Abstract

Nigeria an active member of the Organisation of Petroleum Exporting Countries (OPEC) depends on importation of refined petroleum products to satisfy its domestic demands. This reliance in part, is responsible for the demise of petroleum refineries in the country.

The importance of oil and its relative products in the global market today is unquestionable. Oil is the major source of energy required to facilitate several processes such as transportation, energy generation and other facets that contribute to the growth and sustainability of an economy. This, in my opinion, justifies the need for nations to have full control of their oil resources including its supply and delivery. For this reason, it is of national, economic and security importance that oil producing countries develop and operate their oil refineries, as opposed to relying on foreign sources for refined oil products.

This paper discusses the deplorable state of the oil refineries in Nigeria and need for renovation and rehabilitation. Failure to do so can be detrimental to the growth and sustainability of the economy in the long term. This study identifies the main factors that led to the demise of oil refineries in Nigeria. Key amongst them is general mismanagement, poor government policies, inadequate innovation and investment in appropriate technology. Also key to the demise of local refineries is underutilisation of skilled local manpower and government inability to secure the right investment and follow through on policies.

This study adopts techniques that have been learnt in Engineering and Management modules. These techniques have helped in identifying the strategies and processes required to ensure oil refineries are resuscitated and operate in a sustainable manner. The main focus of this study will be on oil refineries and other downstream sectors in the oil industry.

Keywords

Nigeria; Oil Industry; Oil Refining; Infrastructure and Technology; Downstream Sector; Management and Maintenance; Economy

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Glossary of Abbreviations and Acronyms

ATC – Approval to Construct

Bbl/d or Bpd and Bpsd – Barrels per day and Barrels per stream day

CA – Competent Authority

COREN – Council for the Regulation of Engineering in Nigeria

DPR – Department of Petroleum Resources

ECOWAS – Economic Community of West African States

EGASPIN – Environmental Guidelines and Standards for the Petroleum Industries in Nigeria

EIA – Environmental Impact Assessment

FDI – Foreign Direct Investment

HAZID – Hazard Identification

HAZOP – Hazard and Operability Review

HYSON – Hydrocarbon Services of Nigeria Limited

IDSL – Integrated Data Services Limited

JVC – Joint Venture Company

LNG/ LPG – Liquefied Natural Gas / Liquefied Petroleum Gas

LTE – License to Establish

LTO – License to Operate

MW – Mega Watt

NOCs / MNOCs – National Oil Companies / Multinational Oil Companies

N – Naira

NACE – National Association of Corrosion Engineers

NAPIMS – National Petroleum Investment Management Services

NETCO – National Engineering & Technical Company

NGC – Nigerian Gas Company

NLNG – Nigeria Liquefied Natural Gas Limited

NNOC – Nigerian National Oil Corporation

NNPC – Nigerian National Petroleum Corporation

NPDC – Nigerian Petroleum Development Company

NSE – Nigerian Society of Engineers

NYSC – National Youth Service Corps

OPEC – Organisation of Petroleum Exporting Countries

PIB – Petroleum Industry Bill

P&ID – Piping and Instrumentation Diagram

PPMC – Pipelines and Product Marketing Company

PTDF – Petroleum Development Trust Fund

PSC – Public Service Commission

PTI – Petroleum Training Institute

PHRC – Port Harcourt Refining Company Limited

WRPC – Warri Refining and Petrochemical Company

KRPC – Kaduna Refining and Petrochemical Company

R&D – Research and Development

SONATRACH - Société Nationale pour la Recherche, la Production, le Transport, la Transformation, et la Commercialisation des Hydrocarbures

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Chapter 1 – Introduction

Oil refineries are established based on certain economical and technical factors that have to be taken into consideration in order to maximise the production and distribution of petroleum and associated products. Some of these factors include [1]:

- The location of the refinery and its proximity to the available raw materials.
- The government policies in place.
- The effectiveness and efficiency of the means of transportation employed.
- The presence of skilled labour and technical knowhow.
- The availability of sufficient infrastructure and adequate technology.

Globally, fossil fuel remains a key source of energy. Consequently, several countries ventured into commercial exploitation of crude oil to gain competitive edge in the global market and to meet domestic demands. The United States of America, the United Kingdom, Netherlands and Canada all operate respective multinational oil companies (MNOCs) charged with the management of upstream and downstream oil sectors to meet their nations' goals (in terms of productivity) and to secure their oil reserves for the long term [13].

In fact, oil was so important that it had a huge impact on the economy of the western world, particularly United States of America during the 1973 oil crisis which has been widely documented. The middle-eastern countries that were also member states of OPEC placed embargoes on the western countries that presumably supported Israel in supplying them with weapons and aids during the Yom Kippur war [10]. The western world the largest consumer of oil was greatly affected. Hence, the United States of America had to put in place certain strategies to alleviate the detrimental effect on its economy. Some of which included issuing daylight savings time all year round in order to minimise the total consumption of electricity, curbing the speed limits for vehicles on the highway and encouraging the use of an alternative means of energy generation through incentives [10].

Today, the western world continues to experience expedited progress in the successful management of its interests in the upstream and downstream oil sectors, with their multinational companies overseeing the operation of the oil sectors or its sub-sectors in other continents such as Asia (Middle East), Africa and South America [13]. Africa is enriched with the supply of crude oil. Countries such as Gabon, Angola, Libya, Congo, Algeria and Nigeria are all blessed with the natural

resource but are still heavily dependent on the expertise of the western world to extract and refine the oil [13]. Specifically, crude oil is shipped to oil refineries located in western countries and the refined products are re-imported back to the country of origin!

This study focuses on the Nigerian oil industry. The main objectives of the study are to shed insight into the:

- Operations of its oil industry.
- Demise of the existing refineries.
- Key factors that determine the establishment of refineries.
- The structure of the economy and
- The role of multinational and national oil companies.

These will form the basis of discussions that explore the feasibility of establishing and maintaining fully functional refineries operating at optimum capacity in Nigeria.

1.1. Brief History of Oil Production and Refining in Nigeria

Nigeria with a population of 165 million people has the largest domestic market in Africa. It was estimated that in 2010 Nigeria consumed 280,000 bbl/d of oil, with the nation importing up to 85% of refined oil products between the year(s) 2009 – 2010 [7]. The country is also ranked the sixth largest exporter of crude oil in the world as well as the largest in sub-Saharan Africa [8].The nation, eleven years after gaining independence (1971), became a member of OPEC [2].

Prior to the discovery of crude oil in the Niger Delta area of Nigeria, exploration activities had begun since 1908 by a German company known as the Nigerian Bitumen Corporation [3]. Its activities were short-lived due to the outbreak of the First World War in 1914.

In 1937, Shell Petroleum Development of Nigeria was granted sole concession rights to begin crude oil exploration across the nation. Due to the interruption of oil exploration activities in the country during the Second World War, crude oil was not discovered until 1956 in Oloibiri, Niger Delta in southern Nigeria [3]. Exploration and production followed: production was originally maintained at 5100 barrels a day and it was not until the year 1979 that production peaked at 2.44 million barrels a

day [3]. Consequently, the federal government of Nigeria revised the concession right given to Shell and granted concession to other foreign companies like Agip, Gulf, Elf, ExxonMobil and Texaco. This sped up the rate of oil exploration and production in Nigeria.

Initially, Nigeria exported crude oil and imported refined oil and associated products to satisfy domestic demands. In 1965, the now Port Harcourt Refining Company Limited (PHRC) was established with maximum production capacity set at 35,000 bbl/d sufficient to meet local requirements and the excess exported [3]. As domestic demands soared, Warri Refining and Petrochemical Company (WRPC) was added in 1978, Kaduna Refining and Petrochemical Company (KRPC) in 1980 and another Port Harcourt Refinery also under Port Harcourt Refining Company Limited (PHRC) in 1989 [3]. The maximum production capacities of these refineries (bbl/d) were set at 125,000 bbl/d, 110,000 bbl/d and 150,000 bbl/d respectively [3]. The original Port Harcourt refinery established in 1965 later had its maximum production capacity expanded to 60,000 bbl/d [18].

Due to potential return on investments in the oil industry, the Nigerian government got involved initially for regulatory reasons and collection of royalties. The “Oil in Pipeline Act” cap 145 of 1965, the “Petroleum Profit Tax” of 1967 and the “Oil Navigable Waters’ Decree” of 1968 were all signed into law to facilitate this [3]. In 1971 when Nigeria became a member country of OPEC, Nigerian National Oil Corporation (NNOC) was established by decree “Number 18 of 1971” [3]. The decree charged the corporation with the activities of the upstream and downstream oil sectors as well as other regulatory activities [3]. These include, setting the local market fuel prices, managing oil retail depots and importation of oil and associated products.

The Nigerian National Petroleum Corporation (NNPC), a merger of Nigerian National Oil Corporation (NNOC) and the former Ministry of Petroleum Resources, was later established in 1977 as a parastatal mandated with monitoring and overseeing the operations of the upstream, midstream and downstream oil sectors [4]. The table below shows the various activities that the Nigerian National Petroleum Corporation (NNPC) oversees in the three oil sectors:

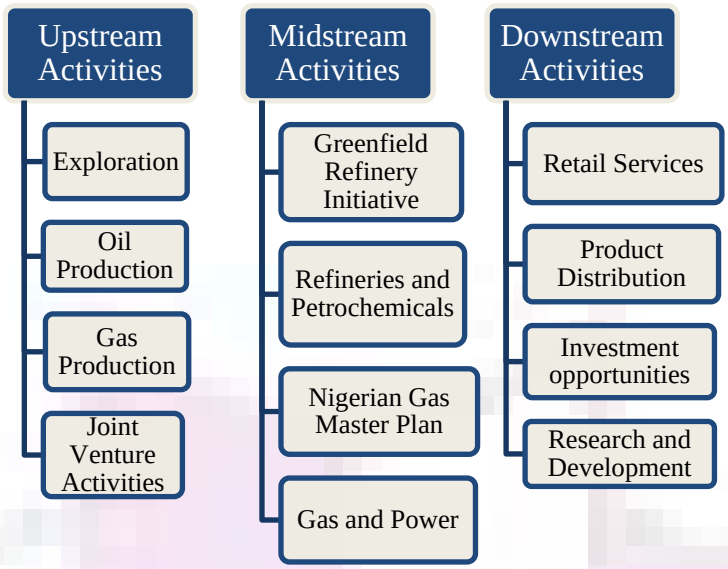

Figure 1. Sub-sector Activities Charged with the NNPC. [4]

"The NNPC Group comprises of the NNPC Board, the Group Managing Director's office, six directorates, namely: Exploration & Production, Refineries & Petrochemical, Finance & Accounts, Commercial & Investment, Corporate Services, and Gas & Power. Each Directorate is headed by a Group Executive Director" [5]. Its Divisions are headed by Group General Managers while the ten subsidiary companies are headed by Managing Directors" [5]. In addition, "NNPC has two partly owned subsidiaries and 16 associated companies" [5]. The Group managing director as well as the executive directors that make up its board is appointed by the Office of the Presidency [6].

The NNPC gives the government a firm control of the revenue generated by the oil sector with 55% of all equities accruing to the federal government via joint venture agreement with companies such as Shell and Chevron, licensed to operate in the country [13].The role of these multinational companies in the Nigerian upstream sector has been beneficial as the production and exploration of oil has seen the country become one of the major exporters of crude oil to the United States of America, Europe and other countries in its neighbouring African region. Shell currently operates the highest production capacity within the country at 1.2 – 1.3 million bbl/d approximately. ExxonMobil and Chevron have estimated production at (700,000 – 800,000 bbl/d) and (600,000 – 700,000 bbl/d) respectively [6].

The figure below illustrates Nigeria's crude oil exports to other parts of the world as of 2010:

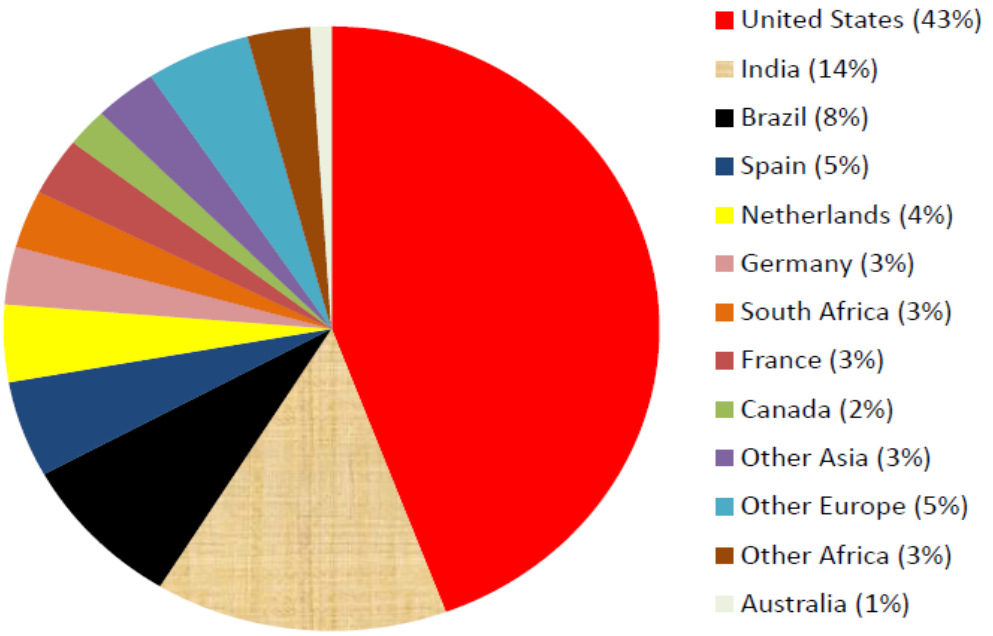

Figure 2. Adapted from "Nigerian Crude Oil Exports by Destination, 2010". [7]

These multinational companies have focused mainly on the upstream sector (production and exploration) in comparison to the downstream sector, where national companies play a more prominent role, in retailing and distribution of petroleum products in Nigeria [13]. The demise of Nigeria's oil refineries has returned the country to its former state of exportation of crude oil and importation of refined products to satisfy domestic demands [17].

The unabated deterioration of the four oil refineries in Nigeria resulted in the collapse of total oil production capacity (bbl/d). Also it was reported that between the 2009 and 2010, the refineries operated at a capacity less than 30 % [7]. Although capacity increased to between 60 -75% in 2011, it was still insufficient for local demand and the gap was filled by importation. The estimated combined refining capacity of the existing oil refineries at 445,000 bbl/d unquestionably cannot satisfy domestic needs for the foreseeable future [7]. This is because of heavy reliance on fossil fuel as well as population explosion in the country [8].

The energy reserves of countries in West Africa and especially member states of the Economic Community of West African States (ECOWAS) were also reviewed to underscore Nigeria's importance as a major player in the global oil market. The figure below shows the fossil fuel and hydro-electrical reserves and resources of the ECOWAS nations:

Nations	Crude Oil Reserves (Millions Tons)	Natural Gas Reserves (Millions m^3)	Coal Reserves (Million Tons)	Available Hydro Potential (MW)
Benin	21	2800	—	300
Burkina Faso	—	—	—	900
Cape Verde	—	—	—	—
Cote d' Ivoire	13	20000	—	1650
The Gambia	—	—	—	—
Ghana	1	24000	—	2000
Guinea	—	—	—	6000
Guinea Bissau	—	—	—	60
Liberia	—	—	—	2000
Mali	Nd	—	Nd	2000
Niger	—	—	70	400
Nigeria	3300	3400000	495	10000
Senegal	10	500	15	300
Sierra Leone	—	—	—	10000
Togo	—	—	Nd	250
EOWAS	3324	3444500	580	25760

Table 1. Fossil Fuel and Hydro-electrical Reserves and Resources. [9]

Following the discovery and exploration of oil, Nigeria has changed from relying on the agricultural sector as the major source of its export commodities. The oil and gas sector is now the major source of its foreign exchange earnings and accounts for 90% of her gross earnings [13]. Aware of this, the government is looking into every means possible to restore its refineries to optimum capacity and also into the

prospects of establishing more refineries. It is hoped that this will lead to increased productivity towards meeting domestic demand [17].

