 4.38% in 2009. In spite of this essential reduction, road traffic crashes still averaged 6,000 deaths in the country.

The current situation in which highways maintain a status of being the dominant mode of transportation in Nigeria, and the situation where about 3,000 tankers ply the roads each day with 'wet cargo' while 1,500 others engage in transfer of 'dry cargo' across the country, further creates more challenges on the state of our roads. More worrisome is the statistical report that shows that there were 4,076 deaths and 12,994 injured persons in 4,017 reported cases between 2007 and June 2010 as a result of road crashes involving only articulated vehicles and trucks. This scenario is further worsened by the position held by Nigeria in the UN 1990-1994 ranking of countries with safest road transport and reduced number of deaths resulting from road crashes per 10,000 motor vehicles. In the ranking, Nigeria polled the 91st spot with a record of 161 deaths per 10,000 vehicles; while Spain posted 2.8 deaths and Norway 1.2 deaths.(Ehinomem and Adeleke, 2012).

Nigeria has the largest road network in West Africa and the second largest south of the Sahara, with roughly 108,000 km of surfaced roads in 1990. However they are poorly maintained and are often cited as a cause for the country's high rate of traffic fatalities. In 2004 Nigeria's Federal Roads Maintenance Agency (FERMA) began to patch the 32,000-kilometre federal roads

network, and in 2005 FERMA initiated a more substantial rehabilitation. The rainy season and poor equipment pose challenges to road maintenance (Ehinomem and Adeleke, 2012).

2.5Pipeline Vandalisation Statistics

The Nigeria National Petroleum Corporation, NNPC, has said that over 5000 cases of wilful act of pipeline vandalism were recorded at the end of 2010 nationwide.The Managing Director of Pipeline Product and Marketing Company, PPMC, marketing and distribution arm of the NNPC, Prince HarunaMomoh, said the high rate of vandalism obstructed the supply and distribution of petroleum products both crude and refined during the period in review (DPR Reports, 2012).

Momoh, who spoke with journalists on the side lines of a gas conference in Lagos, noted that that the situation is reaching an alarming level, as since the late 1990's the NNPC witnessed between 450 and 1,000 cases of vandalism annually.

Broken down, he said that within the last 10 years, NNPC has spent over N174.57 billion for pipelines repairs of a total of 16,083 pipeline breaks. While the majority of about 15,685 representing 97.5 % of the total were from acts of vandalism, the balance of about 398 cases or 2.4 per cent were due to ruptures.(DPR Reports, 2012).

NNPC records showed that System 2E/2EX, which convey products from the Port Harcourt Refinery to Aba- Enugu-Makurdi depots onwards to Yola-Enugu-Auchi appears to be the haven of pipeline vandalism in the country, particularly the Port Harcourt-Aba/Isiala-Ngwa axis.

In all, about 8,105 line breaks were recorded along the system 2E within the period representing about 50.3 % of the total. The attacks left the NNPC with a cost of N78.15 billion in product loses and pipeline repairs.(DPR Reports, 2012

2.6 Desk Study

Some countries have harnessed the rail transport system for movement of both passenger and freight. Among the notable nations that have used this mode of transportation in crude oil/petroleum product delivery are India and the US of America.

2.6.1 A Study of the Indian System

A survey was carried out on the Indian railway system and its role as a viable transporting agent of crude oil and petroleum products around the country. India, being one of the largest world's users of the rail transport system never hesitated in incorporating it in its oil and gas economic sector. India uses basically three other modes of transport for its petroleum products beside the rail transport. These include; road, pipelines and coastal (Ships and Barges) mode. Transportation from port location to Refinery and Refinery to the consumption centres are carried out through the cross-country pipelines in addition to road/ rail movement (Bansal, 2000). Due to the increase in population of India over the decades and consequent rise in the demand for petroleum products, it was pertinent to maintain and upgrade the diversified system of product transportation to the final consumers. The table below shows the share of various modes of transportation in movement of petroleum products between 1993 and 1999. and has not

Table 2.1: Various modes of transportation in movement of petroleum products(Bansal, 2000)

Mode	Unit	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99
Road	MMT	15.3	17.9	22.2	23.1	22.2	25.4
	%	25.2	27.3	30.6	29.9	26.4	28.0

