2018

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Shiwoku, Mervyn Olakunle

http://hdl.handle.net/10026.1/11489

http://dx.doi.org/10.24382/989

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M.O.O.Shiwoku

SUPPLY CHAIN MANAGEMENT AND LOGISTICAL CONSIDERATIONS IN DISTRIBUTING CRUDE OIL FROM NIGERIA TO CHINA

by

MERVYN OLAKUNLE OLAJIDE SHIWOKU

A thesis submitted to University of Plymouth

in partial fulfilment for the degree of

DOCTOR OF PHILOSOPHY

Department of International Shipping, Logistics and Operations

Plymouth Business School

March 2018

Abstract

Mervyn Olakunle Olajide Shiwoku

Supply Chain Management and Logistical Considerations in Distributing Crude oil from Nigeria to China

The evolution of supply chain management has made significant and continuous contributions to logistical processes. This is highly relevant to crude oil logistics in Nigeria, because both indigenous and multinational oil companies who distribute crude oil from Nigerian ports are yet to adopt an integrated export logistics operation. Besides, the study explores the philosophy of supply chain management applying theoretic frameworks of supply chain process management, demand variability, and vertical integration to encourage integrated export logistics for the distribution of crude oil from Nigeria to China. In addition, the research objectives are: to identify the components of crude oil exports; to review the principles of integrated supply chain management; to analyse crude oil demand in China; to evaluate the efficiency of oil distribution, and to propose strategies that will raise the efficiency of crude oil exports to China from Nigeria. A conceptual model was developed to identify relevant issues that guide the synergy of China's requirement for energy security and Nigeria's crude oil supply capability. Also, both a Delphi survey and an archival research method's were adopted to elucidate on the characteristics of the research population, the shipment frequencies between the two countries, and the sources of competing crude oil exports to China. Measures of central tendency from respondent feedback and non-parametric tests support the study's findings. Furthermore, recommendations for strategic, operational, and tactical organisation of resources were identified to raise integrated crude oil export efficiency from Nigeria to China directed by the theoretic framework. Moreover, their implications for sustainable logistics practice in the short, medium, and long-term are considered. Finally, it was found that adopting vertical integration in a crude oil supply chain will ensure responsiveness to support export efficiency, and enhance the geographic characteristics of Nigeria for increased export shipments to China.

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List of Abbreviations

A0	Contextual (Top Level)
AG	Arabian Gulf
ANOVA	Analysis of Variance
APMO	Average Percentage of Majority Opinion
ASB	Annual Statistics Bulletin
BBL/D	Oil Blue Barrels Per Day
BBLS	Blue Barrels
BN	Billion
BP	British Petroleum
BPD	Barrels Per Day
BRICS	Brazil, Russia, India, China, and South Africa
C/M	Conceptual/Methodological
C/S	Conceptual/Substantive
CBO	Congressional Budget Office
CFA	Confirmatory Factor Analysis
CNOOC	China National Offshore Oil Corporation
CNPC	China National Petroleum Corporation
COCs	Chinese Oil Companies
CRSL	Clarksons Research Services Limited
CSCMP	Council of Supply Chain Management Professionals
DEMVAR	Demand Variability
DSR 1	Delphi Survey Round 1

DSR 2	Delphi Survey Round 2
ECOWAS	Economic Community of West African States
EFA	Exploratory Factor Analysis
EIA	Energy Information Administration
ENI	Ente Nazionale Idrocarburi
FIG	Figure
FPSO	Floating Production Storage and Offloading
GDP	Gross Domestic Product
Ibid	Ibidem (In The Same Place or Author)
IBM SPSS	International Business Machines Statistical Package for the Social Science
ICT	Information and Communications Technology
IDCs	Indigenous Oil Companies
IDEF0	Integration Definition for Function Modelling
IEA	International Energy Agency
IOC	International Oil Company
IQR	Interquartile Range
IT	Information Technology
KMO	Kaiser-Meyer-Olkin
M/S	Methodological/Substantive
MBPD	Million Barrels Per Day
MDG	Millennium Development Goals
MEND	Movement for the Emancipation of The Niger Delta
ML	Mining Licence
MMTOE	Million Metric Tonne Equivalent

MNC	Multinational Oil Company
MTOE	Metric Tonne of Oil Equivalent
NDRC	National Development and Reform Commission
NHT	Nigerian Hydrocarbon Tax
NNPC	Nigerian National Petroleum Corporation
NNPC	Nigerian National Petroleum Corporation
NOC	National Oil Company
NSI	National System of Information
OECD	Organisation for Economic Cooperation and Development
OPEC	Organisation of Petroleum Exporting Countries
OPL	Oil Prospecting Licence
PhD	Doctor of Philosophy
PI	Perception Index
PIB	Petroleum Industry Bill
PPIAF	Public-Private Infrastructure Advisory Facility
PPT	Petroleum Profit Tax
RO	Research Objective
SC	Supply Chain
SCM	Supply Chain Management
SCO	Supply Chain Orientation
SCOM	Supply Chain Operations Management
SCPRO	Supply Chain Process Orientation
SCs	Supply Chains
SEM	Structural Equation Modelling

SIN	Shipping Intelligence Network
SINOPEC	China Petroleum and Chemical Corporation
SM	Suezmax
SME	Small-Medium Sized Enterprise
SWAC	Sahara and West Africa Club
UK	United Kingdom
UNCTAD	United Nations Conference On Trade and Development
UNIPEC	United Petroleum and Chemicals Company Limited
US EIA	United States Energy Information Administration
USA	United States of America
VC	Value Chain
VCS	Value Chain System
VEFF	Vertical Integration for Efficiency
VLCC	Very Large Crude Carriers
WA	West Africa

List of Codes

SCOD	Supply Chain Management Operations (Definition)
SCOLM	Supply Chain Management and Logistics (Efficiency)
SCOM	Supply Chain Management Operation (Adoption)
SCOIM	Supply Chain Management Operation (Integration)
HREIM	Human Resource (Enterprise and Information Management)
IVMLM	Inventory Management (Logistics Management)
IMLM	Information Management (Logistics Management)
SFOD	Shipping Frequency (Operations and Distribution)
VCDELD	Vessel Capacity (Distribution and Logistics Development)
SRALM	Shipping Route Adequacy (Logistics Management)
GCOM	Geographic Characteristics (Operations Management)

SUCOD	Supply Capability (Operations and Distribution)
ITIOC	Information Technology (Integration and Collaboration)
ITCLM	Information Technology (Collaboration and Logistics Management)
ISVLC	Information System (Visibility and Logistics Collaboration)
FORMLM	Forecasting (Resource and Logistics Management)
SCOIP	Supply Chain Management Operation (Integration Partners)
PORISC	Port-Infrastructure (Supply Chain Improvement)
GCOLM	Geographic Characteristics (Logistics Management)
COPCLC	Crude Oil Procurement (Contracts and Logistics Collaboration)

Acknowledgements

God, My Mummy, Brother, and Cousins

With sincere thanks to all those who have supported me over the many years of study, including my supervisor Professor John Dinwoodie for his continued influence for brighter outcomes, and perseverance in regards to the undertaking. Likewise, Dr Chukwuneke Okorie and Dr Shunmugham Pandian for their contributions.

Est Verum in Luce

Authors Declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without the prior agreement of the Graduate Sub-Committee.

Work submitted for this research degree at the Plymouth University has not formed part of any other degree either at Plymouth University or at another establishment.

This research has been conducted under a formal agreement with none but the University of Plymouth, for which a Ph.D. degree will be awarded. This study was financed by myself.

A program of advanced study in academic writing was undertaken, which included taught modules over a period of 32 weeks in between September 2010-March 2011. Also a ICT training course in word for windows, Excel, and PowerPoint was attended from June 2010 – September 2010.

Relevant scientific seminars and conferences were regularly attended with a poster presentation at the 2014 annual Plymouth Business School Symposium; and a paper on "A Preliminary Delphi Survey on Distribution and Logistics Networks in the Nigerian Oil Industry" was prepared for internal circulation. Also, external institutions were visited for the purpose of consultation on issues related to the research topic.

Presentation and Conferences Attended:

Cass Business School Ph.D. Workshop Series attended 24th January and 14th February 2013

Plymouth University Business School Symposiums attended 2012 and 2014

Plymouth Doctoral Colloquium 2016

External Contacts:

University College London (Academic Skills)

Cass Business School London (Presentation and Conference Skills)

Word count of main body of thesis: 49,921

Signed: MOO Shiwoku

Date: 21/12/16

Chapter 1: Background of the Study

1.1 Introduction

The study rationale and focus are introduced in this chapter. Besides, recent trends towards consolidating distribution operations into an integrated network of internal and external business unit concentrate on satisfying the ever-changing demands of an industry or market. SCM incorporates this capability, and has embraced numerous definitions relating to its application in industry which includes opinions of peer reviewers. Nonetheless, this chapter presents a background assessment of the implications of SCM on distribution management in section 1.2 followed by a clarification of the research problem. In addition, justification for the thesis is described in section 1.3 and the methods adopted to realise feasible findings are explained in section 1.4. Likewise, a research framework and synopsis of succeeding chapters is reviewed in section 1.5, and finally section 1.6 concludes with a discussion on the benefits of SC theory on logistics efficiency in the Nigerian oil industry.

1.2 Research Background

Primarily, conceptual integration of business processes is termed SCM (Lambert, Cooper, and Pagh, 1998, P.5). These processes have now been transformed from a basic enterprise structure into an extended network that incorporates alliances and partnerships in a logistics system. Moreover, industry and academics alike have explored the benefits of SCM by means of drawing on relevant theories and practices. Accordingly, the evolving nature of business structures has also influenced the composition of a distribution chain from just a supply and delivery capability into an integrated network that encompasses all aspects of distribution management which is termed an SCM framework.

Academics have stated the theoretical importance of SCM since the 1980’s, departing from the traditional outlook of material and information flows from the supplier to the consumer of the finished product. For example, Lalonde and Masters (1994, P. 35-47) propose that a SC is a set of firms that pass materials forward which includes raw material and component producers, product assemblers, wholesalers, and retail merchants as channel members. Also, Lambert et al. (1998) have defined a SC as an alignment of firms that bring products and services to market. The Council of Supply Chain Management Professionals (CSCMP) define SCM as a science that encompasses the planning and management of all activities involved in sourcing and procurement, conversion of products or services, and other logistics operations. Importantly, it includes co-ordination and collaboration with channel partners, which could be suppliers, intermediaries, third party service providers, and customers. Essentially, SCM integrates supply and demand management within and across an organisation’s distribution boundary (CSCMP, 2005). The above definitions transcend most of the earlier definitions of SCM which attempted to justify the discipline of SCM as a management process which involves investigations into scopes and boundaries, elements and functions, relationships between elements and functions, and other disciplines including their direction and significance (Popper, 1977).

Likewise, researchers have argued that SCM has evolved apart from logistics, even though some opinions state that SCM is a relabelling of logistics. Other authors have identified that there is an overlap between functions in both SCM and logistics, without disassociating from their generic functions or parts (Mangan et al., 2008, P.8).

Nonetheless, to relate logistics to SCM requires a need to establish linkages across functional disciplines, including the benefits of integrating logistics activities throughout the firm (Simchi-Levi et al., 2007, P.3). According to Cooper et al. (1997), SCM encompasses the logistics process because logistics emphasises the efficient movement and storage of material requirements or goods for demand fulfilment. Integration of the logistics process with SCM supports an organisation's commitment towards building on an efficient and reliant operation.

However, SCM should not be seen as an extension of logistics, but the entire framework in which logistics exists as a function, which also complements the following definition;

“the network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer” (Christopher, 1992).

In support of the above definition the present saturation of economic development in relation to globalization has considerable influence on distribution decisions in most organizations (Mattsson, 2003). Likewise, the capacity and capability to maximize on possible revenue from an existing distribution operation has become important. Therefore, the composition of SCM as a management science has introduced a thorough process in its application, fortified with theory, and supported by achievable practices, (Ellram, 1991; Christopher, 1992; Lamming, 1996; Handfield and Nichols, 1999; Simchi-Levi et al., 2000; Ayers, 2000).

The current research investigates the logistical advantages of adopting identified theories within an SCM context between Nigerian oil producers and China's National Oil companies in the upstream sector.

In addition, the upstream sector is also called the exploration and production segment of the oil and gas industry with two major distribution streams i.e. direct exports of crude oil from exploration sites, and the transfer of crude oil to the mid-stream segment for refining in a domestic economy.

At present, China has emerged as a major developing country with substantial demand for crude oil from oil producing African countries, and Nigeria has not been exempted in China's investments to secure adequate crude oil supply. According to the EIA (2015) China's oil imports increased to 6.2 mbpd in 2014; with an average net total import of 5.9 mbpd in 2013.

Moreover, growth in crude oil demand from China can be attributed to "domestic economic growth and trade, power generation, transportation sector shifts, and refining capabilities primarily for domestic use and exports of petroleum" (EIA, 2014).

Reliance on imported crude oil by China has fostered the development of supply relationships with African countries with contractual agreements signed between Sinopec and NNPC in recent years to secure 1.4 mbpd of crude oil exports from the year 1999 over the long term (Leung et al., 2011, P. 493). However, recent reports show that China imported only 2,740 bpd of crude oil from Nigeria in 2015 (Africa Oil and Gas Report, 2016). Nonetheless, sustaining Chinese interest in Nigerian crude oil allows assessments and implementation of measures to improve distribution and export frequency. Besides, investigations on production quantities in relation to export demand levels particularly from China should also encourage demand sustainability.

Also, SCM as a science has evolved with significant impacts on distribution structures in most oil companies worldwide and consequently, increasing volumes of crude oil shipments particularly to China has created a focus on encouraging standard distribution procedures in the upstream segment of the Nigerian oil Industry and efficient logistics processes have now become a management necessity (Tseng et al., 2005, P.1657).

Moreover, SCM as a function within operational structures in an organisation is important to distribution processes, including major elements such as distribution flows, nodes, locations, and networks (Hesse and Rodriguez, 2004). Analysing current trends in the industry including an examination of export frequency from Nigerian ports or jetties will provide insights for efficiency recommendations. Presently, there has been no notable audit or report relating to logistical efficiencies within the industry for either IDCs or MNCs in the last twenty years. As a result, operational factors that influence export frequency to China have not been investigated. Also, the research phenomena will be of importance to Nigerian and Chinese oil companies, as well as European and American oil exploration companies with oil production investments in Nigeria, including energy consultants who have an on-going interest in the logistical advantages of distributing oil internationally from Nigeria.

1.3 Research Aims and Objectives

Encouraging the philosophy of SCM incorporates a systematic approach to distribution management in the oil industry, which also permits a cohesive effort to manage the total flow of crude oil from source (exploration or production) to the ultimate customer (COCs) with the objective of creating value in the distribution process (Ellram and Cooper, 1990). Therefore, the aim of the study is to assess the implications of applying integrated SCM for the logistics of distributing crude oil from Nigeria to China.

Moreover, according to Bowersox and Closs (1996) the following factors determine the objectives of a logistics structure in an organisation;

- Integrated behaviour
- Mutually sharing information
- Mutually sharing channel risks and rewards
- Cooperation
- Shared goals and focus
- Integration of processes
- Partnerships

Firstly, the present need for logistical visibility by most Nigerian oil Companies has been brought about by the increasing demands of today's oil market environment. Consequently, both suppliers and customers are now required to be integrated and regularly informed about distribution throughput to maintain mutual interest in a logistics network for efficiency. Secondly, the planning and monitoring process described by Cooper et al. (1997) requires that channel members mutually share information to reduce uncertainty and increase channel performance. Thirdly, risks and rewards are also important to consider over a long-term period, because cooperation among channel members depends on achieving possible competitive advantages (Ellram and Cooper, 1990), which for Nigerian oil companies involves reducing export distribution cycle time. Fourthly, in the context of the present study, both MNCs and IDCs would benefit considerably when objectives are shared with other channel members and cost efficiencies are encouraged in possible joint distribution agreements. In addition, integration of SC processes as a fifth factor can increase productivity and efficiencies in the distribution of products or materials which can be assessed in four stages (Stevens, 1989). For example, the first of these stages is the baseline stage when SC systems are operated in isolation and are fragmented. Likewise, stage two focuses on cost efficiencies, and internal trade-offs for performance improvements. In addition, stage three encourages corporate reliance and increased visibility of operations and the incorporation of management information systems to materialise existing linkages. Lastly, stage four develops integration by encouraging collaboration and partnerships with external organisations with similar objectives. These stages are essential to Nigerian oil industry participants as a guide to operations capability when encouraging an export logistics structure that incorporates SC orientation. However, the transformation of a Nigerian oil company's orientation towards a systemic and strategic perspective depends on organisational antecedents. According to Mentzer et al. (2001, P.15) these antecedents require an assessment of internal structures and characteristics. Moreover, the first of these antecedents is the incorporation of commitment and trust that encourages a concentration on preserving internal and external relationships in the exportation of crude oil for accountable outcomes (Morgan and Hunt, 1994). In addition, organisations should rely on shared goals promoting SC commonality as reported by Bowersox and Closs (1996). Besides, organisational dependency creates an orientation of long-term relationships amongst firms in a SC (Ganesan, 1994). Furthermore, Cooper et al., (1997, P.8) have reported that management techniques and organisational cultures should be compatible for successful SCM. Besides, compatibility of organisations in a SC will depend on the extent of SCPRO amongst partners and alliances of Nigerian oil companies. Moreover, Lambert et al. (1998, P.7-9) have reported that a shared vision with interlinked processes provides firms with joint accountable goals and a basis for distribution consistency. It also assists the organisation in developing strategies that will transcend a SC network for improved efficiency. Therefore, organisations in a SC especially in Nigeria will require similarities in vision to sustain the benefit of co-operation.

Likewise, conceptualisation of a SC is also a management philosophy. This includes all aspects of distribution management that supports the realisation of an elaborate and achievable orientation. Moreover, conceptualisation involves examination of business processes, identification of apposite management components and the incorporation of a SC structure (Cooper et al., 1997, P.5-6). They are affected by factors that may impede the introduction and sustainability of a SC orientation mentioned above by Bowersox and Closs (1996). Accordingly, the capacity of an organisation to sustain SCM relationships is a “willingness to rely on an exchange partner in whom one has confidence, because the possibility to achieve common objectives depend on trust in overcoming internal and external obstacles to predefined objectives” (Morgan and Hunt,1994, P.23). Lastly, Lambert et al., (1998) inform that necessary commitment of resources and empowerment are important to SCM implementation. Besides, participant interest in a SC is also preserved to enable sustainable cooperation through such commitment. Moreover, an organisation developing partnerships towards SCM orientation essentially depends on mutual trust and a commitment towards the realisation of a common approach. In addition, interdependencies created are contingent on the flow of information, finance, and physical products between logistics streams.

1.3.1 Research Aims

At present, Nigeria as an oil producing country has now become China’s major supplier of crude oil in Africa (Ogunkola et al., 2008, P.11). Also, trade agreements between the two countries have seen crude oil volumes shipped to China increase steadily over the last ten years. Consequently, this increase in demand has been primarily associated with growing economic development in the country (Kilian, 2009). Although, China's annual real gross domestic product (GDP) growth slowed to an estimated 7.7% in both 2012 and 2013 (EIA, 2015), there is still a steady interest in crude oil supply from Chinese oil companies to meet the countries on-going concern for energy security. Yet, there has not been a standard export logistics management audit for crude oil exports to China since agreements were reached with NNPC. Consequently, this has influenced the research aim mentioned above in section 1.3 for accountable and efficient exports of crude oil to China from Nigeria

Nevertheless, SCM has been adopted by most oil companies in Europe and the USA for the purpose of distribution efficiency. Yet, most Nigerian oil companies still practise an unpredicted vessel transportation approach in distributing crude oil from Nigerian ports to customers worldwide. Moreover, the benefits of SCM to Nigerian oil companies for logistical advantages in crude oil exports to China needs to be recognised by industry participants. Similarly, dispatched crude oil volumes have steadily increased over the past few years, however, the percentage of crude oil bound for China from Nigerian ports in comparison to other world ports and refineries are uncertain. Therefore, quantifying current crude oil exported to China is essential to the present study, because anticipating demand levels (Chima, 2007), especially in the context of the studied phenomena is a major consideration for oil exporting companies in Nigeria. However, important implications for theory, policy, and practice which are often neglected are also considered in chapter 6 especially on key areas for maximisation within a SC structure when adopted by organisations in the Nigerian oil industry.

1.3.2 Research Objectives

Following on from the studies aim the research objectives have been identified in conjunction with reports by PriceWaterhouseCoopers (2010, P.5); which examined crude oil export reliability and SC insecurity experienced by most African oil producing countries and international importers. These are as follows:

- To identify the components of a crude oil export SC
- To review the principles of integrated SCM and their implications for upstream distribution of crude oil exports
- To analyse the demand for crude oil in China particularly relating to imports from Nigeria
- To analyse the efficiency of the logistics of distributing crude oil exports from Nigeria to China
- To assess strategies to raise the efficiency of distributing crude oil exported from Nigeria to China

Moreover, Nigeria as a leading African oil exporting country has an omnipresent need to address the reliability of crude oil export inventory, which is important not only to Chinese companies with an increasing demand for crude oil, but also IDCs with increasing investments in Nigeria's oil endowment for exports to countries such as China. Also, there are obstacles to the efficient transfer of crude oil for exports such as adequacy of supply operations and regulatory requirements (compliance) by the NNPC explained in Chapter 3, section 3.5.

Nevertheless, Nigeria still produces about 2 mbpd through joint ventures with MNCs (EIA, 2016). In addition, majority (95%) of the crude oil produced by MNCs are from major Niger Delta exploration sites with 5% production by IDCs (NNPC ASB., 2012, P.25). Besides, increased production by IDCs has created a need to reassess the possibility of supporting current oil exports to China especially through companies such as Sinopec; a Chinese oil company with interest in procuring oil exports from Nigeria to satisfy China's domestic demand. Although, no major study on the issue has been identified, there is a scope to increase adequate supply by adopting an integrated SCM for crude oil exports from Nigeria. As a result, the following research question is posed;

How can SCM and integrated logistical considerations be applied in distributing crude oil from Nigeria to China?

Also, this question is essential when investigating the effects of SCM efficiency and integration (Gubi et al., 2003, P.856-858, Chen and Paulraj, 2004, P.131-133: Gunasekaran et al., 2004, P.335) particularly in the Nigerian oil industry. It also guides the research process to include relevant data that will justify measures for efficiency in crude oil distribution between geographically dispersed countries such as Nigeria and China.

1.4 Research Methodology

A research methodology is the procedural framework that guides a study (Remenyi et al., 1998). Therefore, the research objective and questions were major motivations in deciding which research design was appropriate for a better understanding of the circumstances surrounding major logistical flows between Nigeria and China in the distribution of crude oil. An exploratory study enabled an acquisition of information from experts in the industry in the form of a Delphi Survey. A process of inquiry that narrows down broad issues in SCM until only the prevalent aspects are assessed and analysed (Saunders et al, 2007, P.140).

Also, in fulfilling the aim of the study the research methodology adopted has relied on the research objectives and question set to evaluate primary and secondary research findings. Moreover, adopting appropriate methodology has required identifying the context of the study (Easterby-Smith et al. 2001), which were influenced by the following research dynamics:

- Does the research philosophy fit in with the constructs of the research discipline and the actual research project being undertaken?
- Is the methodology chosen sound and appropriate in the context of the general research philosophy?
- Does the research design relate to how the component parts of the study fit together, and are they consistent with the chosen research methodology?

Also, the boundary of research planning identifies three major ways of thinking about research philosophy (Saunders et al., 2007). Firstly, epistemology concerns acceptable knowledge (ibid, P.102) on current SCM trends in the oil industry. Secondly, ontology is concerned with the ‘nature of reality’ (ibid, P.108), in relation to current practises and structures common to SC practitioners. Lastly, axiology is concerned with that branch of philosophy that studies judgements about value (ibid, P110) with reference to the researcher’s philosophy towards an appropriate methodology as illustrated in figure 1.1. In addition, recommendations by Chidambaram et al. (1999, P.1-5) will assist in justifying recommendations on the possible transformation of the present structure of crude oil exports from Nigerian oil ports and jetties.

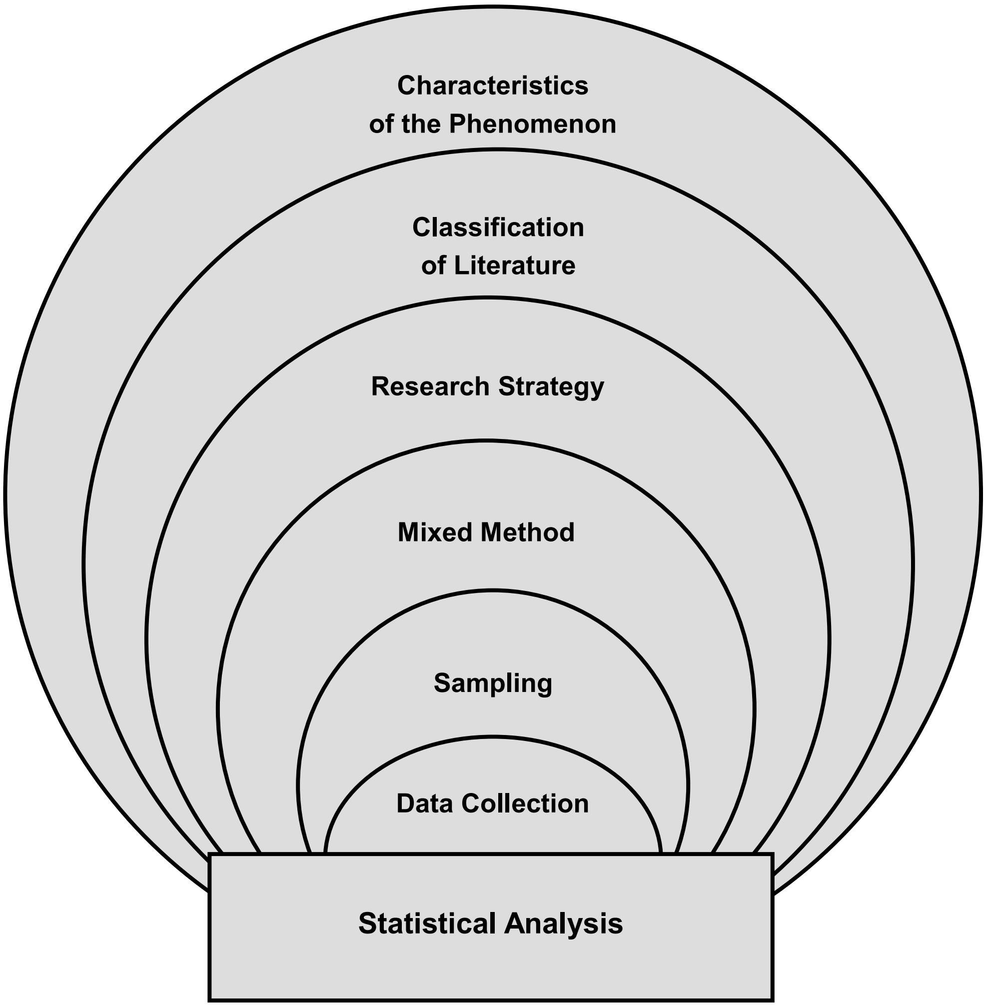


Figure 1.1 Thesis Methodology Shell Illustrated in Chapter 4 (Adapted from: Saunders et al. 2007, P.102)

Furthermore, the research process required an exploratory literature review on relevant issues and papers in SCM. In addition, Borg and Gall (1996) have highlighted the following purposes as reasons for a literature review:

- To assist in refining research questions and objectives.

- To highlight research possibilities that has been overlooked implicitly in research to date.

- To discover explicit recommendations for further research, this could also justify research question(s) and objective(s).

- To avoid simply repeating work that has already been done before.

- To sample current opinions in newspapers, professional and trade journals, and thereby gaining insights into the several aspects of the research question(s) and objective(s) that are considered important to the cause of this study.

- To discover and provide an insight into research strategies and methodologies that may be appropriate to research questions and objectives.

Moreover, Chima's (2007, P.27-36) paper was the most recent one identified on relevant factors and elements that erode value in a crude oil SC with significance to the present state of the Nigerian Oil industry. Likewise, there are two motivations for this research which influence its directional purpose, and the adoption of a positivist approach to gain an insight on the phenomena under investigation. Based on economic and academic recommendations the oil industry in Nigeria requires major transformations to effect realisable economic benefits (Oyejide and Adewuyi, 2011, P.60). This consequently affects networks and links between suppliers and procurers of crude oil from Nigeria to China who are yet to benefit from recent SC theories on distribution efficiency. Likewise, measuring the efficiency of existing distribution and logistics network for crude oil distribution in the Nigerian oil industry are considered important directional strategies for an investigation; which should support the synchronisation of demand and supply.

1.4.1 Research Framework

The procedural framework for this study was conducted by gathering adequate and representative evidence of the phenomena through a Delphi study to solicit common opinions about the probable, preferable, and possible futures (Tapio et al., 2011), that can be evidenced in a crude oil SC. This involved questions on systems and distribution networks that are qualitative in context and quantitative in content i.e. inherent commonalities or industry norms. These were solicited through emails via Survey Monkey and Qualtrics internet survey portals. Also, a link to the research survey was posted on “LinkedIn” the renowned internet professional network.

In addition to the above methodology an archival research strategy was applied because of the lack of consistent and relevant data from Nigerian oil companies, together with the need to rethink the aims and methods of the study (Saunders et al, 2009, P.150). Therefore, data on current volumes of crude oil exported to the Far East were gathered from archival records of the NNPC from 2003 to 2012, while frequency of shipments, load quantities from Nigerian ports or jetties, and other leading world crude oil export ports were recorded from daily intelligence records of Clarksons Research Services Limited (CRSL) called Shipping Intelligence Network (SIN), a renowned industry leader in market reports for all maritime trade flows. This was compiled over a period of six months based on daily records. Besides, the records included types of vessels, despatch points, destinations, number of shipments, and load quantities dispatched to China, the Far East, and other parts of the world which were validated and assessed for suitability (Saunders, 2009, P.276).

Furthermore, a case study approach was initially pursued to investigate demand and supply cycles within an export operation of an IDC with considerable daily exports of crude oil operating in Nigeria such as Afren, Oando, Seven Energy, Seplat, Famfa, Sahara and AMNI. Later this strategy was dropped, because of a lack of cooperation from IDCs on the grounds of commercial confidentiality.

According to Fielden (2003) appropriate ways to analyse data (Fielden, 2003) gathered from industry sources mentioned above should involve four stages. The first stage requires identification of the sample population comprising academics, executives, experts, and companies in the oil industry. A non-probabilistic sampling method was then applied to gather sufficient data from oil industry experts in the form of a Delphi study. Besides, the purpose of this study and questioning process was not only to generalise to the population of oil experts, but to obtain insights about a phenomenon by selecting individuals (experts) that will assist in identifying components of a crude oil SC to answer the first and second objectives of the study, as well as increase understanding of the underlying phenomenon through purposive sampling (Onwuegbuzie and Collins, 2007, P.287). Likewise, the second stage involved using archival data gathered from a secondary research method to rationalise the third and fourth objectives which is to analyse the demand for crude oil in China particularly relating to imports from Nigeria using quantitative assessments on the frequency of shipments i.e. daily, weekly, and monthly shipments of crude oil from Nigerian ports and jetties. This has enabled an insight on crude oil volumes exported in distribution cycles to China. In addition, the third stage involved the application of a case study questionnaire mentioned above to gather operational data on logistical movements of crude oil exports. However, this method did not yield any feedback from MNCs and IDCs operating in the Nigerian oil industry. Nevertheless, idiographic or direct observation research methods such as case study or action research are less popular for SCM related studies (Sachan and Datta, 2005, P.666), although their application will be useful for future longitudinal studies on related issues in the oil industry. Lastly, stage four involves statistically evaluating and validating findings from stage one and two for recommendations and conclusions. Furthermore, because of the lack of cooperation with the case study approach, the research stages were condensed into a three-stage process as described in figure 1.2 below.

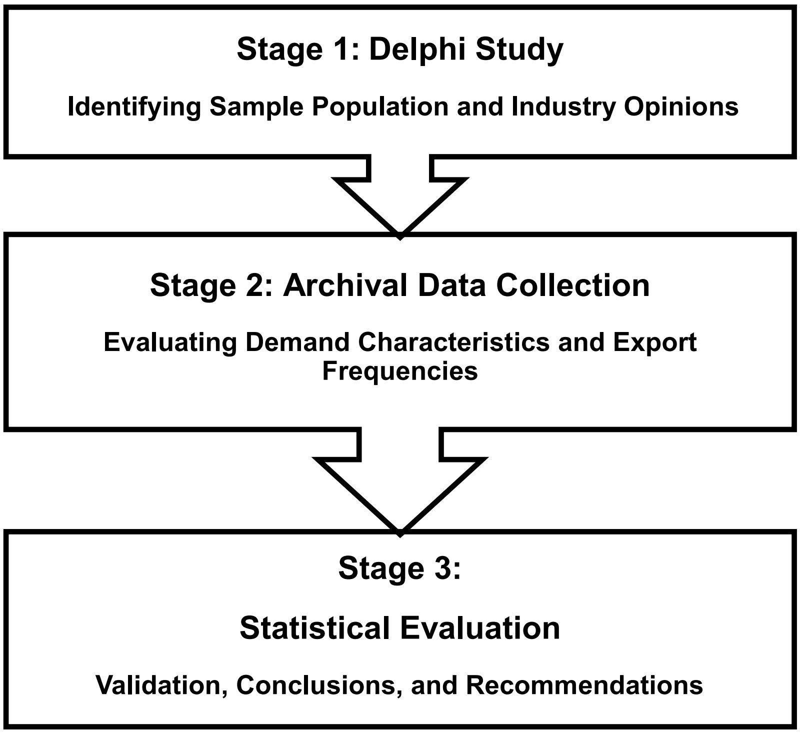


Figure 1.2 Three Stage Research Framework

1.5 Thesis Structure

Below is a synopsis of each chapter and its implication to the studies aims.

Chapter 1: Research Background: Aims, Objectives, and Methodology

Chapter one introduces the evolving nature of business structures and markets which encourages the need to examine logistics processes particularly in the Nigerian oil industry. Likewise, the chapter identifies the aim of the study and explores relevant theories to augment the logistics structure of crude oil export distribution in Nigeria and the conceptualisation of business processes in an SCM. Also, the studies objectives are clarified in relation to the influence of economic development and growth in China and its effects on the need for reliable oil supply from countries such as Nigeria. Lastly, the research question and objectives have supported the studies methodology which is also influenced by the epistemological, ontological, and axiological assumptions made about the phenomena.