1.2. Current Organisation of the Nigerian Oil and Gas Industry

This sub-section covers:

- Some of the important statutory laws and regulations that give the government a stronghold in the Nigerian oil industry.
- Statutory laws and regulations promulgated to guide partakers (individuals and corporate bodies) on the requirements for investing in the Nigerian oil industry.
- The subsidiaries of the NNPC that enable it regulate and oversee the activities of the upstream, midstream and downstream sectors of the Nigerian Oil industry.

1.2.1. Statutory Laws and Regulations Promulgated for the Nigerian Oil Industry

- Oil Pipelines Act (1956): Permits are to be issued to allow for the survey of routing for oil pipelines. Licenses are also to be awarded for the establishment and maintenance of these pipelines alimentary to oil fields [35].
- Petroleum Profits Tax Act (1959): This indicates and specifies the taxable rates that are chargeable on the net profits generated by any company engaged in oil activities within the country [36].
- The Petroleum Act (1969): This gives the Nigerian government the rights over the petroleum assets attributed to the country. The Ministry of Petroleum Resources is mandated to issue licenses to Nigerians and companies operating in Nigeria, allowing them to undertake activities such as oil exploration, drilling, prospecting, production, transportation, storage and refining [36].

- Land Use Act (1976): The federal government of Nigeria has the right to control and acquire land in any part of the country, including jurisdictions overseen by the State and Local governments. Also land occupied before the passing into law of this Act can be revoked and acquired by the federal government for oil purposes, with the previous occupants duly compensated [36].

- Oil in Navigable Waters Act (1979): This act makes it illegal and an offence for any ship or vessel to discharge oil in Nigerian waters, territorial waters and shorelines. Anti-pollution equipment are to be installed in ships or vessels with records taken for anytime oil discharge occurs [37].

- Hydrocarbon Oil Refineries Act (1990): The unlicensed refining of hydrocarbons is prohibited in any place other than a licensed operational refinery. The refineries are also mandated to employ pollution preventive measures [37].

- Petroleum Refining Regulations (1974): Provides guidelines on the various licences required before a refinery can be established to operate in Nigeria [47].

The Petroleum Industry Bill (PIB), not yet passed into law by the government, is a regulatory framework for the Nigerian oil industry. It is targeted at ensuring that guidelines exist for the operations involved in the upstream and downstream sectors of the oil industry and all other activities related [38].

1.2.2. Subsidiaries, Affiliates and Joint Venture Partners of the Nigerian National Petroleum Corporation (NNPC)

The NNPC is currently made up of eleven subsidiaries. An overview of these subsidiaries, year of establishment, activities they engage in and their joint venture partnerships are as follows [35]:

- NPDC: Established in 1988 and is solely owned by the NNPC. It concentrates mainly on the activities of the upstream sector of the industry i.e. exploration and abandonment.

- PPMC: Responsible for the transportation of crude oil from the area of exploration and production to the refineries within the country. It also engages in the business of importing, redistributing and marketing refined oil products through its pipelines.

- PHRC: Established in 1965 and 1989. It is charged with the responsibility of refining crude oil to meet the demands of the market based on its maximum installed production capacity.

- WRPC: Established in 1978 and is also charged with the same responsibility as PHRC.

- KRPC: Established in 1980, is also charged with the same responsibility as WRPC and PHRC.

- IDSL: Established in 1988, is involved in providing seismic data acquisition, processing and interpretation services to the Nigerian oil and gas industry.

- NETCO: Established in 1989, provides the oil industry with engineering technology and expertise in the areas of construction supervision, procurement, project management, environmental consulting and training, quality assurance & control and basic/detailed engineering. It is in a joint venture partnership with American Bechtel Incorporation.

- NGC: Established in 1988, is mandated with the responsibility of developing a gas industry that meets the energy needs and requirements of its internal market through an extensive pipeline supply network. It is also charged with exporting natural gas to countries within the West-African sub-region.

- NLNG: This consists of a joint venture amongst the corporate bodies of the Nigerian oil industry. Their stakes in the agreement are as follows: NNPC with 49%, Shell gas B.V. with 25.6%, TotalFinaElf with 15% and Agip international B.V. with 10.4%. NLNG is responsible for the liquefaction of natural gas for export.

- HYSON: Established in 1988, is responsible for developing technical expertise in respect to the activities of the downstream oil sector and also

ensures that there are returns on investments for the investors within this particular sub-sector. It is in a marketing joint venture partnership with VITOL and CALSON Bermuda limited.

- NAPIMS: Monitors and supervises the operations of JVC's and PSC's in line with ensuring that there is an increased and sustained production of crude oil in the country [39].

DPR, a department in the Ministry of Petroleum Resources together with NAPIMS ensure that the individuals and companies involved in operations and activities pertinent to this industry comply with the rules and regulations promulgated [35].

1.3. Issues Arising

This brief overview of the history and current organisation of the Nigerian oil industry confirms that:

- Nigeria has sufficient oil resources to warrant adequate oil refinery capacity.
- Government has put in place strategies and structures to support establishment of oil refineries.
- Despite these, operation of existing refineries has deteriorated and establishment of modern refineries have been abortive.

1.4. Aims and Objectives of the Project [12]

The aims and objectives of the project are:

- To analyse the failure of oil refineries in Nigeria from an engineering and economic perspective.

- To justify the decision reached i.e. it is viable to refine oil in Nigeria at full capacity, by raising a reasonable argument based on the structural breakdown of the report and having well sourced documentation to back up relevant findings.

- To better understand the oil and gas sector with respect to productivity, the process of refining, resources that aid the process and factors that affect optimum production.

- To identify limitations in establishing new or renovating existing oil refineries in Nigeria.

- To propose technical and economic solutions aimed at reviving oil refining in Nigeria.

The following research questions will be used as a guide to address the aims and objectives:

1.5. Project Research Questions

- What led to the demise of oil refineries in Nigeria given that there is well documented demand for refined oil products in Nigeria and in the surrounding West African region?

- Are oil refineries feasible in Nigeria?

- Assuming that oil refineries are feasible in Nigeria, what strategies and processes should be put in place to facilitate the implementation of oil refineries?

- Is it possible to manage and maintain refineries in Nigeria after they have been resuscitated?

- What should government's role be in development of downstream capacity in the Nigeria's oil industry?

- What does Nigeria stand to benefit from the operation of its refineries at optimum capacity?

- What are the requirements for establishing and operating a refinery in Nigeria?

1.6. Organisation of Project Report

The report is organised as shown in Figure 3.

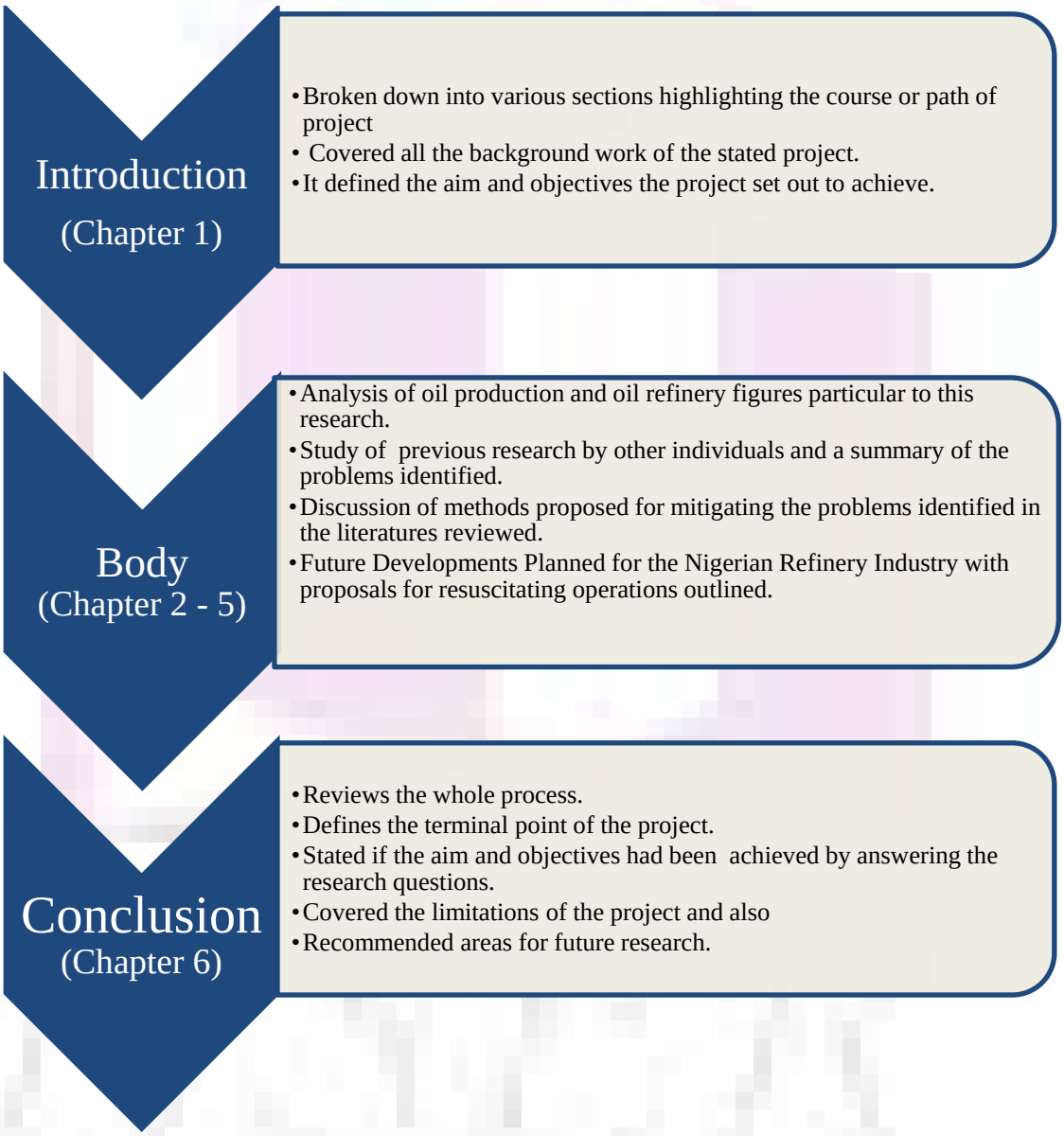

Figure 3. Structural Framework of the Project Organisation.

1.7. Conceptual Framework of the Project

The discussions covered in the body of the report were sourced from books, company publications, websites and journals documented on the subject in view. The breakdown of the project's framework is discussed as follows:

Analytical Statistics of Nigeria's Oil Figures: The analysis of data was sourced from NNPC publications. Statistical information obtained was in respect of the crude oil produced, exported and refined locally. The relevant findings were analysed and discussed.

Literature Review: The papers reviewed comprised of 2 sub-sections, namely technology transfer and the role of government. These are further broken down below:

- Technology transfer is considered because Nigeria still a developing country needs to acquire the required infrastructure and technology from developed countries to sustain growth and development of its economy [53]. The literature reviewed finds out why this has been unsuccessful.

- Governments put in place necessary legal, technical and economic environment for businesses to thrive [54]. The literature reviewed identifies the extent to which government seeks to encourage and support the establishment of oil refineries in Nigeria. Reasons for failure are also explored.

Summary of the problems identified: The problems identified in the papers reviewed were summarised in eight distinct points for better understanding.

Strategies for successful oil refinery industry in Nigeria: Following the literature review, strategies for establishing and nurturing an oil refinery industry were studied. These are broken down into the following sub-sections:

- *Methods for Technology Transfer.*

- *Methods for Maintaining the Operation of Refineries:* This covers approaches to maintaining assets.

- *Methods for Policy Making:* This covers analysis on appropriate policy frameworks critical to the establishment, growth and survival of oil refinery industry.

Development Plans for Nigeria's Oil Refinery Industry: This Covered downstream capacities in Algeria and Nigeria. It outlined the success Algeria had achieved to date and also highlighted the dismal state of affairs in Nigeria's downstream capacity.

- *SONATRACH and downstream capacity.*
- *NNPC and downstream capacity.*
- *Summary of Findings:* Following this, a summary of the findings of both oil service structures were pointed out for clarity and ease of understanding.
- *Government Plans for Future Downstream Development Capacity:* The plans covered two key areas. These are:

  - *Nigerian Government New Criteria for Establishing and Operating a Refinery in Nigeria:* This defined all the licenses required before an individual can start refinery operation in Nigeria.

  - *Government Policies and Actions:* Details the actions planned by government in revamping the downstream sector and resuscitating the operation of local refineries.

Proposals: Based on this study and the knowledge garnered, a 4 point proposal (The 4 R's) in resuscitating refinery operations to meet domestic demands was realised.

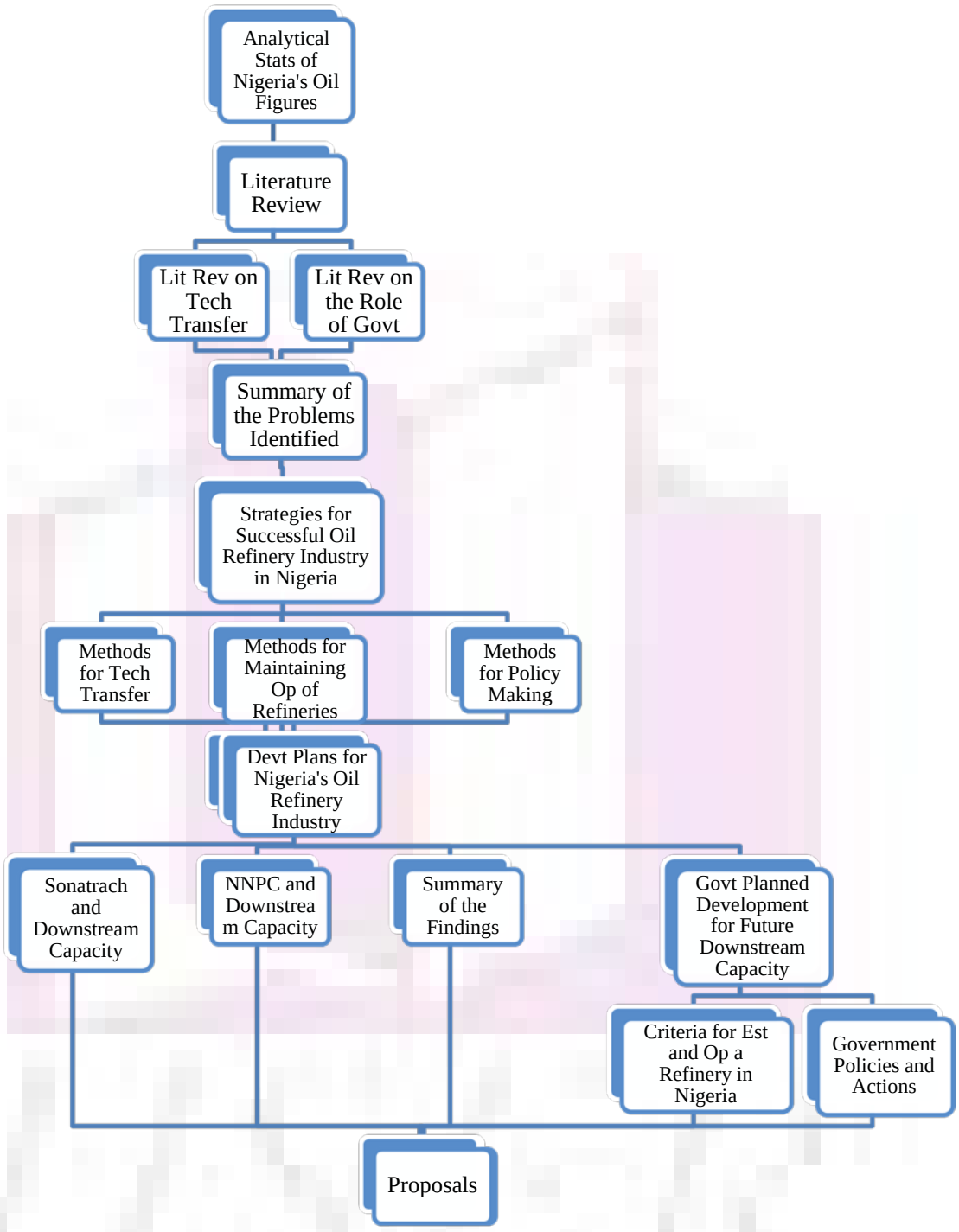

Figure 4. Conceptual Framework of the Project Implementation.