Rail	MMT	26.1	28.1	29.3	29.1	31.8	33.2
	%	42.9	42.9	40.4	37.7	37.7	36.5
Pipelines	MMT	14.5	14.9	15.5	19.2	21.1	23.9
	%	23.8	22.8	21.4	24.9	25.1	26.3
Coastal	MMT	4.9	4.6	5.5	5.8	9.2	8.3
	%	8.1	7.0	7.6	7.5	10.9	9.2

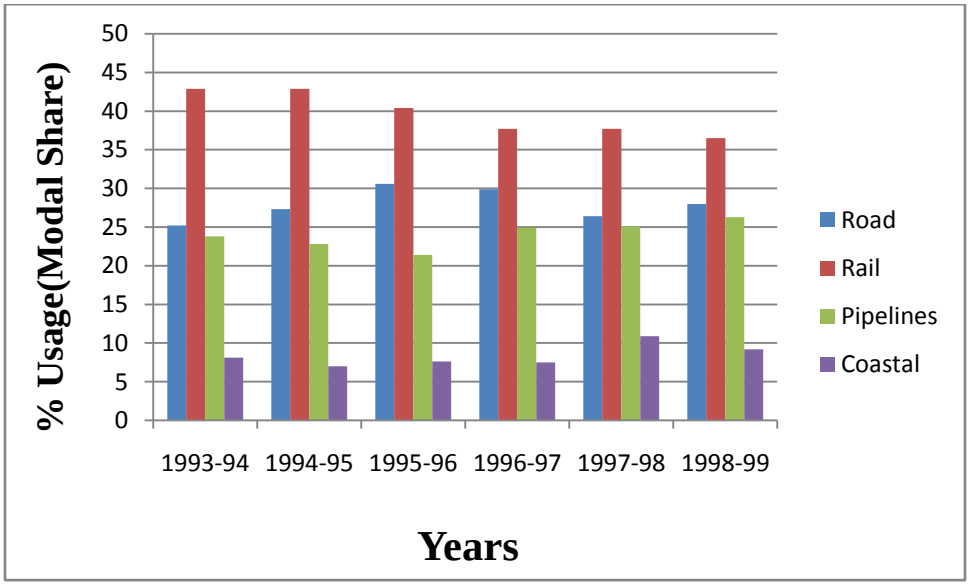

Figure 2.2:Various modes of transportation in movement of petroleum products(From Table 2.1)

The Petroleum Planning and Analysis Cell(PPAC), a parastatal under the Indian Government's Ministry of Petroleum and Natural gas also released a report that validates the key role of the rail mode of transport of crude oil and its products as seen in figures4.3 and 4.4 below.

Table 2.2: Transportation modal share for 2009-2010(PPAC 2011 Reports)

Table 2: Modal Share , 2009-10		
Modes	Petroleum Products only	Crude Oil and Petroleum Products
Pipe Line	20.8 %	44.5 %
Railways	29.1 %	18.1 %
Road	22.3 %	15.7 %
Coastal	27.8 %	21.6 %
Total	100%	100%

Table 2.3: Transportation modal share for 2010-2011(PPAC 2011 Reports)

Table 1: Modal Share , 2010-11		
Modes	Petroleum Products only	Crude Oil and Petroleum Products
Pipe Line	25.8 %	48.4 %
Railways	24.5 %	14.6 %
Road	21.4 %	15.3 %
Coastal	28.3 %	21.7 %
Total	100%	100%

2.6.2 A Study of the American System (USA).

The Association of American Railroad hailed the significant role played by the railroads in efficient distribution of petroleum products in North America. In their December, 2013 report, they highlighted the North Dakota statistics. Crude oil has little value unless it can be transported to refineries, but most U.S. refineries are located in traditional crude oil production areas (Texas,

Oklahoma) or on the coasts where crude oil transported by tanker is readily accessible. (AAR, 2013)Historically, most crude oil has been transported via pipelines. However, in places like North Dakota that have seen huge increases in crude oil production, the existing pipeline network lacks the capacity to handle the higher production. Pipelines also lack the flexibility and geographic reach to serve many potential markets. Railroads, though, have the capacity and flexibility to fill this gap (AAR, 2013). The figure 2.3 below shows the originated carloads of crude oil on U.S. class I railroads between 2009 and 2013.