Chapter 2 Literature Review: Theoretic Assessment

In chapter two the ontological and underlying aspects that influence the transformation of distribution systems relevant to the studied phenomena are evaluated. Also, the characteristics of a SC that endorses its adoption for the logistics of crude oil exports from Nigeria are examined. Similarly, the benefits of a VCS are explained for the organisation of a crude oil export SC. Likewise, concepts and structures to encourage SCPRO in crude oil exports from Nigeria are assessed. In addition, the principles to encourage vertical integration of export logistics processes for the upstream distribution of crude oil is reviewed and the implications of demand variability clarified.

Chapter 3 Literature Review: China's Demand Characteristics and Nigeria's Supply Capability

China's requirement for sustainable energy supply in support of the countries recent economic growth is explained in chapter three. In addition, the countries requirement to diversify oil imports towards Nigeria's ample energy resource is considered including factors that may assist in reducing demand variability. Similarly, the impact of the Petroleum Industry Bill (PIB) on crude oil logistics in Nigeria is evaluated including socio-economic factors that may impact on re-forming Nigerian crude oil export distribution for efficiency. Likewise, the benefit of vertical integration to Sino-Nigerian trade relations in the export distribution of crude oil is again examined and current trade flows obtained from an archival study analysed in a discussion.

Chapter 4 Research Methodology: Philosophy and Design

This chapter explains the characteristics of the phenomena under investigation and adoption of methods to resolve the studies research question. Likewise, the philosophy of enquiry which directs the research design adopted i.e. benefit of a Delphi technique and archival study is expatiated. Moreover, both Liu (2011. P.10) and Brinberg (1982) have assisted in setting the foundation for the re-quired research design, which has been directed by Chima's (2007) study on SCM Issues in the oil and gas industry. Lastly, the reliability and validity of the study is classified regarding the research population and the type of information required.

Chapter 5 Delphi Survey: Nigerian Oil Industry Consensus

An explanation of the Delphi technique as a research method is carried out in this Chapter. In addition, major attributes of the Delphi technique in support of achieving consensus on logistics organisation in the oil industry are reviewed including definitions of the technique and its characteristics. Also, theoretical implications and philosophies associated with this system of enquiry are examined. Furthermore, the rounds involved in the Delphi questioning process is clarified, and the pattern of results confirmed. Finally, the chapter concludes with a discussion on the limitations of the Delphi technique.

Chapter 6: Recommendations and Appraisal: Implications on Theory, Practice, and Industry

Essentially, recommendations in chapter 6 supports the aim of the study and are relevant to the five objectives set for the justification of applying SCM to integrate crude oil export logistics from Nigeria to China. This has been possible with the findings of both the Archival study in chapter 3 and Delphi survey's in chapter 5. Also, the literature review in chapter 2 has contributed towards a theoretic synergy identifying tactical, operational, and strategic considerations that are significant to theory, practice, and industry. Lastly, limitations to the studies research design are reported for the benefit of future studies on the research issue.

Chapter 7 Conclusions: Sustaining SCM Integration and Future Studies

Finally, chapter seven concludes with a synopsis on the studies research design with additional observations to sustain the integration of crude oil exports to China from Nigeria. Each RO is overviewed with succinct recommendations that will support SCM integration in strategic, operational, and tactical export logistics planning. Likewise, a summary on major considerations with respect to the interactions between theoretic variables is expatiated, and directions on future study options identified.

1.6 Discussion

Moreover, the possibility to explore an identified research issue increases the scope of a study. Likewise, the evolution of SCM in the field of distribution has aided significant and continuous contributions to logistics integration. This is particularly relevant to the distribution of crude oil especially in Nigeria, because majority of both IDCs and MNCs are yet to dedicate distribution operations by adopting an SCM approach. Besides, the philosophy of SCM encourages cohesive distribution strategies encouraged primarily by Bowersox and Closs (1996) and Cooper et al. (1997). These strategies enable the introduction of an accountable and efficient crude oil distribution operation. According to Stevens (1998) the present state of the Nigerian oil industry is still at an infant stage; operating a baseline SCM organisation. Nonetheless, encouraging a cohesive distribution operation for this study requires further examination of realisable SCM theories through a literature review. Additionally, the following chapter encompasses theories identified as essential towards encouraging an integrative crude oil distribution process investigated by Chima (2007), which benefits the creation of competitive advantages as theorised by Li et al. (2006, P.107-124). Their contribution elucidates the implications of a theoretical framework on those factors considered as important towards realising applicable SCM recommendations for crude oil exports from Nigeria to China. Furthermore, another major theory examined is the implication of SCM transformation or change models reported by Chidambaram et al. (1999) for crude oil exports especially when there is presently a predominant need to sustain consistency in export distribution procedures. Likewise, the issue of SCM conceptualisation is accessed for a more elaborate pattern of distribution by organising participants and constituents of a crude oil SC towards integration and logistics partnerships. Lastly, exploration of the above theories and other minor but relevant SCM theories in Chapter 2, supports the integration of crude oil exports to China from Nigeria, and assists in realising the latent objective of crude oil export accountability.

Chapter 2: Literature Review: Theoretical Assessment

2.1 Introduction

Most distribution operations in the oil industry involve transportation from exploration sites to refineries worldwide. Moreover, crude oil logistics operations for most Nigerian oil companies concentrates on three major distribution segments; upstream, midstream, and downstream. However, this study focuses on the upstream segment as the commencing point of export logistics operations.

It is significant to mention that over the past twenty years SCM has been adopted by most oil companies in Europe and the USA to increase distribution efficiency (Hussain et al., 2006, P.90-91). However, most Nigerian oil companies still practice an unpredicted vessel transportation approach in exporting crude oil to customers worldwide because systems and strategies to effect export efficient operations are yet to be introduced. This argument is supported by Ogunsoji and Ogunsoji (2011, P.625-629) who report that integrated logistics systems in Nigeria will enhance comparative advantage.

Also, the volume of crude oil transferred between streams has increased over the last twenty years, which is primarily influenced by increasing development and economic growth in emerging countries (Kilian, 2009, P.6). Moreover, Nigeria as an oil producing country has now become China’s major supplier of crude oil in Africa (Egbula and Zheng, 2011, P.6). In addition, trade agreements between the two countries have seen crude oil volumes shipped to China increase steadily over the last ten years. Yet, there has not been an assessment of the required consistency of shipments to satisfy current crude oil demand from Nigeria since supply agreements were signed with China. Consequently, trade flows have become a focus for most energy experts and oil exporting companies in Nigeria, which includes the possibility of adopting SCM in practise for accountability. However, considering the global environment summits Seligsohn (2011) reports on the challenges and opportunities of transforming China's energy systems, which may subsequently affect future oil demand from Nigeria. In a report, the author evaluates the transformation of China's energy system by examining present trends and factors that affect major drivers that impact on China's crude oil import policy. These are energy security, environmental protection, climate change, and economic restructuring illustrated in Chapter 3, Section 3.2.2.

Other recent and relevant papers and reports on the researched issue were also assessed. Moreover, reports by Gainsborough (2005), Hussain et al., (2006), Chima (2007), amongst others, have explored the benefits of SCM to the oil industry. For example, Chima (2007, P.27) has reported on processes and integration in an oil SC, while Gainsborough (2005) focused on the implications of Information Technology (IT) systems on the downstream segment of the oil industry; with an overall perspective on its impact on the upstream segment. Similarly, Hussain et al., (2006, P.91) have reported on logistical challenges which have a major influence on the cost of oil and the possible measures to maximise on distribution productivity. Also, the authors have advised on the use of management science techniques to enhance collaboration in between partners in an SC system; which consequently may improve distribution efficiency. However, relevant parameters or boundaries for measurements which are often neglected still need to be examined, especially in key areas for improvement within the structure of an oil export SC.

In addition, Gunasekaran et al. (2004) report on possible enhancements to an organisations productivity and profitability. These they explain can be achieved through performance measurement metrics within the distribution function. However, the author's advocacy for the application of such metrics does not necessarily consider how the process is or should be introduced; also measures to account for its incorporation within a distribution network are essential considerations. Moreover, the authors further discuss on SC activities and processes, but do not assume that most organisations with various operational functions mentioned in their findings, are yet to introduce SC performance measurement techniques, and are not aware of how to start the process. Most oil firms may have distribution requirements comparable to MNCs, but may not have the capability and capacity of larger companies to organise export distribution for efficiency. Nonetheless, the advised framework by Gunasekaran et al. (2004) is a concise guide on issues concerning performance measurement in a SC for both Nigerian National Petroleum Company (NNPC) and Nigerian oil industry participants.

Authors such as Chidambaram et al. (1999) also focus on standard methodologies to support SC transformations. They report that organisations with world-class SC's have common characteristics when compared to traditional organisations. Moreover, the authors admit that transforming an organisations distribution requirement to meet global standards is an ambitious and challenging task. Especially, Chidambaram et al. (1999) explain that the true nature of business environments may not be readily set and competitive conditions may not facilitate the adoption of changes. However, the transformation methodology is useful to those who can incorporate it with their organisational goals, because most industries differ in practice, and the oil industry in Nigeria may not be receptive to improving performance measures. Therefore, common standards need to be set to support operations between participants in the oil industry, although costs have been identified as a major deterrent in implementing most transformation models (Chidambaram et al., 1999).

Nevertheless, present studies on SCM in the oil industry are limited. Chima (2007) and Hussain et al., (2006) have reported on the main issues that should allow further investigations into the logistics of a crude oil operation. Similarly, little information is available on the adoption of SCM in the oil industry in WA, especially in Nigeria, as further studies may assist in influencing a change from the current transportation centred structure into an integrated SCM system. However, the aim of the study as mentioned in section 1.2 is to assess the implications of applying integrated SCM in the logistics of distributing crude oil from Nigeria to China. In addition, measures for improving the upstream efficiency of crude oil distribution between Nigeria and China are considered. Nonetheless, SCM as a management science has evolved with significant influences on distribution structures in most oil companies worldwide. Consequently, increasing volumes of crude oil shipments particularly to China has created a need to maintain standard distribution procedures in the upstream segment of a Nigerian oil company operation. As a result, the efficiency of transportation networks and logistics processes has now become a management necessity (Rodrigue, 2012, P.15). Moreover, SCM as a function within operational structures in an organisation is essential to distribution processes, including its major elements such as; transport mode, terminals and infrastructure which play a fundamental role (ibid). Therefore, analysing current trends in the industry and assessing existing structures for the adoption of SCM should enable the discovery of root causes. Also, the research topic will be of importance to Nigerian and Chinese oil companies, as well as European and American oil exploration companies, with oil production investments in Nigeria, including energy consultants who have an on-going interest in the countries logistical advantages for international oil distribution.

In this chapter there are four identified aspects which have been critically reviewed and are illustrated in section 2.1 to section 2.5. Firstly, the characteristics surrounding crude oil distribution and theoretical implications that may impinge export distribution efficiency is examined in section 2.1. Following in section 2.2 is an evaluation of the ontological and underlying aspects that influence the transformation of distribution systems relevant to the studied phenomena. Moreover, in section 2.3, the requisites for SCO and process transformation are illustrated i.e. SCPRO together with the impact of information technology on organisational planning. In addition, Section 2.4 explains the benefits of the study by Gunasekaran et al. (2004) on measuring and improving performance in a SC. Likewise, section 2.5 describes the effects of demand variability on crude oil export logistics. Finally, in section 2.6 is a discussion on the overall advantages of the aspects identified in each section with particular attention to those constituents of the studied phenomena that will enable statistical analysis and evaluation of logical deductions based on the research question and objectives set in Chapter 1, section 1.2.1.

2.2 Supply Chain Characteristics: Nigerian Crude Oil Exports

Over the past two decades, the saturation of economic development in relation to globalization has influenced distribution decisions in most organizations (Seuring, 2013, P.2; Yusuf et al. 2013). Besides, the capacity and capability to maximize on possible revenue from an organisations existing distribution hub or enterprise have become necessary. Therefore, the composition of SCM as a management science has introduced a thorough process in its application fortified with theory, and supported by achievable practices, (Kotzab et al., 2011, Christopher and Holweg, 2011 ; Ellram and Cooper, 2014, Stadtler et al., 2015).

Moreover, the current study investigates the application of SCM and integrated logistical strategies in distributing crude oil from Nigeria to China. At present, the oil industry currently operates in between three major distribution streams, namely upstream, midstream, and downstream illustrated in figure 2.1. For example, the upstream encompasses distribution operations in between factors of exploration and production. According to Enyinda et al. (2011, P.38) the upstream in a crude oil supply chain is the process of acquiring crude oil including exploration, forecasting, production, and delivery from remotely located oil wells to refineries. However, the upstream oil industry supply chain involves sizeable investment levels and volatile geological outputs which are often affected by fiscal and political uncertainties within a producing country (ibid, P.39). Similarly, the midstream includes the transfer of crude oil from a primary phase of extraction to the point of refining where it is converted into end products; which include the logistics management of delivering the crude oil derivatives to customers around the globe (ibid). Lastly, the downstream comprises refined products logistics i.e. performing supply and trading activities, as well as distributing and marketing the refined products output (ibid, 38).This includes refined products in the three categories of fuels, lubricants, and petrochemicals (BP Annual Report, 2014, P.29).

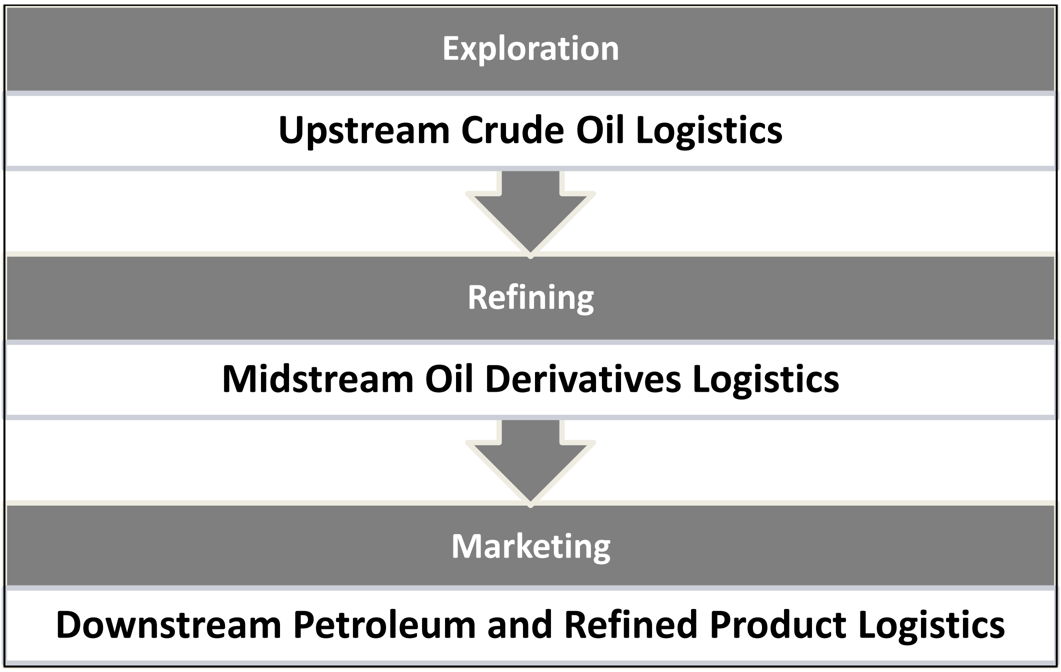


Figure 2.1 Upstream, Midstream, and Downstream Oil Distribution Segments

Moreover, most crude oil extracted in Nigeria is exported at the upstream segment before refining (MBendi, 2011) and China has recently become a major purchaser. Therefore, to sustain Chinese interest in Nigerian crude oil in the upstream segment possible measures of improving export distribution and coordination in between Nigeria and China is investigated, and its process factors examined for potential efficiencies to encourage export demand sustainability.

Furthermore, identification of significant benefits to support the adoption of SCM in the oil industry allows an appraisal of current distribution structures (Hussain et al., 2006, P.92). In addition, interdependent relationships found in the present distribution structures of the Nigerian oil industry are managed with intermittent gains in productivity. These are primarily associated with fluctuating crude oil market prices and pricing structures, which are both influenced by market speculation and demand patterns (Pirog, 2005, P.1). Besides, they are also affected by an increasing demand for petroleum by emerging economies (ibid, P.8). Moreover, the possibility of applying supply chain theory and practice to sustain an elaborate demand and distribution pattern should prove essential to organizational structures, and may consequently encourage efficient crude oil export distribution from Nigeria.

2.3 Supply Chain: Ontology

At present, the predominant application of SCM has developed associations, institutions, and councils with various definitions to justify its adoption in most industries. Also, the definitions supporting SC adoption explains its implications on the process of distribution while identifying as well as consolidating various SC initiatives and factors that enable the development of key SCM constructs conducive to advancing knowledge in the field (Sachan and Datta, 2005, P.665). Moreover, La Londe and Masters (1994) have defined a SC organisation as a set of firms that pass materials forward. A definition supported by Lambert, Stock, and Ellram (1998) who define an SC as an alignment of firms that bring products and services to market. Similarly, the Council of Supply Chain Management Professionals (CSCMP) also defines SCM as a science that encompasses the planning and management of all activities involved in sourcing and procurement, conversion of products or services, and other logistics operations. Importantly, it includes coordination and collaboration with channel partners, which includes suppliers, intermediaries, third-party service providers, and customers. In essence, SCM integrates supply and demand management within and across an organisations distribution boundary (CSCMP, 2005). This definition transcends earlier definitions, as most definitions that surround SCM justifies its discipline as a management process, which involves investigations into scopes and boundaries, elements and functions, relationships in between elements and functions, and also relationships with other disciplines, including their direction, evolution, and significance (Popper, 1977; Kaplan, 1964). In addition, another definition of a SC describes it as the task of integrating organizational units along a SC and coordinating material, information, and financial flows in order to fufil (ultimate) customer demands with the aim of improving the competitiveness of a SC as a whole (Stadtler and Kilger, 2008, P.11), a definition that compliments a commercial perspective associated with formations and processes present in a distribution network.

Furthermore, Lambert (1994) also defines a SC as the integration of business processes from the end user through original suppliers that provides services and information which add value to customer demands. An SC therefore as opposed to SCM is a set of organizations connected by one or more of the upstream and downstream flows of products, services, finances, and information from a source or outlet to a customer. Besides, managing an SC is 'SCM' (Mentzer et al., 2001). Therefore, the definitions of SCM recognise complex interdependencies associated with creating an “extended enterprise,” which reaches beyond an organisation's own boundaries (Handfield and Nichols, 1999).

In addition, definitions and philosophies of a SC also identify its evolution from a value chain (VC). For example, Christopher (1992) states that an SC is a network of organizations that are involved, through upstream and downstream linkages, in different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer or customer. Accordingly, Handfield and Nichols (2002) also have a similar definition, that a SC consists of multiple firms involved in a process, both upstream (supply) and downstream (allocation), with an interlinked system of distribution which evolves from a Value Chain System (VCS). Therefore, a VC creates a focus for both radical organizational development and improvements in present operations structures that could balance the benefits of separation and integration within distribution units (Porter, 1985, P.59).

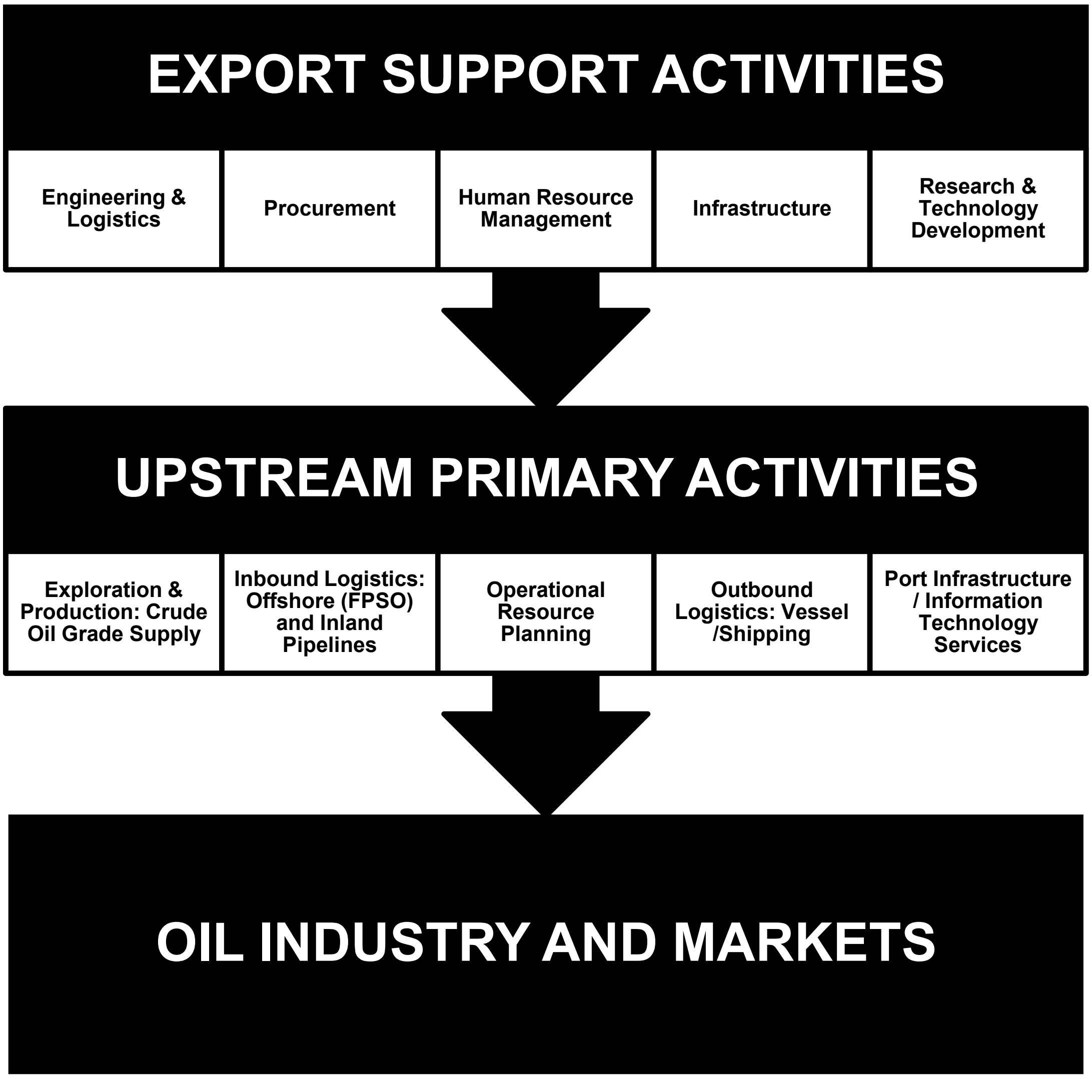


Figure 2.2 Crude Oil Value Chain (Adapted from Porter, 1995, P.59)

However, figure 2.2 illustrates the functional nature of a VC that supports its adoption in a distribution operation, because its organisation assists the assignment of operational efforts useful in evaluating the consequences of distribution requirements. Moreover, SCM in crude oil distribution requires sufficient distribution of efforts within each function in the VC which should assist in developing tangible and intangible measures to meet an overall distribution objective. Therefore, the benefit of a VC as reported by Handfield and Nichols (2002) is that it enables a focus on upstream primary activities which are operationalized by export support activities. For example, there are five upstream primary activities and also five export support activities identified in the VC adapted from Porter (2001, P.52) in figure 2.2.

Firstly, upstream primary activities require the availability of world standard product specification of crude oil agreed majorly through negotiated oil supply contracts with procuring oil companies in China. Secondly, inbound logistics involves transfer of crude oil to holding storage for feedstock export inventory such as Floating Production Storage and Offloading **(**FPSO**)** units in support of oil export responsiveness. Thirdly, operations resource planning combines the five export support activities mentioned above into interlinked processes which assists efficient crude oil exports from Nigerian ports. Fourthly, ocean tankers are the most common mode of intercontinental transport (Tordo et al., 2011, P.111). Therefore, outbound logistics considers the requirements of crude oil shipping from Nigeria by accessing required export vessel capacity and shipment frequency according to demand forecasts.

Lastly, port infrastructure and information technology services are factors which increase the possibility of adding value to the distribution process. Also, this depends on the output of research and development of exports services mentioned above to realise efficient export operations. In addition, the competences of port operations for crude oil exports will depend on speed, economies of scale, expansion of transport infrastructures, efficiency of transport terminals, and use of information technologies, including the need to organise supply chains to meet shared goals (Porter and Kramer, 2011).

On the other hand, complimenting primary activities within the crude oil export SC requires firstly that engineering and logistics as major functions add value to both the exploration and distribution process. According to Zhang and Gregory (2011, P. 758) engineering supports industries through innovation and technologies that enable adequate supply of a product to be generated with efficiency and flexibility. Likewise, logistics acts as a channel for all functions of production including the eventual transportation of crude oil to refiners in China. Secondly, procurement concentrates on the acquisition of factors that facilitate the production of crude oil. Moreover, it expounds on the requirements of a strategic network process and the collaborative VC management of strategic business units to deliver predetermined shared values and enable competitive advantages to be sustained (Hong and Kwon, 2012, P.455). Thirdly, Human Resource Management **(**HRM**)** motivates a VC to realise organisational objectives. Although, the implications of HRM on an SCM is still an under researched issue (Lengnick-Hall et al., 2013, P. 367), HRM encourages the possibility to build strategic partnerships and coordinate logistics practices for system-wide consistency. Fourthly, adequate infrastructure increases logistics efficiency. This supports existing operational processes that allow crude oil export organisational strategies to be achieved. Moreover, accessibility to logistical infrastructures in Nigeria increases the frequency of crude oil shipments to countries such as China. Fifthly, research and technology development increases the basis of competitive advantage in the export logistics process through innovations in the distribution systems that also encourage efficient procurement procedures. This is achieved by the incorporation of information management systems and technology. According to Liu et al. (2014, P.1453) conceptualizing IT systems introduces additional fundamental capabilities that shape higher-order requirements in the form of absorptive capacity and SC agility. For example, absorptive capacity refers to a firm's ability to assimilate and apply new knowledge received from external sources, such as customers, suppliers, or alliance partners (Liu et al., 2014, P.1454). SC agility is defined as a firm's ability to effectively collaborate with channel partners and respond to market volatility (ibid). These two factors form the basis in which adopted IT infrastructure encourages knowledge exchange and aligns business processes for efficient and effective operations within and across organizational boundaries. Similarly, it can be argued that distribution within the oil industry should rely on functions of operations together with an established benchmarked criterion to achieve predetermined results.

2.4 Organisation: SC Structures, Concepts, and Orientation

Furthermore, strategic organization of resources within an oil company should allow operational productivity gains in distribution. These could be achieved through an efficient arrangement of all distribution network components, its core functions, and capabilities. Besides, organisation of logistics structures in most Nigerian oil companies requires incorporation of essential benchmarks to develop on sustainable processes for optimization and value creation. Therefore, the inputs and outputs of products involved in an interlinked process should be organised for manageability. Moreover, the possibility of achieving SC optimization through integration could also enhance an organisation’s overall performance for measurable productivity gains (Gainsborough, 2005).

In addition, Olivia and Watson (2004, P.1) described SC's as incredibly complex with numerous moving parts. This argument could be applied to crude oil SC's, as the author's major study was on what drives SC behaviour, and what activities within a SC are prioritized strategic, operational, and tactical. For example, strategic activities include long–term capacity planning and network configuration of stockholding and distribution units. Similarly, operational activities should include short-term demand planning, forecasting, inventory management, production, and logistics. Lastly, tactical activities involve allocating resources, monitoring, and measuring performance to enhance SC integration and efficiency.

Besides, the nature of most SC's extends beyond an independent distribution process. For example, crude oil export distribution for Nigerian oil companies could be coordinated with similar operational structures within the existing national infrastructure. These will include an entire network of operations that will transform a linear set of linkages between firms into a web of interdependent nodes operating towards common goals and objectives (Raman and Shapiro, 2000). Accordingly, research into infrastructural dimensions needed to sustain distribution efficiency in a developing economy will prove valuable to crude oil distribution in between the two continents. However, the authors have described determinants of a SC network; as important references into understanding why organisations have moved from basic process enterprise businesses into reciprocal and responsive organisations. The five influential factors noted by the authors are as follows;

- Information Technology (Systems Integration)
- Visibility of Best Practices

- Consumer Behaviour or Customer Preferences (Demand Characteristics)
- Competition (Composition of Market Participants)
- Importance of Speed (Time factors)

Firstly, information technology (IT) has become a conduit and facilitator for most business enterprises. Secondly, visibility of best practices has encouraged a scrutiny of processes and an alignment of operational resources for a better understanding of SC operations. Thirdly, consumer behaviour recognises that the customers demand pattern and orientation may influence the organization of a product or service offering. Fourthly, competition may also arise when there is more than one participant with a similar product offering in any market. Besides, demands on the SC by the customer may also increase competitiveness. Lastly, the speed to market quantifies both the time factor and response levels required to fulfill customer demands; which not only includes the level of accuracy and efficiency of satisfying an order, but also the possibility of sustaining long-term customer relationships. Therefore, these five factors are important to decisions on the organisation of processes in a logistics network, which depends on established interrelationships between organisations to achieve shared objectives.

At present, product and market structures create a foundation for an organisation's orientation in the energy industry (Kohli and Jaworski, 1990; Day, 1994). Likewise, commonalities within an energy sector SC accounts for possible similarities in demand management, with a proposition to maximize on value creation. Moreover, a common decision-making approach in crude oil distribution across the industry may contribute towards an efficient SC organization (Julka et al., 2002, P.1757).

Similarly, the relevant concerns for a SC in relation to the present study and in the context of crude oil distribution may manifest functional, spatial, and inter-temporal integration (Shapiro, 2001; cited in Min and Zhou, 2002). For example, functional integration as explained by the author accounts for purchase, manufacture, transport, stockholding, and storage operations, while spatial integration should proliferate activities across geographically dispersed vendors, facilities, and markets. Subsequently, inter-temporal integration also called hierarchical planning will require consistency and coherence among overlapping SC decisions at various levels of corporate planning (Shapiro, 2001). For example, strategic planning includes resource acquisition and divestment decisions to be taken over long-term planning horizons. Besides, tactical planning will also consider resource allocation decisions over medium term planning horizons. As a result, operational planning will include decisions affecting the short-term execution of a company's business (Shapiro, 2001). Furthermore, they argue that overall tactical, operational, and strategic planning process should facilitate inter-temporal integration and a diffusion of objectives across the SC (Shinkevich et al., 2016, P.524). Moreover, a manifestation of functional, spatial, and inter-temporal integration are also important in regards to understanding the multi-layered nature of decisions involved in the distribution of crude oil which supports the development of organizational goals. Accordingly, this allows an examination of operational plans that influence the strategic direction of Nigerian oil companies involved in crude oil exportation.

Presently, extensive research has been carried out in finding better ways of managing the SC and optimizing its performance. This is applicable to the research question on how SCM and integrated logistical considerations can be applied in distributing crude oil from Nigeria to China. Accordingly, Chidambaram et al. (1999) in their study on SC transformation have reported that innovation in a SC depends on strong and weak links. They have also identified certain parameters for SC transformations which are as illustrated in figure 2.3.

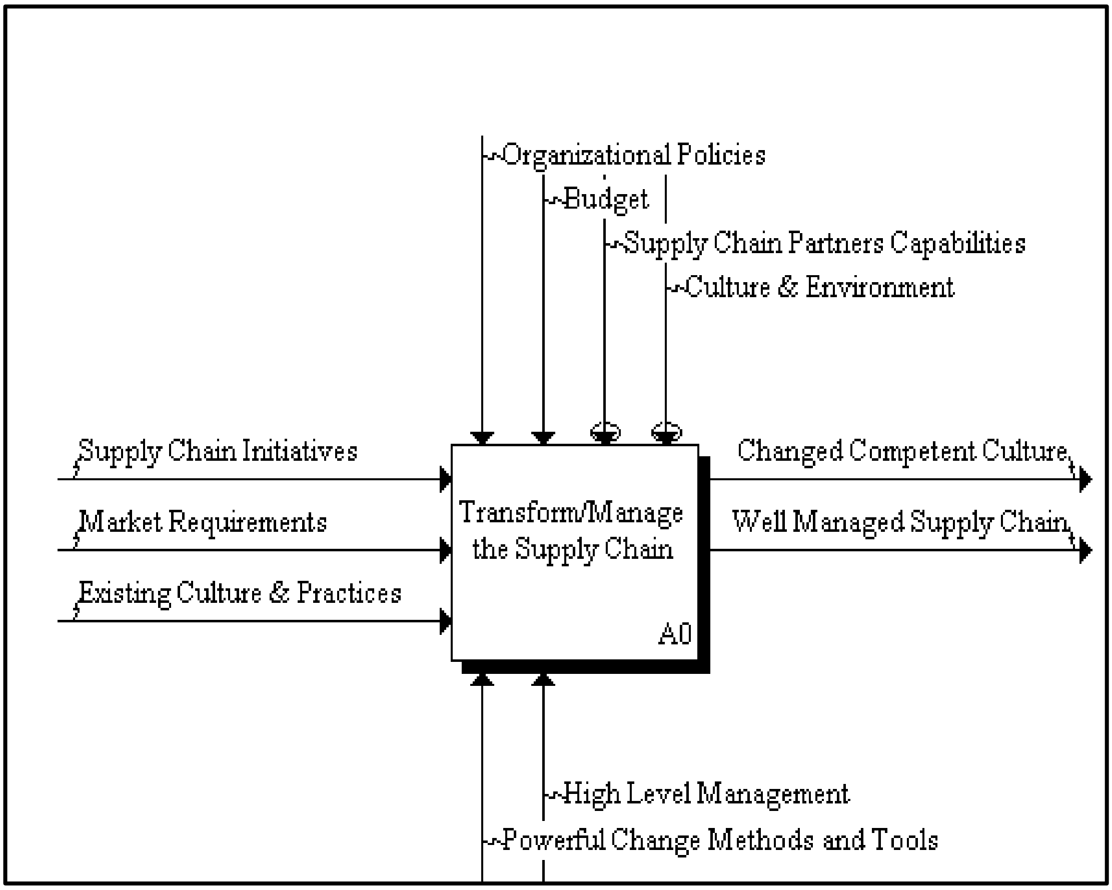


Figure 2.3 IDEF0 (A-0) Level Diagram of the Supply Chain Transformation Model (Source: Chidambaram et al., 1999, P.2-3)

Moreover, IDEF0 as function modelling is defined as Integrated Identification Level 0 which is applied mostly in business process re-engineering and software engineering (Mohammadi and Mukhtar, 2012, P.466). Besides, the IDEF0 transformation model is premised upon well-established tools of investigation that have been confirmed to be highly efficient in SC performance (ibid). This can be classified as illustrated in figure 2.3.1.