Chapter 2 – Analysis of Nigeria's Oil Production and Oil Refinery Figures

2.1. Overview

This chapter analyses the oil statistics obtained from the NNPC on the activities of the Nigerian oil industry over a ten year period (2002 - 2011), pertinent to the upstream and particularly the downstream sector. This analysis was undertaken in order to assess the level Nigeria currently is with regards to the operation of its refineries.

Analysis on; the crude oil exports, crude oil exports to the different regions of the world and crude oil delivery to local refineries over a ten year period are covered in this chapter. Final analysis covered the domestic refining capacity utilization of the refineries in the country. The analysis highlights the consistency in the productivity of the upstream sector (exploration and production) of the Nigerian oil industries over the years. It also highlights the decline in productivity of the downstream sector (oil refining).

2.2. Crude Oil Exports

Oil as already identified, is the major source of foreign exchange earnings for Nigeria. The country generates huge revenue from the exports of crude oil and associated products to other regions of the world. The following analysis carried out was undertaken to highlight the increasing productivity of the upstream sector over the years. Table 2 below shows the total annual production and exportation of crude oil between 2002 and 2011. Tables 3 and 4 show the statistical analysis of the production and exportation of crude oil between 2002 and 2011.

Years	Total Crude Oil Produced (Million Barrels)	Total Crude Oil Exported (Million Barrels)	Percentage Loss (%)
2002	740.7	663.4	10.4
2003	844.2	795.9	5.7
2004	910.2	878.1	3.5
2005	918.7	844.2	8.1
2006	869.2	817.9	5.9
2007	803	791.8	1.4
2008	768.7	724.5	5.8
2009	780.3	769.2	1.4
2010	896	864.7	3.5
2011	866.2	822.1	5.1

Table 2. 10 – Year Crude Oil Produced and Exported (Million Barrels). [43]

Statistical Analysis of Table 2 is shown in Tables 3 and 4 below:

Note: n = 10; illustrates the period the analysis covered.

Descriptive Statistics	Variables
Minimum Total Crude Oil Produced	740.7 Million Barrels
Maximum Total Crude Oil Produced	918.7 Million Barrels
Range of Total Crude Oil Produced	177.9 Million Barrels
Mean Total Crude Oil Produced	839.7 Million Barrels
Standard Deviation of Total Crude Oil Produced	59.7 Million Barrels

Table 3. 10 – Year Descriptive Statistics of Crude Oil Produced.

Descriptive Statistics	Variables
Minimum Total Crude Oil Exported	**663.4 Million Barrels**
Maximum Total Crude Oil Exported	**878.1 Million Barrels**
Range of Total Crude Oil Exported	**214.7 Million Barrels**
Mean Total Crude Oil Exported	**797.2 Million Barrels**
Standard Deviation of Total Crude Oil Exported	**65.5 Million Barrels**

Table 4. 10 – Year Descriptive Statistics of Crude Oil Exported.

Although the figures in Table 2 show that the upstream sector of the Nigerian oil industry is doing relatively well, there are still areas where the industry could achieve better results with respect to exploration, production and exportation. The standard deviation of crude oil exported is also relatively high.

The percentage loss in crude oil produced and that exported can be attributed to delivery to local refineries. These percentages are low; with the highest percentage loss set at 10.4% ten years ago (2002). The decline in production and exportation between the years 2005 and 2009 is also evident. As shown in table 2, crude oil production and exportation grew up steadily from 740.7 million barrels to a peak of 918.7 million barrels in 2005. Since 2005, crude oil production and exportation has fallen such that in 2011 it was 866.2 million barrels.

The decline in the production and exportation over that five year period can be attributed to illegal practices such as the vandalization of oil transportation facilities (pipelines) and theft of oil products. Oil spillage by the licensed multinational companies involved in excavation is also a considerable factor [44].

Year	North America	South America	Central America	Europe	Asia & Far East	Oceania/ Pacific	Africa	Total
2002	240.6	47.5	-	152.7	170.5	-	51.9	663.3
2003	329.2	64	-	175.5	153.2	-	69	791
2004	408.9	102.8	-	114.9	176.3	-	68.4	871.3
2005	427.7	50.6	-	148	147.9	-	69.3	843.5
2006	401	68.1	-	162.9	116.2	-	69.2	817.4
2007	432	73.8	-	120.7	99.1	-	68.1	793.8
2008	342.6	61.6	2.2	172.1	77.1	-	68.9	724.5
2009	276.9	78.9	0.3	163.6	111.4	-	137.9	769.2
2010	352.3	77	-	172.9	147.4	9.5	105.7	864.7
2011	271.5	79.6	-	246.6	136	18.1	70.3	822.1
Total	4393.3	847.1	2.5	2165.3	1764.6	27.6	933.1	10133.3

Table 5. 10 – Year Crude Oil Exported by Region (Million Barrels). [43]

Table 5 illustrates how crude oil exports were distributed to particular regions of the world. From analysing the data in Table 5, it is evident that North-America is the largest importer of crude oil produced in Nigeria with total annual uptake of 4393.2 million barrels per year. Europe and Asia are the next in line importers of crude oil from Nigeria with 2165.3 million barrels and 1764.6 million barrels per year respectively.

An article reviewed online mentioned that in 2011, the amount of crude oil imported from Nigeria by the USA declined due to unrest in the southern area of the country where the oil is prevalent and most exploration and production activities take place [45].

2.3. Crude Oil Delivery to Local Refineries

Table 6 below shows the crude oil delivery (Million Barrels) to local refineries between 2002 and 2011.

Years	Total Crude Oil Produced (Million Barrels)	Total Crude Oil Delivered to Local Refineries (Million Barrels)	Percentage Loss (%)
2002	740.7	78.9	89.3
2003	844.2	44.2	94.8
2004	910.2	37.9	95.8
2005	918.7	72.2	92.1
2006	869.2	41.3	95.2
2007	803	18.4	97.7
2008	768.7	41.3	94.6
2009	780.3	19.6	97.5
2010	896.	34.7	96.1
2011	866.2	45.4	94.8

Table 6. 10 – Year Crude Oil Delivery to Local Refineries (Million Barrels). [43]

Descriptive Statistics	Variables
Minimum Total Crude Oil Delivered	**18.4 Million Barrels**
Maximum Total Crude Oil Delivered	**78.9 Million Barrels**
Range of Total Crude Oil Delivered	**60.6 Million Barrels**
Mean Total Crude Oil Delivered	**43.4 Million Barrels**
Standard Deviation of Total Crude Oil Delivered	**18.4 Million Barrels**

Table 7. 10 – Year Descriptive Statistics of Crude Oil Delivery to Local Refineries.

Note: n = 10; illustrates the period the analysis covered.

From Table 7 above, the statistical analysis of variables show that:

The standard deviation is high in relation to the total crude oil delivered to local refineries for processing over the years. The percentage loss of the crude oil not delivered to the local refineries i.e. lost to exports is high as well. This corroborates the fact that the country produces crude oil to export, because the percentage loss in the crude oil exported is significantly low. This is based on analysis of the figures in Tables 2 and 6 respectively.

2.4. Crude Oil Utilisation of Local Refineries

Table 8 and 9 below show the total amount of crude oil received, processed and the percentage utilisation of domestic refining capacity over the ten year period i.e. 2002 – 2011.

Years	Total Crude Oil Received (Million Barrels)	Total Crude Oil Processed (Barrels)
2002	79.6	78.2
2003	44.8	42.8
2004	38	38
2005	72.4	70.6
2006	43.4	42.5
2007	19.1	18.2
2008	45.5	39.3
2009	19.4	17.7
2010	34.9	33.6
2011	40.4	39.4

Table 8. 10 – Year Domestic Crude Oil Refining (Million Barrels). [43]

Years	KRPC Refinery Capacity Utilization (%)	PHRC Refinery Capacity Utilization (%)	WRPC Refinery Capacity Utilization (%)
2002	34.9	52.2	55.5
2003	15.9	41.9	14.3
2004	26.0	31.0	9.1
2005	33.1	42.2	54.9
2006	8.3	50.3	3.9
2007	0.0	24.9	0.0
2008	19.6	17.8	38.5
2009	22.2	15.2	41.3
2010	20.5	9.2	43.4
2011	22.2	15.3	41.7

Table 9. 10 – Year Domestic Refining Capacity Utilisation (%). [43]

Table 8 shows the total amount of crude oil received and the amount processed. Although the refineries did not receive a substantial amount of crude oil to process each year, they still have deficits more than approximately 0.8 million barrels every year. Two years (2010 and 2011) witnessed an increase in the operations of the refineries and this is evident in the amount of crude oil processed in relation to what was received.

Table 9 shows the domestic refining capacity utilisation of the four refineries in the country. Over the ten year period analysed none of the refineries have been able to produce at optimum operating capacity of 60 % and above. The underutilisation of the refineries as a result of the deteriorating state of infrastructure and facilities has affected productivity with the situation exacerbating over time. In 2007, WRPC and KRPC did not process any crude oil. Consequently 2010 and 2011 recorded increased productivity but still fell short of optimum utilisation capacity.

From the statistics and data reviewed, it is evident that although the upstream sector is productive, the downstream sector with regards to oil refining is in a state of disrepair.

Chapter 3 – Literature Review

This section seeks to identify major problems that led to the dismal state of the refineries in Nigeria by looking at previous research on the topic. Discussions will concentrate on the role of technology in the Nigerian oil industry, the role of government on the growth and development of the Nigerian oil industry and the costs and the requirements of establishing and operating a refinery in Nigeria.

This chapter is organised as follows:

Sub-section (2.1) covers the role of technology in the Nigerian oil industry and reviews papers from **Turner:** "The Transfer of oil technology and the Nigerian State", **Fubara:** "Targeting Strategy for Technological Acquisition in the Sub-Saharan Oil Exporting States of Africa: The Nigerian Experience*", **Ukaegbu:** "The Structure of the Nigerian Industries and the Utilization of Scientific and Technological Manpower" and **Uniamikogbo and Aibieyi:** "An Assessment of Petroleum Technology Development Fund (PTDF)".

The Papers reviewed in sub-section (2.2) are centred on the role of government on the growth and development of the Nigerian oil industry and includes papers from **Okafor:** "Rethinking African Development: A Critical Overview of Recent Developments in the Petroleum Sub-Sector in Nigeria", **Tonwei Oil Refinery Feasibility Study:** "Construction of Tonwei Oil Refinery, Bayelsa State Nigeria", **Bala:** "The challenges and opportunities of the investment environment in Nigeria", **Mthembu-Salter:** "China's Engagement with the Nigerian Oil Sector" and **Eme and Onwuka:** "Political Economy of Deregulation Policy in Nigeria".

Following the conclusion of sub-sections (2.1) and (2.2), a summary of the problems identified in the papers reviewed will be outlined.

3.1. The Role of Technology in the Nigerian Oil Industry

Technology and innovation are regarded as fundamental requirements for the processes employed by the different sectors that contribute to a country's economy [19]. This includes key infrastructure like communications and media, health and transport.

The Petroleum Technology Development Fund (PTDF) and the Petroleum Training Institute (PTI) were some of the schemes promulgated by the federal government of Nigeria following the discovery of crude oil.

PTDF was established in 1973 for the purpose of training and educating Nigerians in, and about the oil and gas industry. The fund provided was to be utilised for the following purposes [29]:

- To provide scholarships and bursaries to students in universities, colleges and other higher institutions at home or abroad.
- To maintain, supplement or subsidise the education as mentioned above.
- To make suitable endowments to faculties in Nigerian higher institutions as approved by the minister.
- To make available suitable books and training facilities in the aforementioned institutions.
- For sponsoring requisite visits to oil fields, refineries, petro-chemical plants and also arranging the attachments of personnel for any of the establishments connected with the oil and gas sector.
- For financing the participation of personnel's in seminars and conferences pertaining to the oil industry in Nigeria and Abroad.

Until 2000, activities of the fund have been dormant, with the administration of President Olusegun Obasanjo (1999 – 2007) leading to a reform and restructure. The activities of the fund were dormant, due to other presumably important and unjustified upstream and downstream activities regulated by the DPR in conjunction with the NNPC and its subsidiaries [48]. The former President made it independent of the Department of Petroleum Resources (DPR) via a parastatal status and also appointed general managers and an executive officer as the chairperson to monitor and oversee its activities [29]. Since inception, there have been five CEO's with the incumbent one assuming duty in 2008.

PTI was established in Delta State, southern part of Nigeria in 1973. Its goals are to train indigenous technical human resources to meet the labour demands of the oil and gas industry in Nigeria and the West African Sub-Region [30].

PTI upgraded its initial project as a result of shortage of indigenous technical manpower in Nigeria's oil and gas industry. This is because Nigerians are not actively employed in the oil and gas industry due to inadequate training in the operation and use of the technology and infrastructural facilities available [30].

The upgrade comprises of the following:

- Education and Training.
- Infrastructure and Facilities.
- Organisational Restructuring.

Notably, the education and training phase has been initiated, but the other two (infrastructure & facilities and Organisational restructuring) remains work in progress [30].

Turner [21] focused on the Nigerian state and transfer of oil technology. She reviewed the involvement of foreign expertise and its stronghold on key positions in the Nigerian oil industry, the lack of technology transfer from foreign workers to indigenous workers and the role of compradors and technocrats in this subject. Turner compared this situation to the success of Algeria in managing the transfer of technology in its oil industry to the indigenous population.

She proposed that successful transfer of technology in Nigeria is possible if elimination of compradors in matters relating to its oil sector is given utmost priority [21]. Further she highlighted technocrats, if given the opportunity to operate without interference from compradors in the oil sector can embody the same methods that led to the Algerian state attaining enviable heights. Some of the methods include learning by doing, crash courses on operation and maintenance and investment on training technical and scientific personnel in established petroleum technology training institutions.

Turner described compradors as individuals who have gained substantial influence in the oil industry by means of the positions they hold or have held in office [21]. The lack of transparency in government practices and policies, have enabled these

compradors to have established links with the "middlemen" and foreign suppliers involved with the oil industry and as such impede or sabotage any policy (transfer of technology and the deregulation of the downstream sector) unbeneficial to them. The situation can be likened to an oligopoly.