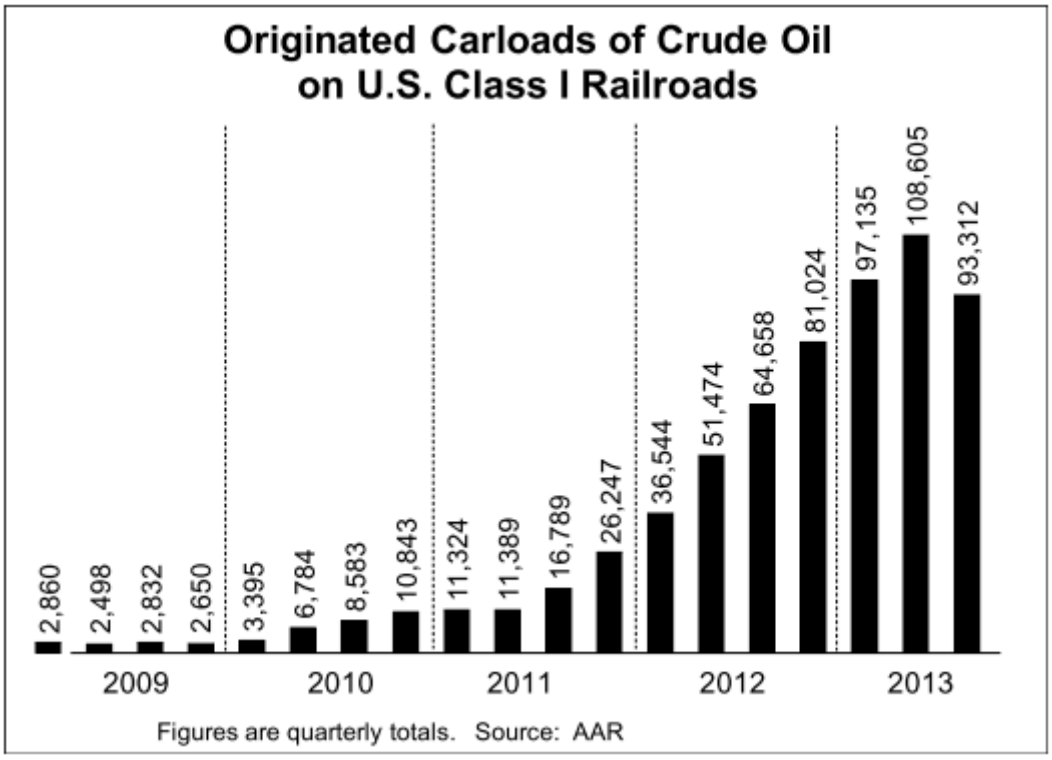

Figure 2.3: Originated carloads of crude oil on U.S. class I railroads between 2009 and 2013: Source: AAR (2013)

CHAPTER THREE

MATERIALS AND METHODS

3.1 Materials/Resources Required

Stakeholdersand materials involved includes:

a. Petrol retail outlets (petrol stations),
b. Petrol tanker drivers,
c. Depot points,
d. Jetty outlets and
e. One of the refineries.
f. Questionnaires

By involving the aforementioned stakeholders this research is poised to cover the entire downstream sector. The stakeholders are better placed to give professional and practical input to this research. The Warri town of delta state is well suited to access all the various stake holders. The town has numerous retail outlets, jetty and depot points, but more importantly it accommodates one of the four refineries in the country. Questionnaires were distributed to employees of the respective stakeholders of the distribution of petroleum products.

A bar chart was mapped out from the questionnaires to compare responses from the various stakeholders about their opinion on railway delivery of petroleum products. A pie chart was also formulated to aggregate the total response from the stakeholders to arrive at a conclusion on the suitability as well as acceptability of railway delivery of petroleum products.

3.2Methods

The methodology employed involved obtaining information through field work and carrying out desk study.

Field work information comprised of distribution of questionnaires and interviewing relevant stakeholders in the distribution link. *Desk study* comprised of assessing information from relevant agencies, carrying out assessments and evaluation of data, and making description.

3.3Source of Information for Desk study

In order to compliment the field work, statistical data were obtained from relevant agencies/countries which have employed rail transport as a mode of transport for their petroleum products to assess trends in transportation and petroleum industry. These were juxtaposed with findings from the field work.A sample of the distributed questionnaire is attached as seen inappendix A. The findings of the desk study however are reported in section 2.5 of the Literature review.

The feedback from the questionnaires shared is expected to give a professional input from relevant stakeholders to this research. Professional opinion from each stakeholder in the petroleum industry was cumulated and represented on graphs. One hundred (100) questionnaires were allotted to employees representing each stakeholder in the petroleum industry in Warri town of Delta State as detailed below. Each of the five (5) stakeholders were served twenty (20) questionnaires.