Inputs	• **SC Initiatives** • **Market Requirements** • **Existing culture & practices**
Mechanisms	• **High Level Management** • **Powerful Change Methods and Tools**
Controls	• **Organisational Policies** • **Budgets** • **SC Partners Capabilities** • **Culture & Environment**
Outputs	• **Changed Competent Culture** • **Well Managed SC**

Figure 2.3.1 IDEF0 Supply Chain Transformation Model Notation (Source: Mohammadi and Mukhtar, 2012, P.466)

Firstly, inputs according to the transformation model will consider the current SC initiatives which assist in identifying the right approach towards restructuring an existing distribution network for crude oil shipments to China. Moreover, the main challenge facing the oil and gas industry is not the availability of oil and gas resources (Chima, 2007, P.28), but allocating these resources into exploration and production, and delivering the final product to the customer cost effectively. Besides, the cost consideration is instrumental to the improvement of distribution structures. Nevertheless, it can be considered that the immediate challenge facing the oil and gas industry in Nigeria is the organisation of existing crude oil infrastructure (EIA, 2015, P.2). Consequently, this affects the cycle of crude oil distribution as well as the orientation of export logistics.

Secondly, Chima (2007), reports that the profit margin for oil and gas companies can be greatly enhanced if the companies manage their trading resources effectively. This is readily sustained by high level management who can initiate achievable SC orientation in distributing crude oil to countries such as China. In addition, Lambert and Pohlen (2001) report that the nature of a product and type of consumers served influences a SC, and its success relies on the coordination of a product strategy (Roh et al., 2011). Therefore, in the exploration and production sectors of the oil industry, the product offering is similar to all competing firms, because crude oil has narrow product differentiation. Besides, many oil organisations cannot differentiate themselves from one another by introducing new products even though there is a current trend to brand outputs according to exploration locations and refining properties. As a result, exploration and production companies can only differentiate themselves from one another "based on the ability to economically find and produce oil more efficiently than their competitors" (Chima, 2007, P.29).

Nevertheless, the major consideration for oil companies in Nigeria is the possibility to manipulate or change standard operations in a logistics network for adaptability, and to capture measures for efficiency in the distribution process. Also, Chima (2007) reports that SCM involves configuration and coordination which requires interrogation of major export logistics issues in practice for improvements. For example, configuration determines the orientation of SC change management which involves questions on the following factors;

- Product Characteristics and Quality
- Networks and Distribution channels
- Resource Management
- Export Location
- Technology adoption or adaption
- Internal and External Communication
- Standards and Benchmarks

In addition, the above factors when examined to encourage efficiency can be better realised with an appropriate change management culture.

Thirdly, Control elements in an SC dictate organisational policies and modes of operation which involves questions on the following issues:

- Supplier effectiveness in cost, timelines, and quality?
- Targets setting for inventory, capacity, and lead-time?
- Market demand and supply monitoring?

- Communication of market performance results internally and externally?

For a SC to be effective in the Nigerian oil industry, policies need to reflect the demands of the industry and market requirements, so that continuous evaluation of internal and external distribution structures will subsequently create better SC performance.

Another essential element of a SC in the oil industry is that it needs to be managed as an integrated and coordinated system (Mentzer et al., 2001, P.9; Deshpande, 2012 P.9). For example, exploration includes seismic, geophysical, and geological operations, while production operations include drilling, reservoir production, and facilities engineering (Chima, 2007). On the other hand, refining is a complex operation, and its output is the input to marketing and distribution in the downstream segment of the oil industry. Besides, each stage of the link can be a separate company or a unit of an integrated organisation. As such the joint issue along the links in the oil and gas industry SC is economics; weighing benefits versus costs along the chain (Chima, 2007, P.28),

Moreover, the advantage of information sharing creates consistency in distributing crude oil even though SC's have been termed inflexible (Hussain et al., 2007; Zailani et al. 2008). For example, Zailani et al. (2008) in their study on factors influencing the effectiveness of operational information sharing within SC channels in Malaysia found that five independent variables namely, information quality, IT commitment, SCM commitment, organisational size, and trust (partnership) were important to sharing operational information. Also, the above theories of Raman and Shapiro (2000) inform that the effectiveness of operational information sharing could support the development of internal and external organisational capabilities to enhance the global positioning of oil exporting companies (Zailani et al., 2008). This will be particularly useful to NNPC Joint Ventures with IOC's, and IDC export operations in Nigeria.

Fourthly, outputs desired from the transformation model will be a competent culture and an integrated logistics structure or system. Furthermore, Chima (2007) reports that very few industries can benefit from maximizing SC efficiencies more than oil and gas companies, and the goal of SCM is to provide maximum customer service at the lowest possible cost. Nevertheless, when assessing production operations, crude oil refining depends on the output of production (Chima, 2007, P.28). Besides, the evident need for each company or operator along the SC to respond quickly to the distribution demands of its customers creates a need for competence in SC operations; because there may be frequent export distribution requirements for adaptability i.e. reliance on buffer inventory or feedstock for possible demand and supply uncertainties (Cheng and Duran 2003; Kilian and Murphy, 2013, P.4). Likewise, a well-managed competent culture can be sustained by continuous appraisal and adjustments of operational factors in a typical crude oil SC as explained above and illustrated in figure 2.4.

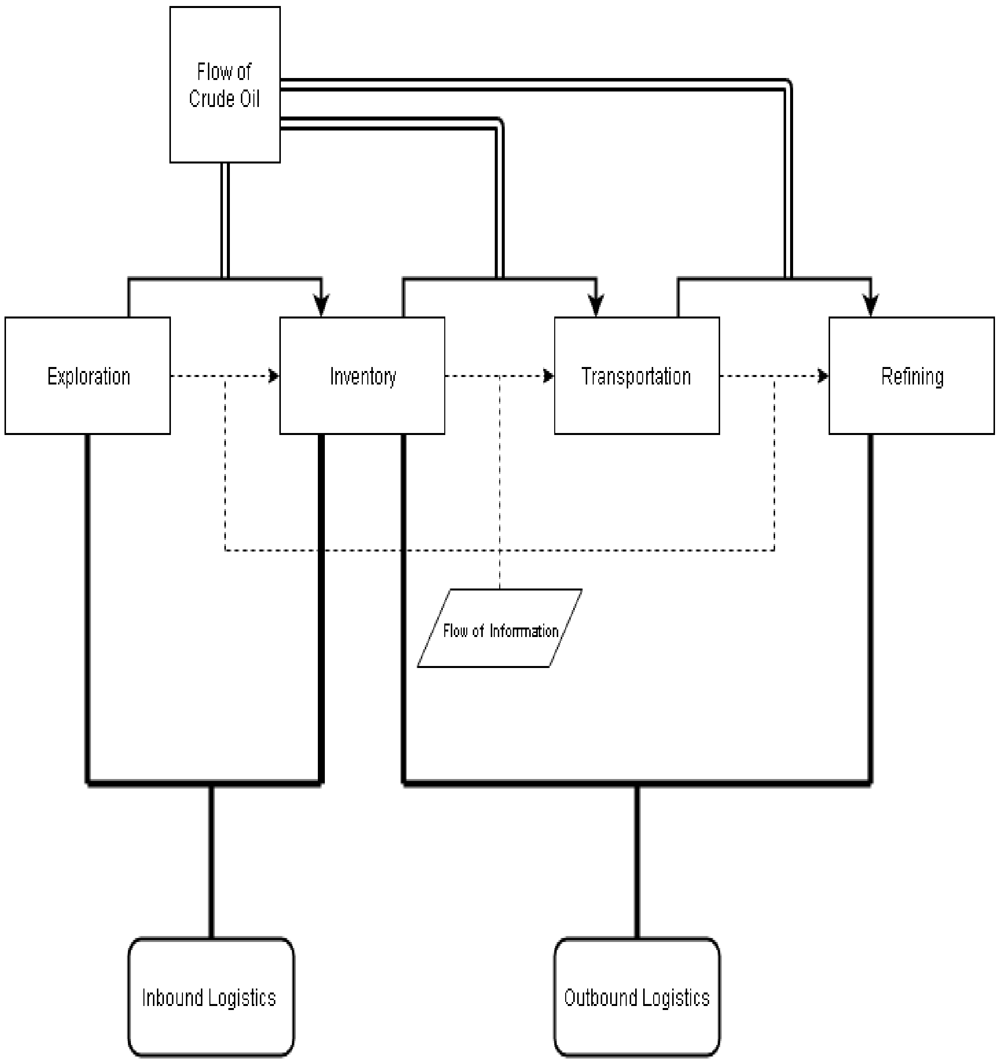


Figure 2.4 Typical Crude Oil Supply Chain (Adapted from: Min and Zhou, 2000, P. 231-249)

2.5 Vertical Integration: SC Performance Measurement

In addition, vertical integration in both a distribution network and a SC is a pre-requisite for distribution efficiency (Ursino, 2015, P.3). This involves connecting one firm with another to which it either sells an output (product) or from which it buys an input (resource). Moreover, vertical integration is essential to the oil and gas industry, where the “output from one firm is the input to another firm along a supply chain” (Chima, 2007, P.30).

According to Chima (2007, P.30), vertical integration supports the need to manage a company’s SC in an integrated and cohesive form. These includes the increased demand for better and faster customer service, ever growing need to globalize the oil and gas business, competition, and the availability of communication technology to facilitate information exchange (Weston et al.,1999, P.150-151). Moreover, integration and cohesiveness will reduce costs if it leads to a more efficient system (Chima, 2007, P29). As a result, an organisation needs to decide on internal and external capabilities in order to realise vertical integration decisions in the oil and gas industry. Also, integration amongst firms can either be forward or backward. While forward integration is determined by the volume of crude oil for export as well as inventory (feedstock) for future distribution, similarly backward integration dictates required quantities of crude oil to be supplied at a predetermined date. Therefore, the oil and gas industry provides excellent opportunities for both vertical integration and productivity maximisation (Barrera-Rey, 1995, P.13); because the output of exploration is the input to production capacity and refining (Chima, 2007, P.30) in figure 2.5. However, Fawcett and Magnan (2002, P.343) reported that many organisations only manage to develop the first tier backward and forward integration mentioned above and are not systematic or strategic.

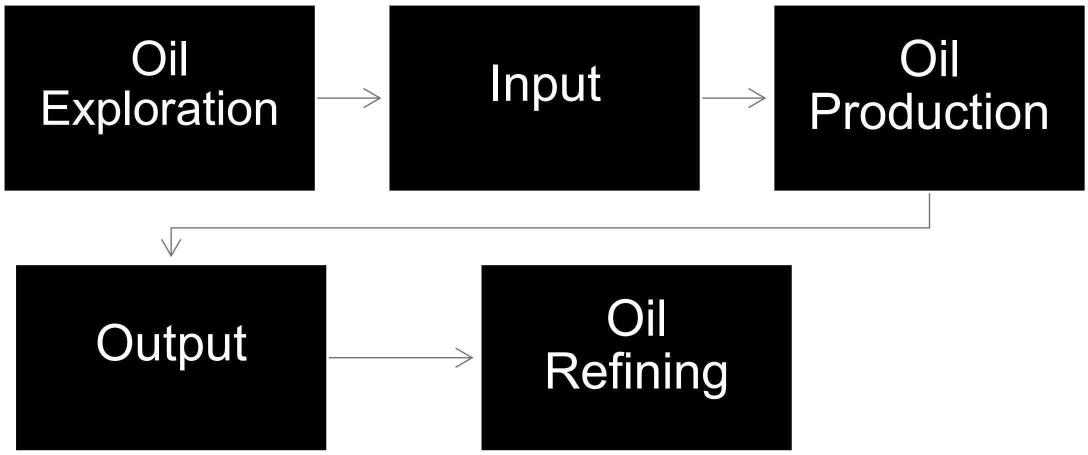


Figure 2.5 Upstream Crude Oil Distribution: Process Input and Output

Also, Chima (2007, P.30) argues that if input materials are not related, unique, or exclusive to the firm's current business focus, then vertical integration is not necessary. These forward and backward linkage decisions set the boundaries for each company's value-adding systems (ibid). Moreover, the goal of a participant firm in an SC is to maximise process benefits and minimise costs, which may consequently increase profits and shareholder returns (ibid).

Other arguments on the requirement of an SCM in the oil industry to integrate its decisions with those made within its chain of customers and suppliers are constructive. This process may involve relationship management by the organisation concerned because customer relations, as well as supplier relations, are key to effective coordination of SC's. Often, the interaction between vendors and their clients are oppositional in nature, based on a negotiated contract that influences the terms and conditions by which all parties involved are required to comply. Instead, it has been stated that a firm can create long-term strategic relationships with their suppliers, and in most cases it involves a

collaboration process or partnerships between the oil and gas operating company and its suppliers (Ahmad et al., 2016, P.205). Yet, most crude oil companies in Nigeria tend to function as a single unit logistics operation. This argument may be investigated further to support any recommendations for a reformation of the process of crude oil exportation, because the possibility to improve on SC's depends on configuration and coordination as explained in section 2.3. Nevertheless, encouraging required improvements over time allows an organisation to gain competitive advantage (Chima, 2007). Moreover, supplementing the flow of control in a SC allows most operating system's to meet the broad competitive and strategic objectives of quality, speed, dependability, flexibility, and cost (Gunasekaran et al., 2001; De Toni and Tonchia, 2001; Slack et al., 2009). As reported by Gunasekaran et al., (2004, P.334) control is also an essential element, as both customer needs and SC performance have a tendency to change over medium to long term periods. These also may support organisational objectives, when outputs of processes meet with measured standards.(ibid).

Moreover, the benefit of standards in SCM "is to allow a comparison of planned and actual parameter values, and once confirmed the parameter values can be influenced through certain reactive measures to improve SC performance or by realigning the monitored value to the defined value"(Gunasekaran et al., 2004, P.334). Also, adoption of suitable and applied methods like process reengineering should enable monitored improvements and a concentrated effort in solving short to long term problems. Therefore, controlling the processes of distribution and applying important benchmarks is significant when improving logistics performance, and is also achievable through adequate monitoring of distribution operations. Besides, an emphasis on a planned and measured logistics process facilitates an enhanced SC operation.

Also, Gunasekaran et al. (2001, P.335) reported that organisations and institutions have concentrated on financial performance measures, while others have preferred to adopt operational measures. They inform that an organisation's priority should be an assessment of balance; from a concentration on financial performance measures useful for decisions on an organisation's strategic direction to non-financial measures which concentrates solely on distribution operations. Likewise, the authors argue that effective performance measurement and improvement must represent organisational goals, and metrics preferred should be related to strategic, tactical, and operational levels of decision making and control (ibid). According to ibid, measuring performance in a SC supports the growth of a competitive market share which enables anticipation of operational and strategic challenges in a SC.

In addition, the authors notify that there are many opportunities to develop measurement techniques that will facilitate improved SC integration. They report the strategic and technological importance associated with managing an SC and emphasise the importance of performance measurement metrics in evaluating the consequences of operational planning and control. Moreover, Gunasekaran et al. (2004, P.333) states that performance measurement and metrics in relation to SCM has not received adequate attention from researchers or practitioners. Likewise, the contribution of performance measurement in their study has important effects on sustaining an efficient operation. Although, the study concentrated on a selection of 150 British companies and may be limited to certain industries, it can be applied to operational audits in crude oil shipping and distribution. Besides, “an organisation that believes its SC has reached optimum capacity can lose competitive advantages when the need for change is ignored” (Chima 2007, P.33). According to the author the following eight strategies are recommendations for improving oil and gas industry SC’s:

- Segment customers based on service needs.
- Customise your logistics network.
- Watch for market signals and plan accordingly.
- Form partnerships to enhance supply chains.
- Apply strategic sourcing.
- Adapt a supply chain-wide technology strategy.
- Develop channel spanning performance measures.
- Adapt or create operational innovation.

These recommendations have the possibility to create a basis for competitive advantages, and at present the orientation of customers such as COCs dictates different and sometimes unique requirements. Moreover, realising these requirements necessitates a different approach to SC configuration and coordination (Chima, 2007, P.33).

2.6 Demand Variability: Logistics Operations Planning

According to Chima (2007, P.33), demand variability in a SC is a continuous problem. At present, the oil and gas industry is engaged in a global SC that involves domestic and international transportation. Therefore, to capture value in the logistics process there is a requirement for the shipper (Vessel) and the oil company (Exporter) to be jointly and mutually involved, or inter-twinned with each other; end to end in logistics management from the moment an oil procurement order is placed by the vendor to the day it is unloaded from the supply resource on the offshore platform (Chima, 2007, P.33). Also, strategic sourcing implies that suppliers who have consistently demonstrated superior performance deserve a favourable status, including customer loyalty and preferential treatment. Moreover, there are arguments that a measure of SC performance is supplier reliability (ibid), and a method of improving SC is through Nigerian oil exporters becoming excellent suppliers. Similarly, difficulties also can arise when oil and gas companies make technology decisions independently along their SC's. Thus, according to the author's information systems are neither coordinated nor compatible, and information is not readily shared back and forth along the SC (ibid). Besides, the oil and gas industry especially in Nigeria needs to reassess its fundamental distribution processes for a change in coordination to incorporate appropriate information systems, so that it can accommodate the growing virtualisation of a multinational business and thereby adjust variability in demand.

Also, Chima (2007, P. 34) reports that the oil industry usually undergoes a continued process of consolidation, and there is a growing need for flexible and extensible SC systems (ibid). At present, oil and gas decision makers need to measure the extent of SC wide performance that will contribute towards extensive improvements. Likewise, innovation in relation to SC extension has been broadly defined as an idea, practice, or object that is perceived as new by an individual or another unit of adoption (Grawe, 2009, P. 361). Therefore, the possibility to improve existing SC systems through innovative decisions will consider both organisational and environmental concerns when recommending changes to effect competitive advantage (ibid, P.364).

Nonetheless, additional theories on SCM are worth considering. For example, Pagh and Cooper (1998) have reported that distribution opportunities exist when postponement and speculation strategies are applied to a logistics network. Moreover, the authors have found that adopting the concept of postponement and applying a holistic management view to a SC will increase productivity and performance levels, and thereby reduce the effects of variability in demand. Furthermore, postponement as a concept has a long history of practical applications which are relevant to transformations that occur during the distribution process (Pagh and Cooper, 1998). Besides, the benefit of postponement to distribution is the possibility to adapt distribution operations to suit inventory at a convenient location or at reasonable levels until a customer commits and demand uncertainties are reduced. For example, production is based on speculation, and logistics is supported by postponement, as a result logistical improvements should involve anticipatory inventory at one or a few strategic locations (Pagh and Cooper, 1998). Nevertheless, postponement strategies should be investigated and considered for possible process adoptions that will permit maximisation of logistical benefits in distributing and exporting crude oil from Nigerian ports to China.

2.7 Discussion

Adopting SCM theories to identify measures for logistical improvements is essential in a distribution operation. Likewise, increasing efficiency will require apposite application of identified theoretical areas. Therefore, examination of crude oil distribution between Nigeria and China for this study has focused on those logistical attributes that influence efficient crude oil exports. Similarly, the efficiency of logistics between Nigerian oil producers and China's national oil companies will depend on SCM orientation in the export distribution of crude oil from Nigeria. Besides, SCM theories are supported by SC institutions and associations with reports and papers on its interrelated logistical dependence which enhances the chain of distribution.

Moreover, of the three segments mentioned in section 2.1 the upstream segment is the centre of crude oil transfer either into inventories for refinery feedstock or direct export supply to China. Also, the possibility to sustain demand for Nigerian crude oil encourages an examination of distribution structures including organising the VC for efficiency as illustrated in figure 2.2. Therefore, sustaining Chinese interest in the upstream segment of Nigerian crude oil exports will involve improving distribution and coordination of shipments towards sustaining demand volumes, market prices, pricing structures, and competitive pressures from other West African and world oil exporting countries.

Likewise, the role of VCs within a SC organisation, adds an extra focus on the need to scrutinise primary distribution activities for added improvements. For example, Camp (1995, P.15) identifies that the examination of commercial relationships found in the organisation of a SC assists in the identification of important benchmarks for improvements. Therefore, upstream primary activities are areas of importance to the logistics of crude oil depending on the strategic organisation of export support activities. In addition, the five primary activities comprise resource factors that influence logistical efficiency supported by the five export support activities typical of a SC strategic organisation. In addition, the two attributes of a VC for crude oil export efficiency influence the research questions and methodology when a Delphi survey is used to gather information from oil industry executives.

According to Olivia and Watson (2004, P.1) interlinked logistical processes create complex and diverse parts which requires configuration of logistics structures in most Nigerian oil companies to include essential strategic, operational, and tactical benchmarks for crude oil exports. Furthermore, determinants of a SC network have caused logistics processes to be more responsive to market demands and are influenced by Raman and Shapiro's (2000) five factors i.e. information technology, visibility of best practices, consumer behaviour, competition, and importance of speed. These factors have consequences on the three theoretic elements of the study i.e. VEFF, SCPRO, and DEMVAR which are issues that influence export logistics efficiency of crude oil to China from Nigeria. Moreover, the nature of VEFF required will consider the functional, inter-temporal, and spatial characteristics of SC integration (Shapiro, 2001), because they determine how organisational resources will enable common distribution goals to be realised. Similarly, SCPRO requires adequate coordination of crude oil export management through transformation of logistics processes when accounting for DEMVAR. In addition, this depends on strong and weak links according to Chidambaram et al. (1999), and decisions on the significance of each link can be determined by weighing benefits versus costs along the chain (Chima, 2007, P.28). Also, reliance on inbound and outbound operations in a VC affects configuration of export support services when coordinating upstream primary activities to sustain crude oil demand from China applying the transformation model.

Nonetheless, Chima (2007, P.28) specifies that DEMVAR as a continuous SC problem requires management of crude oil supply reliability and responsiveness in a VC. In addition, SC strategies such as postponement and speculation allow variability in demand to be offset when predetermined crude oil inventory levels are situated at accessible export locations. Besides, the coordination of primary activities in a VC should support sufficient resource planning to maintain and sustain required crude oil demand from China.

Finally, information sharing in a multi-layered nature of operations for distributing crude oil may contribute to internal and external operational effectiveness. Moreover, IT will enhance operational capabilities of a Nigerian crude oil SC. Also, the inflexible nature of a crude oil SC encourages reliance on IT to realise operational objectives (Zailani et al., 2008), especially when considering the three identified theoretical elements of the study. Nevertheless, improving existing SC systems through innovative decisions should consider all areas of logistical improvements for oil export distribution to China that may have both organisational and environmental implications.

Chapter 3: Literature Review: Synthesis of China’s Crude Oil Demand and Nigeria’s Crude Oil Supply Capability

3.1 Introduction

This chapter examines factors which influence crude oil distribution to China from Nigeria. It concentrates on two dimensions of the study i.e. the impact of China’s policies on crude oil supply and the political, environmental, sociological, technological, and commercial pressures in the oil industry in Nigeria which has caused internal and external organisational rethink. Nonetheless, China’s policies are influenced by the three factors which are demand sustainability, energy security, and environmental concerns (Kolas, 2007). On the other hand, liberalisation of national oil interests since the early 80’s have encouraged an influx of exploration investments into Nigeria by MNCs. Also, existing crude oil distribution structures have been sustained through various stages of reformations and redevelopment over the years in joint initiatives between NNPC and MNCs. Therefore, an amalgamation of the three influential factors on China’s crude oil imports mentioned above, and the socio-political considerations on Nigeria’s capacity to supply will influence the country’s export capability. Furthermore, their implications on the adopted theoretic framework illustrated in chapter 2 are examined for measures that will enhance efficient crude oil exports from Nigeria to China.

In section 3.1 circumstances that influence the sustainability of China’s current crude oil demand are identified. Also, section 3.2 introduces the effect of China’s energy, environment, and climate policies on oil demand, while in section 3.3 China’s requirement for energy security through crude oil supply diversification is examined. Moreover, in section 3.4 the theoretical implications of demand variability on the components of logistical improvements between China and Nigeria are reviewed. Likewise, section 3.5 introduces the effects of the PIB on the Nigerian oil industry including its organisational implications. Section 3.6 assesses Nigeria's national competitiveness through primary, secondary, and tertiary factors that may encourage sustainable SC orientation. Similarly, in section 3.7 demand variability in the Nigerian oil industry is identified with its consequences on supply adequacy; as well as its effects on distribution security risks explained. Also, the benefits of vertical integration in the distribution of crude oil are considered in section 3.8. Lastly, section 3.9 analyses the synthesis of crude oil demand and supply between the two countries applying a six month archival study.

3.2 China: Sustainability of Crude Oil Demand

Recently, China has emerged to be a major developing country with substantial demand for crude oil supported by its population of 1.3 billion people (CBO, 2006, P. 44).Moreover, demand for crude oil in China is growing rapidly (Erickson and Collins, 2010, P.90). For example, in figure 3.1 China's crude oil imports have increased to 6.1 MBPD in 2014, which makes it the largest oil importer in the world in comparison with the USA; relegated to the second leading world consumer of crude oil with a demand of 5.1 MBPD in 2014.

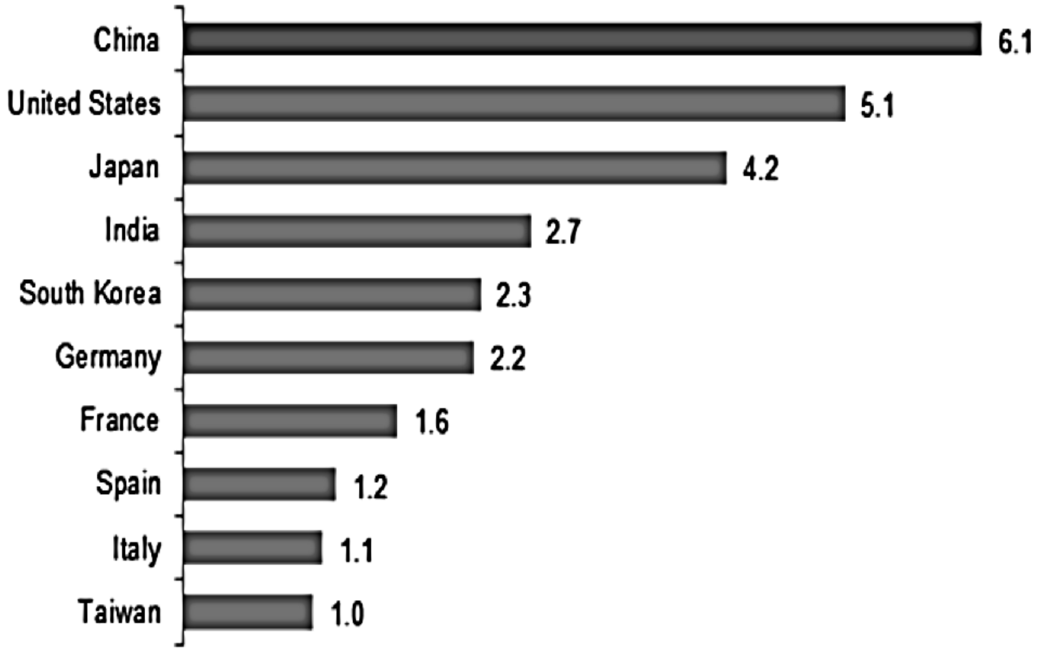


Figure 3.1 Top Ten Annual Net Oil Importers (Source: EIA, 2014)

In 2004 China imported 123 million tonnes of oil equivalent (MTOE) which increased to 308 MTOE in 2014 (IEA, 2016) a substantial increase. Likewise, China's gross domestic product has grown rapidly at an average annual rate of nearly 10% from 1979 to 2014 (Morrison, 2015, P.5).

Additionally, figure 3.2 show most crude oil imported by China was from the Middle East which remains the largest source of China's crude oil imports (EIA, 2015, P.10). Also, African countries such as Angola have increased exports to China which assists in fulfilling more of China's crude oil demands over the past decade.

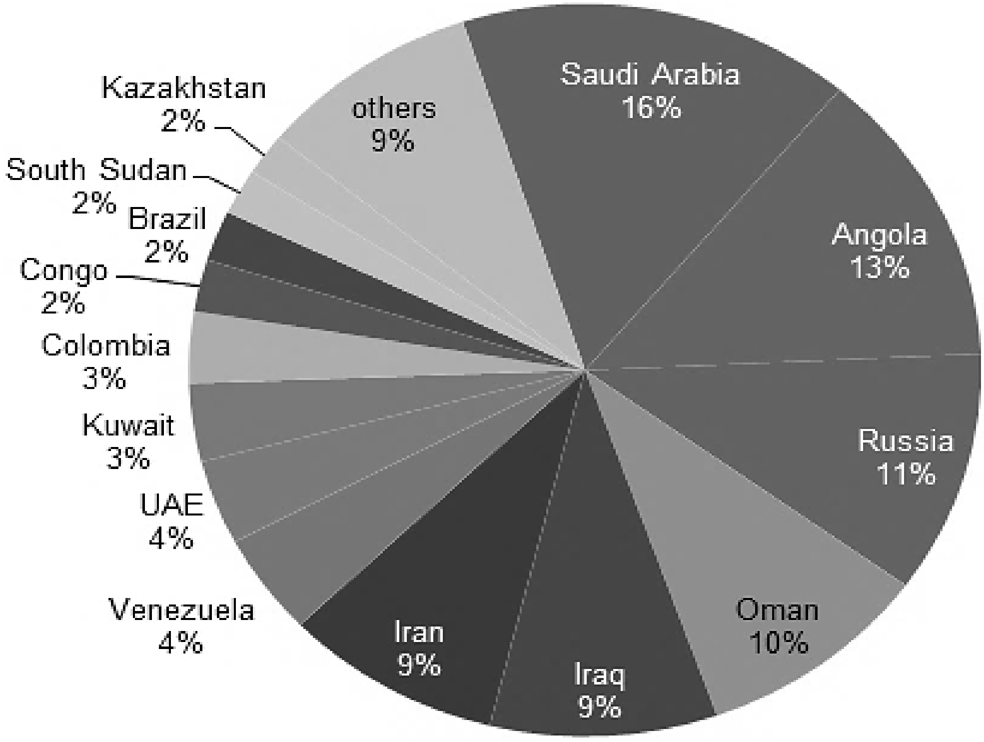


Figure 3.2 Crude Oil Importers by Source (EIA, 2014)

Likewise, China's energy supply security policy is encouraging NOCs to diversify supply sources in various regions through an economic stimulus package to incentivise commercial tax breaks, favourable lending rates and foreign investment funds that will encourage state owned oil companies to increase upstream assets and downstream refining capacity which includes overseas investments in upstream oil projects and long term supply contracts (ibid, 2015). Furthermore reports by Executive Research Associates (2009, P.43) verify increased investment by CNOOC and CNPC in Nigeria. They have both won substantial interests in Nigerian oil exploration projects. For example, CNOOC purchased 45 per cent of block Mining Licence (ML) 130 in the Niger Delta zone of Nigeria, with possible reserves of 600 million BBLS, which covers 500 square meters of Akpo Oil field and other areas (Executive Research Associates, 2009, P.43). Further acquisitions of four oil blocks Oil Prospecting Licence (OPL) 298, 471, 721, and 732, has brought the total amount of investment to at least $5 billion (Ogunkola et al., 2008). Nonetheless, the above imports of crude oil have significantly increased when compared to 1995 figures of 350,000 BBL./D (Kolas, 2007, P.6), which shows that China is increasingly dependent on crude oil. Therefore, motorisation and heating oil demand in the winter are key contributors to China's dependency on crude oil (CBO, 2006, P.5).

Together, national oil companies have an overall monopoly on crude oil distribution in China's oil and gas sectors, and are organised into two vertically integrated firms, namely CNPC and Sinopec. In addition, most assets and national outputs are managed by CNPC through PetroChina Company Limited a commercial entity, while downstream refining and imports are managed by Sinopec (EIA, 2010). Nonetheless, China's internal and external crude oil organisation is receptive towards its recent challenge to secure adequate energy from world crude oil sources which includes increased imports from Nigeria.

3.3 China: Energy Security

Over the last decade, energy, environment and climate policies have emerged to be a major concern in China. This convergence of concerns has been focused on the following drivers; supply diversification (energy security), environmental protection (climate change), and policy makers (economic restructuring) as reported by Seligsohn (2011, P.1-3). Moreover, energy security has been China's major historic concern since the Sino-Soviet split in the 1950's and early 1960's, when China was left without a stable supply of imported oil (Ibid).

Likewise, alternative energy sources which may cause a decrease in crude oil imports from sources such as Nigeria in the future are coal and non-fossil fuel developments (ibid). Finally, dependency on coal from a single region in the Shanxi Province, Northern China leaves the country vulnerable to natural disasters, such as the blizzards of 2008 (ibid). Therefore, diversifying supply from both domestic and international markets will assist in addressing multiple energy security issues.

3.3.1 China: Supply Diversification

At present reliance on imported crude oil has seen the development of relationships among a range of suppliers illustrated in Figure 3.3, and the need for an expansion of global reach, which is also influenced by China's capacity for petroleum refining based on its consolidated crude oil state–run organisations (King, 2010).