For transfer of technology in the oil industry to be successfully implemented in Nigeria, the same processes employed in Algeria will be the most pragmatic. This can only be achieved by addressing the problems of compradors thoroughly in a transparent and systematic manner.

Fubara's [3] study focused on the transfer of technology and acquisition of skills fundamental to the successful operation of the oil industry in Nigeria. It highlighted the cost of foreign expertise to Nigeria as well as the need for sustained economic growth by its indigenes as the major reasons for this postulation.

He also mentioned the amplified measures the federal government of Nigeria put in place to ensure that this (transfer and acquisition of skills and technology) was the case. Based on this reason, the government through the 4th national development plan of 1980 – 1985 sought to achieve [3]:

- An increase in production participation by Nigerians in all the enterprises in Nigeria.
- Development of technical manpower.
- Reduction of unemployment in the country.

Furthermore, the petroleum decree act which has been in place since 1969 required that 60 % of Nigerians be actively employed in all facets of the industry. This included managerial, supervisory and skilled & unskilled labour [3]. This was a requirement for the oil licensees' at a maximum of ten years after commencement of oil activities in the country. In 1982, publications by the NNPC showed that this was not the case and also identified a wider gap of Nigerians to foreigners employed in application specific jobs like chemical engineering, well and drilling fluid engineering, technical work, geology and computer hardware & software programming [3]. Refer to the table below for more details.

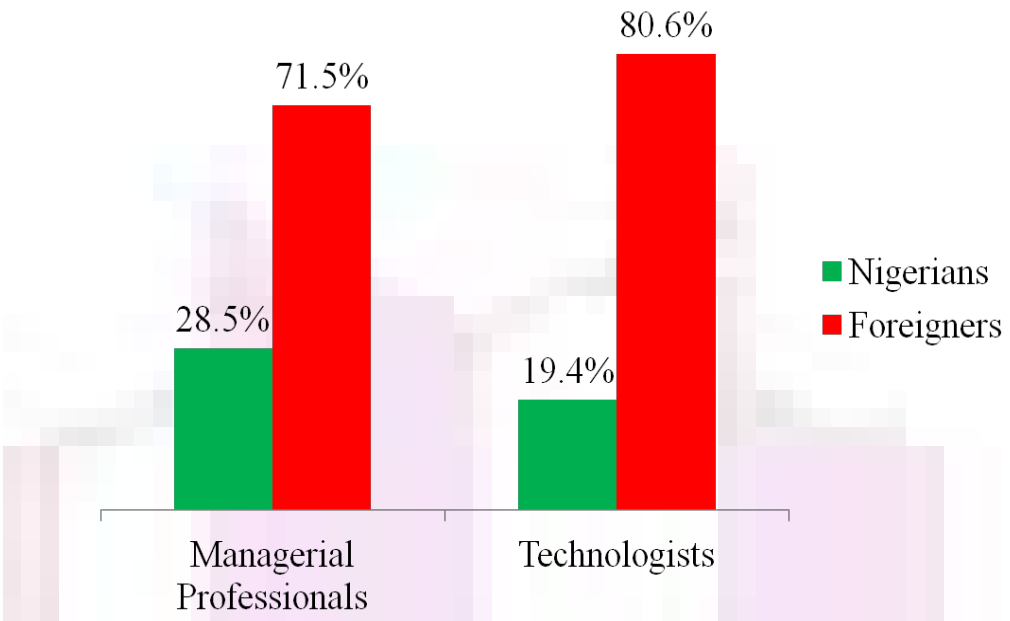

Figure 5. Adapted from "Ratio of Nigerian Professionals and Technologists in the oil service companies to Foreigners". [3]

Therefore, the writer proposed that certain policies be promulgated and strictly adhered to if Nigeria must ease off its dependence on foreign expertise in the core areas of its oil industry [3]:

- Oil service companies should employ locals for their activities.
- Within 5 – 10 years, at least 80% of technical personnel directly involved in oil production should be locals.
- In the absence of suitably trained personnel, these companies should recruit locally trained personnel in engineering or a related technical field and retrain them on the job.
- The Chief Executive Officers (CEOs) of these oil firms and licensees should be locals as this will maintain compliance with the policy.
- Collectively, states in the Sub-Saharan African oil exporting regions should embark on the development of their chemical/petrochemical industries, to spur the development of other industries such as transport, agro based and pharmaceuticals for a balanced economy.

Ukaegbu's [22] discussions were based on the structure of the Nigerian industry and the utilization of science and technology. He analytically describes and scrutinises

the processes that characterise the practices employed in Nigerian Industries. He touches on the relevant industries (sectors) and parastatals that directly or indirectly affect the nation's economy i.e. education, science & technology, agriculture and oil & gas; highlighting areas where drawbacks in their practices are evident.

His proposals for industrialisation centre on the need to embed research and development (R&D) in the aforementioned key economic sectors. Furthermore, he opined that industrialisation will enable Nigeria to successfully deviate from continued dependence on foreign expertise and the regular practice of locals being employed in areas of routine maintenance and assembly technology as opposed to management roles in multinational corporations operating in the country [22].

Other relevant issues raised point to the fact that industrialisation is important in reducing the country's dependence on the oil and gas sector, as appropriate R&D activities will enable industries to make the transition towards "import-substitution" thereby reducing imports.

Ukaegbu also noted that; " In Nigeria, between the middle and late 1970s when the oil boom provided ample revenue for the country, there was no lack of financial capital, though this wealth was not invested in industry" [22].

The assertion above is debatable, because the oil and gas sector is still the most profitable industrial sector in the country. This is evident in the constant influx of expatriates occupying the decision making roles in the sector and the total revenue generated by the oil industry for the economy over the years.

Uniamikogbo and Aibieyi [31] discussions are premised on institutions that already exist in the country i.e. Petroleum Training Institute (PTI) and Petroleum Technology Development Fund (PTDF). It identified their goal as trying to imbibe knowledge (skills and training) by providing the means and capacity for knowledge to be transferred, pertinent to encouraging indigenous workers to be more involved in the Nigerian oil and gas industry. They highlighted these as its objective and discussed to what extent it has achieved its goals.

Before covering the review of the writers, an overview of technological learning will be discussed. Technological learning involves the challenge of acquiring technological knowledge. There are two aspects to technological learning and these are described as the public and tacit knowledge elements of technology [31].

Public knowledge consists of the following:

- Engineering blue prints and designs.
- Underlying genesis of scientific knowledge.
- Management manuals.
- Handbook describing system features.
- Performance requirements.
- Material specifications and quality assurance criteria.
- Organisational methods and routines required for the implementation of these codified items.
- Knowledge of how things work in practice.

Tacit knowledge consists of the following:

- Production capabilities
- Investments
- Minor changes
- Major changes
- Strategy
- Linkage

Tacit knowledge can further be broken down into production capabilities and how it encompasses production management and engineering, repair and maintenance of physical capital in an industrial or working environment [31].

Investment capabilities comprise of:

Pre-investment Capabilities: All activities such as feasibility studies, site-selection, scheduling of investments, search for sources of technology and negotiation of contracts.

Project Execution Capabilities: Ensures that the investment decisions, financial returns and project deliverables are connected and monitored for sustainable results [32].

Minor changes are the changes that affect the activities of an organisation in a menial but positive way. Major changes are usually employed to speed up and effectively aid the process.

Strategy is put in place to effectively manage all the processes that will be employed in the workplace. Linkage connects all stages together to ensure a free flow of the process in order to attain efficient and effective results.

Linking all these activities together, and relating it to the oil industry, we find that strategies were put in place by the federal government with regards to its PTDF and PTI programs. Scholarships and bursaries were provided for Nigerians to encourage increased involvement in all aspect of the oil industry. These investments were funded by the government.

The table below shows the breakdown of PTDF trained personnel (Masters and PhD Levels) between 2002 and 2006:

Serial Number	Courses/Disciplines	No of Persons Benefitted
1	Nigerian Doctor of Philosophy (PhD)	58
2	Masters Degree in various fields of Engineering	153
3	Masters in Geological Sciences	79
4	Masters in Environmental Technology	68
5	Masters in Energy Resources	23
6	Masters in Information Technology	40
7	Others (Unspecified)	73
	Total	494

Table 10. PTDF Trained Personnel Statistical Breakdown over the Years. [31]

The PTDF fund became effective during the regime of former president (Olusegun Obasanjo). It funded the incorporation and upgrade of petroleum and earth related studies in 8 federal government universities [31]. The beneficiaries were the University of Port Harcourt (Gas Engineering), University of Ibadan (Petroleum Engineering), and University of Benin (Chemical Engineering) while University of Nigeria Nsukka, University of Maiduguri and University of Jos all benefitted Geology. Other universities were Usman Danfodio University of Sokoto (Pure and Applied Chemistry) and University of Zaria (Chemical Engineering).

By 2010, the PTDF had started phasing out overseas scholarship scheme of training individuals at the postgraduate (masters) level and intends to have achieved this by 2013 [33]. This is because Nigeria now has local capacity to train its indigenes in the relevant subject areas pertinent to the oil and gas industry. This was corroborated in a statement made by the Executive Secretary of the fund: "it has become imperative following the development by the Fund of sufficient and competent manpower to operate and manage the oil and gas industry in Nigeria" [33].The fund has since its inception so far trained 1800 scholars at masters' degree level and 250 scholars at doctoral level in notable universities that specialise in oil and gas courses in the United Kingdom.

Another scheme supported by the PTDF was the training of indigenous workers practicing in the oil and gas engineering companies, graduate engineers in other firms, members of the Council for the Regulation of Engineering in Nigeria (COREN) and the Nigerian Society of Engineers (NSE), PTDF trained engineers and unemployed graduate engineers [31]. The pilot phase of the scheme was initiated in 2007 and was to span over a 3 year period having trained a total number of 2350 engineers on its completion. Some of the engineering design programmes were based on familiarising the recruits with certain engineering tools such as PIPENET, INTOOLS, PIPESIM and FLARENET [31].

Candidate eligibility for the training is outlined below:

- Proficient in the use of Microsoft office and its related tools and protocols
- Completed the National Youth Service Corps (NYSC) programme
- Graduate of any engineering discipline with minimum graduating degree of second class i.e. upper or lower, or its equivalent
- Less than 40 years old for employed engineers and not more than 35 years for unemployed engineers
- Proficiency and previous experience in the use and operation of AutoCAD is an added advantage.

Moving on to the other project that was initiated by the government, PTI was described as imperative due to shortage of indigenous middle level technical manpower in the oil and gas industry [31]. Infrastructural facilities, workshop, laboratory equipments and information technology equipments were all procured and installed for better training and nurturing of the skills of indigenous workers. Other facilities that were provided to aid this cause were specialised libraries with subject area related journals and textbooks, power generators, information technology software and audio and visual aids for teaching and training purposes.

Finally the authors conclude that the major challenge for the Nigerian government with regards to this subject is the lower priority given to national development [31]. Further, they claimed goes on to mention that some Nigerian trained personnel felt dissuaded and have not been adequately utilized for the development of oil and gas industry in Nigeria. A summary of their views are outlined below [31]:

- Nigeria through the establishment of PTDF and PTI has successfully trained local manpower sufficiently to enable engagement in activities pertinent to the oil and gas industry.
- Technological problems remains despite the skills and training offered to indigenous workforce by these projects.
- The refineries still in a state of disrepair underscore this.
- Insufficient individuals have been trained adequately to cope with the technological challenges in the oil industry.

Consequently, the authors proposed the following methods to address the issues [31]:

- Technological and professional training should both be theoretical and practical i.e. as opposed to being just theoretical.
- The government should promulgate fewer policies backed with full implementation and follow-up action.
- The PTDF and PTI schemes should reach significantly more benefactors each year.

- The research on technological transfer and improvement of the services rendered by PTDF and PTI should be a continuing process among scholars and researchers.

3.2. The Role of Nigerian Government in the Growth and Development of the Oil Industry

The government of a nation plays a vital role in stabilising the economy and promulgating policies that lead to the growth and sustainability of the country. The state and welfare of a nation's economy is measured by the marketable goods produced and services rendered within the country over a stipulated time period, usually a year (Gross Domestic Product) [20]. Nigeria, still considered a developing country, requires investments from able individuals and corporate bodies in various sectors of the economy. Foreign expertise from developed countries is also required to oversee industrial activities and harness economic growth and development [23].

The Nigerian oil industry, historically the biggest generator of national revenue, has had various policies enacted in the past. These include, "the "Oil in Pipeline Act" cap 145 of 1965, the "Petroleum Profit Tax" of 1967 and the "Oil Navigable Waters' Decree" of 1968 amongst others. This was to ensure that the federal government stays abreast of activities involved in the oil industry [13]. It also led the government to establish a parastatal (NNPC) charged with the activities of the upstream, midstream and downstream sectors in the oil industry. Policies that could improve the downstream sector were also postulated. The government also explored deregulation of the downstream sector to increase investments from private bodies locally and overseas.

Okafor [18] focused on the predominance of the public sector as a major player in the state of affairs of the economy and how this has limited or restricted the involvement of private enterprises. This is pertinent to the development and effective management of the downstream sector (refining, distribution, gas development and petrochemicals) of the Nigerian petroleum industry.

Private sector involvement in the oil industry has been limited to the upstream sector (exploration and production), under the supervision of the NNPC. The corporation oversees and monitors proceedings; with the interest of the nation as utmost priority and in view of the importance of this particular sector, as the major generator of the country's foreign exchange earnings.

Consequently, he proposed that private sector be given the opportunity to establish new and modern refineries and also be allowed to renovate and manage existing and ageing refineries in the country. He supported his criticism of the public sector by saying; “The problems of the petroleum industry are similar to those of the electric power sector and emanate primarily from the incompetence and poor accountability of the public sector in managing enterprises”. He also added that while the upstream sector appears to be working well (investments are managed by foreign technical partners), the downstream sector is in a virtual state of collapse. [18]

The table below shows the barrels per day (bbl/d) production and the relative products of the four existing refineries in Nigeria:

Location	Commissioning Dates	Capacity (bpd)	Products
Port-Harcourt	1965	60000	Petrol, Kerosene, Diesel, Fuel Oil
Warri	1978	125000	Petrol, Kerosene, Diesel, Fuel Oil, Liquefied Petroleum gas, Polypropylene, Carbon Black
Kaduna	1980	110000	Petrol, Kerosene, Diesel, Fuel Oil, Base Oil, Waxes, Solvents, Linear alkyl benzene
Port-Harcourt	1989	150000	Petrol, Kerosene, Diesel, Fuel Oil
Total capacity (bpd)		**445000**	

Table 11. Profile of Nigerian Refineries. [18]

The problems identified in this paper as some of the issues plaguing the downstream sector are:

- Mismanagement that has led to the dismal state of the existing refineries in the country.

- Underlying factors that have impeded the inflow of FDI. This paper in particular draws attention to the financial structure of the banking sector in the country, identifies the reason these banks cannot afford to support private enterprises, through means of investment(s) in the establishment of new and renovation of the existing refineries.

The total financial structure in the banking sector in Nigeria is estimated at less than $100million and the funding required to set-up a refinery or renovate existing ones is in the region of $200 million to $1billion depending on the structure and size of the refinery [18].

These problems are believed to be solvable with the advantages highlighted as:

- The existence of refineries in Nigeria.
- The functional operation of the upstream sector of the oil industry in the country.

The paper **Tonwei Oil Refinery Feasibility Study** [27] proposes the establishment of a refinery with modern and adequate infrastructure, required technology and transportation facilities at its disposal. The refinery is to be run by private investors, following the approval of the government and its parastatals - Nigerian National Petroleum Corporation (NNPC) and the Ministry of Petroleum Resources. Details of how the refinery will operate and the long term benefits to the country were covered in the report.