Retail outlets: 20 questionnaires were shared among 5 NNPC mega filling stations in warri, with each allocated 4 questionnaires.

Jetty: 20 questionnaires were distributed amongst staff of the warri jetty.

Refinery: 20 questionnaires were distributed to staff of warri refinery.

Product Depot: 20 questionnaires were distributed in Matrix Depot, warri.

Tanker Drivers: 20 questionnaires were distributed amongst tanker drivers in warri.

3.4 Data Presentation

Based on the feedback from the questionnaires circulated, the raw data was presented in a tabular form as shown in table 3.1 below. The table caters for every grouping in the Nigerian petroleum industry.

Table 3.1: Field Data Table

FIELD DATA					
	JETTY	**REFINERY**	**PRODUCT DEPOT**	**TANKER DRIVERS**	**RETAIL OUTLETS**
WILL RAILWAY TRANSPORTATION ADDRESS LINGERING ISSUES OF FUEL SCARCITY					
YES					
NO					
TOTAL					
WILL RAILWAY TRANSPORTATION BE ACCEPTABLE BY STAKEHOLDERS IN THE PETROLEUM INDUSTRY					

YES					
NO					
TOTAL					
PREFERRED MODE OF PETROLEUM PRODUCTS TRANSPORTATION IN NIGERIA					
ROAD					
RAIL					
PIPELINE					
TOTAL					

The raw data from the table above were further transformed into graphs for further analysis. The graphical presentation of the field data is for advance comparative analysis.

3.5 Calculations

The following expressions were used for computingresults for the pictorial representation of data from the field study.

3.5.1 Computation Formulae

$$\text{Height of 'Yes' bar} = \frac{Yes\ Response}{Total\ Allocation(20)}\ x\ 100\% \quad [1]$$

$$\text{Height of 'No' bar} = \frac{No\ Response}{Total\ Allocation(20)}\ x\ 100\% \quad [2]$$

$$\text{Mode of Transport}(\theta^o) = \frac{\sum Responses}{Total\ Responses(100)} x\ 360 \qquad [3]$$

3.5.2 Computation Values

The table 3.2 below shows the sector angular values for the Pie chart representation of the aggregate of preferred mode of transportation for petroleum products.

Table 3.2: Pie Chart Calculations

S/N	Initial Data	Computation	Remark
1.	$\sum Responses = 32$	Pipeline $\text{Pipeline} = \frac{32}{100} x\ 360$ From Egn. (3)	$\theta_{Pipeline}$=115.2^o
2.	$\sum Responses = 49$	**Road** $\text{Road} = \frac{49}{100} x\ 360$ From Egn. (3)	θ_{Road}=176.4^o
3.	$\sum Responses = 19$	**Rail** $\text{Rail} = \frac{19}{100} x\ 360$ From Egn. (3)	θ_{Rail}=68.4^o

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1Field Study

The response obtained from the questionnaire distributed are as summarized and presented in table 4.1 below

Table 4.1: Field Data

FIELD DATA					
	Jetty	**Refinery**	**Product Depot**	**Tanker Drivers**	**Retail Outlets**
WILL RAILWAY TRANSPORTATION ADDRESS LINGERING ISSUES OF FUEL SCARCITY?					
Yes	14	4	8	2	11
No	6	16	12	18	9
Total	20	20	20	20	20
WILL RAILWAY TRANSPORTATION BE ACCEPTABLE BY STAKEHOLDERS IN THE PETROLEUM INDUSTRY?					
Yes	11	16	18	6	8
No	9	4	2	14	12
Total	20	20	20	20	20

PREFERRED MODE OF PETROLEUM PRODUCTS TRANSPORTATION IN NIGERIA					
Road	7	5	3	18	16
Rail	5	3	6	2	3
Pipeline	8	12	11	0	1
Total	20	20	20	20	20

Based on the preliminary field data report the following charts where deduced:

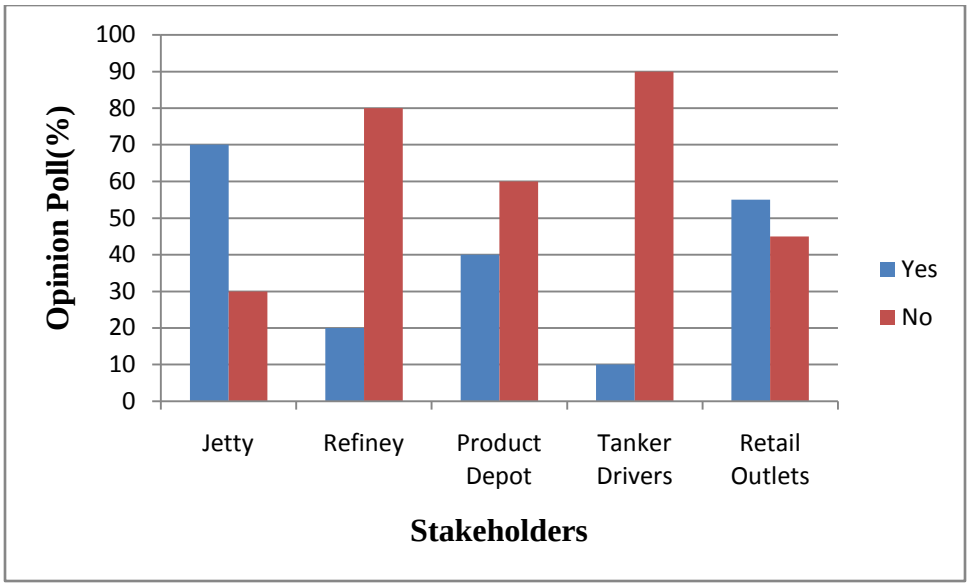

Figure 4.1:Will railway transportation address lingering issues of fuel scarcity?

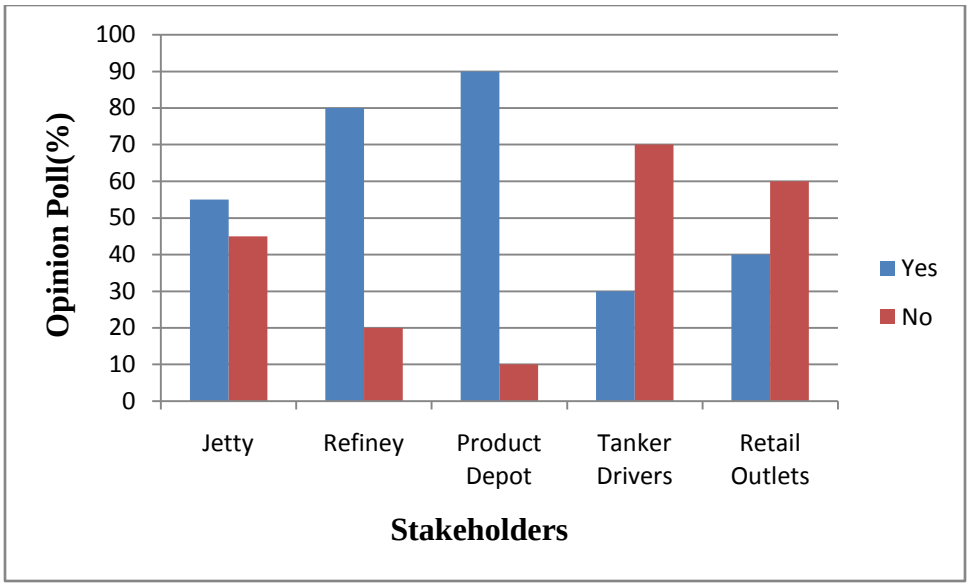

Figure 4.2: Will railway transportation be accepted by stakeholders in the industry?