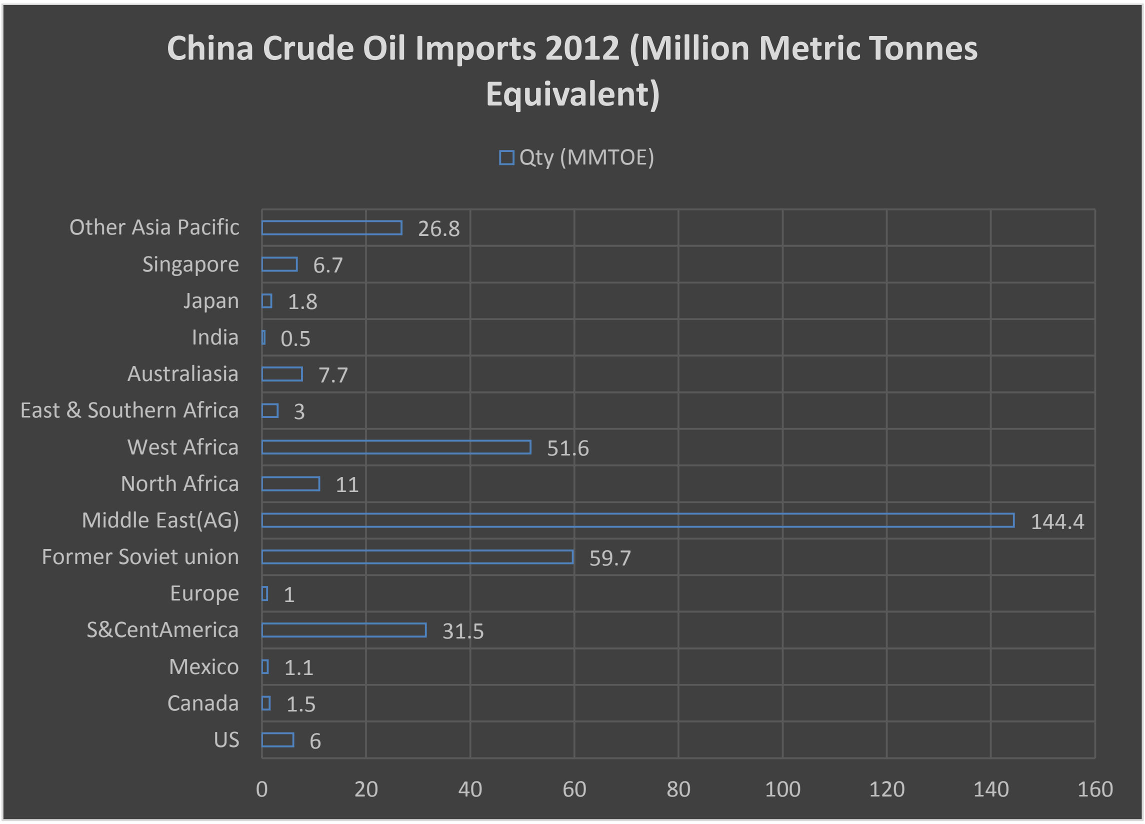


Figure 3.3 China Crude Oil Imports 2012 (Source: IEA Sankey Diagram, 2015)

Moreover, China's policymakers have realised the necessity of diversification for other sources of oil imports, and to reduce over reliance on AG. Similarly, in 2004 diversification of investment and procurement has resulted in agreements between Sinopec and NNPC (Kolas, 2007, P.6). Also, further trade agreements were concluded in 2005 in which Nigeria supplied China with 30,000 BBL/D over a year (Hurst, 2006, P.11). Therefore, oil as a strategic commodity is vital to China's economic growth. Likewise, increasing investment in Nigerian oil resources should assist in reducing China's dependency on crude oil imports from unstable Middle Eastern markets (Andrews-Speed, 2006, P.9). Besides**,** sustaining crude imports from Nigeria is in the interest of its refining capacity because crude oil extracted from Nigeria and other African countries has low sulphur content; which makes it compatible with production specifications for major refineries in China (Hellstrom, 2009, P.12). This includes investments in oil exploration blocks by Sinopec and CNPC as well as a $2 billion refining investment to support Nigeria's oil infrastructure (Market Watch, 2012). Another major incentive to sustain long-term strategic distribution plans with Nigeria are its oil reserves at 36.22 bn BBLS or 2.92% of world reserves (Mbendi, 2011), supported by China's need to diversify source of oil imports for energy security (Hellstrom, 2009, P.12). Although, Nigeria has an opportunity to consistently supply crude oil to China, the possibility of sustaining demand from this export source is uncertain.

3.3.2 China: Environmental Protection

Moreover, China has increasingly become concerned about environmental pollution (Seligsohn, 2011). Under the government's 11th five-year plan (2006-

2010), it made considerable progress by meeting its energy intensity target, and thereby reducing it to 19.1% over a five-year period. Likewise, it also increased non-fossil fuel by 3.1% per year; because non-fossil energy now comprises 8.3% of China's total energy consumption (ibid). Furthermore, climate change is another influence on the country's importation of crude oil and its subsequent use for the growing production of cars in China's domestic market. Similarly, China in the 1990's viewed the climate discussion purely in terms of external pressure, but recent reports by the National Development and Reform Commission (NDRC) believe China is highly vulnerable to the impact of climate change. However, this applies to China's domestic policy formation and its international climate negotiations with an interest in developing stronger country targets (Seligsohn, 2011, P.3).

3.3.3 China: Policy makers

At present, China's government and policy makers are continually developing strategies to sustain economic growth. Besides, transformation of China's economy is important not only for environmental sensitivity, but also to allow growth beyond middle-income developing nation status (Seligsohn, 2011, P.4). Likewise, Hellstrom (2009, P.12) has reported that China's demand for crude oil from Africa will play an increasing role in shaping global oil markets in future years. In addition, the continuing growth in demand from China is expected to influence the production of crude oil from exploration and production companies in African countries; which will also influence new exploration projects (ibid). Moreover, China's recent trade agreements have seen an increase in production supply from its overseas equity shares and acquisitions over the past several years, from 1.36 mbpd in 2010 to an estimated 2.1 mbpd in 2013 (EIA, 2015, P.9) There are similar trade agreements with other African countries such as Angola and Sudan, because China is seeking to explore opportunities for crude oil supply with Africa from unilateral agreements through foreign direct investment and aid (Renard, 2011, P.19). However, the major question is whether Africa, especially Nigeria can supply China with crude oil efficiently, because there is currently a lack of both adequate port infrastructure and efficient logistical systems to support and maintain accountable crude oil export processes (Hanson, 2008).

In addition, EIA (2015) reports that China's oil consumption will continue to grow through to 2016, with demand reaching almost 11.3 mbpd in 2016 in figure 3.4. Likewise, developing countries will continue to increase growing demand levels from 30% in 2002 to 40% by 2030; with China's total demand for crude oil expected to increase to 13.1 mbpd in 2020, 16.9 mbpd in 2030, and 20.0 mbpd in 2040 (ibid).

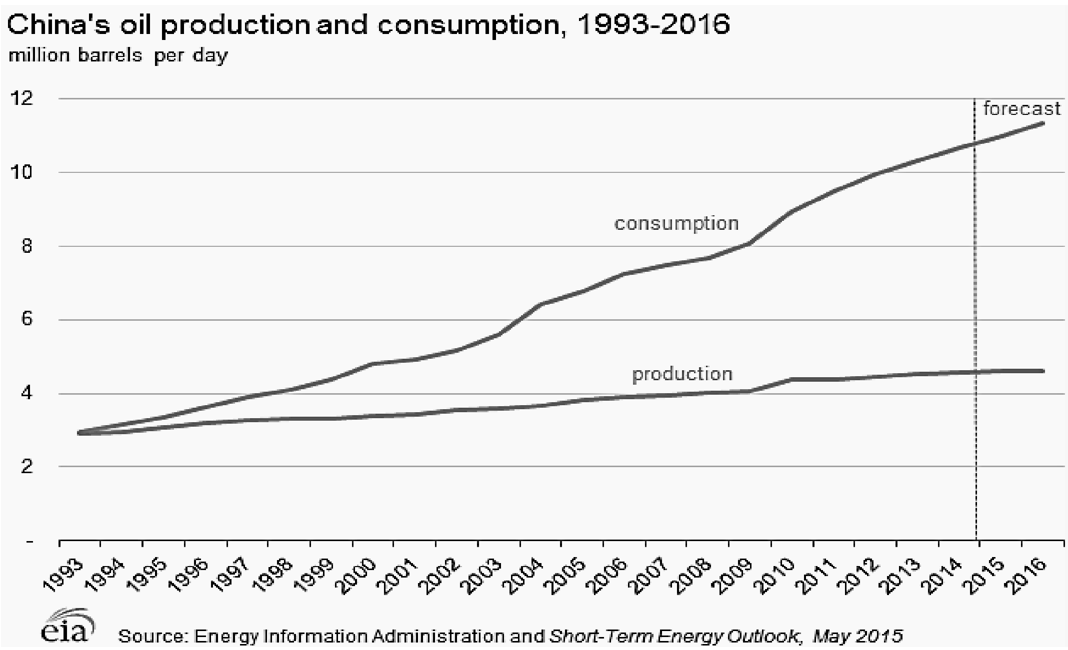


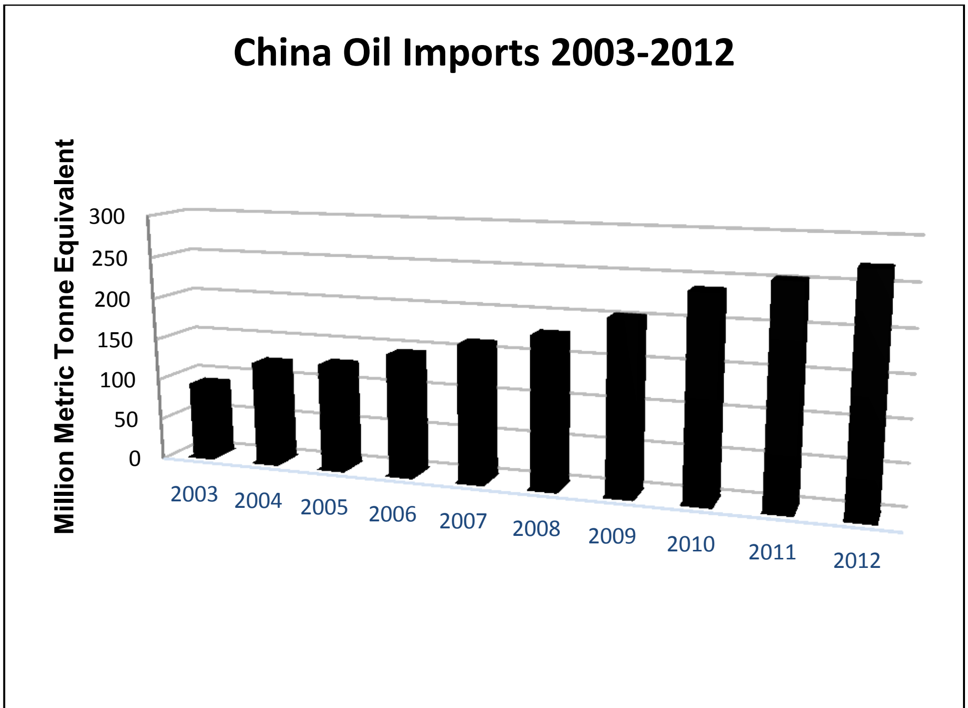
Figure 3.4 China Crude Oil Imports Production and Consumption (Source: EIA, 2015)

3.4 China's Demand Variability: Logistical Improvements

At present crude oil distribution involves transportation from exploration sites to refineries worldwide for processing into petroleum and other chemical by-products. It is also classified as an integral part of the distribution process, a central operation between the upstream and downstream functions of the oil industry. According to Li et al. (2004) determining modes of transportation for crude oil depends on the following factors:

- Crude type
- Distance
- Costs
- Availability of suitable alternatives

Apart from the other two major modes of transportation for crude oil distribution i.e. pipelines and road transport, shipping remains the most predominate means of transporting crude oil to destinations worldwide. For example, pipelines are economical and can be used to cover long distances, but are limited in routes and destinations. Likewise, road transport on the other hand involves trucking in between depots and sites on land at a distance of in between 50km and 500km approximately by estimation. However, tankers are used to carry large volumes of crude oil across international waters to link with importing nations. Nonetheless, figure 3.5 shows increased imports of crude oil by vessel shipments over a ten-year period.



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
■ China	91	123	127	145	163	179	204	238	254	271

Figure 3.5 China Oil Imports 2003-2012 (Source: IEA Sankey Diagram, 2013)

Therefore, tanker shipping (Vessels) is considered a major transport mode which provides low cost transportation for 63% (56.5 Mbpd) of crude oil daily production volumes transported across oceans (EIA, 2014). Besides, a typical oil company operates or distributes to single or multiple refineries worldwide (Hussain et al., 2006, P.91), where several thousand BBLS of crude oil processed every day. A typical transportation route by sea is through the Strait of Malacca to countries such as China from Nigeria described in figure 3.6 below.

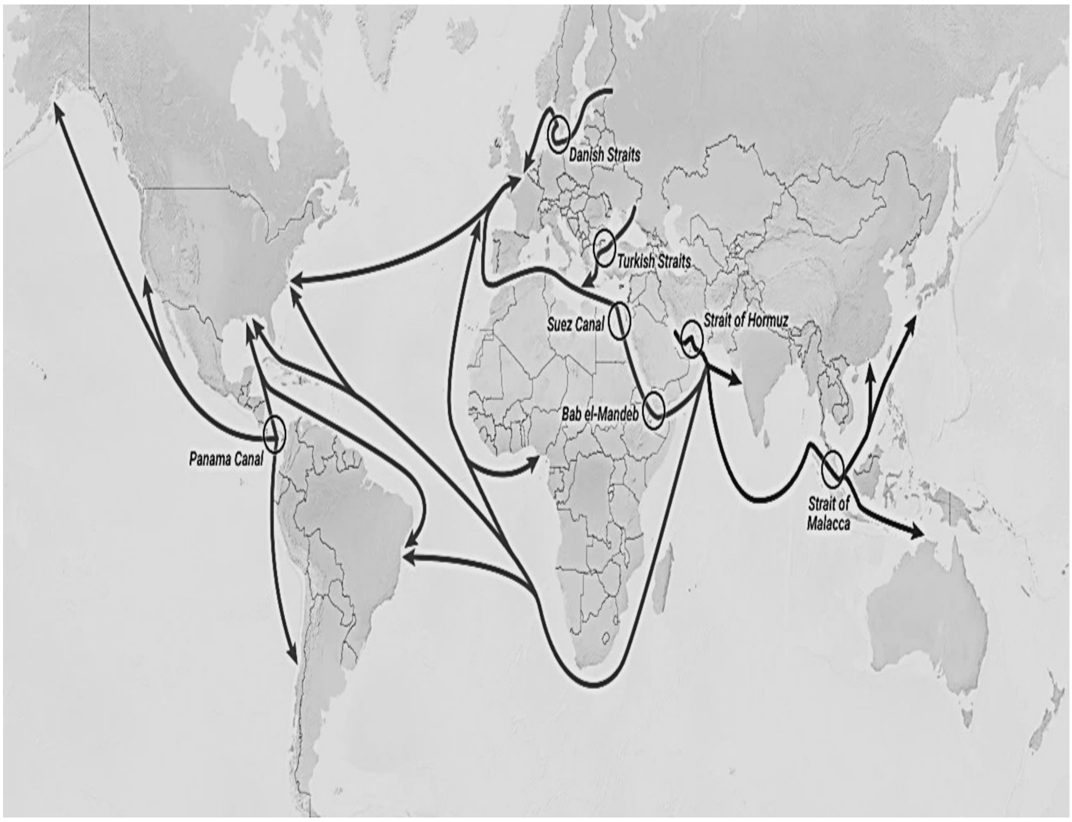


Figure 3.6 World Crude Oil Shipping Transportation Route (Source: EIA 2014)

According to Chima (2007) the process of distribution is handled with less attention for productivity in comparison to the benefits of a systematic logistics process. Moreover, Hussain et al., (2006) report that the logistics network of crude oil companies has been termed highly inflexible. Likewise, Jenkins and Wright (1998) inform that there are three important factors that influence the dynamics in the upstream segment of crude oil distribution which are production capacity, transport duration, and transport limitations. Firstly, production capacity of crude oil suppliers will vary according to invested capital, production apportionment rights, and exploration technology. Similarly, the global nature of crude oil transportation makes distribution a challenge with longer lead times.

Moreover, the distances between partners in a crude oil SC and available options for transportation increases the cost of distribution and inventory. This distance factor presents variable supply lead times which influences buyer or customer decisions, with distribution options limited to shipping, trucking, pipelines, and rail roads (Hussain et al., 2006). Therefore, logistical improvements have implications on the transport of crude oil, because sustaining competitive advantage relies on adequate management of these factors.

Moreover, Hussain et al., (2006) have also reported that collaboration is an important issue. This limits the sharing of demand and cost information between crude oil companies to protect an organisation's competitive stance. As a result, opportunities for logistics alliance or partnerships are not utilised to effect cost minimisation. However, investigations on quantities of crude oil for exportation between both the NNPC and IDC could clarify important requisites for collaboration amongst crude oil exporters. Therefore, improved SC efficiency in the petroleum industry needs a new philosophy on collaboration which includes information sharing and asset optimization (Hussain et al., 2006). These should facilitate increased exports of crude oil in the long term.

Lastly, most studies on the issue of crude oil logistics and SC have replaced recommended strategies with sophisticated management concepts or systems that may not be widely used by Nigerian oil companies or readily adaptable for small to medium-sized crude oil operations. From an observational perspective larger oil companies benefit from economies of scale, although they endure a uniform problem of longer lead times that may affect frequency of shipments. However, there is a possibility of logistical distribution partnerships in between NNPC and IDC's to increase the frequency of shipments to destinations such as China.

3.5 Nigeria's Crude Oil Supply Capability

According to Al-Moneef (1998, P.207), major changes in market structures since the 1970's from an oligopolistic organisation into a cartel has led to refor-mations in oil industry services and strategies. Besides, the transfer of owner-ship through nationalization and takeovers from MNCs by government con-trolled national oil companies has influenced the reformation of national oil in-terests by the Nigerian Government (Balouga, 2012, P.24-25). Consequently, this has led to a separation of roles in the upstream sector; with NNPC control-ling the country's crude oil reserves and exploration rights. In addition, active exploration and production is operated mostly by indigenous and international oil companies (Al-Moneef, 1998, P.204) as explained in figure 3.7 below. Invari-ably, the structure of crude oil markets in Nigeria is evolving according to changes in international markets, and consequently relationships between both the producer and consumer including oil industry contractors and oil procurers are following the same process of transformation (Iledare, 2008, P.23).

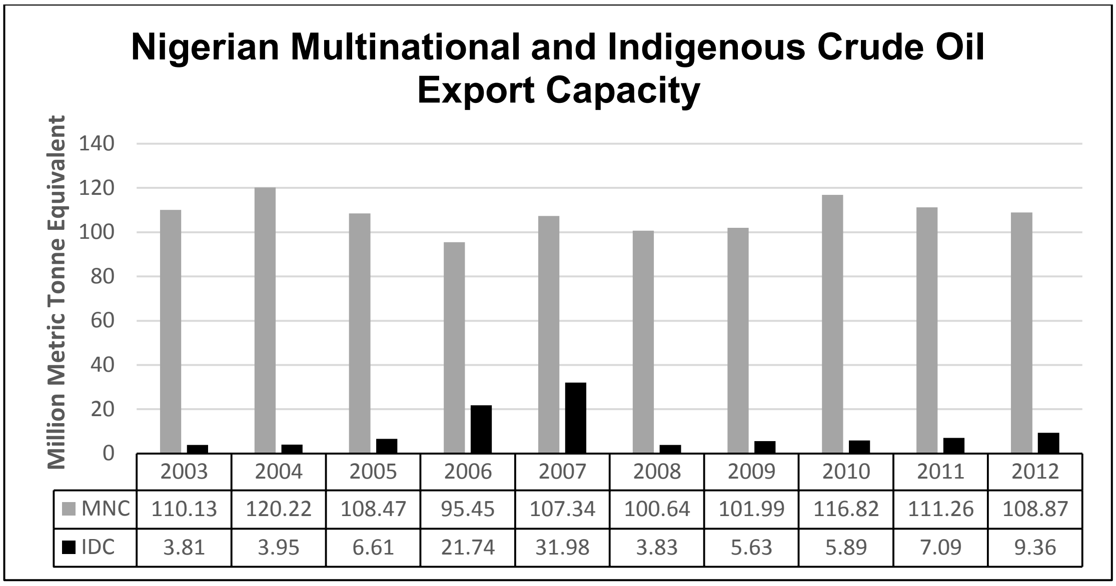


Figure 3.7 MNC and IDC Crude Oil Outputs (Source: NNPC ASB Data, 2013, P.30-31)

In addition, there has been an upsurge in demand for crude oil from emerging world markets, and Nigeria as a primary oil producer has realised the challenges of controlling both domestic and international crude oil interests. These interests have been well served by NNPC which was created in 1977 to manage exploration joint ventures in between the Nigerian federal government and MNCs (Nwokeji, 2007), exporting crude oil to other African countries, America, Asia, and Europe as described in figure 3.8.

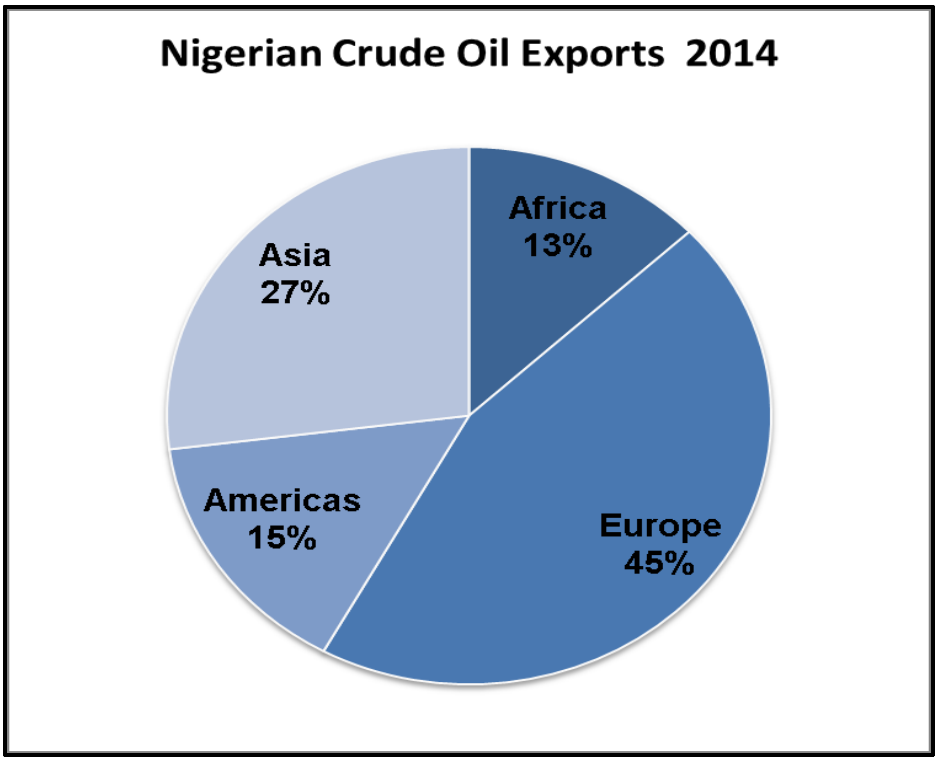


Figure 3.8 Nigerian Crude Oil Export Destinations 2014 (Source: E IA, 2015)

Likewise, the industry has for many years called for an effective operations policy for transparency, and the need for increased domestic involvement for commercial sustainability. Therefore, the above factors have encouraged a re-examination of present structures to support necessary regulations.

According to Nwokeji (2007, P.9), managing the interest of the Federal Republic of Nigeria in the oil and gas industry involves developing an industry-wide policy, performing regulatory functions, and promoting Nigeria's economic, industrial, and technological development. Therefore, the corporation's objective is to increase Nigeria's economic and technical advancement at the same time economically leveraging the country's crude oil endowment; which can be achieved through growing production capacities and self-reliance in all related commercial spheres of upstream and downstream operations.

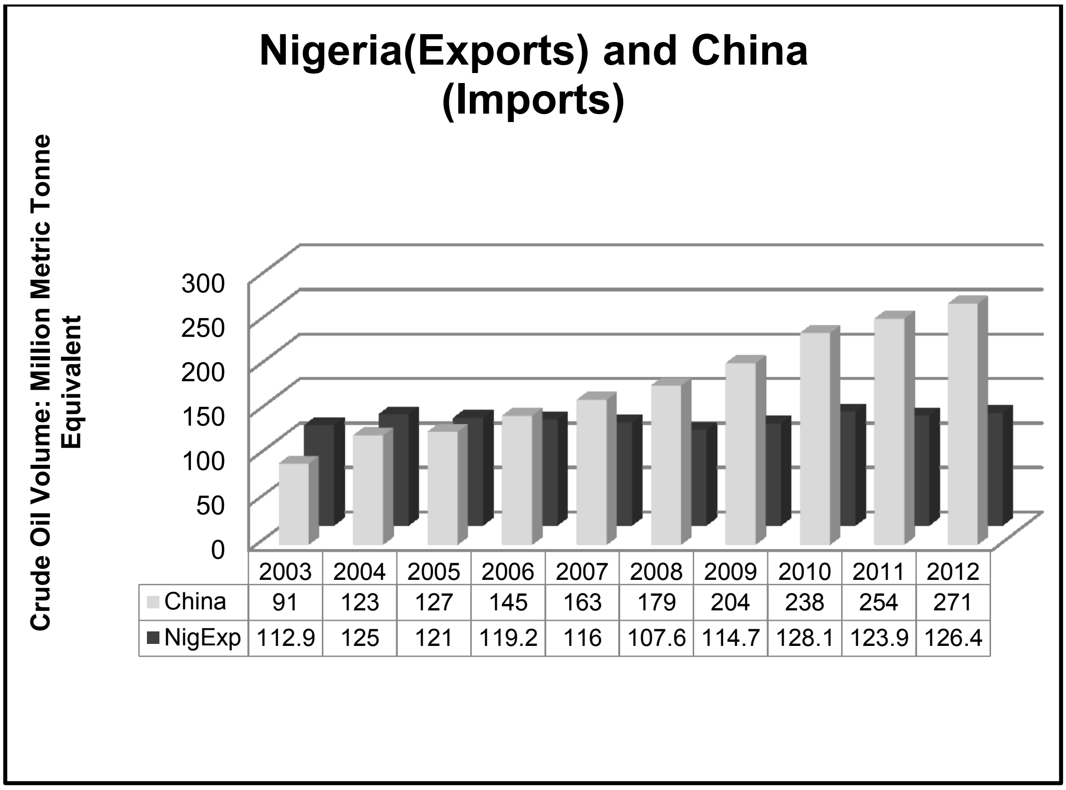


Figure 3.9 Nigeria Crude Oil Exports and China Crude Oil Imports (2003 to 2012) (Data Source: IEA Sankey Diagram, 2013)

Although, China's demand for crude oil has surpassed Nigeria's supply capability since 2005 in figure 3.9, Nigeria is still ranked sixth amongst OPEC's largest oil exporters (NNPC, 2016), and fifteenth largest producer of petroleum in the world (EIA, 2016). As a result, the country has constantly produced crude oil according to its OPEC quota, since becoming a member nation in 1973. Besides, NNPC has served as the only conduit in between crude oil reserves and organisational interests in oil exploration and procurement in Nigeria i.e. MNCs. For example, multinational companies such as Addax, Agip, Chevron, Elf Aquitaine, Pan-Ocean, Shell, Mobil, and Texaco have partnership agreements with NNPC to conduct oil exploration and production (NNPC ASB, 2015, P.2). According to EIA (2011), the country produces an estimated 2.15 mbpd and exports 90% of its production, a total of 1.935 mbpd. Although, in 2006 Nigeria exported 198 mbbl of crude oil and received about £11.9 Billion from an average price of $60 per barrel, which represents a third of the country's GDP and 95 percent of export revenues (Nwokeji, 2007, P.16-17). Therefore, sustaining Nigeria's economic development through NNPC is a major factor in developing and maintaining this important source of national revenue.

3.5.1 Nigeria: Petroleum Legislation

Presently, NNPC's three principal functions are policy formulation, government regulations, and commercial operations. Nonetheless, policy formulation is a major area of concern as oil industries across the world are currently undergoing a further reformation process; because of an increased interest in domestic crude oil exploration, technology advancement, global change or green initiatives, and the recurring need for energy security (PriceWaterHouseCoopers, 2010). Consequently, Nigeria is not exempted as it has recently proposed a new PIB and is following environmental policies on zero gas flaring which is an on-going issue. As a result, government regulations are now aimed towards modernising operational policies that may affect commercial operations in the oil industry.

According to NNPC (2009) the purpose of the PIB is to eliminate regulatory uncertainty amongst most oil companies operating in Nigeria including MNCs. Moreover, the fundamental objective of the PIB initiated in 2008 is to support property and sovereign ownership of petroleum infrastructures within Nigeria and its territories, which is achieved through licensing, leasing, and contracting. This involves adequate management of resources, good governance, transparency, and sustainable development within territories in Nigeria (Nwokeji, 2007). However, the PIB will separate the three functions of policy formulation, government regulations, and commercial operations monitoring from NNPC. It plans to establish independent units to administer and control explorations, productions, and regulations including research and development on its behalf (International Bar association, 2011). In relation to the present study the implications of any policy formation such as the PIB on the upstream segment of a crude oil SC will predominately be a need for corporate or enterprise compliance with both government policies and industry norms. These will cover issues such as operational transparency, upstream investments, and environmental issues. Moreover, it will eventually consolidate existing national petroleum organisations, and regulatory bodies into functional agencies. As a result, rationalisation of existing oil agencies which involves division of organisational roles and functions into public agencies are the main objectives of the PIB.

3.5.1.1 Petroleum Industry Bill: Operations Transparency

The importance of the current legal framework for petroleum operations in Nigeria should not be underestimated as the PIB has also been introduced to increase transparency. At present, a survey conducted by transparency international and revenue watch confirms NNPC as among the least transparent oil companies in the world (African Business, 2012, P.38), even though efforts have been made to increase the flow of information between NNPC and its stakeholders. Also, it accounts for regulatory concerns that often discourage foreign investments (PriceWaterHouseCoopers, 2010, P.2). Moreover, the added incentive for the Nigerian government in adopting the PIB is the provision for newer taxation laws that will reduce the fiscal burdens of companies who have an increasing interest in the Nigerian Oil Industry (International Bar Association, 2011). As a result, introduction of a Nigerian Hydrocarbon Tax (NHT) and low royalties are possible measures of incentivising domestic and foreign interests in the oil industry. Besides, provisions in the PIB simplify tax assessments and payments made with the current Petroleum Profit Tax (PPT). In addition, NHT would be pegged with rates from 30 percent to 50 percent and also qualified on the bases of production site location, with other tax exemptions, in particular tax deducted items and allowances. Moreover, the government will benefit in the form of royalties and tax receipts that will consistently generate revenue regardless of price fluctuations and production rates.

However, the possibility of increased aggregate taxes under the PIB may discourage investments by MNCs, who could in turn search for new production developments, by investing in favourable oil exploration countries such as Angola and Ghana. Nonetheless, the three important benefits of the PIB far outweigh immediate assessments of its shortfalls to the Nigerian government. Firstly, the local content rule should increase national involvement in the oil industry through participation in exploration and production, because employment in the petroleum industry will receive increased training, with more human resource development opportunities. Secondly, environmental regulations will encourage obligatory reports on operations throughout the oil and gas SC. Lastly, increasing transparency in the allocation of exploration and production licences will contribute towards a more accountable production and distribution structure (International Bar Association, 2011).

3.5.1.2 Petroleum Industry Bill: Upstream Investments

As mentioned in section 2.1 and according to Wiig (2001), the upstream segment comprises of the following production sections;

- Exploration and Drilling
- Engineering and Project Management
- Construction of Production Facilities e.g. platform

- Subsea construction, Pipe lay, and Fabrication of subsea equipment
- Installations
- Production Operations

Moreover, the above sections concentrate on upstream exploration activities in Nigeria and are licensed predominately to MNCs and IDCs, with the aim of securing investments for the development of local infrastructures, human resource development, and also the application of locally produced equipment's (Ihua, 2010, P.3). Besides, the trend of multinationals repatriating profits abroad has caused NNPC to introduce the local content policy incorporated into the PIB. Also, this should discourage the repatriation of profits and provide employment opportunities (ibid).

3.5.1.3 Petroleum Industry Bill: Environmental Issues

Furthermore, the PIB was formed to address major environmental issues such as gas flaring which has plagued the Nigerian oil industry for many years. According to the International Bar Association (2011) the country currently burns 2.5 billion cubic feet of gas every day, "a practice that involves waste gases being released and burnt as they exist flare stacks in oil and gas wells" (ibid). Therefore, international environmental obligations together with the need to increase fuel efficiency are underlying reasons to support adoption of the PIB, because at present developing countries account for 54% of total global emissions (ibid). Also, the Nigerian government regards the bill as predominately directional with the inclusion of the Nigerian Extractive Industries Transparency Initiative Act 2007 in all forms of administration and it also provides for environmental and energy efficiency concerns by introducing energy reliable tax policies that will encourage the adoption of fuel efficiency by producers and consumers (Oil and Gas Sector Reform Implementation Committee, 2008, P.14).

Nonetheless, the PIB promotes the interest of the Nigerian government in the oil industry by enforcing integrated health and safety, environmental quality, and emission targets for oil and gas pollutants (Oil and Gas Sector Reform Implementation Committee, 2008, P.14). This ensures compliance with international standards and encourages the continued interest in oil exploration by MNCs. Besides, the bill takes into consideration the need to cooperate with state and local governments to encourage and sustain peace in oil producing areas of the country, especially after the past consequences of the Ogoni crises in 1993 with Shell Oil Corporation (Osaghae, 1995).

3.5.2 Nigerian Petroleum Reform: Organisational Implications

Organisational implications of the PIB on the oil industry are invariably significant. Also, the bill will change existing compliance requirements of organisations, and will affect crude oil SCs in between domestic markets and exports overseas. However, there are certain difficulties and restraints in sustaining and developing current SCs in the Nigerian Oil Industry, because most national and multinational companies may need to incorporate and adapt the three factors mentioned in section 3.5.1 to sustain the productivity of existing SCs, as well as encourage a consistent logistics operation. Therefore, the bill's effect on logistics administration and networks in between oil exploration sites, depots, port loading terminals, transits, and ship transfer are important considerations for Nigerian crude oil exporters.

At present, the strategic concern of most oil companies is sustainability and establishing competitive cost advantages. In addition, the possibility to reduce expenditure has remained predominate and popular in the objectives of most oil companies. Therefore, the functions of exploration, production, trading, transportation, refining, distribution, and marketing all depend on an organisation's internal and external structure for efficiency and profitability. In particular, vertical integration in the upstream segment starts from wellhead to refining, which includes engineering and production. According to Al-Moneef (1998, P.212) integration supports a company's infrastructure, by creating an interlinked system that depends on joint outputs for results. Moreover, vertical integration assists in spreading operational risks and maximises on possible return on investments at every stage of the distribution cycle or SC (ibid). These encourage stability as well as identify potentials for growth (ibid).

Furthermore, the bill separates policy formulation, government regulations, and commercial operations, which affects both strategic and operational decisions on integration. Although, the purpose of the bill is to eliminate uncertainties that may affect distribution operations, the need for direction through governance, transparency, and possible sustainability may not be easily achieved, because there is yet to be a consensus on the operational standards expected from an oil company in Nigeria. Besides, oil companies in Nigeria will need to incorporate the bill in accordance to their respective capabilities or capacity. These may be easily achieved for the larger corporations but may also create more uncertainties for the small-medium sized companies (SME's) or IDC's. However, companies operating in the industry will need to incorporate the three major functions of the PIB mentioned above into the operational structure of their organisations upstream logistics network, which includes the SC. Evidently, the new government regulation will influence corporate decisions, and encourage further investigations on shortfalls in distribution cycles.

3.6 Measuring Nigeria's Competitiveness: SCPRO

Nigeria has achieved positive economic results since the beginning of the millennium. Although, the country does not display the same dynamism in growth rates in comparison with the world's leading emerging markets such as Brazil, Russia, India, China and South Africa (BRICS), it has impressively grown by 7.8% and 10.1% respectively over the millennium (Anyanwu and Erhijakpor, 2009, P.101). Accordingly, Nigeria's GDP growth rate is projected to be 6.8% in between 2012-2017(Average year on year rate) (PriceWaterhouseCoopers, 2013, P.63) which is higher than most countries in the world. Nevertheless, Anyanwu and Erhijakpor (2009, P.101) report that the economy continues to appear to be susceptible to external downturns when already accustomed to the countries dependence on oil for public expenditure and its intrinsic price instabilities. However, the positive growth rate is encouraging and a platform for future economic development.