Tonwei refinery limited is a subsidiary of Tonwei group of companies whose principal office is situated in Switzerland, with other interests dispersed across Africa, Europe and America. It is one of a list of companies run by private investors designated to start full operation of refineries in Nigeria [28]. Tonwei proposes to put to good use the land it has acquired, located in the oil rich state of Bayelsa; south-south of Nigeria, by establishing other infrastructural and social amenities such as hotels, shopping malls, schools, hospitals, banks amongst others within the

same complex. These will cater for its employees, and where possible, serve other purposes such as tourism.

The merits and de-merits identified for the implementation of this process are as follows:

Merits

- Creation of jobs for indigenes.
- Potential increase in tourism in the area with the establishment of hotels and guest houses.

De-merits

- Less Job opportunities for indigenes with the influx of expatriates occupying the decision-making positions.
- No transfer of skills to indigenes anticipated, which may lead to continued dependence on expatriate refinery expertise.

The federal government under the administration of the former president (President Olusegun Obasanjo) had granted this particular company and 25 others the license to begin operation in the country in 2002, with eight of these 25 due to start in 2004 [28].

A committee in the House of Representatives, the government arm in charge of the legislation pertinent to the oil industry, corroborated this. Other discussions focused on the issue of fuel subsidy removal with respect to the development of downstream sector (oil refining) of the industry; highlighting its importance for the long term. It also identified fuel subsidies as a secondary reason impeding the influx of private investors in this sector while other underlying factors are inadequate security and dilapidated infrastructure.

Bala [24] based his discussions on the factors limiting the total take-off of foreign direct investment (FDI) in Nigeria. He highlighted numerous opportunities available within the country; in terms of skilled workforce, abundance of natural resources and the presence of a large domestic market. If exploited, he asserted, this will benefit both foreign investors and the nation in the long term.

He used Japan, a known powerhouse in technology, infrastructure and innovation, as a prime example to further his discussions [14]. The country already invests in other sectors of the Nigerian economy such as manufacturing (transportation and mobility) with the presence of Yamaha, Honda and Toyota amongst others [15].

For Nigeria and Africa as a whole to attain sustainable development, Bala proposed that Japan and other members of the G8 will have to play a part; “by mobilizing capital to support the key investment sectors that will enable Africa (and thus Nigeria) achieve meaningful growth and development” [24]. Also, he added that the following areas be addressed as prerequisite to securing FDI.

- Complete rehabilitation of socio- economic infrastructure such as power generation.
- Rehabilitation of rail networks, construction of intra and inter- city links and the introduction of other means of transportation such as tramlines to support and alleviate the pressure on road and air transportation.
- Finding an enduring solution to the insecurity that faces the country.

Nigeria is blessed with a huge domestic market [8] and its abundant natural resources like crude oil is an attractive potential for FDI. The right investment from firms and businesses could close several gaps in the market. This will be beneficial to the country as investments can also be channelled to the oil sector especially the downstream sub sector.

Mthembu-Salter’s [25] research dug deep into international relations with Chinese firms and industrial establishments during the tenure of former president (Chief Olusegun Obasanjo) with regards to the oil industry. He based his discussions on the agreement established between these firms and the nation under the leadership of the former president.

In fact, he stated that the administration of the former president allowed Chinese firms, through the process of bidding alongside notable competitors, to acquire oil assets (oil blocs) in exchange for the development and maintenance of infrastructural facilities in Nigeria. Some of the alleged infrastructural investments agreed included the construction of rail networks linking the south west to the north (Lagos to Kano), rehabilitation of the refinery in Kaduna (northern Nigeria) and construction of a hydro-electric power station and this batter is widely referred to as “Oil for Infrastructure”. [25]

The advantages of this kind of agreement can be seen to bolster bilateral relations for the foreseeable future and also enable the development of modern infrastructure and technology at no direct monetary value to the country.

However, the disadvantages which outweigh the advantages, included:

- No means to measure the real input value contributed to Nigeria. Oil for cash payment would have been a better and more substantial option.
- Stagnancy may be experienced, as contracts are based on and limited to certain projects whose priorities are not necessarily justified.
- Continued dependence on foreign expertise and the requirement of foreign investments, without any structure in place to eventually become self-reliant, is detrimental to the growth of the country. This is in terms of economy, innovation, infrastructural facilities amongst others.

Finally, Mthembu-Salter's proposals did not support the "oil for infrastructure agreement" as the best means of bringing about the development of the oil industry. One of the ways the nation; still a developing country could achieve its objective of attaining sustainable development and become one of the largest twenty economies by 2020 [26], is to trade oil assets for cash payments that have no restraining parameters on its inflow towards the development of any sector. The opposite is the case with the "oil for infrastructure" agreement.

Eme and Onwuka [34] based their discussions on the consequence of deregulating the downstream sector of the oil industry in Nigeria. They also highlighted the implications associated with this concoct and the challenges that could face its implementation.

They attributed lack of transparency in policy making and the mismanagement of Nigerian resources as major causal factors for the deplorable state of affairs in this sector and Nigeria at large. The solutions proposed for an effective and efficient oil sector are as follows [34]:

- Deregulation of the downstream sector to increase private investors, drive competition and reduce prices of petroleum products.
- The exportation of crude oil and importation of refined petroleum products to meet domestic demand should be phased out, because it is detrimental to long term economic growth.
- The government should not be overly focused on renovation and rehabilitation of the existing refineries, but should be open to establishment of modern environment friendly refineries.

- The profits made from the oil windfalls and removal of subsidy should be channelled into the establishment/renovation of refineries, and infrastructure such as transportation system pertinent to the oil industry and also into other sectors of the economy that are in derail.

The table below shows the consistent increase in oil prices in the country, over 30 years (1978 – 2009) under seven different administrations.

Note: N Indicates Naira (the currency of the Federal Republic of Nigeria).

The current exchange rate is set at [50]: £1 = N272

$1 = N157

Date	Price per Litre	Regime	% Increase
October 1, 1978	15 Kobo	General Obasanjo	73.86
April 20, 1982	20 Kobo	Shehu Shagari	31
March 31, 1986	31 Kobo	General Babangida	99.5
April 10, 1988	42 Kobo	General Babangida	6
January 1, 1989	42 Kobo (commercial vehicles)	General Babangida	43
January 1, 1989	65 Kobo (Awate Vehicles)	General Babangida	43
December 19, 1989	60 Kobo	General Babangida	43
March 6, 1991	70 Kobo	General Babangida	16.6
November 8, 1993	N5	Ernest Shonekan	614
November 22, 1993	N3.25	General Abacha	-
October 2, 1994	N15 and then N11	General Abacha	316.5
December 20, 1998	N25	General Abubakar	1257

Date	Price per Litre	Regime	% Increase
January 6, 1999	N20	General Abubakar	-
June 1, 2000	N35	Olusegun Obasanjo	50
June 8, 2000	N25	Olusegun Obasanjo	-
June 13, 2000	N22	Olusegun Obasanjo	-
June 20, 2003	N40	Olusegun Obasanjo	-
September , 2004	N48	Olusegun Obasanjo	-
April 11, 2005	N52	Olusegun Obasanjo	18.2
May 28, 2005	N75	Olusegun Obasanjo	-
June 25, 2007	N70	Umaru Musa Yar'adua	-
January 15,2009	N65	Umaru Musa Yar'adua	-

Table 12a and 12b. Oil Price Adjustment since October 1978. [34]

The advantages and disadvantages of the argument in the paper are highlighted below:

Advantages

- Deregulation of the oil sector could induce price reduction as private investors compete for market share.
- Removal of oil subsidy could free up cash to invest in other sectors of the economy and infrastructure development in this sector.

Disadvantages

- Removal of oil subsidy would worsen hardship faced by the populace, as consequent increase in cost of transportation triggers a domino effect on the cost of living. The current price of fuel in Nigeria as of January 2012 is N97; 49.2% increase from its previous price in 2009 [51].
- The costs associated with renovation or establishment of a refinery is particularly prohibitive.

In light of the foregoing and all the points raised, it is evident that effective management of Nigeria's natural resources will be enhanced by transparent, reasonable and structured policies. Implementation of the points suggested will restore industry reputation and cause a ripple effect to other parts of the economy.

3.3. Summary of the Problems Identified

The problems identified in the literature review are summarised and detailed:

- Compradors described as government personnel through their positions have acquired shares in key areas of the Nigerian oil and gas industry.

- The costs of foreign expertise to the Nigerian oil industry and the broader Nigerian economy.

- Overdependence on the Nigerian oil industry (upstream sector) for income generation.

- Lower priority given to national development as well as underutilisation of available skilled labour.

- The dominance of the public sector in sub-sector activities of the oil industry.

- Dilapidated infrastructure, insecurity and interrupted power supply.

- Government efforts with regards to securing the right investment for the downstream sector of the Nigerian oil industry.

- Lack of transparency in government policies and the mismanagement of Nigerian resources.

Chapter 4 – Strategies for Successful Oil Refinery Industry in Nigeria

This chapter covers methods as possible solution to the problems identified in the literature review. Strategies proposed for successful operation of refineries in Nigeria are based on papers by; Mohagar et al on *"Evaluation of technology transfer strategy of petrochemical process"*, Accenture on *"Maintaining Refinery Assets for High performance (An Accenture point of view for the downstream refinery sector)"* and Onorato W.T on *"Legal frameworks used to foster petroleum development"*.

4.1. Methods for Technology Transfer

The paper by Mohagar et al on *"Evaluation of technology transfer strategy of petrochemical process"* [49] and the proposals therein, make up the methods covered in this sub-section. Their study was on the Islamic Republic of Iran.

4.1.1. Selected Strategy for Technology Transfer

Strategies for technology transfer include the following [49]:

General Channels: Information is available to the general public with no limitations and restrictions. Sources include education, training, publications and conferences.

Reverse-engineering Channels: Technology is accessed and assessed to suit purpose. Capabilities are developed and duplicated to reach a wider range provided patents and proprietary rights are not violated.

Planned Channels: Technology transfer follows defined procedures and processes in consent with the technology developer. Planned channels are further broken down into:

- **Licensing:** The receiver purchases the right to employ another individual's technology. Be it an outright purchase or payment of lump-sums including percentage of sales.

- **Joint Venture:** Entities combine interests in businesses, resources and developing technology to support a cause. International joint ventures are common to foster acquisition and transfer of skills and technology required to gain access to most markets.

- **Turnkey:** A country acquires a project from another source designed and delivered to operate.

- **Foreign Direct Investment:** Corporations invests technology, resources and funds in various business ventures abroad. This gives rise to technology transfer, with the host nation benefitting from development of infrastructure, job opportunities and investment capital.

- **Technical Consortium and Joint R &D Projects:** Entities combine resources because of inadequacies of one to effect technological change.

  Technology transfer required for petrochemical processes are only realised by facilitating planned channels [49].

4.1.2. Criteria and Factors for Technology Transfer

"The Analytic Hierarchy Process (AHP), is a multi-criteria decision model used hierarchic or network structures to represent a decision problem and then develops priorities for the alternatives based on the decision maker's judgements throughout the system" [49]. It encompasses all factors for technology transfer (tangible and intangible). Adopting this model, the factors for technology transfer are listed as follows [49]:

Organisational Factors: The competence of managers and the extent to which local experts are involved in the organisation facilitate technology transfer. The skills and experience of indigenous labour is also a core factor.

Nature of Technology Factors: Technology brings about technological change which has various impacts on the growth of an economy.

Technology Provider Factors: The role of multinational companies and their contract with host nations.

Beneficiary Factors: Efforts of the host nation in supporting and sustaining technology transfer.

Law and Regulation Factors: The flexibility of the laws of the planned channels critical in securing investments that facilitate technology transfer.

The table below shows a petrochemical process technology transfer criteria and factors:

CRITERIA	FACTORS
Organization	➢ Adequate risk of investment. ➢ Adequate material resources such as machinery. ➢ Adequate technology transfer to organization. ➢ Proactive leadership and management support. ➢ Communication between the key personnel of all parties. ➢ Product export target. ➢ Adequate market share.
Nature of Technology	➢ Training of local manpower. ➢ Technology gap. ➢ Technology changes.
Technology Provider	➢ Adequate technological and managerial knowledge and skills of the technology supplier. ➢ Technology supplier co-operation in technology transfer process.
Beneficiary	➢ Technology transfer for related industries such as machinery. ➢ Usage of local technical experts and technical support staff. ➢ Local contractor and manufacturer. ➢ Reduction of technical gap in related local technical expertise.
Laws and Regulations	➢ Political problem. ➢ Local law for international investment and technology transfer. ➢ Socio-economic matters. ➢ Existing culture and ethic value. ➢ Resources available.

Table 13. Petrochemical Process Technology Transfer Criteria and Factors. [49]

4.1.3. The Link between Strategies and Factors for Successful Technology Transfer

The writers' propositions linking the strategies and factors for successful technology transfer is shown in Figure 6 below [49]:

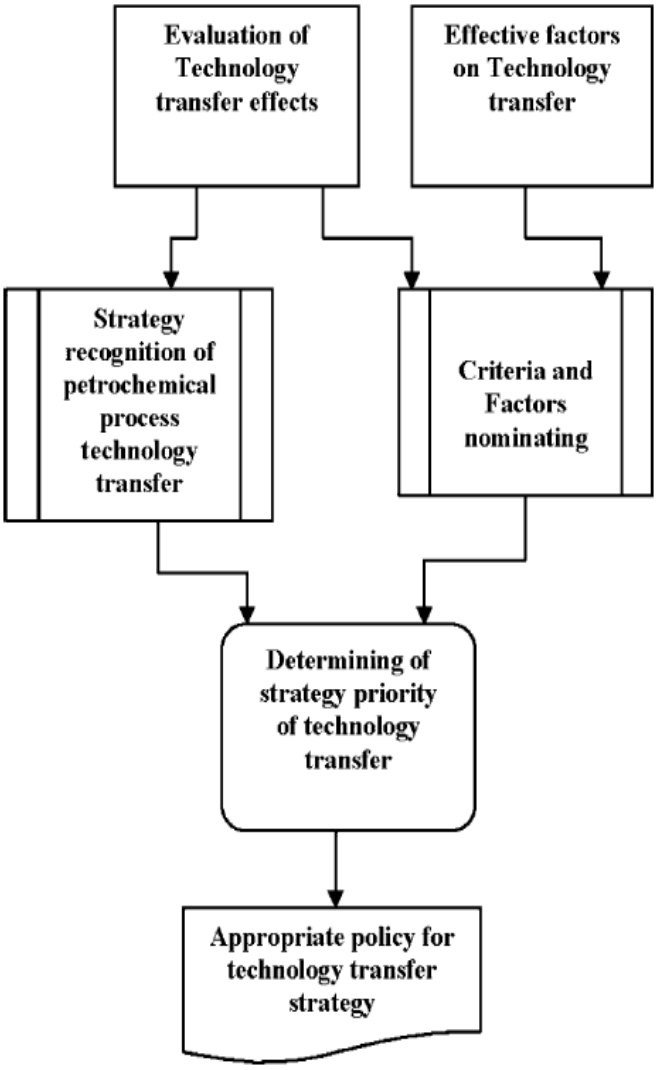

Figure 6. Conceptual Framework of the Strategies and Factors for Successful Technology Transfer. [49]

The writers concluded that Joint ventures and licensing are the best strategies in facilitating technology transfer to developing countries like Iran, as limitations could impede other strategies such as turnkey and FDI, achieving desirable results.