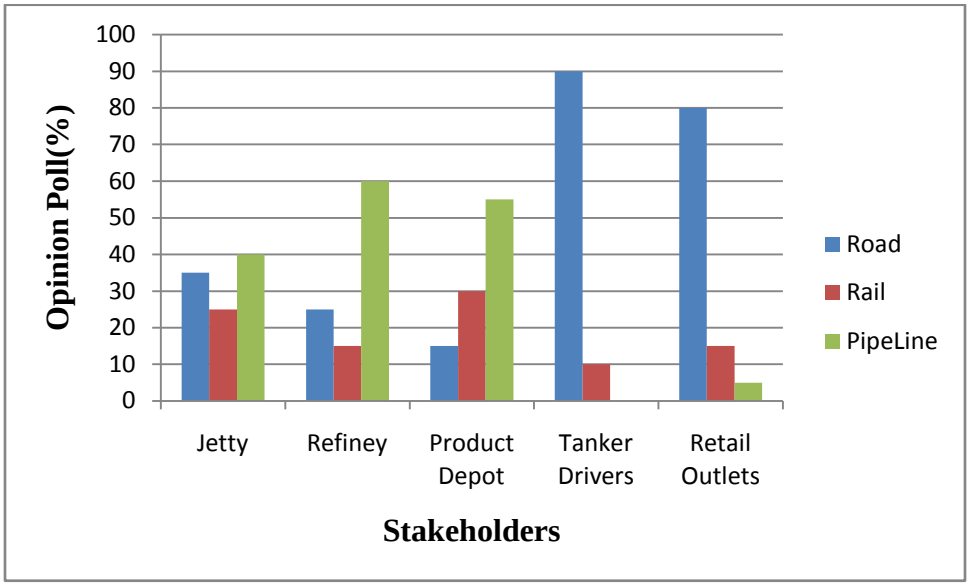

Figure 4.3:What is your preferred mode of transportation for petroleum products?

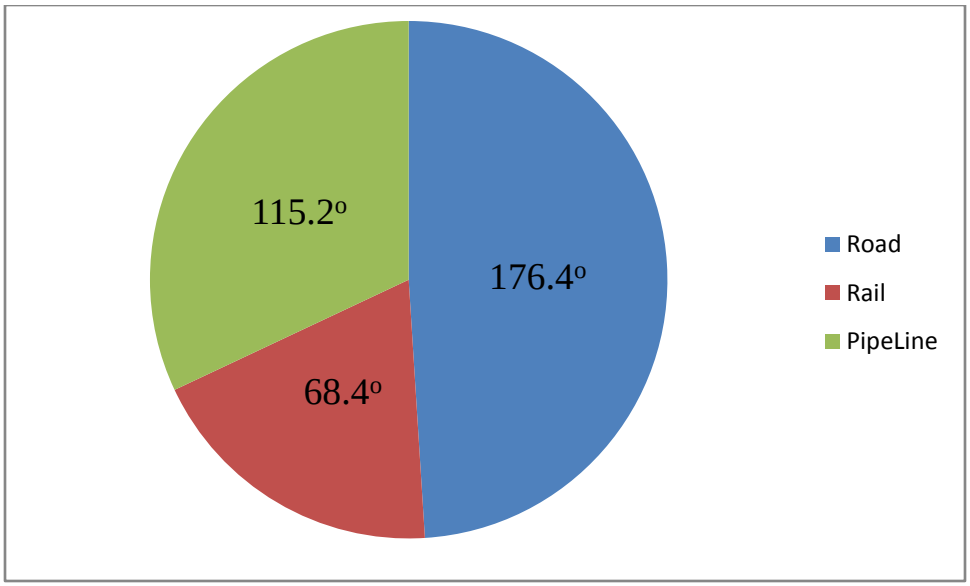

Figure 4.4: Aggregate of preferred mode of transportation for petroleum products.

4.2 Discussion

From the questionnairedistributed,Figures 4.1 to 4.4 were formulated. Each figure is explained below.

Figure 4.1: Most of the Jetty personnel were of the opinion that railway transportation will address fuel scarcity in the country. However a large number of refinery personnel did not agree with jetty personnel, they believe railway transportation cannot solve fuel scarcity in Nigeria. Depot personnelaswell as tanker drivers also agreed with refinery workers. Surprisingly retail outlets share the same opinion as jetty personnel.

Jetty personnel argue that fuel scarcity in Nigeria is more of a distribution problem. The burden of distributing petrol is mainly on tanker trucks with alot of pitfalls. Bad roads, road congestion (traffic jam), product diversion, road accidents and product theft are the major pitfalls identified by jetty personnel. They strongly believe railway transportation will tackle these pitfalls. Retail

outlets also share this opinion with jetty personnel but not as optimistic, hence the reason for a lower figure of agreement (yes) on the chart.

Refinery personnel base their argument of non-availability of petrol in the country in Nigeria's low refining capacity. There are currently five refineries in Nigeria and even at maximum refining capacity together they cannot meet the local demand in the country. The refineries are under performing due to lack of maintenance, an issue railway transportation cannot address. While depot personnel slightly agree with this argument tanker drivers are in strong support.