Furthermore, Anyanwu and Erhijakpor (2009, P.104) state that competitiveness and sustained growth are determined by interrelationships among several and diverse factors assessed by the 12 pillars of competitiveness which are illustrated in figure 3.10.

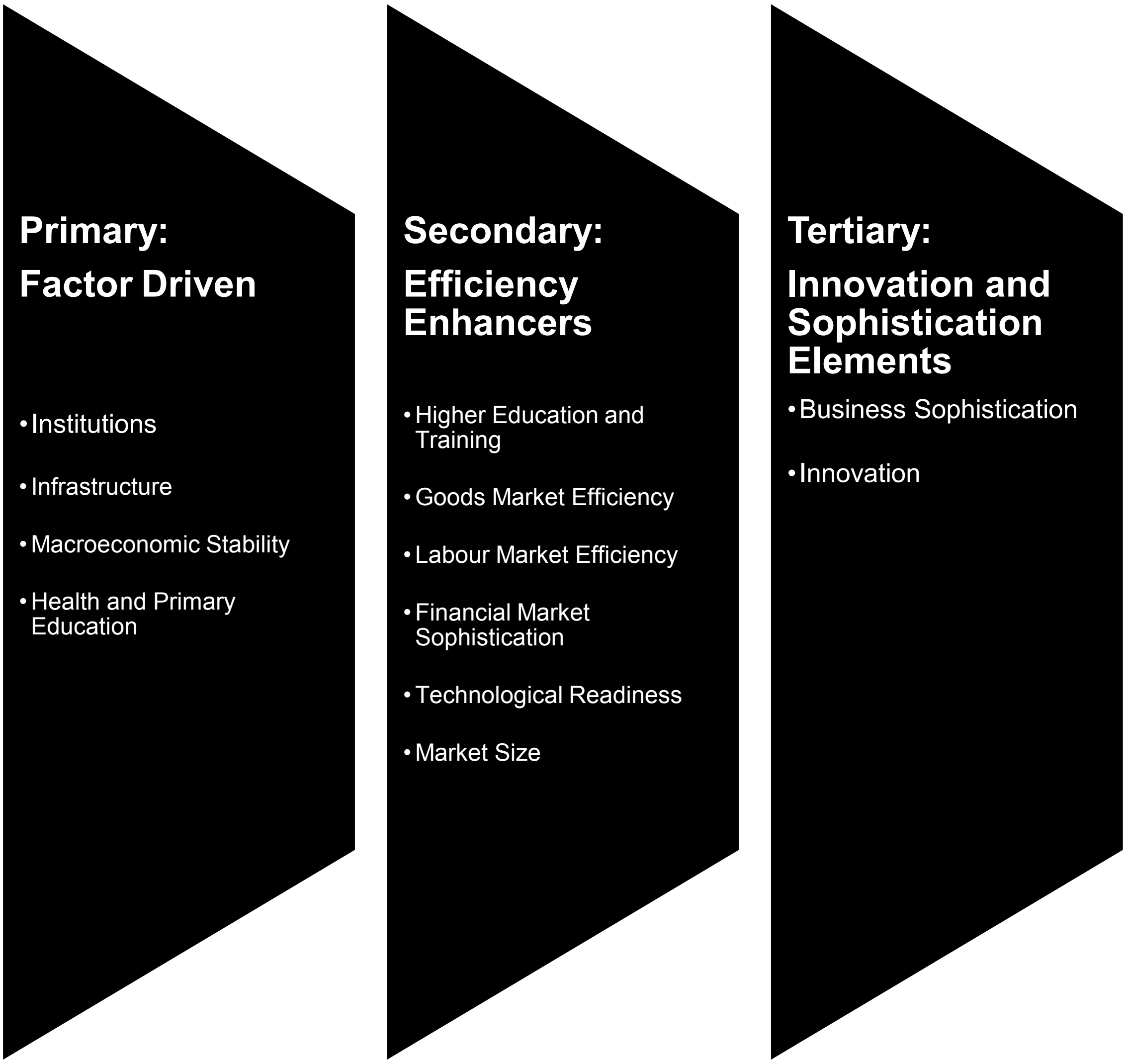


Figure 3.10 Twelve Pillars of Global Competitiveness (Source: Vares et al., 2011, P.125)

3.6.1 Primary Factors: Factor Driven Economy

Most factor driven economies depend on natural resources and are commodity based with basic manufacturing, which in turn relies on economic cooperation from public and private organisations for sustainable growth. Likewise, factor driven economies concentrate on developing, sustaining, and maintaining a nation's; institution, infrastructure, macroeconomic stability, and primary education and health care (Salai-martin et al., 2007, P.7). Firstly, developing countries like Nigeria have embraced macroeconomic adjustment and deregulation, nevertheless the need for strong institutions cannot be overemphasized (Omojimite, 2012, P.1). According to Schwab (2011, P.70) this is relevant in the following areas; property rights, ethics and corruption, judicial independence, government regulations, national security, corporate ethics, and organisational accountability. Moreover, issues such as endemic corruption impede the potential for efficacy and transparency in the governance of the Nigerian economy (Anyanwu and Erhijakpor, 2009, P.101). According to the competitive index, Nigeria's corruption ranking is 129 out of 150 countries (Schwab, 2011, P.281), a significantly low ranking in comparison with countries such as Denmark and New Zealand ranked leaders (ibid). However, the ranking is comparable with countries such as Cameroun and Argentina with lower scores. Also, crime, environmental insecurity, and piracy have continually been stated by most Nigerian socio-economic authors as a continuing concern especially in the Niger Delta (ibid), and require institutional involvement to assist in bridging the gap between the government and organisations, as well as liaise with the surrounding communities. Likewise, institutions in Nigeria are yet to enforce operational benchmarks for industries to incorporate. Besides, the Nigerian oil industry is in need of institutional approval on policy issues and incorporation of apposite technology to encourage efficient operations. In addition, revenues generated from the oil economy could be used in supporting "complementary productive public investments" (Anyanwu and Erihijiapor, 2009, P.116). Moreover, growth potentials can be facilitated by increased investments in interdependent structures of the economy such as power, transportation, agriculture, health, and education. In addition, sustainability will encourage good governance and possible political reform, because there is a need to investigate energy access and industry reformations for increased production volumes and efficiency to meet the Millennium Development Goals (MDG's) and the countries long-term economic initiatives (ibid). Also, a political and social contract for managing Nigerian oil revenues is essential (Anyanwu and Erihijiapor, 2009, P.116). This should be encouraged by institutions for transparency and democratic participation from all structures of the economy. However, this can only be realised from political stability, enduring fiscal policies and responsible investments. Besides, there is a possibility to initiate proceedings by piggybacking on the proposed PIB.

Secondly, infrastructure development is an on-going issue which requires attention from the government especially when introducing vertical integration for crude oil export efficiency. Moreover, the Nigerian government's Vision 20: 2020 development plans towards the crude oil industry include the prioritisation of exploration, inventory capacities, and regulatory implementations over the next 20 years (Oyejide and Adewuyi, 2011, P.60). For example, optimisation of oil and gas exploration will be important towards generating newer oil interest and investments. Therefore, deteriorating conditions of public power structures and port or jetty facilities in Nigeria hinder supply activities; likewise the ongoing sabotage of oil facilities for bunkering is an added burden on national oil infrastructure. In addition, poor transport, energy, and telephony infrastructural facilities require institutional and government aided appraisal for sufficiency (Schwab, 2011, P.71). Although, there has often been recurring debates on how the government should develop or support existing systems, however, it is essential that relevant private and public organisations are consulted on paths and structures for redevelopment.

Thirdly, macroeconomic stability in the Nigerian economy is still engaged with serious challenges. This includes high level of poverty, inefficient delivery of social services, high youth unemployment, poor infrastructure facilities, endemic corruption, and widespread insecurity and crime (Anyanwu and Erhijakpor, 2009, P.101). As a result, foreign direct investment (FDI) is often undermined which stagnates the business environment including the oil industry. Moreover, the options available to the government are in the form of both monetary and fiscal policies to stimulate economic activity. For example, fiscal policy involves controlling taxation and government expenditure, while monetary policy encourages the flow of money within an economy through i.e. circulation of money, level of interest rate, and banking and credit markets (Abata et al., 2012, P. 76-78). According to Anyanwu and Erhijakpor (2009, P.101) the recent oil boom and reform programme has led to significantly-improved macroeconomic results; with a modest growth in GDP and lower inflation. However, Nigeria has made some advancement in macro and micro economic policy. As a result, there is a need to sustain emerging growth with accountability. For example, macroeconomic policy is in need of sound policies in the finance, development, and governance sectors of the economy to promote “social” security, education, and eliminate corruption (Anyanwu and Erihijiapor, 2009, P.115). Likewise, microeconomic policies need to address the organisation of fiscal assets, and their impact on domestic market structures. Therefore, future advancements in economic competitiveness will require apposite micro and macro policies, to incentivize the economy and capture opportunities for growth.

Lastly, the major issue about ill health in a developing country is that among adults it affects the productivity of the work force. Likewise, the efficiency of the labour force determines the production of national industries, which cannot be realised with ill workers. Moreover, investment in the provision of health services is thus critical for clear economic, as well as moral considerations

(Schwab, 2011, P.5). In addition, modern societies show serious concern for the education of their young by providing needed support to prepare them to succeed later in school (Sooter, 2013, P.174). Besides the objective of primary education in Nigeria are as follows: (i) encourage private efforts in the provision of pre-primary education (ii) making provision in teacher training institutions for the provision of specialist teachers in pre-primary education. (iii) ensuring that the medium of instruction will be principally the mother-tongue or the language of the local community. (iv) to ascertain that the main method of teaching in pre-primary institutions will be appropriately oriented towards achieving the national education curriculum (ibid, P.175).

3.6.2 Secondary Factors: Efficiency Enhancers

In addition, efficiency enhancers such as higher education and training, goods market efficiency, labour market efficiency, financial market sophistication, technological readiness, and market size contribute towards maintaining and developing on a nation's basic competitiveness. Firstly, according to Omopupa and Abdulraheem (2013, P.44) higher educational institutions in Nigeria where developed to support manpower requirements that will serve in different capacities and contribute positively to the nation's socio-economic and political development. Moreover, the level and quality of graduates including training facilities and courses will contribute towards the development of the oil industry. These will consequently improve the efficiency of operations and availability of appropriate personnel.

Secondly, most goods market economies are supported by a demand and supply orientation. Although, most governments set parameters for greater market efficiency by setting basic parameters in the form of policies, licencing, and operational procedures, achieving efficiency within sectors and industries is still challenging. According to Vares et al. (2011) each of the components of the three factors comprising the twelve pillars are interdependent, with goods market efficiency acting as a major enhancer in a market economy, because countries with an efficient goods market are well positioned to produce the right mix of products and services (Schwab, 2011, P.7). Besides, oil as a commodity goods export in the Nigeria economy requires efficient logistics processes to realise competitive advantages that are comparative with other major oil exporting countries in WA. Likewise, strengthening capacities of storage during cycles and maintaining technical requirements to satisfactory standards are important. Also, environmental concerns are included in both development plans and regulatory implementation. In particular, the Nigerian government plans to meet the growing need for energy security from developed countries with responsible oil production during the next decade. This is also important to economic sustenance and local area dependence on crude oil exploration revenues. Therefore, successful implementation of the above plans will determine the future of the Nigerian oil industry including operational directions, infrastructure investments, and immediate environmental concerns (ibid, P.54 P.60). Besides, the advantages of SCM include the adoption of strategic and operational objectives for sustainable and measurable logistical outcomes (Chima, 2007).

Moreover, international cooperation in the Nigerian oil industry will benefit from appropriate resource allocation, customer orientation, and institutional organization to sustain market efficiency. Likewise, the demands of countries such as China will ultimately encourage oil companies to be more innovative and customer oriented (Schwab, 2011, P.57).

Thirdly, high youth unemployment has contributed to the number of redundant educated and literate people in Nigeria (Kakwagh and Ikwuba, 2010, P.232). However, there is a lack of information on the number of jobless young people roaming the streets of Nigerian cities, towns, and villages (ibid). Also, they inform that unemployment affects between 15%-20% of the workforce, of which 40%-75% of the total number of the unemployed are young people. However, a significant factor which contributes to high youth unemployment is population growth (ibid). Nevertheless, efficiency of labour markets in Nigeria will require adequate organisation and training to increase the level of productivity and diversity. Likewise, retention of talent is important when logistical recommendations involve encouraging SC integration and collaboration to realise long-term distribution strategies. Besides, the Nigerian government will need to introduce policies that will enable professional competence in logistics functions, because highly efficient personnel could encourage FDI in the oil sector (Danilovich and Croucher, 2015).

Fourthly, a sophisticated financial market allows investments in relevant sections of an economy gained mostly from the savings of the public, and return on investments of organisations operating within the economy which includes FDI. Moreover, the oil industry is a capital consuming industry; in particular oil exploration. Therefore, Nigeria requires an efficient exchange market, venture capital organisations, substantial fund management companies, and dynamic financial instruments to encourage increased levels of investments in the economy. Furthermore, this can only be achieved with trustworthy and transparent regulations to protect possible investors (Schwab, 2011, P.7).

Fifthly, Nigeria’s anticipation of economic growth through technology is deficient in some major areas. Likewise, introduction of information technology for productivity enhancements has still not materialised (Anyanwu and Erijihapor, 2009, P.110). However, technology is essential to both productivity and sustaining competitive advantages (Apulu and Latham, 2011, P.51: Liu et al., 2014, P.1452). For example, information and communication technologies (ICT) have encouraged organisations to be more responsive and reciprocal to market requirements. Moreover, managing demand in the oil industry through ICT enables SC agility and increases absorptive capacity to satisfy market and customer requirements (Liu et al., 2014, P.1453-1454). This is particularly relevant to SCM because IT alignment and information sharing are required in operational performance improvement (Ye and Wang, 2013, P.375). Likewise, ICT promotes vertical integration which supports collaboration between market participants for efficiency (Ngai et al., 2011 : Moshkdanian and Molahosseini, 2013, P.189). Furthermore, the possibility to innovate and secure logistical export processes through ICT is a major consideration for the Nigerian oil industry.

Lastly, the size of the market for crude oil although vast is restricted and aligned primarily with national governments or organisations and companies acting on their behalf. Therefore, the growth of crude oil export market for the Nigerian oil industry depends on the customers and OPEC’s export quotas for individual country members. Besides, the premise for the current study is China’s ever-increasing demand for crude oil from countries such as Nigeria. However, the possibility to efficiently export crude oil from Nigeria will require economies of scale in the logistics process for productivity.

3.6.3 Tertiary Factors: Innovation and Sophistication Elements

Furthermore, the most elaborate trend in business organisation is improving productivity which requires the application of operational systems developed from theory. Accordingly, innovation and sophistication of operational elements encourage sustainability in a national economy. Moreover, according to Schwab (2011, P.8) sophistication of an organisation's networks and operations are major concerns. Likewise, the possibility to sustain oil exportation to countries such as China applying the theoretical framework of the study will majorly depend on the development of Nigeria's export logistics, which according to Stevens (1989) is at the baseline stage. Therefore, there is an opportunity to increase efficiency in the VC of crude oil exports to incorporate the demands of the industry and its customers. Besides, developing business partnerships and collaboration increases the level of integration in the process of oil exportation. Lastly, innovation is essential to the less advanced countries because it can improve their productivity (Schwab, 2011, P.8). Moreover, the predominate demand of the two pillars of technological readiness and business sophistication as efficiency enhancers encourages the adoption of more innovative systems to support the productivity of logistics operations. Also, continuous collaboration and support between the industry and academic institutions in the form of research and development will influence all competitive pillars mentioned above for renewed economic development and sustainable growth.

3.7 Nigeria's Logistics Operation: Demand Variability

Presently, NNPC together with IOC's are encouraging possible best practice measures to sustain variable demand levels in the export SCs of the Nigerian oil industry. Moreover, NNPC has created a forum to discuss ethical issues, acquisitions, and methods of maintaining efficiency in the industry, including the adoption and administration of government policies (NNPC, 2011). Moreover, the introduction of SC wide practices into the Nigerian oil industry should assist in developing an efficient and accountable logistics system. Therefore, assessing current organisational performance and competitive advantages of logistics structures are important elements to sustain variability in demand.

Furthermore, China's emergence as possible SC partners to both NNPC and MNCs should encourage improvements in domestic logistics structures, because the demand for crude oil by China will increase the requirement for efficient export logistics coordination. Accordingly, China's two major oil companies Sinopec and CNPC have focused on improving their organisation's distribution systems in Africa (Jiashan and Jingzhing, 2005, P.835), possibly to support varying demand levels. In a report by Vines et al. (2009, P.17) NNPC has signed annual transportation agreements with Sinopec's trading company UNIPEC to double the existing export levels to 100,000 bpd, the same agreement has been reached by NNPC with CNPC to increase export levels to 30,000 bpd (Hurst, 2006, P.12). This indicates China's interest in securing and procuring oil from Nigeria to sustain long-term demand. Likewise, Nigerian oil companies will need to continuously reassess distribution structures to satisfy China's logistical oil demands similar to those supplied to the Far-east in figure 3.11.

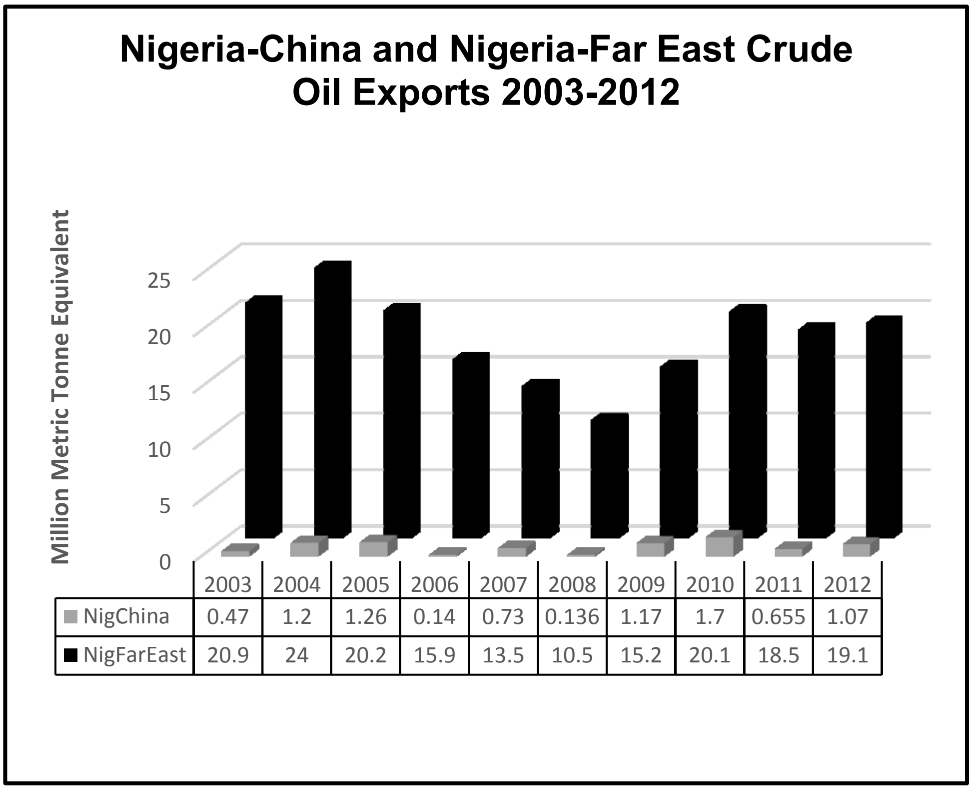


Figure 3.11 Nigeria-China and Nigeria-Far East Ten Year (Net) Export Data (Source: NNPC ASB Data, 2003 -2013)

Consequently, reports by Jiashan and Jingzhing (2005, P.835) have shown that resource disposition, cost reduction, and enhancing competitive advantage are major reasons for SC adoption by China's major oil companies. For example, resource disposition considers the adequacy of operations, and the consistent flow of materials i.e. crude oil through the SC. Likewise, cost reduction involves assessments of current logistics costs, while competitive advantage assists in sustaining organisation and distribution structures for growth (ibid). As a result, Nigerian oil companies need to consider these three factors when assessing compatible distribution processes for possible efficiencies. Besides, Chima (2007, P.33) has recommended SC partnerships to solve logistical challenges in crude oil distribution. Nevertheless, the possibility of satisfying the demands on crude oil logistics will continue to be of importance, because Nigerian oil companies still require sustainable and efficient export logistics operations to be compatible logistics partners. Therefore, the five drivers discussed by Oyejide and Adewuyi (2011, P.60) i.e. ownership, infrastructure, national system of innovation (NSI), skill spill over, and policy formations will continually affect SC operations in Nigeria. Moreover, ownership structures will be important to the integration of logistics services, because it involves the process of distributing crude oil in between more than one business unit. Similarly, the ownership composition of oil distribution services will influence required levels of coordination and efficiency. Likewise, infrastructural capacity of oil companies will determine outbound logistics operations. In addition, NSI will continually be of importance to most stakeholders in Nigeria, because the development of workers should assist with measuring the impact of the local content policy on the economy, as well as encourage future incorporation of technology. Besides, the development of staff, will improve local skills and information exchange amongs firms in Nigeria and WA (Oyejide and Adewuyi, 2011, P.46-47). Also, policy formations for the oil industry by the Nigerian government will support adequate planning and facilitate long term measures for NNPC and MNCs. This should increase investments in most crude oil operations for both local and international firms. Moreover, development of operational advantages through process assessments should depend on internal and external structures that support crude oil logistics.

3.7.1 Logistical Considerations: Supply Adequacy

Moreover, the consequences of uncertainty, inefficiency, and bureaucracy will be important to operational decisions on crude oil SCs. Firstly, uncertainty in securing crude oil supply can be attributed to unrest in the oil producing areas such as the Niger Delta[1], including current insufficiency in infrastructural investments has deterred new oil projects; therefore, national reserves and production output are lower than anticipated. Added to the above the PIB which could rectify major concerns including adequate supply when passed by the government is yet to be finalised for decision makers to ratify, which also creates a climate of uncertainty. Besides, distribution channels for crude oil transfer often have long periods of delays, according to African Business (2012, P.71) “Delays at the ports have been a headache” for most Nigerian exporters of crude oil, which leads to an accrual of unnecessary costs in the form of demurrage[2] and port charges. Likewise, inefficiency of ports services after privatisation has increased the burden of prolonged lay-time for most oil tankers carrying crude oil to and from Nigerian ports. Nonetheless, transport and export procedures are still in the process of standardisation which adds to pressures of an unavoidable and bureaucratic structure of oil exportation from Nigeria. However, there is a need to determine in measurable scales the impact of uncertainty, inefficiency, and bureaucracy on an organisations possibility to sufficiently supply crude oil to Chinese oil companies.

3.7.2 Distribution Security: Socio-Economic and Political Audit

Also, recurring socio-economic factors are an additional liability to crude oil logistics in the Nigeria oil industry. Nevertheless, Anyanwu and Erihijiapor (2009, P.113) have reported that the following factors affect Nigerian oil production and distribution:

- Waste

[1] Niger Delta : Oil producing area in the Midwest of Nigeria were most exploration and production sites are situated.

[2] Demurrage: refers to the period when the charterer remains in possession of the vessel after the period normally allowed to load and unload cargo(lay time).

- Corruption
- Consumption
- Debt overhang
- Deterioration
- Wars / Conflicts

Firstly, waste can be classified a constant problem in the transfer of products for lifting or storage. Secondly, corruption is also a regular hindrance to transparency and objective clarity in crude oil export processing and administration. Moreover, an estimated number of about 10% is assigned to crude oil loss through oil thefts, siphoned into storage holds, and transferred onto waiting ships called Bunkering[3] (EIA, 2012). Besides, bunkering at present is depleting Nigerian crude oil supply to international markets, because the trade in stolen oil has increased, and the Nigerian government informs that about "400,000 BBL/D of oil was stolen in April 2012 which has led to a 17% fall in official oil sales" (ibid). In addition, "Nigeria's largest producer Royal Dutch Shell, estimates that up to 180,000 BBL./D or 6% of the country's total production as an average is lost to oil bunkering and spills" (ibid). Despite numerous initiatives to stem this trend bunkering persists. Thirdly, world consumption is bordering on the high level at present, and is still prone to volatile world price fluctuations and demand uncertainties. Fourthly, debt overhang has always been a consideration of the government when considering oil revenue allocations, because borrowed funds consistently need to be financed or repaid at arranged or stipulated intervals. Fifthly, since 1970 most oil infrastructures and platforms onshore or

[3] Bunkering: a neologic term for crude oil theft or illegal transfer of crude oil into waiting vessels, or tankers.

offshore have not been refurnished or redeveloped and has consequently suffered from deterioration. Likewise, environmental inadequacy as sixth factor in the Nigerian oil industry is an on-going concern. Approximately 2400 oil spills have been reported between 2006 and 2010 from sabotage, bunkering, and poor infrastructure (EIA, 2012). As a result, the Nigerian government estimates pipeline vandalism in the Niger delta costs the state and oil companies £9.3bn ($14bn) a year (Vidal, 2015). These constantly create irregularities in exploration or production patterns including distribution cycle sufficiency. Finally, the continual and increasing threat of militant groups such as "Boko Haram" and ship piracy mentioned above are prioritised important by the Nigerian government. As a result, negotiations and initiatives to eradicate threats to the country's economic viability are widely supported in the oil industry. Consequently, this has led to a fall in production and in other cases a declaration of force majeure on oil shipments (ibid). Although, amnesty in 2009 was granted to militants in the oil region with cash payments for holistic improvements in the environment of the oil producing regions (Amaraegbu, 2011, P. 209), nonetheless, the Nigerian oil industry is still burdened by the need to limit security risks which affects the outbound flow of Nigeria's major export resource.

3.8 Nigeria's Logistics Development: Vertical Integration

However, vertical integration within functions in the oil industry has contributed to value creation. It has long been a factor for sustaining growth and developing on potential market opportunities in most industries. Accordingly, a vertically integrated organisation can appropriate capital investments, and also assist in structuring distribution networks with perfect coordination (Al-Moneef, 1998, P. 207). Besides, major oil companies have adopted vertical integration for many years to support organisational growth strategies (ibid). Furthermore, there are three important reasons to integrate the distribution network of an oil company according to Al-Moneef (1998). Firstly, vertical integration assists in capturing value from refining and marketing a standard barrel of oil. Secondly, it sustains the market share of the organisation in supplying crude oil to contracted parties over an averagely long period of time, e.g. 5-10 years. Lastly, integration encourages strategic alliances similar to those found in other industries (Treat et al., 1996, cited in Al-Moneef, 1998, P.213). Therefore, vertical integration can be particularly useful to oil organisations, especially when price factors influence demand and supply decisions at the upstream segment, which also consequently depends on product quality and efficiency of market structures (Ibid, P. 214). According to the authors "integrated companies have pronounced advantages in the logistics of handling fluid flows". Moreover, the current oil industry trend is organisational transformation through acquisitions and consolidations (ibid, P.207), which supports the integration of upstream oil operations.

Nevertheless, the conceptual framework developed in figure 3.12 below was influenced by the theoretical framework of Lambert and Cooper (2000). Their framework considered the growing relationship in between logistics and SCM with an emphasis on SCPRO. Also, attributes of their framework inform that the span of an SC includes both primary and secondary level of activities similar to those found in a Value Chain System (VCS) as reported by Porter (1985), Handfield and Nichols (2002), and illustrated in Chapter 2, Section 2.2. Moreover, the three interrelated elements of an SC identified by Lamberts and Cooper (2000) i.e. network structure, business processes, and management components are significant to integration in the Nigerian oil industry. According to the authors, there is a need to design through several steps before successful adaptation. However, for the present phenomena participant firms and organisations have been identified using a network structure. Likewise, activities that produce specific outputs of value have been encapsulated by business processes in the form of an infrastructure and organisational audit, while management components are the theoretic variables by which the crude oil SC processes are integrated. Nevertheless, figure 3.12 illustrates the conceptual framework developed to justify the substantive focus of the phenomena under study which incorporates two components of Liu's (2011) adaptive system i.e. transformation and strategy sets.

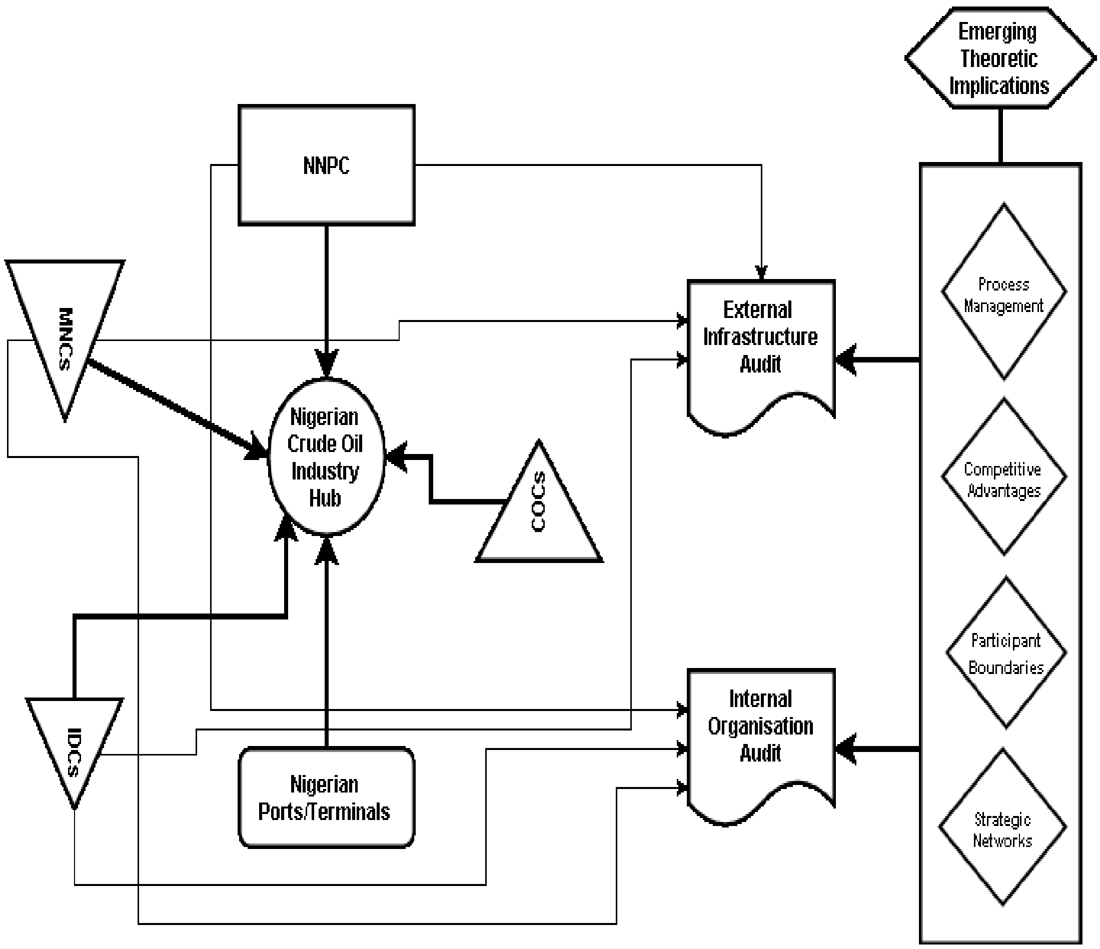


Diagram Symbols

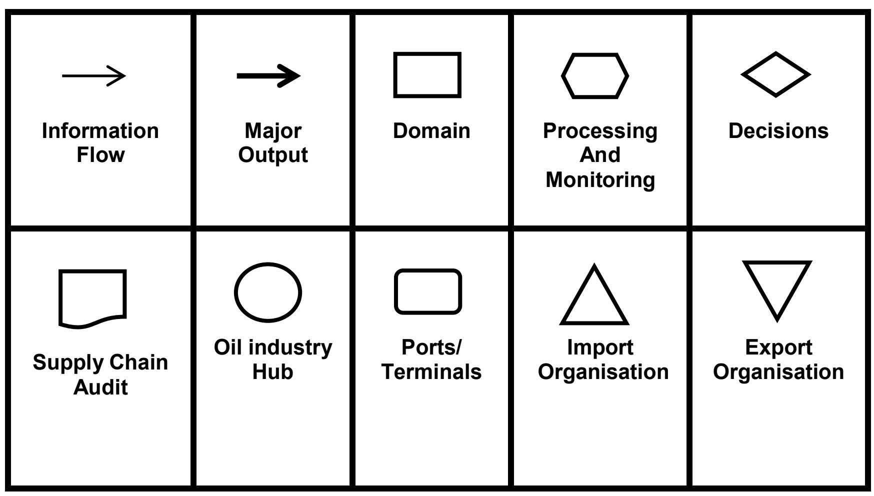


Figure 3.12 Conceptual Operations Model: Nigeria-China Crude Oil Exports

3.9 Discussion

Accordingly, the dominance of OPEC and OECD countries in the supply of crude oil influences world import and export logistics. Moreover, crude oil as an essential commodity is important to China's present need to sustain national energy security. In addition, increasing investments in Nigeria for crude oil supply assists in securing considerable imports of crude oil on a yearly basis to China without the over reliance on the AG. Nonetheless, the requirement for crude oil cannot be isolated from China's major concerns i.e. energy, environmental, and climate policies, which may influence short to long-term planning of crude oil supply. Also, these concerns are major considerations for Nigerian oil companies together with the possibility to ascertain factors that influence efficient crude oil distribution between the two countries, because at present Nigeria's crude oil exports to China between 2003-2012 has been at an average of 0.84 MTOE a year illustrated in figure 3.13.