4.2. Methods for Maintaining the Operation of Refineries

The methods discussed are those proposed by Accenture, a global management consulting, technology service provider and outsourcing company. The report: *"Maintaining Refinery Assets for High performance (An Accenture point of view for the downstream refinery sector)"* [42] was reviewed for this purpose. The methods proposed are broken down into three headings and are detailed as follows:

4.2.1. Overview of Asset Maintenance

This postulates the maintenance improvement initiatives required. The paper affirmed the need for refiners to employ equipment-specific strategies that will improve the efficiency of the work in the industry. It identified the need for an analysis to be implemented in extirpating repetitive problems with a proactive culture imbibed in anticipating them and finding adequate solutions.

Once maintenance improvement is underway, supply chain support has to be evaluated and employed in improving productivity and reducing working capital. Following this, a system has to be initiated to ensure that all facets of the industry benefit from this support.

Methods should always be researched to ensure that the improvement is continuous. This can be achieved by investigating optimal systems and technology enhancements procedures and processes. Also a full life cycle approach should be employed by taking into consideration capital-replenishment methods, supply chain support and refining strategies that can ascertain the results required.

4.2.2. Practices Employed in Maintaining Assets

Leading Practice Number One: Developing equipment-specific strategies should be the number one leading practice. The other two practices emanate from understanding and effectively implementing this practice. It is recommended that before developing equipment-specific strategies, the following should be considered [42]:

- What are the critical assets for the refinery?
- Based on risks, how do different activities reduce the probability of failure for each asset?
- How are the strategies for specific pieces of equipment leveraged and applied to other assets?

A proactive measure is usually encouraged to be employed in industries. The refinery comprises of various critical equipment that are necessary for production. The causes of asset failures and the measures that can be taken to mitigate the resulting effect of these failures should be scrutinised. The strategies for maintenance are usually effective when the refiners understand the cause of failure to assets and the benefits that can be realised through mitigation measures.

It is essential that refiners understand operation and maintenance procedures, as in some cases equipment-specific strategies may identify the cause for failure as misapplication of a process or equipment. This can highlight the need for a readjustment of processes and equipment to suit all intent and purpose.

A risk based analysis of failure modes and their effects should be carried out. Management personnel by employing this will be able to identify the relationship between costs and the critical assets integral to the work process. Also based on this risk analysis, managers can better understand the need for investing in mitigation measures.

Finally for refiners to achieve minimal costs for repairs and activities in proactive and reactive work, Accenture recommends that lean six sigma principles, applied in many manufacturing industries should also be applied to all facets of this industry. Starting with improving the planning and implementation of the work.

Leading Practice Number Two: Improving maintenance efficiency is the second practice proposed. The major objective of the refineries is to ensure that the amount of time spent at work i.e. using the tools, critical equipment and engaging in activities is maximised. The workers within the working environment should be focused on augmenting productivity with the available resources. Other priorities should encompass the means and methods for eliminating wastes and non-value added activities.

Planning and scheduling processes are fundamental for increasing efficiency and reducing the cost associated with finding solutions to problems. A link should be established with the refiners, contractors and those in charge of maintenance to enhance the implementation of planning and scheduling

processes. This will help the maintenance team develop a suitable schedule that prioritises the work process of the refineries, as identified by the refiners and contractors.

Leading Practice Number Three: Identifies the need to enhance support efforts and mechanisms once transformational activities have been initiated. Support in this case defines anything required to aid maintenance operations but not exactly part of the maintenance operations. Key in this area will be the effective management of the supply chain efforts such as procurement, warehousing and the supply of spare parts. It is integral that contactors are incorporated to the work process and in overall maintenance effort to improve efficiency. Also, there has to be a predefined work plan for the refiners and contractors to work with. Projects characterised by planning as the work process progresses, will end up costing the company more money for the services of the contractors depending on the terms and conditions of their contracts.

4.2.3. Sustaining Improvements to Asset Maintenance

Institute a governance and performance review process: Good governance has to be in place, to support the effort of refiners. It will enable them act upon results and continuously monitor the improvements of the practices employed in the refining process. Good governance process entails the following [42]:

- Requirements for the leadership in directing and supporting the on-going efforts.
- A structure of defined roles, responsibilities and accountabilities across the organisation that gives clarity on process details and requirements, resulting in enhanced decision making.
- A process for managing the performance of each facility's maintenance effort and everyone involved in it, form the corporate level to the shop floor.

Manage Change Efforts and Communications: For refiners to be able to implement the leading practices discussed in sub-section (4.2.2) above, it is essential to effectively manage the change efforts and the necessary communications in the working environment. This will support the changes that are being instilled to the working process and environment at large.

Senior management should be kept up-to-date in respect to the new efforts that are to be introduced to the work place. This will help avoid a derail in the current practices of the industry before the new practices are institutionalised. A lack of information and communication may result in the stakeholders allocating funds to other projects.

Build Skills and Capabilities: In changing the guidelines for the working environment, it is important that employees are given the right skills and capabilities to effectively execute their jobs. A proper training approach is essential so as to align the right skills with the right job roles to enhance individual professional development.

The area of developing skills and capabilities should not be limited only to the technical aspects of the industry but also to encompass the organisational and managerial aspects. As the development of skills and capabilities improves the success potential for employees; thus improving the operations and processes of the refineries.

Make Effective use of Tools and Technology to best enable the Improvements: Information technology provides a means to garner the information used in assessing asset performance so that personnel can institute appropriate corrective measures. Through the incorporation of data and information to the processes of refining, refiners can expedite the on-going maintenance and reliability improvements in the industry.

4.3. Methods for Policy Making

Onorato W.T draft *"Legal frameworks used to foster petroleum development"* [55] proposed a framework to effective policy making for oil industries with regards to increased production and returns on investments. Prior to this, key objectives for oil industries were highlighted. The objectives will be outlined with the framework covered subsequently.

4.3.1. Objectives for Oil Industry Development [55]

- Full and prompt exploration of prospective areas.
- Fair sharing of the fiscal "pie" between the state and the contractor
- Protection of the environment.

- Proper treatment of residents and communities affected by petroleum development operations.

- Training and education of the state's citizens.

- Purchase of local goods and services.

- Reasonable controls over development activity.

4.3.2. Guidelines to Effective Policy Making for the Oil and Gas Industry

The framework is detailed as follows [55]:

- State property in its petroleum resources. Through petroleum law, the country asserts and confirms ownership of all petroleum resources prevalent onshore, offshore and collectively in its geographical area.

- Establishment by law of an independent government agency mandated with implementing petroleum sector policy i.e. NNPC. It serves as a point of contact for investors in the nation's oil industry. The policy purpose of this authority is to separate the country's bequest and licensing of petroleum resources from the administration of the sector.

- The petroleum law should encompass all permitted forms of petroleum operations. It should allow the country flexibility in its operations i.e. be it through joint ventures, private entities or national companies. These operations should be mandated by licensing and be in conformance with petroleum laws.

- The petroleum law should allow the competent authority (CA) design models outlining the criteria for investors. Minimum requirements should be stated with the main information revealed during negotiation. The role of the authority in matters of supervisions, relinquishments, suspension and revocation should be clearly defined.

- The legal basis for the authority to make regulations under the law should be defined. Policies not of a technical nature should be subject to inter-ministerial review and approval process.

- The petroleum law should define the qualifications, rights and duties of contractors who will conduct petroleum operations. Contractors must report any

milestones turned to the authority, present an appropriate development plan and work in line with set petroleum industry practices.

- The petroleum law should make available a section that addresses fiscal terms such as taxation of profits. A good tax regime aims to [55]:

  - ✓ Reduce Uncertainty.
  - ✓ Present a clear picture of the applicable regime.
  - ✓ Limit negotiations on tax issues.
  - ✓ Provide fair and equitable tax treatment for all investors.
  - ✓ Avoid double taxation and assure home country foreign tax credits; and provide for a reasonable period of tax stability.
  - ✓ A regime easily applied to any form of petroleum agreement selected.

Nigeria, Yemen and Venezuela were some of the countries highlighted as having less attractive tax regimes, with the UK, Australia and Peru on the other side of the scale.

- The Petroleum law should address other key fiscal and operational provisions such as free entry of goods used in petroleum operations, split-payrolls for expatriates and access to local capital markets amongst others.

- The petroleum law provisions with regards to guaranteeing fiscal stability should be distinct. This is targeted at allaying the effects of new laws on contracts and the job of contractors.

- Provisions in the law should outline the requirements mandated for petroleum operations in line with protecting the environment. An environmental impact assessment must be carried out before petroleum operations can commence.

- Rounding up, other brief issues of the petroleum law should be addressed i.e. incentives for natural gas development, technology transfer, training and employment of nationals, utilisation of overlapping deposits and relationships to other conflicting laws.

In summary, a well-documented petroleum law should make provisions for an extensive definitions section at the beginning for clarity and ease of reference [55].

Chapter 5 – Nigeria's Oil Refinery Industry Future Developments

This chapter puts into context Algeria's oil service structure SONATRACH and the success it has achieved to date in enhancing and supporting the activities of its downstream sector. Downstream activities of SONATRACH and NNPC to date are also discussed to affirm the extent of success achieved in practices of the former and highlight areas where Nigeria's downstream capacity is failing. Following this, government actions and policies to revive Nigeria's downstream capacity will be defined and proposals on resuscitating Nigeria's oil refineries inferred.

5.1. SONATRACH and Downstream Capacity

SONATRACH, the national petroleum corporation of Algeria has succeeded in the process of technology transfer to sustain the activities and operation of downstream capacity. The country has transitioned core management areas of its refineries by expatriates to its indigenes. The methods employed in achieving this are called out and outlined below [21]:

- Nationalising the technical structure serving the oil industry.
- Government found foreign technical partners for the exploration and production of crude oil as well as downstream projects. Locals were attached to work directly under these expatriates, with the term referred to as "Learning by Doing".
- Investments on training technical and scientific personnel in established petroleum technology training institutions.
- Crash courses on the operation and maintenance of the processes involved in refining were also commissioned.

Furthermore, through its downstream activities, SONATRACH owns [56]:

- Four LNG complexes, 3 in Arzew and 1 in Skikda, with a full production capacity of 44 billion m^3 of LNG/year.

- Two LPG complexes in Arzew, with a full production capacity of 10.4 million tons /year.

- Five Refineries [56]:

  - One in Algiers, with a crude oil processing capacity of 60,000 bbl/d.
  - One in Skikda, with a crude oil processing capacity of 300,000 bbl/d.
  - One in Arzew, with a crude oil processing capacity of 60,000 bbl/d.
  - One in Hassi Messaoud, with a crude oil processing capacity of 30,000 bbl/d.

Total crude oil processing capacity of the four refineries is set at 450,000 bbl/d.

Rehabilitation of three of the four mentioned refineries is underway with a view of expanding current crude oil processing capacities to meet rising domestic market demand and is outlined as follows [56]:

- Algiers Refinery from 60,000 bbl/d to 80,000 bbl/d by 2014.
- Arzew Refinery from 60,000 bbl/d to 90,000 bbl/d by 2012.
- Skikda Refinery from 300,000 bbl/d to 330,000 by 2012.
- A 5 million tons/year Condensate Topping Refinery in Skikda.

Other ongoing projects include [56]:

- One natural gas liquefaction train in Skikda with a capacity of 4.5 million tons (9.978 million cm/year of LNG).
- One natural gas liquefaction train in Arzew with a capacity of 4.7 million tons (10.484 million cm/year of LNG).

5.2. NNPC and Downstream Capacity

The NNPC through its downstream activities owns [57]:

- Four Refineries:
  - Two in Port-Harcourt, with combined crude oil processing capacity of 210,000 bbl/d.
  - One in Warri, with a crude oil processing capacity of 125,000 bbl/d.
  - One in Kaduna, with a crude oil processing capacity of 110,000 bbl/d.

Total crude oil processing capacity of the four refineries is set at 450,000 bbl/d. A comprehensive network of pipelines and depots located throughout Nigeria link these refineries. Due to poor maintenance, these refineries have never operated at optimum capacity [7].

The Kaduna refinery produces linear alkyl benzene, benzene, heavy alkyl ate and deparaffinised kerosene. A 35,000 metric ton per annum polypropylene plant and an 18,000 metric ton per annum carbon black plant are linked to the Warri refinery [57].

NLNG a subsidiary of the NNPC, currently has six trains and a production capacity of 22 million tons/year. As a result of inadequate sufficient infrastructure to produce and market associated natural gas, it is often flared. It was reported that Nigeria in 2011 lost $2.5billion in revenue to flaring [57].

Currently there are no projects towards developing refineries. Although three additional LNG plants, served by seven trains, intended to commence operations this year has been postponed to unspecified dates in the future [7].

5.3. Summary of the Findings

It is deduced that the schemes undertaken by Algeria (identified in sub-section 5.1), has been able to sustain the operation of its refineries to date. Plans have been initiated to expand crude oil processing capacities in three of its refineries to meet domestic demand. The nation also engages in production of natural gas with full production capacity of 44 billion m^3 of LNG/year. Further developments to increase capacities in Skikda and Arzew refineries are in progress.

Also deduced is the deplorable state of downstream capacity in Nigeria. The Nigerian Government aware of this, have proposed policies and planned actions to address this issue. Sub-section (5.4) is therefore central to the discussion of these policies and actions.

5.4. Nigerian Government Development Plans for Future Downstream Capacity

The Nigerian government has provided guidelines and is reviewing certain areas of the downstream sector of its oil industry, as efforts to secure investments required to develop downstream capacity. These are:

I. Nigerian Government New Criteria for Establishing and Operating a Refinery in Nigeria.

II. Nigerian Government Policies and Actions.

5.4.1. Nigerian Government New Criteria for Establishing and Operating a Refinery in Nigeria

A document published by **DPR [40]**, focused on guidelines for potential investors in the downstream sector, with respect to establishing and operating a refinery in Nigeria. The aim of the document is to inform investors about the technical and economic implications of the venture, as well as the attending environmental and sociological impact. This will facilitate adequate provision of health and safety facilities for the workforce involved directly or indirectly with the refinery. The safety for the plant and adjoining facilities will also be considered. Hopefully, these would ensure optimum resource utilisation and compliance to statutory requirements at each phase of the project.

The three stages to be satisfied before project approval are [40]:

- License to Establish (LTE)
- Approval to Construct (ATC)
- License to Operate (LTO)

- **License to Establish:** This phase seeks to validate the process viability, market plan, product specifications, site selection, proposed crude oil supply plan, product evacuation plan, safety & environmental statements and the organisational plans. The proposal to obtain this license has to cover the following:

The application and statutory payments cover the preliminary paperwork and funding for the licenses sought. All payments must be made to and in the name of the department of petroleum resources (DPR). A refundable deposit of one million dollars must be paid for every 10,000 bpsd. This sum becomes non-refundable if and when the investors fall short of meeting their proposed planned implementation and the requirements set by the DPR. This is determined within a stipulated period of 2 years prior to expiration of the license to establish. Other statutory payments include [40]:

- Payment of $50,000 for LTE, Plant Relocations and ATC Revalidation.
- $100,000 paid as LTO can be an alternative to the aforementioned.
- Payment of N500, 000 service charge in bank draft in favour of the DPR.

The refinery's target market - domestic, export or both has to be defined. Strategies to acquire and develop infrastructural facilities that will serve the plant also need to be proposed. The source of technical expertise, training of staff and the financial plan for the period of establishment are to be defined. The DPR is also set to mandate a technical team to oversee the project from conception to completion.

The basic design and concepts envisaged for the project must be shown in the preliminary plot plan, the proposed implementation schedule and the specification & analysis of the proposed crude oil feedstock. Furthermore, the technical partners involved and their responsibilities must be stated in addition to a flow diagram showing the configurations and capacity of the plant.