Figure 4.2: Jetty, refinery and product depot agree on the acceptability of railway transportation in the petroleum industry, with refinery and depot strongly optimistic about the integration of railway transportation for petroleum products. This is quite understandable considering the fact that these groups deal in bulk petroleum products and as such require innovation to distribute them. They are more concerned about letting these products out in the market than storing them up. Tanker drivers and retail outlets on the other hand do not agree with accepting railway as a means of petroleum products distribution. Tanker drivers argue that railway transportation cannot cover all the nooks and crannies of Nigeria, a job suited for road transportation. Retail outlets argue that it will be difficult accessing the products from trains as to trucks.

Figure 4.3 and 4.4: The above graph shows that railway transportation is least preferred amongst the stakeholders in the petroleum industry. Pipeline is more popular amongst the grouped stakeholders however road transportation raked the highest number of acceptance in total as shown in the pie chart of figure 4.4.

Tables 2.2 to **2.3** contain the data collected on the various modes of transportation of petroleum products across India. From table 2.1 and Figure 2.2, it can be seen that rail mode of transportation received much higher patronage than road, pipelines and coastal modes from 1993 to 1999. The coastal mode was observed to have received least patronage. This could be attributed to the few inland water bodies that could support transport of ships and barges. Pipelines which ranked third after Road was seen to gain momentum in usage over the said period. Nigeria's distribution of inland water ways that will reinforce the transport of petroleum products through ships is not a suitable option at the moment, leaving the nation with the options of road and pipelines. It can however be observed from the above data that incorporating rail transport in the Nigerian oil and gas industry will buffer the tension on the current modes also palliate the problem of products scarcity.

According to the PPAC report as seen in **tables 2.2** and **2.3**, rail transport was the most explored mode of transport of 'petroleum products only' for the 2009-2010 fiscal year. Rail transport however trailed behind pipeline and coastal modes within the same year for the transport of 'crude oil and petroleum products'. It was observed to maintain the trail in the fiscal year, 2010-2011. It is important to note how rail transport has competitively participated in the transport of petroleum products in India. This mode of transport could serve as a vibrant and robust player in the Nigerian oil and gas industry if adequately harnessed.

Figure 4.6: Small amounts of crude oil have long been transported by rail, but since 2009 the increasein rail crude oil movements has been enormous. As recently as 2008, U.S. Class I railroads (including the U.S. Class I subsidiaries of Canadian railroads) originated just 9,500 carloads of crude oil. By 2011, carloads originated were up to nearly 66,000, and in 2012 they

surged to nearly 234,000. In the first three quarters of 2013, Class I railroads originated 299,652 carloads of crude oil, 96 percent higher than the 152,676 carloads originated in the first three quarters of 2012. Based on the first nine months of the year, crude oil originations in 2013 will probably total around 400,000 carloads. Crude oil accounted for 1.4 percent of total Class I originated carloads in 2013 through September, up from just 0.03 percent in 2008(AAR, 2013). The United States of America who is currently experiencing a boom in the energy oil sector and driving towards self-sufficiency, has quickly embraced this viable alternative of railroad transport. This should serve as a bold step that is worth emulation by the Nigerian government. The figures 4.5 **a** and **b** below are images of the crude oil tank cars used in North America for the transport of crude oil.

(a) **(b)**

Figure 4.5 (a) and (b): Crude oil tank cars used in North America. Source: AAR (2013)

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Railway transportation of petroleum products will reduce the number of tanker trucks on the road. In terms of accidents railway transportation appears to be statistically safer than road transportation. The issue of traffic jam and bad roads are no problem for railway transportation, thus it is a faster means of transporting petroleum products as far as modern technology is employed in railway infrastructure. Railway has the capacity to move more products at lower cost than road. More importantly railway transportation will significantly address product diversion and mobile theft of products. These are the views shared by most stakeholders in jetty, refinery and depot respectively.

However stakeholders of retail outs and tanker truck have strong reservations. Integration of railway in the petroleum industry will result in job cuts. Most tanker drivers are of the opinion that railway transportation of petroleum products will reduce the need of tanker trucks and thus cost them their jobs. They also argue that railway transportation is not as flexible as road transportation. Their pessimistic view on railway transportation of petroleum products is reflected on the graphs.

Tanker drivers do not agree that railway will address intermittent fuel scarcity as the scarcity is more often not an issue of transportation problem but an availability problem. On the issue of safety they argue that with better roads tanker truck accidents will be reduced. On the issue of

product diversion and theft they insist on better security in the country to forestall these problems.