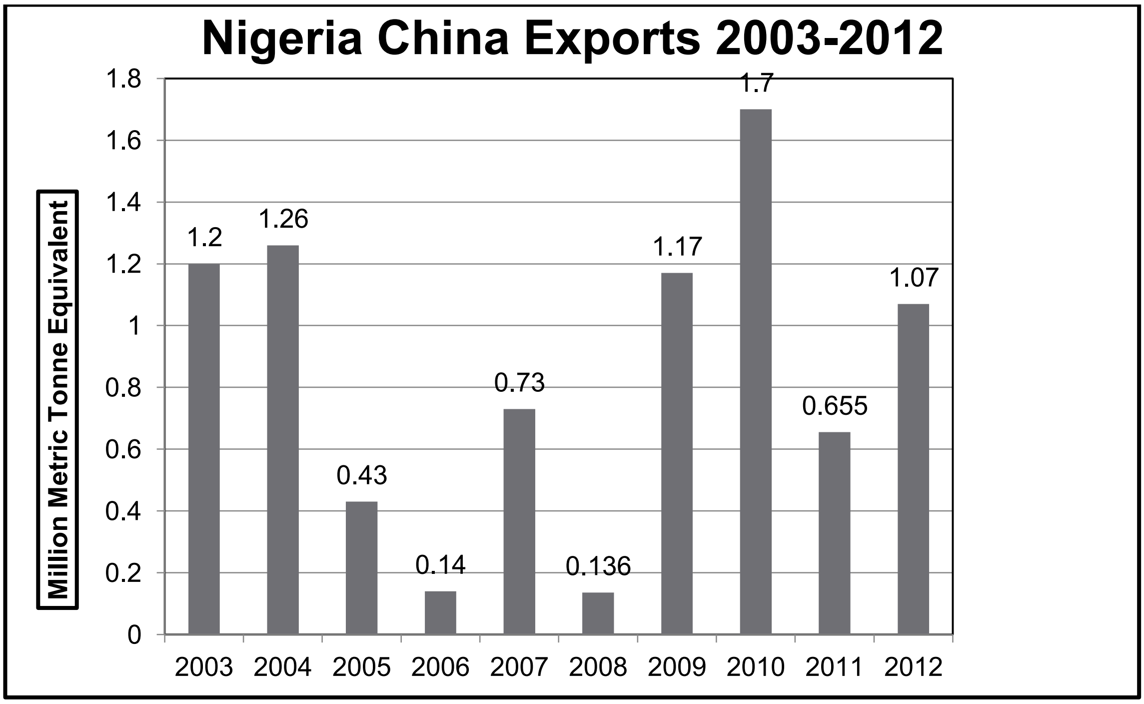


Figure 3.13 Nigeria Crude Oil Exports to China 2003 to 2012 (NNPC ASB Data, 2013)

Additionally, an archival study on crude oil shipments in between the two countries was carried out; investigating the elements of crude oil export operations commonly used by industry experts i.e. quantities, vessel size, departure and destination points, and number of shipments (Christiansen et al. 2007, P.196).

3.9.1 Archival Research (6 Month Study)

Identifying the elements of crude oil supply involved examining the current export quantities between Nigeria and China in the form of a six-month study. This archival study involved a daily collection of data from 21st June 2013 to 21st December 2013 illustrated in Appendix **C** from SIN. Moreover, the concentration of this study is on two major vessel categories i.e. Suezmax (SM) and Very Large Crude Carriers (VLCC). They are the most frequently contracted vessel carriers for crude oil across world oceans. Similarly, the capacity of the two vessel classes highlighted in table 3.1 below enables adequate quantities of crude oil to be transported over long hauls to destinations worldwide including the Far East and especially China.

Tanker Category	Length	Beam	Draft	Typical Min DWT	Typical Max DWT
Seawaymax	225.6m (740ft)	24m (79ft)	7.92m (26ft)	10,000	60,000
Panamax	228.6m (750ft)	32.3m (106ft)	12.6m (41ft)	60,000	80,000
Aframax	253m (830ft)	44.2m (145ft)	11.6m (38ft)	80,000	120,000
Suezmax	**275m (900ft)**	**48m (157ft)**	**16m (52ft)**	**120,000**	**200,000**
Very Large Crude Carrier (Malaccamax)	**330m (1080ft)**	**60m (200ft)**	**20m (66ft)**	**200,000**	**315,000**
Ultra Large Crude Carrier	415m (1542ft)	63m (207ft)	35m (115ft)	320,000	550,000

Table 3.1 Crude Oil Tanker Classification (Source: Maritime-Connector 2014)

Furthermore, data gathered over the stated period involved not only identifying the number of shipments between Nigeria and China. Besides, appraisal of shipment frequencies enables an examination of commercial and economic factors that may influence disparity in oil movements between oil producing regions. These may encourage recommendations on present causal relationships which are essential in understanding the operational nature of the phenomena under investigation (Hoyle et al, 2002, P. 31). In addition, this study's interest in demand variability as a theoretical construct is investigated using the data gathered, because of its effect on export efficiency. Also, the collected data has concentrated on the two constructs of crude oil logistics; imports (Causal Demand) and exports (Affected Supply) between the two countries.

3.9.1.1 Frequency of Shipments (VLCC and Suezmax): Nigeria to China

Nonetheless, tables 3.2 and 3.3 report vessel movements in both categories with only a single shipment to China from Nigeria in both VLCC and Suezmax categories over a six-month period.

Tanker Type	Departure	Destination	Number of Shipment	Average Quantity (BBLS)	Total Quantity
VLCC	Akpo Termi-nal (Nigeria)	India	1	260,000	260,000
VLCC	Nigeria	India	5	260,000	1,300,000
VLCC	Nigeria	China	1	260,000	260,000
VLCC	Nigeria Agbami	India	2	185,000	390,000
VLCC	Nigeria Bon-ny	India	1	260,000	260,000
VLCC	Nigeria EA	India	1	260,000	260,000
VLCC	Nigeria Qua Iboe	India	1	260,000	260,000
VLCC	Nigeria Yoho	India	1	260,000	260,000
		Total Shipment	**13**		3,250,000

Table 3.2 VLCC Category - Clarksons SIN Data 21/06/13 to 21/12/13: (Nigerian Crude Oil Exports)

These shipments were for a total quantity of 260,000 (BBLS) or 35470.70 (MTOE) in the VLCC category and 130,000 (BBLS) or 17735.35 (MTOE) in the Suezmax category.

Tanker Type	Departure	Destination	Number of Shipment	Average Quantity (BBLS)	Total Quantity
Suezmax	Nigeria	China	1	130,000	130,000
Suezmax	Nigeria	India	3	130,000	390,000
Suezmax	Nigeria	Abidjan	3	130,000	390,000
		Total Shipment	**7**		**910,000**

Table 3.3 Suezmax Category - Clarksons: SIN Data 21/06/13 to 21/12/13 (Nigerian Crude Oil Exports)

However, further examination of crude oil trade flows for the stated period evidenced a substantial number of shipments to China from other parts of WA and AG. For example, there were 75 shipments from WA to China in the VLCC category in table 3.4 with a total of 19,500,000 (BBLS) or 2,660,300.14 (MTOE) exported.

Tanker Type	Departure	Destination	Number of Shipment	Average Quantity (BBLS)	Total Quantity
VLCC	WA	China	21	260,000	5,460,000
VLCC	WA	China	8	260,000	2,080,000
VLCC	WA	China	9	260,000	2,340,000
VLCC	WA	China	17	260,000	4,420,000
VLCC	WA	China	8	260,000	2,080,000
VLCC	WA	China	12	260,000	3,120,000
		Total Shipment	**75**		**19,500,000**

Table 3.4 VLCC Vessel Category - Clarksons: SIN Data 21/06/13 to 21/12/13 (WA Crude Oil Exports – China)

Tanker Type	Departure	Destination	Number of Shipment	Average Quantity (BBLS)	Total Quantity
Suezmax	WA	China	2	130,000	260,000
Suezmax	WA	China	1	130,000	130,000
Suezmax	WA	China	2	130,000	260,000
		Total Shipment	**5**		**650,000**

Table 3.5 Suezmax Vessel Category - Clarksons: SIN Data 21/06/13 to 21/12/13 (WA Crude Oil Exports – China)

In the Suezmax category 5 shipments were recorded for the same period with a total of 650,000 (BBLS) or 88,676.67 (MTOE) in table 3.5. Likewise, crude oil shipments to China from AG confirm that 234 shipments of crude oil were exported to China in the VLCC category with a total quantity of 62,480,000 (BBLS) or 8,523,874.49 (MTOE) in table 3.6, and 6 Shipments in the Suezmax category which amounts to a total quantity of 1,324,998 or 180,763.71 (MTOE) exported in table 3.7 for the same period.

Tanker Type	Departure	Destination	Number of Shipment	Average Quantity (BBLS)	Total Quantity
VLCC	AG	China	57	265,856	15,187,500
VLCC	AG	China	32	265,000	8,510,000
VLCC	AG	China	27	267,115	7,219,000
VLCC	AG	China	35	266,143	9,315,000
VLCC	AG	China	44	268,432	11,811,000
VLCC	AG	China	39	267,628	10,437,500
		Total Shipment	**234**		**62,480,000**

Table 3.6 VLCC Vessel Category - Clarksons SIN Data: 21/06/13 to 21/12/13 (AG Crude Oil Exports – China)

Tanker Type	Departure	Destination	Number of Shipment	Average Quantity (BBLS)	Total Quantity
Suezmax	AG	China	6	220,833	1,324,998
		Total Shipment	**6**		**1,324,998**

Table 3.7 Suezmax Vessel Category - Clarksons SIN Data: 21/06/13 to 21/12/13 (AG Crude Oil Exports – China)

3.9.2 Chi-Square Test of Association: Departure, Destination, and Vessel Size

Further examination of logistics relationships in both vessel categories for the stated period in Appendix **D7.1** focused on the most frequent destinations i.e. China, India, UK, USA Far East, South America, Europe, and Africa against the most frequent departure points i.e. Nigeria, WA, Africa, and AG which resulted in a total of 107 shipments. This allowed tests to ascertain the level of independence among categorical variables i.e. the factors of export logistics such as departure, destination, and vessel size. In addition, α = 0.05 was used as a criterion of significance in the chi-square test of independence. Nonetheless, non-parametric tests were sufficient in expatiating on the relationships found between vessel size and destination, as well as departure and destination points from the SIN data gathered over the six-month period.

3.9.2.1 Chi-Square Test of Association: Vessel Size and Destination

Moreover, investigating the test of independence in the relationship between vessel size and destination of shipments from the SIN data in Appendix **D7.1** has resulted in a Chi-Square value of 21.165 with an asymptotic significance of .004 in between the two variables of crude oil exports in table 3.8.

Chi-Square Tests

	Value	df	Asymptotic. Sig. (2-sided)
Pearson Chi-Square	21.165[a]	7	.004
Likelihood Ratio	26.012	7	.001
N of Valid Cases	107		

a. 6 cells (37.5%) have expected count less than 5. The minimum expected count is 1.46.

Table 3.8 SIN Data: Total Vessel and Destination Chi-Square Test

These results show that P < 0.05 which confirms that the two variables are independent.

3.9.2.2 Chi-Square Test: Departure Point and Destination

In addition, the test of independence between departure point and destination applying the data in Appendix **D7.2** also produced a Chi-square of x^2 = 34.64

and an asymptotic significance of .031 in table 3.9 which shows that the two variables are also independent.

Chi-Square Tests

	Value	df	Asymptotic. Sig. (2-sided)
Pearson Chi-Square	34.641[a]	21	.031
Likelihood Ratio	39.491	21	.009
N of Valid Cases	107		

a. 22 cells (68.8%) have expected count less than 5. The minimum expected count is .14.

Table 3.9 SIN Data: Departure and Destination Points Chi-Square Test

Nonetheless, a total of 81 shipments were observed with AG and WA as two major export departure points in Appendix **D7.3**. Also, the SIN data was merged to allow for at least 5 expected frequencies for each destination in Appendix **D7.3a** (Swift, 2001, P.699).

Moreover, results in table 3.10 shows a Chi-square of x^2 =1.215 with an asymptotic significance of 0.876. Therefore, shipments from the two departure points when compared with the same destination points mentioned in section 3.9.2 are not independent because **P** > 0.05.

Chi-Square Tests

	Value	Df	Asymptotic. Sig. (2-sided)
Pearson Chi-Square	1.215[a]	4	.876
Likelihood Ratio	1.220	4	.875
N of Valid Cases	81		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.93.

Table 3.10 SIN Data: Departure Point (Grouped) and Destination Chi-Square Test

Finally, applying an archival strategy to answer the third objective of this thesis has proven valuable to the aim of the study. Nonetheless, recommendations by Liu (2011, P.10) requires the need to examine the dynamic environment of crude oil logistics operations i.e. sequence or frequency of distribution. Besides, capitalising on real time data from SIN, NNPC (ASB), IEA, and EIA has allowed clarifications on the quantity of crude oil flows between the two countries. For example, data gathered from SIN between June and December 2013 shows limited crude oil shipments from Nigeria to China. Also, the total vessels recorded in the two categories i.e. VLCC and Suezmax were 75 VLCC and 5 Suezmax shipments from WA in comparison with 234 VLCC and 6 Suezmax shipments from AG to China for the same period. This confirms that China's interest to procure crude oil in support of the country's energy demands requires appraising the three theoretical constructs of the study alongside identified factors of operations i.e. China's requirement for energy sustainability (sections 3.2 and 3.3) including logistical improvements in exports to China (section 3.4) compared to the current state of the Nigeria oil industry and measures for competitiveness (sections 3.5 and 3.6) which also includes logistics operations and development to encourage efficiency (sections 3.7 and 3.8). Consequently, improving the relationship between these constructs and the identified factors will eventually influence decisions of participants in the Nigerian oil industry, and may stimulate an increase in crude oil exports to China.

Chapter 4: Research Methodology

4.1 Introduction

The research discipline for the current study is immersed in epistemological beliefs that have guided the first set of assumptions made about the phenomena and methods to achieve a better understanding of the said phenomena (Wall et al., 2015, P.258). Besides, academic literature also involves a hegemony of research topics and questions; the domination of theories and research methods that carry similar assumptions, including common beliefs about the most suitable application of research methods, and interpretation of research findings (ibid). Moreover, the research method adopted for the present study has been influenced by the studies aims in section 1.2.1 by assessing existing crude oil export frequency (reliability) of Nigerian oil producers including indigenous oil companies to countries such as China, which is achieved by investigating the total export volume of crude oil from Nigeria to China and the frequency of present shipments between the two countries. Besides, the prerequisite when considering adoption of research methodology is the capability of the method being appropriate to answer the research question set in section 1.2.2. in Chapter 1 which investigates how SCM and integrated logistical considerations can be applied in distributing crude oil from Nigeria to China; which consequently requires a synthesises of the characteristics of Chinese crude oil demand from Nigeria, as well as measures to qualify the efficiency of existing logistics operations for crude oil exports from Nigeria to China.

Although, there is a plethora of methodologies, literature, and themes to research thoroughly on a given research topic, however the research purpose and questions identified to support the enquiry process predominates the approach adopted for this study (Creswell, 2003).

Nonetheless, to develop knowledge about the phenomena under investigation it is necessary for mature fields of enquiry to be explored, which involves a sort of logical leap going a stage further than the theory provides, and using data collected to verify or test its possibility as in figure 4.1 (Marshall, 1997, P.18). This has enabled the justification of the enquiry process with the possibility for feasible recommendations.

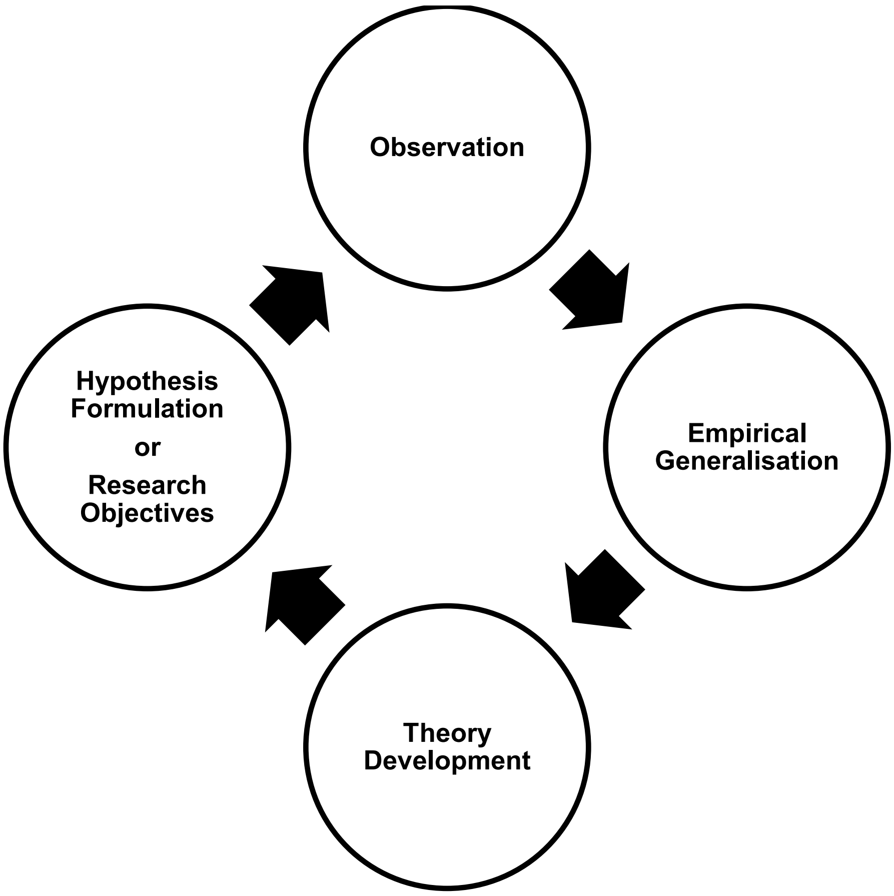


Figure 4.1 Circular Process of Science; Source Marshall (1997, P.18)

Therefore, the composition of this chapter includes the following; an examination of the characteristics of the phenomena under investigation in section 4.2. Section 4.3 investigates the scope of enquiry through the studies research question. Also, section 4.4 describes the philosophy of enquiry which directs the research approach used i.e. the logic of the research philosophy. Then section 4.5 extensively assists in determining the studies research design by engaging and classifying the most relevant methods that has permitted data acquisition to justify the question and objectives set in sections 1.3.2 and 4.3 respectively. Likewise, both sections 4.6 and 4.7 sanction that the research design is reliable to expound on the phenomena. Lastly, section 4.8 in a discussion appraises and justifies the research methodology adopted for the purpose of the study.

4.2 Characteristics of the Phenomena: Conceptual Framework

Most studies on SCM (SCM) issues are compiled to justify and resolve current distribution problems found within organisations. According to Gibbon et al.'s (1994) concept on knowledge creation, Mode 1 emphasises a research concentrated on academic interest, while Mode 2 emphasises the world of practice, highlighting the importance of collaboration both with and in-between practitioners (Starkey and Madan, 2001, cited by Saunders et al., 2006, P.6). Also, Starkey and Madan (2001) observe in their recommendations for organisational and institutional stakeholders that research within the Mode 2 approach brings together supply side knowledge represented by universities, with the demand side represented by businesses, and thereby overcoming the hurdle of research orientation. Accordingly, the present study SCM in the oil and gas industry characterises a Mode 2 approach, as it is particularly relevant to the demand side of oil transportation, and logistical feasibilities associated with the energy industry. Moreover, the characteristic of distribution in the energy industry surrounds a centralised matrix or project management structure adopted by most MNC's in oil exploration (Skjaerseth and Skodvin, 2001, P.53). Also, SCM in the oil industry is still at a developing stage when compared to most industries (Schwartz, 2000), especially in Africa. Nevertheless, developing a framework on how the research phenomenon identified will be investigated has involved understanding the boundaries of research planning and the three core attributes of the study's philosophy i.e. epistemology, axiology and ontology.

For example, the present study's epistemology concerns acceptable knowledge that surrounds an issue in SCM (Saunders et al, 2007, P.102). Also, ontology is defining the 'nature of reality' (ibid, P.108) about current practices common to SC experts, while axiology is that branch of philosophy that studies judgements about values (ibid, P.110). These three areas were relevant to the process of gathering data for this study including the choice of issues in support of the research topic to be investigated. In addition, Fielden (2003, P.129) contends that research bias may be determined through the entities involved in its association; for instance, the research discipline (ontology), the phenomenon concerned or investigated (epistemology), and the personality and assumptions of the researcher (axiology). Therefore, these factors have influenced and guided the research process from the beginning to the end. Moreover, the present study relies on a broad competition of theories on SCM in figure 4.2 below, which are explored both in the literature review and the Delphi study in section 4.5.3 as major components that encourage efficiency in an export SC. Furthermore, investigating the characteristics of the phenomena is the initial step towards developing a sound framework to guide the course of study from inception.

"What one wants to learn determines how one should go about learning it" (Trauth, 2001, P.4).

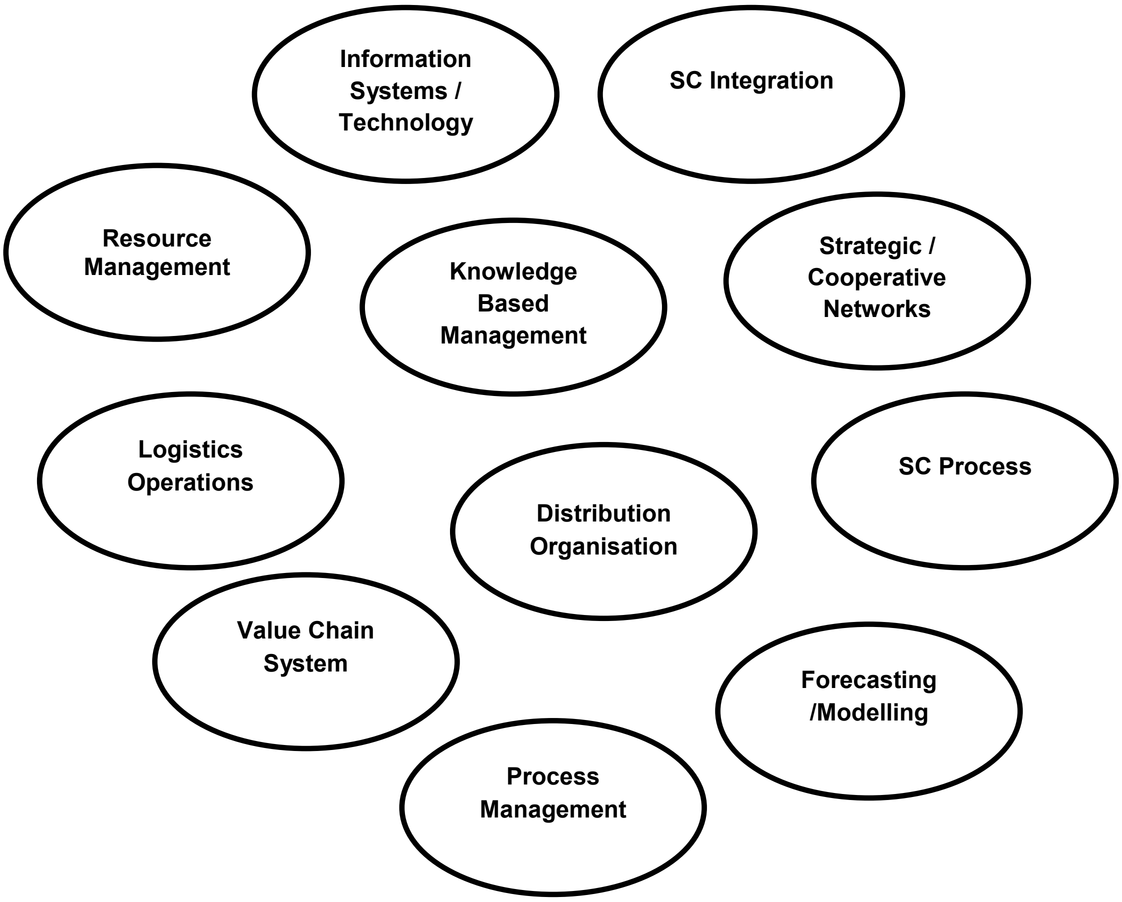


Figure 4.2 Component Phenomena of the Current Study (Source: Author's own)

Besides, identifying the phenomenon being investigated consequently leads to basic conceptual questions, about the entity of the phenomena and associated definitions. Also, the preliminary question to answer is can a phenomenon be established and contextualised; answering these questions formed the basis of adopting an appropriate methodology to investigate the research problem. Likewise, the five objectives of the study in section 1.2.2 encourages additional investigations on the export output capability of indigenous oil companies in Nigeria, as wells as to answer the research question also in section 1.2.2 identified at the onset of investigating this contemporary phenomenon. In addition, the underlying philosophy of justifying the above objective required empirical investigations into the context of the study.

However, at present, integral activities to facilitate efficient transfer of crude oil in Nigeria are not coordinated with adequate process visibility by domestic participants to link with international participants for an overall visibility in export operations, even though “the structure of activities within and between companies is a critical cornerstone of creating unique and superior SC performance (Lambert and Cooper, 2000, P.76). Nevertheless, the conceptual framework developed was influenced by the theoretical framework of Lambert and Cooper (2000). Their framework considered the growing relationship between logistics and SCM with an emphasis on SCPRO. Also, attributes of their framework inform that the span of an SC includes both primary and secondary level of activities like those found in a Value Chain System (VCS) as reported by Porter (1985), Handfield and Nichols (2002), and illustrated in Chapter 2, Section 2.2. Similarly, the three interrelated elements of an SC is identified as the network structure, business processes, and management components. According to the authors, there is a need to design through several steps before successful adaptation. However, for the present phenomena participant firms and organisations have been identified using a network structure. Likewise, activities that produce specific outputs of value have been encapsulated by business processes, while management components are the theoretic variables by which crude oil SC processes are integrated which the conceptual model in Chapter 3 figure 3.6 represents.

4.3 Research Objectives

Additionally, conceptualising and articulating the research question aids the focus of the research and scope of enquiry (Eisenhardt, 1989). This is determined by the following five factors. First, the definition of key characteristics of the phenomenon to be investigated needs to be clarified and assessed about similar studies on the research issue. Secondly, classification of academic literature essential in elucidating on the above characteristics is required when trying to contextualise the phenomena especially. This classification also allows the third factor of identifying associated disciplines or a synergy of disciplines related to the phenomena. Fourthly, decisions on the target population of the study require adequate representation to ensure respondent feedback is reliable. Likewise, the type of data collected as a fifth factor considers the requirement for different data sets because there is a need to adopt a mixed research strategy in acquiring primary and secondary data about the phenomena to answer the research objectives.

Nonetheless, other characteristics of the phenomena to be investigated include establishing two contexts of enquiry:

1. Investigation of the extent of SC adoption in the distribution of crude oil by companies in Nigeria. Is oil distribution in a developing country such as Nigeria geared towards logistics and SCM integration?

   Also, logistics implications in exporting crude oil have direct consequences on the distribution practice of oil companies. Moreover, the requisite for shipping as a major mode of distributing crude oil has direct implications on distribution strategies and networks to fulfil scheduled oil exports.

2. Secondly, according to Chima (2007), examination of processes when creating efficiency and value is to quantify and qualify the basis for measurable improvements and to increase possible competitive advantages found within crude oil logistics.

For the deductive characteristics of the study related books, papers, and articles on SC trends were consulted to understand the nature of distribution processes, common theories adopted and the extent of their application in crude oil logistics (Sachan and Datta, 2005).

Following the literature review on the current state of the Nigerian oil industry and China's need for sustainable crude oil supply in Chapter 3, including a review of recent SCM theories applicable to the oil industry in Chapter 2 the research question in section 1.2.2 was proposed on the research phenomena from a standpoint of an objectivist.

- **How can SCM and integrated logistical considerations be applied in distributing crude oil from Nigeria to China**

Moreover, Trauth (2001) argues that the researcher's opinion is important to the contextual constructs of the study. Besides, factors which relate to the researcher as a "self" driven cognitive entity is called a researcher's theoretical lens and skills. Moreover, they have a guiding effect on the researcher's ontological viewpoint on the selected issue of study, which assists in developing the objectives set in section 1.3.1 in Chapter 1 i.e. RO1, RO2, RO3, RO4, and RO5. Also, Fielden (2003, P.128) observes that the inducing point of view acquired by the researcher is inevitable. It is inevitable because a researcher's mindset, skills, and know-how becomes an essential part of the information gathering process (ibid). However, this argument contradicts the positivist approach to research, which supposes that a researcher has a clear theoretical focus for the research at the outset (Saunders et al. 2006, P.103).

In addition, Gill and Johnson (1991; cited by Saunders et al. 2006, P.113) states that the deductive nature of research encourages determination of causal relationships between variables. Likewise, the epistemology of the researched phenomena allowed an assessment of credibility for both quantitative and qualitative data to authenticate the reliability and validity of findings. This approach has allowed a highly structured methodology to facilitate replication (Gill and Johnson, 2012). Also, a deductive approach has influenced the coordination of the research process by controlling limitations of the research method in the acquisition of adequate data for statistical analysis.

4.4 Research Philosophy

Nevertheless, understanding the philosophy behind the investigation of a phenomenon is important (Saunders et al. 2009, P.107-108). This is influenced by practical considerations associated with gathering representative literature and data on the studied phenomenon. In addition, Dobson (2002) supports a two-dimensional focus on research methodology, and explains that determining a philosophy involves understanding the object; crude oil export logistics, and the need to justify measures for efficiency in distributing crude oil between geographically dispersed countries, including export systems and processes. Moreover, Saunders et al. (2009, P.108) argue that the main consideration is not majorly the philosophical nature of the research content, but the need to justify a better understanding of the phenomena through methodology.

According to Saunders et al. (2009, P.109) the philosophy adopted should be influenced by the research question, which may not necessarily rely on a single research paradigm. Therefore, an assessment of relevant research papers using “Google” scholar and “Microsoft” academic search was carried out to ascertain the most applicable method of inquiry as well as philosophical focus.

As a result, most of the papers relevant to the research issue were predominately empirical (Croom et al., 2000, P.74). Their paradigms were functionalist in composition, reflecting the influence of SCM on organisational development or change management (Burrell and Morgan, 1985, P.25: cited in Saunders et al., 2009, P.119-120). For example, Croom et al. (2000, P.67-83) have studied contributions to critical theory by examining literature on SCM based on content and methodology. Moreover, Chen and Paulraj (2004, P.120) have consolidated important constructs of SCM investigations that encourages methodological rigour focusing on a positivist paradigm. On the other hand, epistemology describes the possibility and pursuit of knowledge, and how one obtains and classifies that knowledge (Cameron and Price, 2009, P.53-54). A researcher’s perspective on world issues determines their philosophical assumptions about that world, which in turn are intrinsically connected to any underlying research epistemology (Myers, 2008).

This is apparent in the present study because the topic chosen is particularly relevant to stakeholders such as public companies, management consultants, SC practitioners, port authorities, and government agencies in the Nigerian oil industry. Besides, Collier (1994) reminds the researcher of the need for a research philosophy to support philosophical assumptions about an issue or topic. Likewise, an awareness of underlying arguments or paradigms about the present topic should support the research process and other aspects of the study that may influence research validity (Guba and Lincoln, 1994). For example, the strategy for the research investigation required both a preliminary Delphi survey and a focused archival study. Also, the latter strategy was adopted to map the nature and relationship of underlying variables in the form of quantitative data assessments. Likewise, the former strategy explored the studied phenomenon from its empirical focus. This involved gathering data from a selected panel of experts, and according to Mitroff and Turoff (1975) the epistemological positions of the researcher influences the respondent's answers to the Delphi questionnaire. An argument supported by Churchman (1971) who reported on the various philosophical perspectives of a Delphi study (Tapio et al., 2011, P.1626). These perspectives are categorised according to the following philosophies of John Locke, Gottfried Leibniz, Immanuel Kant, George Hegel, and Edgar Singer (Hammer and Boggs, 2011, P.254-256). Therefore, the above philosophies were examined about the present study, because their adoption supports requirements of research methodology to validate essential empirical findings illustrated in Chapter 5, section 5.2.2.

4.5 Research Design

Consequently, the research design was influenced by those elements of the research philosophy mentioned in section 4.3 above and in Chapter 5. Besides, a research grid was formed to clarify key elements of the study that affects the design of the inquiry process.

	Ontology	Epistemology	Axiology	Paradigm
Philosophy	***Critical Realist***	***Positivist***	***Leibnizian***	***Functionalist***
Research Technique	***Subjective Theory***	***Data (Causality)***	***Objective***	***Quantitative***

Table 4.1 Research Classification Grid

From table 4.1 above, the stance of a realist is to explore objective reality in the context of the studied phenomena. According to Saunders et al. (2009, P. 114), the ontological perspective of realism is similar to positivism in that it assumes a scientific approach to the development of knowledge. Also, realism as an epistemological perspective is classified in two contexts; direct realism and critical realism. For example, direct realism is when the objective reality of a phenomenon is considered as a sufficient criterion in understanding the facts about that phenomenon. However, the critical realist considers the underlying aspects of that phenomenon as equally relevant and is also considered subjective in realisation. Likewise, the direct-realist perspective would suggest the world is relatively unchanging and operates at one general level in a business context i.e.

the individual, the group or the organisation (ibid, P.115). For the purpose of this study the demand and supply synthesis of crude oil without the underlying characteristics of the logistical process is considered direct realism. However, a multi-level study of the phenomenon is important, because each level has the capacity to change the researcher's understanding of that which is being studied (ibid). Understanding the demand structures (quantities and frequency), and systems as well as underlying SCM theories in relation to the conceptual nature of the distribution processes between Nigeria and China as explained in Chapter 3, figure 3.6 is considered an epistemological position of a critical realist. Therefore, the critical realist incorporates the changing nature of business events in an organisational setting, especially when understanding a phenomenon as a precursor to recommending change (Saunders et al 2009, P.115).

Likewise, Saunders et al. (2009, P.116) argues that our values are the guiding reason of all human action. Furthermore, researchers demonstrate axiological skill by articulating their values as a basis for making judgements about the type of study to be carried out and available methods to justify research findings. At all stages of the research process, the researcher's value will be demonstrated in the type of information gathered. Moreover, the researcher's values also influence the selection of the research topic. According to Saunders et al. (2009, P.116) choosing one topic rather than another suggests that you think a topic is as important as another. As a result, the choice of philosophical approach depends on the researcher's associated values in relation to the chosen topic, likewise the choice of data and collection techniques (ibid). For example, the current literature on the Nigerian oil industry examines the socio-political factors that influence the need for reform and infrastructural investment i.e. Osaghae (1995), Nwokeji (2007), Subramanian and Sala-i-Martin (2003), Edoho (2008), Ihua (2010), and Amaraegbu (2011) in Chapter 3. In addition, the increasing activity in the global economy has a considerable impact on energy consumption, which consequently creates a demand for more crude oil.

At present, China is one of those global economies with an increase in economic output and domestic incomes (Congressional Budget Office, 2006, P.1). As a result, there is a need to replenish crude oil reserves and refinery feedstock to support China's requirement for energy security; especially by procuring crude oil from African oil producers which includes Nigeria. Therefore, in support of this significant development the need to examine current logistics throughput to maximise on the efficiency of crude oil exports to China from Nigeria has become relevant to NNPC, MNCs, and IDCs, as well as oil industry experts.