Intended safety measures and a proposal complying with health and safety regulation standards set by DPR should be defined. Presentation of the proposal has to be made to the department of petroleum resources to express intention of purpose. This should be accompanied by risk assessment forms such as hazard identification (HAZID). Only on completion of all the procedures outlined and consequent recommendation by the DPR, that the Honourable Minister of Petroleum Resources or a representative on his/her behalf may grant the applicant the license to establish (LTE) [40].

After obtaining LTE, the investor will have to provide a more structured presentation on the detailed engineering that will phase the implementation stage (ATC) in order to obtain an ATC license. Some of the prerequisites are covered below:

The detailed configuration of the proposed refinery should include the electrical single line diagram, the material and energy balances, final process technology selectors & licensors and the process flow diagram of the plant. A detailed piping and instrumentation diagram (P&ID) of the units, utilities and offsite facilities must also be included.

A quality assessment should be carried out encompassing proposed quality control programme to be employed and a detailed list of the equipment to be installed after appropriate test procedures. This will be supplemented by defining what project execution strategy will be most suitable.

Process safety consideration and utilities provision should encompass control and instrumentation methods, power distribution and load flow analysis, source of electric power generation, safety equipment layout, general facilities layout and a detailed environmental impact assessment [40].

- **Approval to Construct:** The "approval to construct" license is valid for two years; after which a revalidation will be required depending on the extent construction on site. A revalidation will be required if at least 50% of mechanical construction is not evident. Failure to complete construction following revalidation will lead to the loss of the initial deposit made as a statutory requirement prior to obtaining the ATC license.

The conditions that govern the construction of a refinery comprises of the fabrication, installation and erection stages. For fabrication to be approved by the DPR, the following criteria have to be met [40]:

- The résumé of the principal technical staff as well as the name and job references of the quality control inspectors should be forwarded to the office of the DPR.
- The fabrication procedures that will be implemented should also be included.
- The quality control inspectors will have to produce a report on completion that corroborates compliance with the standards and codes of practice for all the processes outlined for the fabrication stage.

The environmental issues surrounding the establishment and operation of a refinery are also broken down to cover areas such as the environmental factors, environmental protection, safety factors and hazard reviews.

Environmental factor analysis should cover relative humidity, atmospheric pressure, maximum wind velocity, as well as the direction of the wind [40]. All information should be obtained from site and a detailed report drafted thereafter.

The procedures proposed for the operation of the refinery on completion of construction should be in line with the standards and codes of practice as defined by the DPR [40]. The refinery should also have facilities installed to ameliorate any effect from oil spillages and cases of fire outbreak or related extremities.

Environmental agencies whose guidelines also have to be followed include EIA and EGASPIN.

The safety of the workforce employed is paramount and applicants are required to conform to the regulations provided. Some of which are outlined below [40]:

- Room should be provided for the implementation of fire alarms and safety check points.
- The noise level emanating from any equipment in the refinery should be at 90dB.
- The flare stack should conform to the approved limit of emission and located at a specified distance from the storage unit.

Finally the hazard and operability review (HAZOP) and safe chart analysis will be carried out by accredited members of the commission. It is imperative that 4 weeks prior notice is given, and that all the criteria assessed are met before an application of a LTE is considered, pending approval.

- **License to Operate:** Before the approval of a "license to operate" the refinery, certain prerequisites must be met and the plant design deemed satisfactory and in compliance with all the regulations set. An assessment carried out by DPR officials will be the adjudging factor. These prerequisites are as follows [40]:

- A qualified plant manager will be appointed and the necessary documentation on his appointment forwarded to the office of the Honourable Minister of Petroleum Resources.
- Complete equipment report on equipment such as pressure vessels, fire heaters and boilers.
- Completion of all equipment to approved standards.
- The warehouse should have in store adequate spare parts and materials in the event of a breakdown to the operation of one of the processes employed in the facility.
- Approved operating manuals should be made available following the completion of all necessary modifications to the plant.
- Trained and skilled expertise to run the refinery should be available.
- Functional fire prevention and controlled measures should be available.
- Functional safety enforcement policies should be in existence and available.
- The quality control laboratory is complete and operational.
- A first aid clinic should be in placed with trained personnel employed.

- An effective and internationally applicable codification and managements system should be in place.
- Confirmation that all the environmental protection standards have been met.
- Payment of subsequent fees to the respective bodies in charge i.e. the Federal Government of Nigeria and the Department of Petroleum Resources.

Following this, the plant operation and any planned modification will have to be in line with the Petroleum Refining Regulations of 1974 and any subsequent amendments therein. A report documenting the proposed plan for operation and modification will have to be forwarded to the office of the Director, the Department of Petroleum Resources for review purposes.

In conclusion, the maintenance schemes employed will comprise of routine preventive schedule and turn around maintenance. Preventive maintenance as scheduled for the critical equipment like pressure vessels and fire heaters will be submitted to the office of the Director, Department of Petroleum Resources. Periodic examination of the infrastructural facilities available within the plant is mandatory and should be in accordance with current NACE standards and procedures. Compliance will therefore be monitored by NACE officials.

Any turnaround maintenance scheme scheduled for refinery will have to be documented and submitted to the office of the Director of the Department of Petroleum Resources, with a monthly progress report maintained thereafter until the proposed schedule is completed.

5.4.2. Government Policies and Actions

Following post fuel subsidy removal protests earlier this year (2012), a taskforce was set up to address certain areas of the downstream sector in Nigeria. The Minister of Petroleum Resources announced the constitution of each task force with their responsibilities defined. The taskforce and their objectives are as follows [46]:

5.4.2.1. Petroleum Industry Bill (PIB) Special Task Force

- To review all sections of the PIB and harmonise the existing different versions to produce a draft copy.

- To work with a technical committee, drawn from the Ministry of Petroleum Resources & industry experts & produce a new copy of the bill to be presented to the National Assembly and its quick passage.

Comments: The PIB still under review by lawmakers in Nigeria, if passed into law will increase national gas production, privatise NNPC's downstream activities and provide a greater share of revenue to oil producing areas. Increased and sustained production of natural gas can be used to generate electricity which in turn can be a solution to Nigeria's power supply issue [58].

5.4.2.2. Special Task Force on Governance and Controls in the NNPC and other Parastatals

- To review all management controls within NNPC and other parastatals.
- To design a new corporate governance code for ensuring full transparency, good governance and global best practices in the NNPC among others.
- To design a blueprint for separating policy from operations in the NNPC and other parastatals.
- To set key performance indices for NNPC and other parastatals, design blueprint for eliminating all rent-seeking opportunities and arbitrage in the NNPC system.
- To design a blueprint for professionalism of management and personnel in the NNPC and other parastatals.
- To design a road map for transition to the PIB.

Comments: The President's approval to re-composition the executive management of the NNPC is in line with ensuring the on-going reforms of the Nigerian oil and gas industry materialise [5].

5.4.2.3. National Refineries Task Force

- To ensure self-sufficiency of petroleum products in Nigeria within a strong framework in the shortest possible time.

- Conduct a high level assessment of Port Harcourt, Warri and Kaduna Refineries, review all past reports and assessments and produce a diagnostic report complete with a charge journey map.

- To review the operations of Port Harcourt, Warri and Kaduna Refineries, with a view to improving efficiency and commercial viability.

- The findings of this review should be part of a diagnostic report.

- To work with a world class firm to audit the finances of the Port Harcourt, Warri and Kaduna Refineries, and Produce audited accounts over the past 2 years ending 31st December, 2011.

- Design investment models and a road map to self-sufficiency in local production of petroleum products in Nigeria; and produce a report, complete with timelines and milestones within the next 60 working days.

Comments: The Nigerian government signed a memorandum of understanding with Vulcan an American firm with respect to developing more refineries to meet domestic demand. The refineries (six) will be dispersed all over the country and have a combined total production capacity of 180,000 bbl/d. Two of the refineries are expected to begin operation within a year [17].

5.5. Proposals

The proposals on resuscitating refinery operations in Nigeria are based primarily on the knowledge imparted through the duration of my course. The subject *Management and Professional Skills* particularly helped refine the proposal ideas discussed in subsequent headings.

5.5.1. Proposals on Technology Transfer and Maintaining Refinery Assets

The paper "An Assessment of Petroleum Technology Development Fund (PTDF)" reviewed the role of technology transfer in the oil industry. It highlighted methods that could improve current practice. Some of the methods that stood out are [31]:

- The need for more people (workers and students), to benefit from the PTDF scheme.

- The need for continuous research in technology transfer with a view of finding new ways to improve the scheme.

Nigeria is now thought to be capable of imparting requisite knowledge at both undergraduate and taught postgraduate levels for the operation and maintenance of its refineries. Executive Secretary of the PTDF board has highlighted the need to cut back on spending, thus saving funds currently spent in sponsoring MSc candidates abroad. Facilities acquired for certain tertiary institutions in Nigeria to teach Geology, Chemical Engineering and Petroleum Engineering in line with the requirements to gain employment in various sectors of the oil industry were also highlighted [31].

Furthermore, individuals with higher national diploma (HND) can be attached directly to oil industries (downstream sector) as apprentices to facilitate their training process. The current practice of sending these individuals to training institutes like PTI is flawed. This is corroborated by the fact that PTI's success in the "education and training" phase has not been replicated in the "organisational structure and infrastructural facilities" phase which is linked to the former [30].

Underutilisations of available skilled labour due to employment of Nigerians for routine maintenance and assembly technology still hinder technology transfer in the industry [22]. The apprenticeship scheme will be a good way to enable indigenes build their capability and take on more managerial and supervisory roles in the Industry. Therefore, the experience to manage and maintain refinery operations will be gained by locals.

Overseas postgraduate research training should still be in place for the foreseeable future. This will ensure that the research on technology transfer is continuous and will uncover methods to improve current practices in the oil industry. Admission process for prospective students could be easier through partnership developed with reputable tertiary institutions abroad. Also, the institutions abroad should be engaged to monitor students' progress and ensure compliance with the conditions for the award of respective scholarship. Candidates can be recruited for this process based on enthusiasm, tenacity and above all academic competence. These could be

assessed through resumes, cover letters and references. Consequently, shortlisted candidates should be interviewed prior to the award of scholarship.

Tuition and course duration should all be considered in advance in order to identify the best ways to implement this process. The government will save N1.256 trillion annually following the removal of fuel subsidy [28]. A substantial part of the savings can be channelled into funding this cause and into infrastructure development to ease technology transfer.

To develop organisation structure and infrastructure for training institutes in Nigeria, the country can make further investments through joint venture with manufacturers and suppliers of technology, infrastructure and services to oil and gas industry. For example, Technit Engineering & Construction Company is renowned in the oil and gas industry for engineering, procurement, construction, operation and management services for large-scale projects at a global level [41]. It is currently active in the sector of LNG in the Nigerian oil industry. The company has had first-hand experience in the Nigerian oil industry and is suitable for this purpose.

Graduate of the apprenticeship schemes and scholars returning from abroad could be responsible for ensuring impartation of required knowledge on students going through the training institutions. The training development scheme (PTDF) needs to be run by personnel that are experienced in the timely delivery of results, enacting laws and in the management of people and processes.

5.5.2. Proposals on Workplace Policies

The policies governing the work place should support enhancing the timely delivery of results. Government and organisational policies are to embody methods that will result in promulgating the right policies for the broader organisation. This can motivate employees in achieving the objectives of the industry and also generate revenue for the government through taxation [59]. The methods reviewed will be discussed as follows:

The management in charge of enacting policies in the work place should be shuffled between departments within the organisation and where possible posted to other organisations [5]. Essentially, a strict quota system should be in place with policies enacted and followed through aptly. This, for example, will ensure that the awards

secured for the students on scholarship schemes are based on merit and future potential as opposed to relationships with the people in decision-making positions.

The number of workers employed and how long they serve in the industry should be in line with a structured system. There should be two career pathways, one for research and training other recruits on the job (R&D), and the other for managing and overseeing the activities of the industry [49]. The progress of workers in their respective career paths should be outlined with every employee knowing the requirements for progress.

Tests and exams should be set and taken periodically; half yearly or annually, to ensure that the employees are still familiar and up to date with the practices and activities that characterise the working environment. Competition should be driven by continuous demand for the services of experienced individuals on the job. This will ensure that current workers are always engaged in continuous professional development activities pertinent to their job roles. Lackadaisical attitude to work should be totally frowned at and not tolerated on any level in the work place.

A link should be established so that expertise can be passed on from older employees to newer recruits without disrupting refinery operations. This will help prevent stagnation of work process when older generation retire. Also, during the training phase new recruits should be kept on basic salaries and advanced as they improve on their respective job roles. This usually instils the right attitude to work and increases the efficiency and effectiveness of the working environment at large. In situations where some workers are not dedicated to the job, they should be assigned with menial jobs with no path for progression. This strategy can save money for the organisation and in some cases force the employees out of work without necessarily having to terminate their employment contract.

Incentives should be provided to ensure that the students sponsored on courses abroad return home to take up positions that will help sustain the growth and development of the downstream sector of the oil industry. Incentive packages such as bonuses and insurance to cover family, life, health, and pension schemes amongst others will dissuade prospective employees from seeking employment in other countries with better means and standards of living.

Labour laws in Nigeria should be adhered to in regards to how employees are treated on the job. The recruitment, termination, contract of employees & their contributions to the industry, and other factors that face the industry should be assigned to human resource personnel and should be in line with the laws governing the work place. Open access should be encouraged with the removal of entry barriers in regards to the supply and distribution of oil products in the Nigerian oil market. The PIB under review, if passed into law will create more transparency in how contracts are awarded to potential investors and what requirements are to be met before they can be licensed to operate in this industry [58].

5.5.3. Theoretical Framework for the Proposals (The 4 R's)

Based on the methods reviewed and the book "Rescue the Project Problem", a theoretical framework deduced as possible solution to resuscitating the operation of refineries in Nigeria, is summarised:

- **Re-think:** Develop new plans and methods to implement processes that enhance productivity. The planned channels i.e. R&D can facilitate this.

- **Re-evaluate:** Determine and analyse past success and failure to ascertain what processes can be better incorporated or totally eliminated. The task force set-up by the Nigerian government post fuel subsidy removal will assess areas of failure and find better means of implementing future process.

- **Re-strategise:** Based on successful strategies employed by organisations in the same field and those studied, develop new strategies to improve and maintain the efficiency and effectiveness of the workforce in the timely delivery of results. This is where experts in the related field are required. For example, global consulting firms like *Accenture* and *Mckinsey* can be contacted for advice. *Accenture* covered one of the methods reviewed in this project.

- **Re-engineer:** This is a critical assessment of what led to the failure of the previous practices. This can be achieved by breaking down the process from its finished state and working backwards by thoroughly examining and identifying areas where the former system failed. This will help in thinking through, evaluating and developing strategies for better implementation of a new system. This incorporates the three other processes (re-think, re-evaluate and re-strategise) in achieving the required results.

An illustration of the theoretical framework is shown in Figure 7 below:

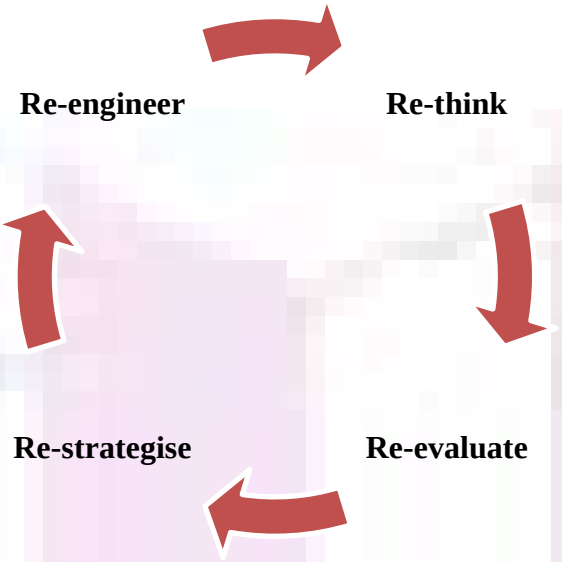

Figure 7. Four Point Cycle Plan in Resuscitating the Operation of Refineries in Nigeria.