The interest of Nigerians should supersede the interest of tanker drivers alone. Rail way transportation will bring about reduced road traffic. Reduced road traffic translates to less expenditure on roads for:

- Maintenance
- New road development

Less traffic also means less road accidents and congestion all of which have a negative impact on productivity.

Besides, a compromise can be reached between railway operators and tanker drivers in petroleum products distribution. While railway transportation will cover long distances such as region-to-region tanker drivers can cover short distances inter or intra state transportation of products. Railway transportation will compliment pipeline distribution to depot points.

Retail outlets argue that tanker trucks are more flexible for transporting petroleum products than trains. Tanker trucks will deliver the products right into the filling stations but with trains that will be impossible. The contention is how to extract the product from the cargo trains into the filling station without incurring extra cost. For this reason retail outlets are pessimistic about railway transportation of petroleum products.

It is quite apparent that the predisposition of the operators of the downstream oil and gas sector is negative towards rail transport for reasons of job insecurity. Understanding that the parlous economic state of the country will likely cloud the objectivity of the stakeholders made further

research necessary. The study carried out on India and USA revealed the healthy role played by the rail mode of transportation in moving petroleum and its products across these countries. Besides being safe and a fast mode, it has great potential of buffering the stress on the other modes and bringing sustained stability in the Nigerian oil and gas downstream sector.

5.2 Recommendations

1. Rail Rehabilitation

- Preliminary steps
  - Clear tracks of refuse dumps and weeds
  - Construct new culverts and maintain existing ones in areas prone to flooding and washouts
  - Adopt pro-active environmental management policies
- Major Steps
  - Institute organizational culture that values maintenance
  - Rehabilitation of NRC locomotives
  - Recruit and retain competent staff
  - Repair of bridges, and washed-out track sections on Eastern Line (repairs had begun in 2006 and scheduled for completion at year end)
- The rehabilitation would put the NRC back into full service and allow them to participate competitively in the transport sector.

2. Further research should be carried out on related areas, focusing on the safety and cost reduction in the transport of petroleum products.

The Nigerian petroleum industry is yet to attain its full potentials even though the country is a leading player in the international market. Nigerian domestic market for petroleum products has not been well catered for. The country lacks a well-planned distribution system of petroleum products. Whatever distribution plan Nigeria appears to be operating is outdated and as such need to be evaluated. The integration of railway transportation for petroleum products will help ease off the load on road transportation of petroleum products.

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APPENDIX A-QUESTIONNAIRE

AHMADU BELLO UNIVERSITY ZARIA, NIGERIA

MECHANICAL ENGINEERING DEPARTMENT

AYABINA EBIKELA BENARD

QUESTIONNAIRE

I am a postgraduate student of the aforementioned department presently conducting a research on "The Evaluation of Rail transportation for petroleum products delivery in Nigeria".

Kindly complete the questionnaire to the best of your ability.

All answers will be treated confidentially and used for academic purpose only. Your permission will be sought if the response given is to be shared with others.

Thank you for your anticipated cooperation

1. Name of company/organization:_____
2. Current position in company/organization:_____
3. Select your preferred mode of transportation for petroleum products (petrol, diesel and kerosene) distribution on land:

   ☐ Pipeline

   ☐ Road transportation

   ☐ Railway transportation
4. Select which mode of transportation is the most common for petroleum products distribution on land in Nigeria:

☐ Pipeline

☐ Road transportation

☐ Railway transportation

5. Is railway transportation currently used for petroleum products distribution in Nigeria?

   ☐ Yes☐ No

6. If No to 6 do you support incorporating railway transportation in petroleum products distribution? ☐ Yes ☐ No

7. If No to 6 does Nigeria possess the necessary technical infrastructure to incorporate railway transportation in petroleum products distribution?

   ☐ Yes

   ☐ No

8. Considering recurring scarcity of petroleum products in Nigeria due to product diversion select your preferred mode of transportation for petroleum products distribution:

   ☐ Pipeline

   ☐ Road transportation

   ☐ Railway transportation

9. Do you think railway transportation will address recurring incident of petroleum products diversion? ☐ Yes

   ☐ No

10. Considering the spate of pipeline destruction in the country select your preferred mode of petroleum products distribution:

☐ Road transportation

☐ Rail transportation

11. Considering the level of road accidents in Nigeria select your preferred mode of petroleum products distribution:

☐ Pipeline

☐ Railway transportation

12. Do you support the privatization of Nigerian Railway Corporation (NRC)?

☐ Yes

☐ No