Moreover, the phenomenon is usually a conditional entity, and this circumstance supports the researcher's rationale about the investigation and raises questions on research design (Saunders et al, 2007, P.130). This includes relationships between the purpose of the study, underlying epistemology, and resulting methodologies as explained in figure 4.2

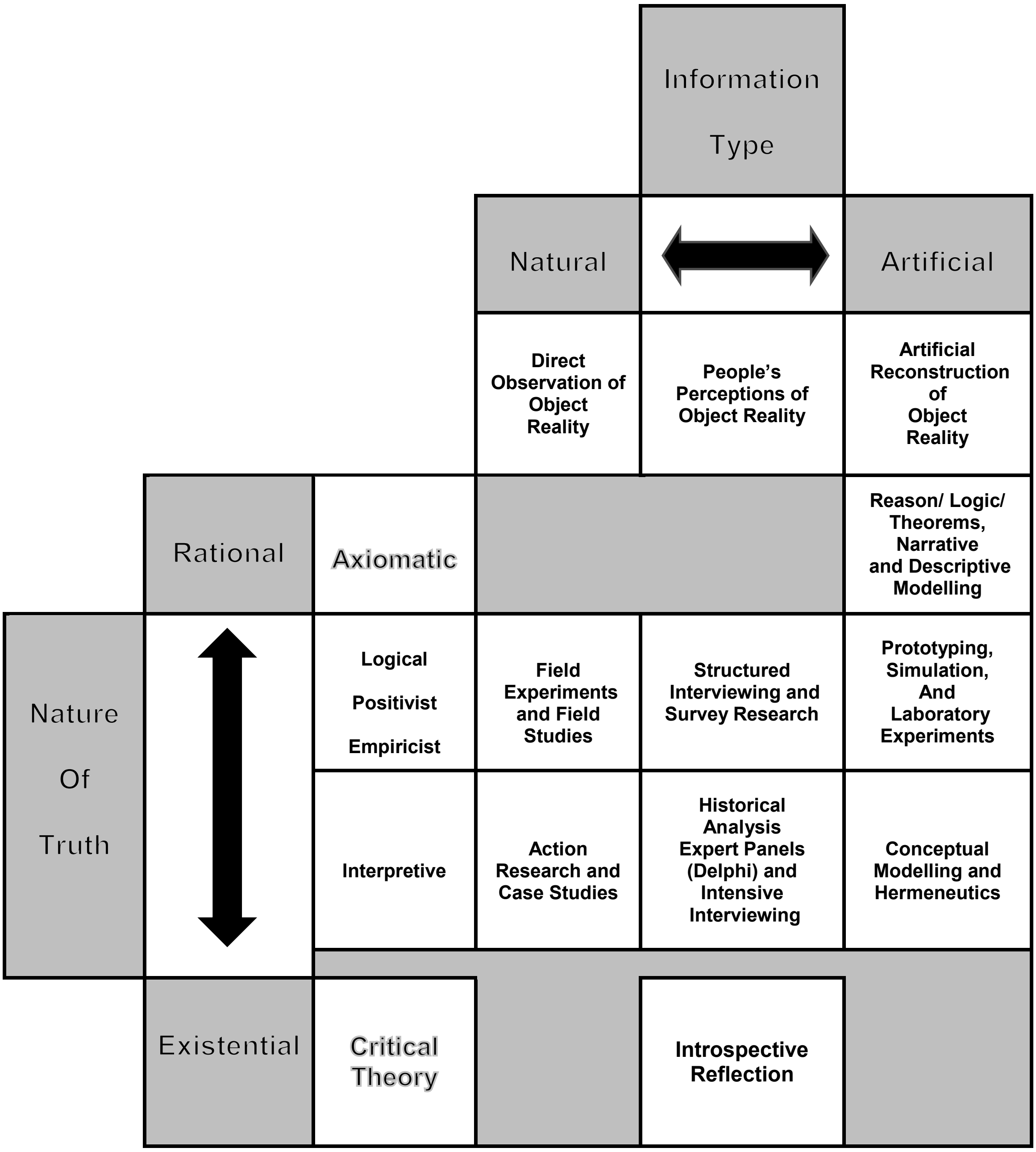


Figure 4.3 Research Information Grid (Meredith et al, 1989, P.309)

Besides, the above is particularly relevant to the objective of this study, because SC has a philosophical perspective limited by its context, and a practice relevant to organisational management science. In addition, Chopra et al, (2004) suggest that the most valuable contributions to SCM will involve addressing real problems in real SCs. Similarly, the contextual nature of SCM in relation to crude oil distribution, logistics, and or shipping has also been covered by Handfield and Nichols (2002). This has allowed theoretical examinations on available segments of distribution and measures to improve on current practices.

Also, justifying the application of a research methodology involved an examination of recent literature on SCM issues. It was found that SCM is dominated by quantitative research methods, which has significantly influenced a deductive paradigm (Sachan and Datta, 2005). In a study on SCM and logistics research by Sachan and Datta (2005, P.665 – P.705) the authors find that in the *Journal of Business Logistics (JBL), 80* per cent of papers surveyed, out of 442 papers in total, applied quantitative research models i.e. empirical and secondary research. In the *International Journal of Physical Distribution & Logistics Management (IJPDLM)* empirical quantitative methods of research were applied in 35 per cent i.e. 72 papers, while “Supply Chain Management” *an International Journal (IJSCM)* published between 1998-2003, qualitative methods of research i.e. empirical and secondary research were applied in 64 per cent of papers published. Therefore, the above statistics provides evidence that supports the use of a deductive method as an appropriate form of enquiry about current SC related issues.

Purpose of Study	Epistemology	Methodology	Observation
Theory Testing	Deductive Reasoning	Generalised	Specific
Theory Building	Inductive Reasoning	Specific	Generalised Ideas

Table 4.2 Research Purpose and Methodology Matrix (Adapted from: Saunders et al, 2009, P. 138)

Nonetheless, outlined in table 4.2 is the difference in outcomes between a deductive and an inductive reasoning. Also, developing research objectives and consequently testing SCM theories with reference to crude oil logistics benefits the study's deductive approach (Saunders et al, 2007, P.117). Similarly, SCM in the oil and gas industry provides a platform to explore common concerns on configuration, coordination, and the need for continuous improvement of sequentially organised sets of operations as illustrated in Chapter 2; section 2.3. Moreover, a deductive approach promotes the possibility to explore the directional findings of Chima (2007) and the research objectives set in Chapter 1 section1.2.2. Likewise, Cooper et al. (1997) introduce three major elements of an SCM i.e. organisational management, business processes, and SCM structure. They assist in the transformation of a distribution system to facilitate the process of integration. In addition, their theory supports a vertically integrated export-oriented logistics system, a major aim of the study. On the other hand, an inductive approach allows data to be collected, and afterwards developing theory from the data gathered (Saunders et al, 2007, P.119). This approach may have been adopted if the research objectives were more focused on the processes and sets of events which permit the materialisation of crude oil exports rather than the conceptual elements of the study. Nevertheless, for the purpose of this study a deductive approach is adopted supported by the literature reviews in Chapter 2 and 3; which also enable RO2 to be achieved.

4.5.1 Research Structure

According to Brinberg (1982, P.41) there are three domains of study relevant to the structure of a research undertaking. These are the conceptual, methodological and substantive domains. Firstly, the conceptual domain supports the research process by establishing the key areas of the studies epistemology with concepts and ideas in abstract form i.e. figure 4.2. Secondly, the methodological domain includes instruments and techniques for obtaining observations and relating sets of observations. Finally, the third domain includes events, processes, and the actual phenomenon of the study in a real-world context. Furthermore, the relevance of the above domains becomes apparent when assessing the composition of the study in support of the studies validity criterion; as explained in section 4.6 and 4.7.

Also, Liu (2011, P.10) supports the theory that adaptation and learning within an SCM framework is a dynamic planning process which is centred on three factors. Firstly, the environment in which the organisation operates with certain structures and purposes where the adaptation process occurs. Secondly, there is a need for an adaptive plan: a sequence of operations and transformations in response to the environment. Thirdly, there is also a need to measure performance in relation to the structures and purposes within the given environment.

In addition to the above, Liu (2011) characterises the dynamics of an adaptive system in SCM with four components:

- **Strategy Set**: an attainable strategy (research structure) that constitutes the SC conceptual domain of the study (adaptive process).
- **Data Set**: information required at a particular time, which is entered for configuration and can be dynamically observed over time. This can be found in the methodological domain of the study.
- **Transformation Set**: operations and functions that transforms objects and modifies strategies in physical and abstract forms and are found in the studies substantive domain.
- **Plan Set**: plans generated on the basis of data input and strategy; an elaboration of the data set in the form of statistical inferences.

This study follows a similar path to the characteristics explained above. To expatiate further on its significance to the design element of this study; the strategy set explained in section 4.1 constitutes the fundamental components of the phenomena that have influenced the three identified theoretical constructs in the literature review (Chapter 2) and assist in answering RO2 which is considered essential to crude oil exports from Nigeria. Likewise, the data set consequently concentrates on the methodological domain of a research path (Brinberg, 1982, P.41). This has allowed adoption of the following research methods to assist in answering RO1:

A. A Delphi Survey: as mentioned in section 4.3 on research philosophy, has been used to investigate significant characteristics and future trends in the distribution of crude oil in Nigeria; which is further illustrated in chapter 5. Also, questionnaires were used particularly in gathering a consensus from the two Delphi survey rounds recommended by Saunders et al. (2009, P.360), because questionnaires play a major role as a data collection technique. They are particularly useful when using the survey strategy (ibid). In composition, the most prevalent advantage of a questionnaire is that it provides an efficient way of collecting responses from a large sample prior to quantitative analysis. Although, Oppenheim (2000) and Bell (2005) cited in Saunders et al, (2009, P.361) contest that it is harder to produce a good questionnaire than most researchers envisage, however it is essential to collect relevant and precise data that will allow fulfilment of RO1.

For the Delphi survey, self-administered questionnaires were composed with the following precautions as advised by Saunders et al, (2009, P.362):

- Questions were carefully designed to be understood

  by academics, experts, and industry executives.

- A clear and articulate layout was adopted.

- Also included at the beginning of the survey was a predefined purpose in the introduction for respondents to understand the nature of questioning and the significance of its use within a research context.

- Application of the survey method was assessed amongst other research students and lecturers at Plymouth Graduate School of Management, Plymouth University. Their initial response prior to the survey launch date provided enough feedback, with six respondents and one unfinished questionnaire.

Likewise, the period for gathering response from the researched population was agreed with the PhD supervisor to last a period of 6 months for Delphi Survey Round one and two (DSR1 and DSR2). However, there were provisions for revisions and extension of collection time limits in anticipation of low response rates and the collection period lasted for 14 months (21/11/2011 to 16/01/2013).

In addition, questionnaires were used because it was the ideal method of communicating with industry executives with practically no time to facilitate in-depth interviews on SCM issues in the oil industry. Moreover, the survey questionnaire can be widely dispersed within the sphere of study at significantly low cost. Similarly, self-administered questionnaires allowed the characteristics of respondents to be determined beforehand and the sample population defined; explained in section 4.5.4. Also, questions posed were determined and organised to solicit new knowledge within the predefined research frame, with a provision to answer the research question set in Chapter 1, section 1.3.2.

B. Archival research: A six-month archival study on current trade flows between Nigeria and China over a period of six months i.e., between 21/06/2013 to 21/12/2013 were recorded from Clarkson's Shipping Intelligence Network (SIN) website. This gathered data included frequency of shipments, load quantities from Nigerian ports or jetties, and comparisons with another leading world crude oil export ports. Also, ten-year records of total crude oil exported from Nigeria compiled by the Nigerian

National Petroleum Corporation: Annual Statistical Bulletin (NNPCASB) between the years 2003 to 2012 were recorded directly from the organisation's website. Moreover, adopting an archival research strategy allows research objectives which focus on the past and change over time to be answered (Saunders et al, 2009, P.150). For example, research objective three RO3; regarding analysing the demand of crude oil in China particularly relating to its import from Nigeria, and research objective four RO4 which analyses the efficiency of the logistics of distributing crude oil exports from Nigeria to China; synthesising the characteristics of crude oil demand from China relies on the type of data acquired from SIN and NNPCASB, which enables statistical analysis. Nevertheless, Kitchen et al, (2012, P.39) explain that the use of archival research is now several decades old and consistently moving towards increasing acceptance in terms of scholarly legitimacy. Therefore, for guidance it is advised that researchers should ensure that archival material used is of a reliable standard and should also capture the constructs they are intended to represent (ibid).

According to Brinberg (1982) the data set contains the empirical aspects of crude oil distribution which are considered observable events, such as demand quantities, loading ports, despatch dates, and destination of crude oil shipments. These observable events are found in the substantive domain of research. In addition, the transformation set is found in the conceptual operations model initially developed for this study, which contains elements and relations of the phenomena. Lastly, the plan set constitutes the quantitative characteristics of the study. Besides, adaptation of the studies philosophy when in combination with research design enables each plan to determine which operations and functions are examined and applied in parts for realisable recommendations. Moreover, studies of adaptive systems according to Liu (2011) usually resort to descriptive tools and methods which also lead to numerical solutions.

4.5.2 Research Path: Internal Validity

Developing a research path contributes towards identifying the basis of validity in research compilation. This could be used to quantify and qualify research content and context including extent (Brinberg, 1982). A typical research process for this study involved the interrelationships of three domains: conceptual, methodological, and substantive as represented in figure 4.4 below.

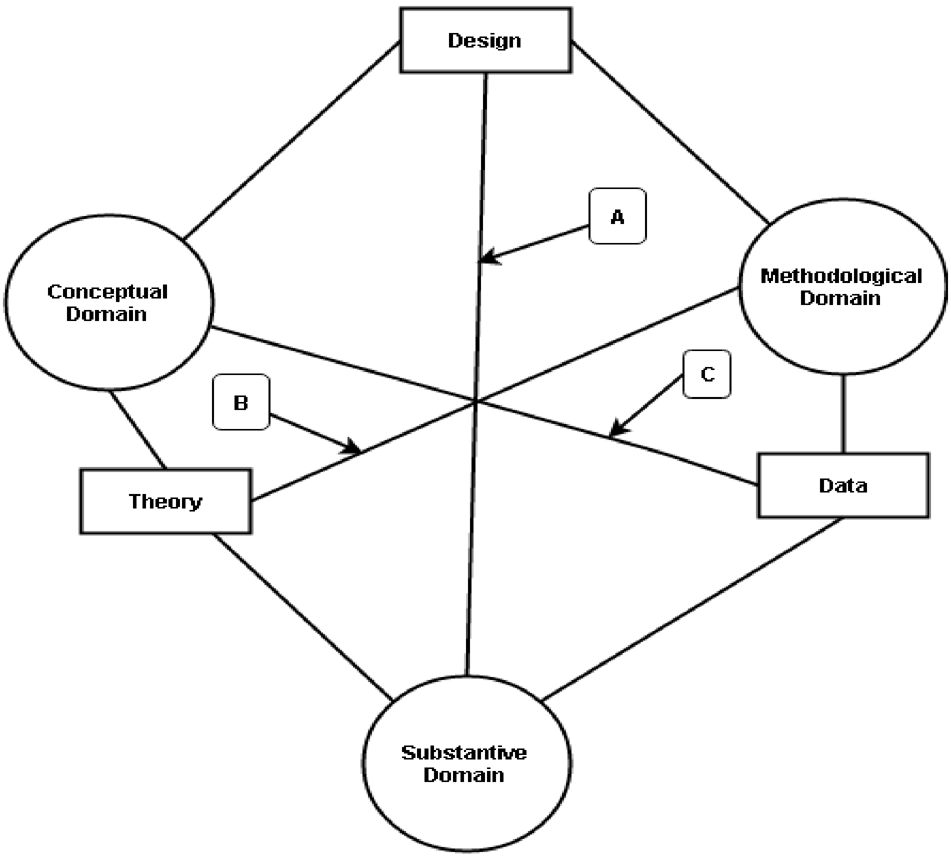


Figure 4.4 Validity Concepts in Research; An Integrative Approach (Paths: A, B, & C) (Brinberg, 1982, P.41).

In relation to the current study, the conceptual domain consists of SC concepts and ideas in abstract form. Likewise, the methodological domain includes network designs, competitive and distribution strategies, benchmarks, and measuring devices such as SCOR modelling, and other analytic techniques that can be classified as appropriate to the study of a phenomenon or theory. Lastly, the substantive domain concentrates on distribution scheduling i.e. events or network processes to be examined and studied (Brinberg, 1982). Therefore, structuring and integrating steps of the research process involve a selection or sample of elements and relations from the three domains. For example, elements and relations from the conceptual domain consist of concepts and patterns which are termed conceptual relations (CR) (Brinberg, 1982), while in the substantive domain, elements are observable events with relations as sets of processes. Furthermore, as the methodological domain consists of methods or strategies for making observations, while relations will act as techniques for making comparisons among a set of observed events or concepts (Brinberg, 1982).

Moreover, the three ways represent the distinct research paths with different advantages and limitations for the researcher (Brinberg, 1982). It is further argued that any research project may contain elements and relations from each of these domains, and a research generally proceeds by combining two of the domains to form a structure and subsequently incorporating or integrating the third domain with the developed structure, (Brinberg, 1982). These three paths of research methodology may involve the following: research design, testing a theory or explaining a body of data. According to Brinberg (1982), a researcher will need to connect events and processes from the substantive domain with a design structure which is labelled Path **A** in table 4.3 and is classified an implementation process. Therefore, implementation when applying Path **A** involves selecting particular distribution events or network processes and connecting it with opinions and attitudes of SC Managers and directors towards for instance demand planning in crude oil logistics. Moreover, linking distribution events or network processes with SC opinions and attitudes using a Likert scale for measurement allows implementation of a research design (Brinberg, 1982). Similarly, the second path is to build a theory or test a theory i.e. develop a set of constructs by selecting applicable research techniques to test this theory; described as Path **B** (Brinberg, 1982). Likewise, the third path is to construct a body of data and subsequently select concepts to explain these data labelled Path **C** in table 4.3 which is an interpretation or explanation of existing distribution events present in oil distribution, and is relevant to quantitative measurements in interpreting collected data on transportation; for example, vessel movement or shipping between ports. It also includes the application of concepts in categorising various components of data or information.

Domain	Conceptual	Methodological	Substantive
Path	A	B	C
Structure	Concepts / Methods	Concepts / Substantive	Methods / Substantive
Validity	Ecological	Methodological	Explanatory
Dependants	Relations /Techniques	Concepts / Patterns	Techniques / Events
Consequence	Generalisability across methods	Generalisability across events	Generalisability across concepts
Elements	Comparison	Relations	Analysis
Effects	Research Design	Theory	Body of data
Application	Literature Review	Finding Suppositions	Quantitative/ Qualitative
Development	Instrumentation	Hypothesis	Relations

Table 4.3 Thesis Research Path adapted from Brinberg (1982)

Although, achieving all levels of validity may be difficult. However, establishing a relationship between any of the phenomena studied does not necessarily require internal validity. Likewise, an interpretive archival study can be classified a one-off and therefore will not require the findings to be generalizable and does not necessarily require external validity. However, construct validity is essential to this study if the findings are to be considered valid, reliable, and replicable even within the research context (Brinberg, 1982). This is explored further in section 4.6 and 4.7.

4.5.3 Questionnaire

Nevertheless, questionnaires are widely used methods of gathering data. They are particularly useful when applying a survey strategy with the added capability of collecting responses from a large sample of respondents prior to quantitative analysis. Although, Oppenheim (2000) and Bell (2005) cited in Saunders et al., (2009, P.361) contest that it is harder to produce a good questionnaire than most envisage, because of the need to collect relevant and precise data required to answer the research question by exploring the objectives that will support achieving the studies aim.

Delphi Question Criterion	Category
Q1. SCM; Essential Operation	Operations Management
Q2. SCM; Logistics Efficiency	Operations Management
Q3. SCM; Adoption	Strategic Implementation
Q4. SCM; Effectiveness	Strategic Implementation
Q5. Relationship; SCM and HRM	Human Resource Management
Q6. Inventory Management and SCM Effectiveness	Operations Management
Q7. Information Management and SCM Integration	Integration
Q8. Adequacy of Shipment Frequency	Transport Geography
Q9. Availability of Vessel Capacity	Transport Geography
Q10. Shipping Route Adequacy	Transport Geography
Q11. Geographic Characteristics	Transport Geography

Q12. Supply Capability	Supply Management
Q13. IT Inadequacy	Information Systems Management
Q14. Enhancing Collaboration (Software)	Information Systems Management
Q15. Information Systems: Visibility	Information Systems Management
Q16. Simulation Systems Modelling	Forecasting
Q17. Advantages of Integration	Vertical Integration
Q18. Geographic Location Advantages	Transport Geography
Q19. Supply and Port Accessibility	Transport Management
Q20. Sustaining Crude Oil Distribution Relationships	Supply Management

Table 4.4 Delphi Question Categories (Source: Authors Own, 2015)

Besides, the table 4.4 above describes the category of questions asked and its relevance to the studied phenomena. Moreover, self-administered questionnaires allow the use of the internet, as a means towards gathering a response from an identified group or organisation in comparison to interview-based questionnaires predominately applied when undertaking a qualitative study. For the purpose of this study, meeting with academics, company executives, and oil industry experts is impractical considering the geographic distance involved i.e. oil industry executives and experts employed by MNCs and IDCs based in Nigeria. Although, a case-based investigation of IDCs and their major logistical concerns was pursued, but only limited data was collected from a pool of 8 IDCs out of 18 operating in 2015.

Likewise, the type of questions asked were categorised according to the theoretical framework of the study i.e. structures and concepts in Chapter 2 section 2.3 as illustrated in Table 4.4 which allowed an identification of factors for configuration and coordination according to Chima (2007, P.29) which are as follows:

- Importance and benefits of SCM to logistical concerns in the distribution of crude oil.
- Implications of various SCM definitions on the organisation of a crude oil SC (Cooper et al, 1997, P.2: Handfield and Nichols, 1999).
- Impact of a VCS on radical organisational development and operational structure improvements.
- Determinants of an SCM organisation which includes the advantages of information technology for the integration of processes, visibility of operations, and customer preferences, incorporating the characteristics of China's present demand for crude oil.

Also, these questions were merged with the competitive aspect of Nigeria's geographical location in relation to crude oil export considering the country's logistical distance to the discharge destination. In addition, shipment turnaround time was considered in the criterion of SCM and logistics efficiency.

Lastly, questions were presented to respondents through internet mediated questionnaires. Moreover, this medium of data collection offered greater control, because most users read and respond to their own email from personal computers (Saunders et al, 2009, P.363). Added to this are the advantages presented below in table 4.5.

Questionnaire Attributes	***Internet Mediated***
Population Characteristics	**Computer literate executives, experts, and Academics**
Relevant Respondents	**Very High: using Emails**
Contamination of Response	**Significantly Low**
Size of Sample	**Large samples can be solicited effectively and efficiently**
Likely Response Rate	**Variable results possible, but 11% is an achievable response rate when using the internet**
Length of Questionnaire	**Fewer webpages are better to encourage engagement of respondents**
Question Types	**Closed questions but not complex**
Time Factor: Collection of Feedback	**2-6 Weeks (as advised)**

Table 4.5 Questionnaire Attributes (Adapted from: Saunders et al, 2009, P.364)

4.5.4 Non-probabilistic Sampling

Similar, important to the type of data gathering method was the element of questionnaire design and representative sampling of the researched population. Sampling is significant when adequate representation of the research population is required, especially for the purpose of generalisation. According to Saunders et al, (2009, P.212) sampling allows greater accuracy of representation of the research population and saves time. Besides, the impracticalities of surveying the entire population of crude oil producers with export operations in Nigeria have required a need to collect data from a specific sample and manageable size. Also, there are varied roles in the industry and multiple echelons of department executives within an organisation. Therefore, acquiring relevant information from the researched population was important considering there are 50 oil organisations currently capable of exporting crude oil out of Nigeria in 2013 which includes both MNC's and IDC's (NNPCASB, 2013, P.32).

Besides, there are two methods of sampling available when investigating a research population. Firstly, probability sampling allows the research question and objectives to be answered from a statistical estimation of the characteristics of the studied population which are usually considerable in number (Saunders et al., 2009, P.214), so as a result it is mostly applied in business survey research. On the other hand, non-probability sampling enables gathering data from a small number of respondents selected from a subjective judgement of the researched population (ibid, P. 233). Also, it is not practical to apply non-probability sampling techniques when there is a need to make statistical inferences about the characteristics of the studied population (ibid, P.213). To understand the underlying structure and logistics composition of the Nigerian oil industry a non-probability sampling method was adopted. Thus, oil industry executives in Nigeria and academics with an identified interest in crude oil logistics were contacted. These pools of academics were identified in relation to their designated academic job title in the following frame: Logistics and SCM Professors, Senior Lecturers, Lecturers, Research Graduates and Post-Graduates. Likewise, Nigerian oil industry executives were grouped according to their level of responsibility within the logistics function of an oil company. Moreover, a significantly minor number of oil companies operating in Nigeria at the time of gathering data for this study had a dedicated SCM operation for crude oil distribution, because distribution in the Nigerian oil industry is solely considered a logistics function.

These executives were categorised according to the following job titles: export, trading, supply, shipping, logistics, and business development.

Furthermore, their corporate relevance was also classified either strategic or operational.

I. **Strategic management: Chief Executive Officers, Managing Director, and Partners**

II. **Operations Management: Managers, Executives, Traders, and Associates**

In addition, RO1 which investigates components of crude oil export distribution allowed a purposive sampling strategy. From the typical characteristics of the industry's structure with reference to crude oil exportation has allowed the identified pool of respondents to communicate their opinions on the logistical organisation of the Nigerian oil industry using a Delphi survey (ibid, P.240). This pool of respondents described in table 4.6 was reached through direct emails, grouped email addresses and website postings. Also, email addresses of academics in the sphere of logistics and SCM were easily obtainable from university websites.

Respondents	Number
Academic	*27*
Oil Executives	*48*

Table 4.6 Type and Number of Respondents

Besides, oil industry executives were reached through their company websites, and the LinkedIn website portal with designated forums and groups such as Nigeria Oil & Gas Industry, Nigeria Oil & Gas, Nigeria Oil & Gas Trade, Nigeria Oil & Gas Trade and Investment, Port Harcourt Business Club, and OilPro (Africa Oil & Gas: Nigeria, Angola, Cameroon, Libya, Gabon, Egypt, South Africa, Sudan, Chad, Uganda) forums. These groups have a considerable number of followers with subgroups for those with common oil industry interests, which include the possibility of posting direct links to the Delphi questionnaires. Some other respondents were reached directly through this link including reminders when response rates were extremely low.

Furthermore, the motivation for a Delphi study is achieving a consensus that allows subjective judgement and a certain degree of generalisation on elements of the issue under investigation. In addition, the characteristics of a Delphi survey as described in Chapter 5, Section 5.2.1 will only permit the solicitation of those executives who could take part in the studies iterative process and subsequent rounds. Moreover, applying sample size calculations in Saunders et al, (2012, P.221) has allowed a figure of 40 respondents to be calculated as a reasonable sample size when response rates are expected to be 50% from an estimated total population of 200 for a Delphi survey as opposed to a probability survey where the estimated total population would have been over 1000 respondents judging by the number of members on the LinkedIn Oil forums.

According to Saunders et al, (2009, P.221) na is the actual sample size required, n is the minimum (or adjusted minimum) sample size while "*re*%" is the estimated response rate expressed as a percentage. Therefore, the calculations in figure 4.5 represent the projected sample size for this study.

$na = \dfrac{n \times 100}{re\%}$	$na = \dfrac{20 \times 100}{50}$ $na = 40$

Figure 4.5 Sample Size Formula and Calculations (Saunders et al, 2009, P.221)

As a result, 75 oil executives were contacted via emails, which were more than 40 respondents advised by calculation. This included Nigerian internet oil forums with member email addresses. However, for a non-probability sampling technique adopted for this study, calculating sample size is considered ambiguous (Saunders et al, 2009, P.233) and there are no stipulations on how sample size is calculated. Moreover, the important consideration is the relationship between sample selection technique adopted and the purpose (focus) of the study (ibid), as well as the acquisition of credible data that will allow an elucidation of the phenomenon and justify recommendations (ibid); which is exemplified in the results in Chapter 5, section 5.3.and 5.4.

4.5.5 Statistical Analysis: Chi-Square Test of Independence

Likewise, non-parametric test on the level of independence among categorical variables was conducted applying a Chi-squared test on the data gathered from SIN. This has allowed the significance or relationship between Departure, Destination, and Vessel Size to be identified particularly when justifying RO3 and RO4 of the study. Also, the level of dependence between vessel categories and destination points were examined for tactical logistical planning. Moreover, the benefit of this statistical method is that anticipated export distribution requirements of Nigerian oil companies can be measured using throughput records of monthly crude oil exports to China over a 6 month period.

4.6 Research Reliability

Although, the construct of the present study may be expanded survey wise i.e. Delphi questions posed on DEMVAR, SCPRO, and VEFF. However, two factors limit this possibility; time limitations, as well as the level of organisational maturity present in the Nigerian oil Industry. This can only materialise sufficient feedback comparable to those already achieved from the present respondents. Lastly, on reliability the possibility to make random errors is reduced because of the nature of the data applied and characteristics of the population (uniformity). Therefore, the reliability of this study was higher than recommended and suitable for replication.

4.7 Research Validity

Similarly, validity in a research context is established through adherence to the right methodology and is fundamentally linked to research design (Brinberg, 1992). Also, analytical methods for this study have allowed examination of data, and ensured that quantitative results coincide with research design, and are not inconsistent with design limitations or variables (Brinberg, 1992).

Also, Robson (1993) has charted threats to validity which provides a guide into avoiding pitfalls during the research process. These are as follows;

a) **History**: Relevance of research material and level of respondents in a chosen field of study may influence findings. For example, more respondents in mid-level management may direct findings towards operational conclusions, while the response from senior-level management may be more strategic in orientation.

b) **Maturation**: Respondents may be influenced by other organisational motives, which may not be evident at the time of data collection. Likewise collected data might prove irrelevant to the cause of the study and may possibly change research direction.

c) **Testing**: Effect of testing on the validity of this research is limited to the attitude of respondents about current SC issues; for example, respondent replies may include SC theories and distribution methods which Nigerian oil companies do not necessarily apply.

d) **Instrumentation**: Methods adopted to collect data may induce insignificant feedback from the respondents. However, instrumentation is relevant not only for the validity of research composition, but also for usability. For example, the easier it is for respondents to answer questions set in the Delphi Surveys the more likely it is that reply rates will be higher than expected, which should allow the significance of the theories used in questioning to be amply analysed.

e) **Mortality**: Sustainability of participants i.e. respondents dropping off at the earlier stages of the data gathering process may lead to inconclusive evidence and the possibility to abandon research direction for qualitative data (Saunders et al, 2009, P.157). For example, the Delphi technique encourages an iterative process of response; however, the possibility to sustain the engagement of respondents over the required course of questioning is difficult.

f) **Generalisability**: Sometimes referred to as external validity is concerned with the extent to which research findings are generalizable. In particular the results of the Delphi will be highly generalizable to the population of Nigerian Oil Industry exporters than for example the Nigerian Food industry when investigating a similar phenomenon, because the number of major organisations in the Nigerian oil industry is relatively low compared to other industries i.e. there are 13 major oil joint venture exploration companies and 24 indigenous oil companies with a capacity to export 89.80% and 10.20% of crude oil respectively (NNPC ASB, 2013, P.32).

In addition, validity and reliability issues assist in verifying research method components for the adequacy of that particular component, which can be grouped as follows;

1. Internal (Content) Validity: **research design**
2. Construct Validity: **theoretical variables**
3. External Validity: **robustness of research findings**

4.7.1 Content Validity

Appraising content validity is the extent to which measurement questions constructed for the Delphi study (questionnaires) covers the core of the research issue (Saunders et al, 2009, P.373). Therefore, evaluating content validity for this study involved setting questions with the course supervisor from a preliminary literature review covering relevant aspects of the studied phenomenon in table 4.7 below and categorised in Chapter 5 (5.3.3 Delphi Methodology).

CATEGORY	AUTHORS
Operations Management	Raman and Shapiro (2000), Chima (2007)
Strategic Implementation	Coia (1999) Beamon (1998)
Resource Management	Hussain et al, (2006)
Integration	Williamson (1985), Cooper, Lambert, and Pagh (1997)
Transport Geography	Hesse and Rodrigue (2004), Li et al,(2004)
Supply Management	Chidambaram et al,(1999), Gunasekaran and Ngai (2004)
Information Systems Manangement	Cheng and Duran (2004), Gainsborough (2005)
Transport Management	Hussain et al. (2006)
Forecasting	Cheng and Duran (2004)

Table 4.7 Literature Content and Authors Grid (Source: Author's Own, 2015)

4.7.2. Construct and External Validity

Moreover, the data gathered from the Delphi and archival study were also validated and assessed for suitability (Saunders et al, 2009, P.276). Likewise, construct validity involves mostly measuring the connection of two identified constructs considered essential to the study from the archival data gathered. These two constructs are termed either causal or affected, and are essential in understanding the operational nature of the phenomena under investigation (Hoyle, 2002, P. 31).

According to the authors “if a study has high construct validity, all the constructs that motivated the study have been successfully measured or captured by the specific variables on which the researcher has gathered data” (ibid, P.32). Therefore, the studies concern on demand variability as a theoretical construct is investigated using response from the Delphi survey because of its effect on export efficiency which is evaluated applying the two constructs of crude oil imports (Causal demand) and exports (Affected supply) between the two countries and related logistics sources in appendix **C**.

Besides, the effects of construct validity are to ensure replication, because obtained results can be consistently investigated over time (ibid, P.33), to effect measures for increased efficiency from Nigerian oil exports and capitalise on the recent trend of increased export of crude oil to China. Also, measures to assure construct validity were scrutinised. According to Hoyle (2002, P.34) “a variable that has a great deal of construct validity is one that mostly measures the construct of interest with minimal contributions from constructs of disinterest and random error”.

Nevertheless, the major purpose of examining construct validity is to assess the usefulness of Delphi one survey results on the relevance of the three major theories adopted. Likewise, external validity using the chi-square test on the archival data gathered from the SIN data i.e. China’s demand and Nigeria’s supply of crude oil considered correlational fallacy, because the “China effect” on world crude oil demand does not necessarily imply there will be more imports (Demand) of Nigerian crude oil from China, nor that a possible increase in export volumes of crude oil (supply) from Nigerian ports have been caused by this effect. In addition, analysis of the archival data to ascertain demand requirements and supply capability ensures quantities of crude oil distributed by the research population is imitated which permits generalisation.

4.8 Discussion

In conclusion establishing the truth about a phenomenon is essential in every research undertaking. This is often stimulated by two factors which are either intrinsic or extrinsic in value. When a study has intrinsic value the study is always influenced by a mode 1 enquiry and centred on an academic awareness about the phenomenon under study, while a mode 2 enquiry is more extrinsic in characteristics and also essential in the development of knowledge about operational aspects in a particular industry, and often some studies have both properties in their supporting ideology. Therefore, the present study will be described as a mode 2 enquiry.

However, the initial consideration when trying to actualise the present study was to justify the nature and method of inquiry. According to Meredith et al, (1989, P. 309) the nature of investigation into crude oil exportation in the Nigerian oil industry is described mostly positivist in nature, especially when considering the extent of the truth about the phenomena under investigation, and the type of information required to ascertain organisational dynamics that may positively influence oil export distribution from Nigeria.