Chapter 6 – Conclusion and Future Work

6.1. Conclusion

This section outlines how the research objectives have been achieved by answering the research questions put forward.

In order for these research objectives to be achieved, the research questions that were formulated to cover key areas of the project are outlined as follows:

- Research Question 1: *What led to the demise of the refineries in Nigeria?* Chapter 3, sub-section (3.1) covered the role of technology in the Nigerian oil industry and subsequent papers reviewed identify the problems as underutilisation of skilled labour, lack of proper schemes to transfer skills and technology from expatriates to indigenes and the general mismanagement of the infrastructural facilities and critical equipment that aid refining of petroleum and associated products. Sub-section (3.2) covered the role of Nigerian government involvement in the growth and development of the oil industry and the papers reviewed identified the problems as the inability of the federal government to secure adequate FDI. Also identified were discrepancies in the activities and policies promulgated by the government and lack of adherence to policies passed into law beneficial for the growth of the oil and gas industry.

- Research Question 2: *Are oil refineries feasible in Nigeria?* Oil refineries are feasible in Nigeria, if all the points raised and discussed in this project are implemented. The discussions on the points and proposals inferred, covered in Chapters 4 and 5 (particularly sub-sections 5.4 and 5.5) have identified the requirements, procedures and processes to facilitate the operation and sustenance of refineries after they have been implemented.

- Research Question 3: *What strategies and processes should be in place to facilitate the implementation of Nigerian oil refineries?* Chapter 4, sub-sections (4.1), (4.2) and (4.3) have answered this question. The methods proposed by Accenture on *"Asset Maintenance"*, Mohagar et al on *"Evaluation of technology transfer strategy of petrochemical process"* and Onorato W.T on *"Legal frameworks used to foster petroleum development"* aided this cause. Their reviews identified the methods that can be employed in successfully implementing oil refinery projects.

- Research Question 4: *Is it possible to manage and maintain refineries in Nigeria after they have been resuscitated?* Apart from the methods identified in chapter 4 and sub-sections (4.1), (4.2) and (4.3), chapter 5, sub-section (5.5) covered proposals on the practices that act as guidelines for an effective and efficient working environment.

- Research Question 5: *What should government's role be in development of downstream capacity in Nigeria's oil industry?* Chapter 5, sub-section (5.4) indicated some of the plans the Federal Government intends as efforts to resuscitate the activities of local refineries and also revamp the operations of the downstream sector of the Nigerian oil industry at large.

- Research Question 6: *What does Nigeria stand to benefit from the operation of its refineries at optimum capacity?* If these plans identified in chapter 5, are followed through, the coming years will see the nation producing sufficient enough to meet domestic market demands with potential of having excess supplies to export to the West African sub-region and the broader African region. Thus eliminating current practice of importation and saving funds for other project developments.

- Research Question 7: *What are the requirements for establishing and operating a refinery in Nigeria?* Chapter 5, sub-section (5.4) outlines all the requirements and milestones to be turned before establishing and operating refineries in Nigeria.

6.2. Limitations and Future Work

Over the course of this project, several limitations were identified which also offer perspectives for future research. These limitations were realised as the project progressed from the introductory sections to the conclusion of the report. A summary of the limitations identified and the areas for future research are outlined in the following paragraphs.

The data reviewed and analysed in this report were obtained from a secondary source. All attempts made to correspond with key personnel in the Nigerian oil industry were unsuccessful. Furthermore, focusing on the objectives defined from the outset of this project, a more rounded report correlating secondary data with primary information would have better justified the argument raised.

The multinational companies identified in this paper have centralised their activities around the upstream sector of the Nigerian oil industry. These companies have concentrated operations to encompass the exploration and production of crude oil and are renowned for the activities they engage with all over the world.

Future research can cover the role of these multinational companies in the world oil market. An analysis can be carried out to compare the role of the multinational companies and the national companies in determining the world oil market prices. If government managed national companies can be more effective than multinational companies and what practices will be beneficial to the nation for the long term development and growth of the downstream sector.

The midstream oil sector was not particularly covered in this report with the only exception being the area of engineering and technology. The scope of the project and the word limit restricted the extent to which the discussions could span, with more substantial discussions centred on the activities of the upstream and importantly the downstream sector.

Future research should cover areas in Greenfield Refining, Renewable Energy Sources and the Nigerian Gas Master Plan. All these sources, if exploited for energy generation, can reduce the dependence on oil and its associated products substantially and also minimise the effect of pollution (CO_2 emissions) on the environment from current refining practices.

6.3. Final Remarks

In all, the papers reviewed have identified the areas were the problems lie and methods have been proposed to find a lasting solution to the causal factors of these problems.

Finally, if Nigeria analyses the discussions covered in this study and adopts the methods proposed, it could return to her former state of refining oil and its associated products to meet domestic market demand.

REFERENCES

[1] Oil Refinery (2011) *Siting/locating of petroleum refineries* illustrated [online] available from http://www.globalpetrometal.com/Oil%20Refinery.pdf [7th February 2012]

[2] Organisation of the petroleum exporting countries (2011) *Nigeria facts and figures* illustrated [online] available from http://www.opec.org/opec_web/en/about_us/167.htm [7th February 2012]

[3] Fubara B.A. (1986) *Targeting Strategy for Technological Acquistion in the Sub-Saharan Oil Exporting States of Africa: The Nigerian Experience**. Journal of Business Ethics

[4] Upstream, Midstream and Downstream Activities (2010) *Nigerian National Petroleum Corporation* illustrated [online] available from http://www.nnpcgroup.com/ [7th February 2012]

[5] NNPC Management (2010) *Nigerian National Petroleum Corporation* illustrated [online] available from http://www.nnpcgroup.com/AboutNNPC/ExecutiveManagement.aspx [8th February 2012]

[6] NNPC Board (2010) Nigerian National Petroleum Corporation illustrated [online] available from http://www.nnpcgroup.com/AboutNNPC/Board.aspx [8th February 2012]

[7] Nigeria (2011) *Country Analysis Briefs*. Energy Information Administration

[8] Central Intelligence Agency (2012) *THE WORLD FACTBOOK: Nigeria* illustrated [online] available from https://www.cia.gov/library/publications/the-world-factbook/geos/ni.html [9th February 2012]

[9] ECOWAS (2005) *White Paper for a regional policy*. UNDP & the French Ministry of Foreign Affairs

[10] Horton S. (2010) *The 1973 Oil Crisis*. MDN PDF Library

[11] Helen Chapin Metz, ed. Nigeria: *A Country Study* (1991): *The Economy: Oil and Gas* illustrated [online] available from http://countrystudies.us/nigeria/ [10th February 2012]

[12] Olowosejeje S.A. (2012) *MSc Project Proposal: Viability of Oil Refining in Nigeria: A Technical and Economic Consideration*. University of Exeter; College of Engineering, Mathematics and Physical Sciences

[13] Nigerian National Petroleum Corporation (2010) *History of the Nigerian Petroleum Industry* illustrated [online] available from

http://www.nnpcgroup.com/NNPCBusiness/BusinessInformation/OilGasinNigeria/IndustryHistory.aspx [3rd March 2012]

[14] The world's leading nations for innovation and technology (2011) *The Atlantic Cities Place Matters* illustrated [online] available from http://www.theatlanticcities.com/technology/2011/10/worlds-leading-nations-innovation-and-technology/224/ [19th June 2012]

[15] Japanese firms visit Nigeria for investment opportunities (2012) *Sustainable Development Africa Platform* illustrated [online] available from http://africasustainable.ning.com/profiles/blogs/22-japanese-firms-visit-nigeria-for-investment-opportunities [22nd June 2012]

[16] Foreign Direct Investment in Nigeria (2012) *Dartmouth Business Journal* illustrated [online] available from http://dartmouthbusinessjournal.com/2012/05/foreign-direct-investment-in-nigeria/ [22nd June 2012]

[17] Yahoo News (2012) *Nigeria Signs $4.5bln refineries deal with Vulcan Petroleum* illustrated [online] available from http://news.yahoo.com/nigeria-signs-4-5-bln-refineries-deal-vulcan-055546041--sector.html [5th July 2012]

[18] Okafor E.E (2007). *Rethinking African Development: A Critical Overview of Recent Developments in the Petroleum Sub-Sector in Nigeria*. Department of Sociology, University of Ibadan; Nigeria.

[19] Weerapana A (2009). *Lecture 14: The Role of Technology in Economic Growth.* Wellesley College

[20] ECN 212 (n.d.) *The Gross Domestic Product (GDP)* illustrated [online] available from http://www.su-bc.org/PDF/tutorials/ECN212.pdf [8th July 2012]

[21] Turner T (1976) *The Transfer of Oil Technology and the Nigerian State.* Development and Change, Vol 7 pp. 353 – 390: Wiley Online Library

[22] Ukaegbu C.C (1991). *The Structure of the Nigerian Industries and the Utilization of Scientific and Technological Manpower*. Journal of Economic and Social Studies

[23] Mabey N and McNalley R (1999). *Foreign Direct Investment and the Environment: From Pollution Havens to Sustainable Development*. A WWF – UK Report

[24] Bala J (2003).*The challenges and opportunities of the investment environment in Nigeria*. Nigerian Investment Promotion Commission Abuja Nigeria.

[25] Mthembu-Salter G (2009). *China's Engagement with the Nigerian Oil Sector.* SAIIA policy briefing 11, China in Africa Project.

[26] Concept for Nigeria's Vision 2020 (2008). *The Presidency, Nigeria Vision 2020.* Concept Paper for Development of Vision 2020.

[27] Tonwei Oil Refinery Feasibility Study (2006). *Construction of Tonwei Oil Refinery, Bayelsa State Nigeria.* T&T Calgroup and Solutions for Tonwei Group of Companies

[28] House investigates non take-off of private refineries (2011) *The Nigerian Voice* illustrated [online] available from http://www.thenigerianvoice.com/nvnews/76685/1/house-investigates-non-take-off-of-private-refiner.html [12th June 2012]

[29] Petroleum Technology Development Fund (2011) *HISTORY* illustrated [online] available from http://www.ptdf.gov.ng/index.php?option=com_content&view=article&id=40&Itemid=54 [15th June 2012]

[30] Petroleum Technology Development Fund (2011) *PTI Upgrade Programme* illustrated [online] available from http://www.ptdf.gov.ng/index.php?option=com_content&view=article&id=42&Itemid=222 [15th June 2012]

[31] Uniamikogbo S.O and Aibieyi S (2008). *An Assessment of Petroleum Technology Development Fund (PTDF).* Journal of Contemporary Research

[32] Action Learning Plus (2010) *Business Process and Execution Capability* illustrated [online] available from http://actionlearningforsuccess.com/3.-Execution-Capability.html [18th June 2012]

[33] Vanguard (2010) *PTDF begins phasing out of overseas scholarship scheme* illustrated [online] available from http://www.vanguardngr.com/2010/08/ptdf-begins-phasing-out-of-overseas-scholarship-scheme/ [18th June 2012]

[34] Eme O.I and Onwuka C.C (2011). *Political Economy of Deregulation Policy in Nigeria: The Challenges Ahead*. Journal of Business and Organizational Development

[35] Akinrele A (2005). *Nigerian Oil and Gas law*. Volume IV/ Hydrocarbons: Economics, Policies and Legislation

[36] Illedare W and Suberu R (2010). *Oil and Gas Resources in the Federal Republic of Nigeria*. Conference on Oil and Gas in Federal Systems

[37] ELRI (2011) *A Synopsis of Laws and Regulations on the Environment in Nigeria* illustrated [online] available from http://www.elri-ng.org/newsandrelease2.html [25th June 2012]

[38] NNPC (2010) *The Petroleum Industry Bill* illustrated [online] available from http://www.nnpcgroup.com/PublicRelations/PetroleumIndustryBill.aspx [25th June 2012]

[39] NNPC (2010) *National Petroleum Investment Management Services* illustrated [online] available from http://www.nnpcgroup.com/NNPCBusiness/Subsidiaries/NAPIMS.aspx [25th June 2012]

[40] DPR (2008) *Guideline for the Establishment of Hydrocarbon Processing Plants (Petroleum Refinery and Petrochemicals) in Nigeria*. Department of Petroleum Resources 2008

[41] TECHINT (2012) *Techint Engineering & Construction* illustrated [online] available from http://www.techint.com/en/teic.aspx#milestones [1st August 2012]

[42] Scullin P (2010). *Maintaining Refinery Assets for High performance (An Accenture point of view for the downstream refinery sector)*. Accenture Plant and Automation Solutions.

[43] NNPC (2011) *Draft Annual Statistical Bulletin.* Corporate Planning & Strategy Division (CP&S).

[44] Ogbonna G.N and Ebimobowei A (2012) *Petroleum Income and the Nigerian Economy: Empirical Evidence*. Arabian Journal of Business and Management Review.

[45] Npr (2012) *Where does America Get Oil? You May be Surprised* illustrated [online] available from http://www.npr.org/2012/04/11/150444802/where-does-america-get-oil-you-may-be-surprised [5th August 2012]

[46] EIE summary of committees and Task Forces (2012) *Nigeria's Downstream Petroleum Sector*. Special Task Force on Governance and Controls in the NNPC and other Parastatals.

[47] Petroleum Act (1996) *Petroleum Refining (Amendment) Regulations* illustrated [online] available from http://www.babalakinandco.com/resources/lawsnigeria/SUB/PETROLEUM%20REFINING.htm [8th August 2012]

[48] PTDF (2011) *PTDF Endowment Programme* illustrated [online] available from http://www.ptdf.gov.ng/index.php?option=com_content&view=article&id=41&Itemid=223 [12th August 2012]

[49] Mohagar A, Monawarian A and Raassed H (2010) *Evaluation of technology transfer strategy of petrochemical process*. Springer Science and Business Media, LLC.

[50] OANDA (2012) *Currency Converter* illustrated [online] available from http://www.oanda.com/currency/converter/ [18th August 2012]

[51] BBC News (2012) *Strike-hit Nigeria 'to drop price of petrol'* illustrated [online] available from http://www.bbc.co.uk/news/world-africa-16571637 [21st August 2012]

[53] Hoekman B.M, Maskus K.E and Saggi K (2004) *Transfer of Technology to Developing Countries: Unilateral and Multilateral Policy Options*. Institute of Behavioural Science.

[54] HM TREASURY (2011) *The Plan for Growth*. Department for Business Innovation & Skills.

[55] Onorato W.T (n.d) *Legal frameworks used to foster petroleum development*. UNDP Discussion Paper No 6.

[56] SONATRACH (2012) *Downstream – SONATRACH* illustrated [online] available from http://www.sonatrach.com/en/aval.html [25th August 2012]

[57] NNPC (2012) Downstream Ventures illustrated [online] available from http://www.nnpcgroup.com/NNPCBusiness/DownstreamVentures.aspx [26th August 2012]

[58] Stanley R (2009) *PIB and the Deregulation of the Downstream Sector*. NNPC

[59] Employment Essentials (2010) *Workplace Policies and Procedures*. NSW Government, Industrial Relations.

[60] Williams T.C, 2011. *Rescue the Problem Project*, pp.183 – 190. USA: Amacom.