From a standpoint of a critical realist the aim of the study is to explore objective reality which is actualised by merging theoretical underpinning with the axiological perspective of the researcher and also available research methods. Likewise, the study by Chima (2007, P.27-36) has provided an awareness of relevant issues in an oil industry orientated SCM to support investigation procedures, especially when applying the Delphi technique. In addition, Liu (2011. P.10) argue that the dynamic nature of a SCM framework when under investigation is centred on three factors; primarily the environment in which the organisation operates i.e. Nigerian oil industry. Secondly the need for an adaptive plan or sequence of operations i.e. the regularity of oil movements and the synthesis of oil demand and supply from Nigeria. Thirdly, measuring performance of structures and the resource capability within the stated environment.

Also, both Liu (2011. P.10) and Brinberg (1982) have assisted in setting the foundation for the required research design. For example, the four components of an adaptive SCM system according to Liu (2011. P.10) considers that the strategy set can be found in the methodological domain which represents the characteristics and structure of the study as explained in section 4.2. Similarly, the data set refers to the substantive aspect of the study which required gathering information over a six-month period from a reputable industry source and configured through statistical appraisal. Moroever, based on the characteristics of the phenomena a conceptual framework was developed which assisted in identifying the nomological context of inquiry as well as latent variables required to validate quantitative evaluations. Nonetheless, the plan set elaborates on the data set mentioned above in the forms of both the Delphi and archival study.

For instance, conclusions deduced from the preliminary Delphi survey data allowed verifications from oil industry experts in relation to the identified three substantive theories of the study i.e. SCPRO, DEMVAR, and VEFF. Although, qualitative methods were explored with the possible interviews with oil industry executives in Nigeria, triangulation of the inquiry process was more sufficient, because it allowed data collection from two sources of information to corroborate findings (Saunders et al, 2009, P.154) i.e. the Delphi and archival studies data which substantiates limitations of the research design expressed in section 4.5. In addition, the threats to reliability expressed by Robson (2002) such as participant error, participant bias, observer error, and observer bias were minimised especially for the Delphi study through the questioning procedure and channel of communication i.e. generalised web-based solicitation. Therefore, data collected for the Delphi survey have a satisfactory level of reliability based on the sampling technique applied and the nature of respondents, including the average response rate described in section 4.5.4, as well as the type of questions included in the survey (Saunders et al, 2007, P.267).

Likewise, data gathered for the archival study were obtained from reputable industry sources. According to Dochartaigh (2001), the reputation of organisations providing data is augmented by copyright statements found at the bottom of the sources web pages. In addition, the data collected from SIN was close to real-time data, because they were actual daily statistics of crude oil movements from world ports which assist in authenticating the validity of the information gathered.

Moreover, reliability according to Saunders et al. (2007, P.149) involves that the data set applied for the purpose of a study yields consistent results. Besides, replication and transparency are vital in sense making of the studies data set (Easterby–Smith et al. 2002, P.53). Therefore, evaluating the process of gathering and analysis of data involved the application of Miles and Huberman's (1994) three linked sub-processes of data analysis i.e. data reduction, data display, and conclusion drawing or verification which all occur after data collection.

Likewise, the archival study involved a time frame of six months to gather data from daily oil shipment schedules in the two identified classes of vessels that transport crude oil from Nigerian ports i.e. VLCC and Suezmax from Nigerian and world ports through SIN records. Also, data from both methods were scrutinised with reference to the research question set in support of the studies objectives, which also required a thematic and coding process to ascertain relevance. Besides, the resulting data were organised and appraised applying descriptive and inferential statistics for both methods of enquiry.

Also, satisfying the research validity criterion was also an important element of the present study. These involved positioning between the two factors that influence research methodology and design in figure 4.3 i.e. nature of truth and information type required to justify the studies objectives (Meredith et al, 1989, P. 309). Similar to the above concerns on reliability the studies axiological positioning is also centred on the researcher's perspective. For example, Miles and Huberman (1994, P.429) explain that the position of a critical realist will differ from either a critical theorist or a phenomenologist, because what is classified as fact about a phenomenon will depend on their separate views. According to Sachan and Datta (2005, P.666) researchers are mainly using people's perception (survey and interview) or artificial methods as an SCM research methodology. However, this perception holds significant because the practicality of adopting theories in SCM depends on the people whose perceptions have been used to explore the relevance of theory on reality. Furthermore, understanding the rudiments of crude oil logistics requires an investigation of objective reality by not only quantifying the extent of demand and supply of crude oil to China, but also by examining the criteria or factors that influence the logistics process i.e. identifying theoretical implications.

Although, the research approach adopted has been significantly influenced by characteristics of the phenomenon and access to the research population, both the Delphi and Archival studies have enhanced justification of this research undertaking by applying the rigours of research methodology. Besides, using real-time data from SIN assists in balancing limitations of construct validity and the possibility of generalising about the conceptualisation of constructs (Barnes et al., 2015, P.4). Most organisations have competitor preventive measures, which inhibit the disclosure of sensitive information directly to researchers or observers, however, using archival sources enables a bridge towards discovering actual outputs for measurements and thereby encouraging an elucidation of parameters and estimation of crude oil volumes characteristic of the phenomena, and are also uniquely robust when compared to information gathered through primary sources (Saunders et al., 2009, P.150). Finally, research reproducibility is further enhanced because of data transparency. Indeed, the possibility of maintaining consistency of data analysis enables verification of results and conclusions through multiple independent parties (Barnes et al., 2015, P.6).

Chapter 5: Delphi Survey: Achieving Consensus on Nigeria's Crude Oil Logistical Efficiency

5.1 Introduction

Since, the development of the Delphi technique of investigation by Dalkey and Helmer (1963) as a means towards clarifying specific issues from a consensus its adoption has increased. Major management scientists have applied the Delphi technique when assessing current issues and trends in different industries. Moreover, the possibility to predict or determine future outcomes in relation to a chosen issue has increased its usage as a research method. Likewise, the logistics industry has not been exempted, and according to Tholen et al., (1971, P1-103), and McDermott and Stock (1980) the Delphi technique has been applied in logistics research especially when ascertaining possible futures or trends in a sector of distribution. For example, Cranfield School of Management (1984) applied the Delphi technique to find out opinions of industry experts on the future of distribution systems over a 20-year period. Similarly, a larger study was carried out in 1993 in collaboration with the European Research Institute to forecast logistics systems development in Europe until the year 2001. Authors such as Gattorna et al. (1991, P.36-39), Cooper (1994), European Community (2004), Piecyk and McKinnon (2009), and Von Der Gracht and Darkow (2010) have all applied the Delphi technique to ascertain future scenarios or long range forecasts in the logistics industry. In addition, the Delphi technique was also adopted in various studies by PhD students at Plymouth University to ascertain future paradigms on logistics systems, for an example Cottam et al. (2004) and Islam et al. (2005). Therefore, the popularity of the Delphi technique has encouraged its present use as an ideal method to investigate significant characteristics and future trends in the distribution of crude oil in Nigeria.

Consequently, the purpose of the present study is to understand prevalent industry issues that will encourage standardization, efficiency, and adequacy of current logistical processes in the Nigerian oil industry. Besides, most oil organisations and companies in Nigeria have not established a form of consensus on distribution and logistics systems to capitalise on increased productivity. Neither are there any studies of relevance on Nigerian oil logistics including exports that has adopted a Delphi based approach in evaluating current industry practices or trends. Therefore, the application of a Delphi study is apposite in the attempt to involve oil industry experts to agree on the present and possible future states of Nigerian crude oil export logistics. This chapter is organised as follows. Section 5.2 reviews major definitions of the Delphi technique and its characteristics including the qualities of the technique in application. In section 5.3 on the efficacy of the Delphi method theoretical implications and the philosophies associated with this system of enquiry are considered, and section 5.4 introduces findings from empirical observations from the first and second round of questioning. Also, section 5.5 examines the pattern of results gathered through statistical appraisals, while section 5.6 confirms relationships in statistical outputs, as well as limitations of the Delphi technique in relation to the present study in a discussion.

5.2 Delphi Technique Review

There are several definitions of a Delphi technique. An earlier definition by Linstone and Turoff (1976) describes the Delphi technique as “a method of structuring a group communication process, so that the process is effective in allowing a group of individuals from a continuum to deal with complex problems (McKinnon and Forster, 2005, P.1). In addition, the authors further explain that a Delphi study assists in allowing a subjective judgement on a collective basis, especially when problems do not permit the application of precise analytical techniques. Also, experts are not often in direct communication, and are too numerous to communicate with in a group discussion or interspersed in a face to face interview. Moreover, a Delphi study has been expressed;

“as a relatively strongly structured group communication process in which unsure matters and incomplete knowledge benefit from the judgement of experts” (Hader and Hader 1995, P.12).

Additionally, Hader and Hader (1995, P.12) in their definition emphasis the group communication process i.e. the selection of a group of people with various views about a topic, and then organising consensus through an assessment of expert opinions. Moreover, the opinions of experts have significant impact on the theoretical framework when applied to resolve major logistical issues, because their opinions determine which SCM theories will be significant to real world situations. Likewise, Rowe and Wright (1999, P.354) identify the characteristics of an unstructured problem situation, and the application of an appropriate research method to reach a decisive agreement on how issues should be approached and resolved. Indeed, the “intended application of a Delphi technique is to allow judgement and forecasting situations in which pure model based statistical methods are not practical or possible because of the lack of appropriate historical or economic or technical data, and thus where some form of human judgement is necessary” (Ibid). Therefore, the Delphi method can be described as a means towards a deliberation on creative aspects of problems, because it allows individual opinions to converge towards gradual resolutions.

5.2.1 Characteristics of Delphi Technique

According to Okoli and Pawlowski (2004, P. 2-3) the judgement properties of a Delphi method supports the decision making process with an added possibility to forecast future trends. Moreover, these characteristics of the Delphi technique benefit the need for succinct opinions from experts on crude oil export management that will increase the possibility of theoretical and pragmatic solutions to capture the value of distribution as well as increase logistical efficiency. Furthermore, reliance on such collective judgement allows empirical consensus to be achieved on possible future states of Nigerian crude oil exports.

On the other hand, the epistemological relation of a Delphi study to this research is also important, because the approach used in gathering information has an impact on quantitative and qualitative results (Cameron and Price, 2009, P.53-54). Therefore, objectivity is relevant in relation to the design option for a Delphi study, which also influences the type of questions posed and the basis for research validity when adopting an appropriate research method. Subsequently, the first enquiry will be the adequacy of the current research procedural framework, which is to gather evidence of the phenomena through a questionnaire. Similarly, the research method adopted supports the required validity criterion; construct validity, by designing and organising data collection tools to facilitate response (Slater and Atuahene-Gima, 2004, P.227-249). Besides, the positivistic nature of the study into Nigerian crude oil supply chains also compliments a future case study. According to Dinwoodie and Xu's (2008, P.398-399) categories of case study approach, category three involves refocusing studies, and analysing the dynamics of distribution processes. As a result, it is possible to analyse as well as understand current practice in crude oil logistics through a Delphi survey which should complement future studies on the research issue.

5.2.2 Delphi Technique: Applications

Moreover, Hader and Hader (2000) have categorized three major functions of the Delphi technique. These are idea generation, judgement function, and narrowing down or consolidation (Okoli and Pawlowski, 2004, P.11-13). Firstly, the process of idea generation allows questions to be developed on broad issues relating to the research topic, which is usually found in a “Policy” Delphi. Secondly, the judgement function allows the selection and formulation of ideas about a particular industry, which is typical of a “Classical” Delphi and relevant to the information gathering process for this study. Lastly, the process or technique of narrowing down is also relevant; by asking experts involved in the distribution of crude oil to ascertain important issues or drivers for efficiency in logistics processes. However, the most important aspect is securing the advantages of a Delphi study in application, because adequate qualitative data can be developed by applying Miles and Huberman’s (1994, P.278-280) evaluative criterion i.e. objectivity, reliability, validity, and orientation. Also, Goluchowicz and Blind (2011) have also reported on the benefit of standardizing Delphi techniques to effect technical standards useful to both qualitative and quantitative research. Likewise, Banuls and Turoff (2011), and Tapio et al. (2011) have investigated the dual application of Delphi studies with scenario planning, which is also relevant to the present study, especially when a case approach is adopted for a future study. In addition, Hussler et al. (2011), Gnatzy et al. (2011) and Hasson and Keeney (2011) respectively have argued the benefits of a Delphi method and possible biases in forecasts. They have identified major differences in Delphi methods, including its major characteristics or elements such as rigour and reliability in satisfying research validity criteria. However, eliminating duplication of research work already carried out influences the type of questions asked, as well as the method of collecting data. Therefore, to guide the conception of applicable research questions, major characteristics of existing supply chains in the oil industry were defined and current industry opinions monitored including an investigation on current papers or issues of importance to the research topic (Eisenhardt, 1989, P. 535). In addition, areas of relevant synergies to SCM in practice were assessed.

5.3 Delphi Method: Utilization and Design Considerations

In application, the three types of Delphi techniques mentioned above can be defined as follows. Firstly, the classical Delphi and is characterised by Skulmoski et al., (2007, P.2) with the following features:

I. Anonymity of participants; allows free expression of opinions and feedback is motivated by individual experiences rather than expectations from industry groups.

II. Iteration; allows the participants to refine their views in comparison with the panellists without losing credibility.

III. Feedback; Informs the participants of the other participants' perspectives thereby providing an opportunity for Delphi participants to clarify and change their views (Skulmoski, et al., 2007, P.3).

IV. Statistical aggregation of group response; allows for a quantitative analysis, and interpretation of data (Ibid).

Moreover, the above is supported by Rowe and Wright (1999) as essential to a Delphi technique, and a process of investigation which applies the four criteria may be deemed a classical Delphi, although the technique can also be modified to meet the need of a given study (Skulmoski, et al., 2007, P.3). Secondly, the intention of a Policy Delphi is to achieve stability in responses among those whose expert opinions have considerable impact on current industry trends, while building on policy alternatives using a system of public discussion. None-theless, the purpose of the present study could be considered instrumental when developing policies within government departments, agencies, institutions, as well as large companies or organisations; by promoting participation from opposing opinions, especially with stakeholders. Like the “Classical” Delphi, a “Policy” Delphi is characterised by selective anonymity; iteration, controlled feedback, polarised group response and structured conflict (Hanafin, 2004, P.6). Thirdly, a “Decision” Delphi is mostly applied when conducting social science investigations. Besides, this enquiry system is centred on a group of decision makers rather than from ad hoc decisions of a small number of people (Ibid). Moreover, the construction of a panel in a “Decision” Delphi technique rely on the opinion of a cluster of decision makers rather than a collection of people with expertise in the chosen area of study or on the issue investigated. As a result, the benefit of a “Decision” Delphi is to structure opinions, so an agreement can be reached, especially from a “hierarchy of decision makers” (Ibid). According to Hanafin (2004, P.6) the characteristics of a Decision Delphi is “quasi-anonymity” when the chosen cluster of respondents is accounted for by name and are acquainted with the other participants, however their responses to the questions posed are answered anonymously. Furthermore, considering the sample size for this study and the nature of the investigation i.e. logistical developments in the Nigerian oil industry, a “Classical” Delphi was adopted. Moreover, restrictions on time and scale of investigation including the purposive use of findings and iterative inconveniences of gathering enough responses from Nigerian oil executives make the other types of Delphi technique impractical.

5.3.1 Delphi Inquiry Process

Applying the Classical Delphi technique for this study required the process illustrated in figure 5.1 below.

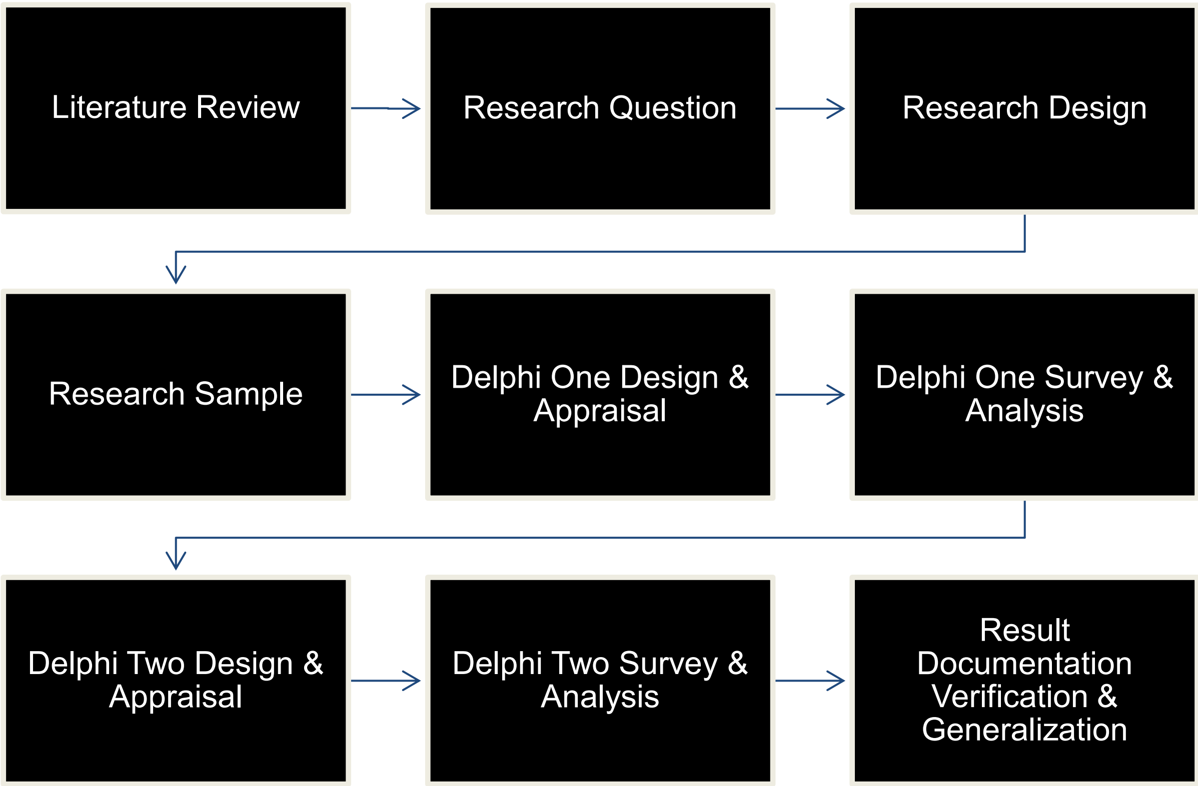


Figure 5.1 Two Round Delphi Process

This process encouraged the composition of the research questions in appendix **A1** and **A2** which were developed from a literature review on the Nigerian oil industry and the benefits of SCM to the process of export logistics. Similarly, the theoretical frameworks identified pertaining to the study area were demand variability, vertical integration, and SCM process orientation. In addition, Nigeria as a major crude oil exporter amongst others in the African continent has predominately depended on the resource base of MNCs oil companies to sustain efficiency in export distribution. Moreover, notable audits on distribution efficiency have not been well documented by Nigerian National Petroleum Company (NNPC), and Nigerian oil interest groups. Therefore, the gap observed in the quantities of crude oil exported from Nigeria in comparison with AG in Chapter 3, Section 3.9.1, table 3.6 and 3.7 has encouraged further investigations into root causes regarding the disparity in quantities exported by applying a Delphi technique to gather a consensus of opinions relying on the theoretical implications mentioned above. Initially, research questions were developed to further understand underlying industry observations or heuristics established from planning the theoretical framework. In addition, the literature review assisted in determining key issues relevant to oil exportation from Nigerian upstream ports and jetties, incorporating the observed and investigated theoretical gaps. Furthermore, these theoretical gaps were utilized to develop the main research question;

> “How can SCM and integrated logistical considerations be applied in distributing crude oil from Nigeria to China?”

Also, this research question has encouraged an assessment of applicable research design and perspectives from relevant topics within the upstream segment of oil distribution which has been adopted from pattern matching; by devising a theoretical proposition that the process of crude oil distribution in Nigeria is managed with less attention for productivity in comparison to the benefits of an export oriented and systematic logistics process (Hussian et al., 2006; Chima, 2007).

Moreover, the inclusions of qualitative and quantitative assessments are essential to the gathered research data. Indeed, qualitative and quantitative methods of research complement each other, and as a result the integrated nature of the two research methods, when combined, has become popular (Tapio et al., 2011, P.1617). However, pragmatism “has often been used as the philosophical basis for mixed methodology” (Ibid). Applying a Delphi technique to solicit common opinions about the probable, preferable, and possible futures (Ibid), in a crude oil supply chain involves questioning existing systems and distribution networks, which can be categorised as both qualitative in context and quantitative in composition i.e. inherent commonalities or industry norms. Moreover, qualitative questions can be termed flexible material and interpreted in a systematic and non-systematic way (Ibid), while quantitative questions on distribution frequencies and scheduling requires statistical analysis to assure reliability, objectivity, or representativeness (Ibid). However, the compatibility of quantitative and qualitative methods of research has been regularly debated (Ibid); besides, most research approaches have been acknowledged to have their merits. For example, qualitative research has proven useful in investigating meanings and interpretations of numerous phenomena; similarly, a quantitative approach is valuable when explaining relationships between parts of studied objects (Ibid). Also, Bryman (2007, P.9) reported that mixed methods affect the design element of a study, because research findings may be misinterpreted or interpreted with difficulties (Azorin and Cameron, 2010, P.97). Moreover, the pragmatic feature of both qualitative data (i.e. non-numeric, oral, textual, or visual) and quantitative data (i.e. Numeric or countable) collections allows its application in a study or research. Furthermore, the major consideration at the beginning of a Delphi process as reported by Tapio et al. (2011, P.1623) concentrates on balancing a qualitative and quantitative approach, which includes constructing formal structures and questions for discovering both present and future states of the studied phenomena. Therefore, arguments in support of applying either a quantitative or qualitative approach depend on the current epistemological perspectives in relation to gathering data.

5.3.2 Delphi Philosophy

At present, research on the studied phenomenon is empirical. This involves gathering data from a random or selected panel of experts which a Delphi study facilitates. According to Mitroff and Turoff (1975) the epistemological positions of the researcher influences the respondents' answers to the Delphi questionnaire. An argument supported by Churchman (1971) who reported on the various philosophical perspectives of a Delphi study (Tapio et al., 2011, P.1626). These perspectives have been categorised according to the following philosophies of John Locke, Gottfried Leibniz, Immanuel Kant, George Hegel and Edgar Singer (Hammer, 2011, P.254-256). In addition, Mitroff and Turoff (1975) have also emphasised the discussions of the above philosophers in the context of a Delphi technique and the application of quantitative and qualitative data (Tapio et al., 2011). Therefore, the above philosophies were examined in relation to the present study, because their adoption should support research methodology requirements that will validate essential empirical findings.

Moreover, the first philosophy described by Churchman (1971) is the Lockean inquiry system which focuses on an inductive approach towards a possible future state (Mitroff and Turoff ,1975). These involves "mostly quantitative questions posed to a representative sample of individual experts" (Tapio et al.,2011, P.1626), and would be a "pre-treatment or a post treatment survey; where a system of dialogue on a particular issue would be indicative of possible future states and can also be measured statistically (Ibid). Secondly, a Leibnizian inquiry system is based on fact nets and emphasises theory over data, resulting in quantitative modelling, and afterwards testing it with the gathered Delphi data; an approach that allows the combination of quantitative and qualitative data, because quantitative feedback can be described as intuitive future states of variables, “the nodes of the net”, and qualitative feedback as the relations between variables “the strings of the net” (Ibid). Besides, consensus with this inquiry system would be viewed more primarily hypothetical than a reachable goal; for example, an agreement in opinion by experts on possible measures for standardization of logistics operations in between loading and discharge points for crude oil shipments can be considered hypothetical. However, alternative or plurality of opinions on one major issue would be accepted as a possible future scenario, i.e. opinions on manageable quantities of crude oil to establish consistency or regularity, rather than intermittent shipments in between Nigeria and China would serve to justify possible future states. Moreover, one view or opinion would describe the eventual course of development (Ibid), although a consensus is applicable. Thirdly, a Kantian system of inquiry combines data and theory through reciprocity in an abductive manner. Therefore, quantitative or qualitative data within this type of study should raise important aspects about the future worth considering. However, a Kantian oriented Delphi would address both probable and preferred futures (Ibid). Fourthly, a Hegelian inquiry system is based on forming a thesis and its antithesis proceeding towards a synthesis in a dialogue (Ibid). These implies that a “Hegelian Delphi study would form a plan and its counter plan, which would transcend into a new synthetic plan through discussions” (Mitroff and Turoff, 1975, cited in Tapio et al., 2011, P.1626).

Moreover, quantitative and qualitative enquiry methods for Hegel are inter-linked, because extensive change in quantity also affects quality (Ibid). Also, Mitroff and Turoff (1975) argue that in scenario studies quantitative data could be the thesis, and qualitative data the antitheses; for this study frequency of shipments, demand quantities of crude oil loaded, vessel capacity, and des-patch or shipping frequency could be considered the thesis, with logistics net-works and supply chain structures or organisation as the antitheses. Lastly, Singerian system as a fifth method of inquiry for a Delphi study assists in setting goals and builds a path towards achieving these goals. Besides, this inquiry system allows opinions and views or expectations to guide the analysis of the preferred future with the possibility to revise, based on predictable or unpredict-able situations as factors. Moreover, probability estimates from mathematical analysis, as Singer preferred may be reduced to the role of estimating the effi-ciency of reaching predetermined goals based on experience (Tapio et al., 2011, P.1626). In addition, a Singerian inquiry system offers a complete method of gathering a consensus, but the scale and categories of data to be collected can only be relevant to the aim of the research and are also interdisciplinary.

Besides, Delphi philosophies allow the researcher to construct possible images of the future through a combination of quantitative and qualitative material in da-ta collection. However, data collection is time consuming for both the researcher and panellists, and these influences the design element of the study, and the reason for adopting a classical Delphi with a Liebnizian inquiry system in gath-ering data for this study.

5.3.3 Delphi Methodology

Also, the number of Delphi rounds for an investigation was directed by the level of agreement achieved from an overall sample size of 75 respondents as explained in Chapter 4: Section 4.4.4, which included Nigerian oil industry experts and executives, as well as academics with interest in the global oil industry. In addition, oil executives were categorised according to their oil industry role or function (i.e. Group A. Managing Directors, Group B. Logistics Directors, and Group C. Operations Managers) which was effected in the dispersal of the survey i.e. batch emailing according to the respondent's role in the oil industry.

Although, Delphi participants vary in number from 4 to 345 (Skulmoski et al., 2007, P.5), the current study managed a total of 20 respondent feedbacks with 13 complete questionnaires in round one. Nonetheless, the essential characteristic of a Delphi study in application is a group size of 20 respondents to overcome individual biases influencing overall feedback from respondents (Akkermans et al., 2003, P. 290). According to Skulmonski et al., (2007) heterogeneous samples tend to have a considerable number of respondents, while homogenous samples are limited in number possibly due to the nature of the researched issue or phenomenon. Similarly, a non-probabilistic sampling orientation was adopted because the goal of the study is not only to generalise to the population of oil experts, but to obtain insights about a phenomenon by selecting individuals (experts) that will increase the understanding of that underlying phenomenon through a purposive sampling method (Onwuegbuzie and Collins, 2007, P.287).

However, a two round Delphi survey was chosen with the intention of synthesising results towards more than 60% APMO in both rounds (Dajani, et al., 1979), nonetheless, if less than 60% percent APMO was achieved on majority of the questions in both rounds, a third round Delphi would have followed to satisfy the required level of consensus on each of the issues identified (MacCarthy and Atthirawong, 2003, P.800) in table 4.3 in Chapter 4.

Although, questions were developed concentrating on the Liebnizian inquiry system, emphasising on the main requisite for efficient crude oil distribution was a paramount consideration in questioning, with reference to the present description of the Nigerian oil industry as an entity in need of major restructuring and transformations (PriceWaterhouseCoopers, 2010, P.22-25). Their impacts on export logistics are also significant with the development of a regulatory framework through the proposed Petroleum Industry Bill (PIB) to replenish and enhance the growth prospect of the Nigerian oil industry explained in Chapter 3 section 3.4.1. In addition, soliciting industry experts increases awareness on significant measures for logistical improvements. Therefore, the mixed nature of an impartial and subjective enquiry process found in a Liebnizian enquiry system appropriates this mode of questioning to effect functional opinions. Besides, questions were asked in a closed ended format with the respondents required to answer Likert-style rating scale questions (Saunders et al, 1997, P. 259). Also, this questioning process required respondents to provide feedback by "*circling one of the options provided, labelled as 'Agree', 'Disagree', and 'Unable to Commen*t". Although, in the situation were the response to a statement is 'Disagree', the respondents are requested to provide further comments on why they disagree. These comments formed the basis for the second round of questioning for questions with lower than an APMO of 60% (Cottam et al, 2004, P.14).

Moreover, Delphi researchers have discussed several forms of ascertaining agreement levels to quantify consensus amongst experts. At present most researchers rely on different measures for a consensus and they are applied after the analysis has been carried out (Von Der Gracht, 2012, P.1529). According to (Ibid, P.1528-1529) there are several methods of establishing consensus which can be categorised as either subjective analysis or descriptive statistics. However, for these study measures of central tendency and dispersion were applied for a statistical understanding of the survey's findings. Also, for consistency, the APMO and interquartile range (IQR) were calculated. Moreover, APMO enables the 59.23% (60% approximately) cut-off point to be determined using total figures in appendix **A3** from the response of experts on the overall percentage level of agreement or disagreement either to determine when a consensus has been attained or to develop further iteration of questions for subsequent rounds; until sufficient feedback is achieved. Figure 5.2 explains the formula involved in reaching a predetermined level of consensus or cut off rate.

$$\text{APMO} = \frac{\text{Majority Agreements} + \text{Majority Disagreements}}{\text{Total Opinions Expressed}} \times 100$$

Figure 5.2 APMO Cut-Off Rate Calculation (Islam et al., 2005)

Moreover, Von Der Gracht (2012, P.1530) argue that when calculating measures of central tendency, the median is a better calculation in comparison to the mean because outliers may pull or push the mean unrealistically. Likewise, the measures of central tendency can be analysed in connection with one or more measures of dispersion such as the range, standard deviation, IQR, and coefficient of relative variation (Ibid). To expound on the above, firstly the range is the difference between the lowest and highest score in a distribution (Ibid). Secondly, the standard deviation is a measure of dispersion from the mean; average distance of each score from the average. Thirdly, the IQR is the measure of dispersion for the median and consists of the middle 50% of the observations which implies that an IQR less than 1 equals more than 50% of all opinions fall within 1 point on the scale (Ibid). This measure is frequently used in most Delphi studies, because of its objectivity in interpreting consensus (Ibid). Lastly, the coefficient of variation is a standardised measure of dispersion and useful for the comparison of distributions, which is calculated as the standard deviation divided by the mean (Ibid). In addition, parametric tests were also conducted to assess the relationship between the first quarter of respondents and the last quarter of respondents in the two survey rounds.

5.4 Delphi Survey Findings

In appendix **A3** empirical observations in the first round of questioning informed that there were latent and significant opinions. These opinions reflected expert judgments on the industry's present state and in particular logistics development. Besides, most questions in round one was categorised in relation to their area of assessment i.e. theoretical areas. Also, the initial findings indicated more than 70% agreement levels from respondents was achieved from the first 7 questions, which considered the importance of SCM to the Nigerian oil industry including; related dependencies, operational elements, and efficiency requirements. Also, question 10 had an agreement level of 69.23%. However, the remaining 12 questions had varied opinions on pertinent issues that characterise the operations of crude oil logistics which influenced the overall APMO for DSR1 at 59.23%. These were questions on crude oil transportation, transport geography, information technology adoption, and contractual agreements with respondents unable to agree unanimously.

Moreover, application of a Delphi technique is considered effective when majority opinion is achieved (Rowe and Wright, 1999, P.354). Therefore, there was a need to design a second round of questioning to justify the basis of disagreement among the 13 respondents. These questions were developed on the respondent's varied opinions on each of DSR1 questions from numbers 7 to 20 in appendix **A3** and were derived from the latent feedback comments. Also questions i.e. 11, 16, 17, and 19 with low agreement levels or interest, and without feedback comments were withdrawn to allow response consistency in the second round. They were questions in regard to Nigeria's geographic location as appropriate for crude oil distribution to China, simulation methods to determine crude oil distribution, cohesiveness of logistical integration to reduce overall distribution cost for partners, and the capacity of Nigerian oil companies to fulfil the demands of COC's. Besides, alternate questions on related or similar issues were answered favourably in both rounds of questioning.

Nonetheless, the second-round feedback comments in appendix **A4** resulted in an overall APMO calculated at 64.17% or more agreement levels from 22 questions, and unlike the previous round the questions had a better agreement rate. In addition, 3 questions resulted in 64% or more levels of disagreement. For example, respondents disagreed on the lack of importance of Human Resource Management (HRM) on established SC's, and on the efficiency of crude oil SC's without effective inventory management. In addition, questions 14.2 and

15.2 on information systems required in an SC resulted in 100% of respondents unable to comment. However, four questions were split on levels of agreement and disagreement with scores less than 34% agreement or disagreement (either way). These were questions 5.3 on HRM, 8.3 on Port Infrastructure 9.1 on Vessel Capacity, and 20.2 on Nigeria's 2020 economic plan. However, because of time limitations, and the realisation of more than average number of agreements, a third-round Delphi was not pursued. Likewise, theoretical saturation had been achieved and sufficient information had been exchanged (Skulmoski, et al., 2007, P.11) especially from otherwise occupied industry experts. Furthermore, the level of respondents with completed surveys dropped from 13 to 6 in the second round with an average of 1.13 skipped questions, which implied that the panel were not as interested as in the first round, and the longevity of the survey could not have been sustained for a third round.

5.5 Delphi Result Assessments

Achieving consensus is the aim of investigating oil exportation in the Nigerian oil industry by means of a Delphi method. Initially the first round of questioning was structured from a literature review on the present issues and factors which influence major distribution decisions in the industry. Likewise, the research aim was also explored on logistical improvements to sustain efficiency in the upstream segment of the oil industry. In as much as SCM is adopted world-wide in most oil industry logistics structures the Nigerian oil industry is still at the stage of infancy in the adoption process which includes indigenous oil companies. Therefore, consensus gathering using a Delphi has allowed an assessment of essential opinions on the following:

- Information Technology Adoption

- Logistics Efficiency
- Supply and Transportation Management
- Transport Geography
- HRM
- Demand Management
- Operations Management

Furthermore, the process of questioning has relied on major authors on crude oil supply chains. These questions were appraised to influence adoption of SCM in crude oil exportation. Nonetheless, the pool of positional leaders (Hsu and Sandford, 2007, P.7) consists of three major authors. Firstly, Chima (2007) has reported on the possibility of capturing value from existing distribution operations. Secondly, Hussain et al. (2006) reports on the benefits of transport dynamics in oil distribution. Lastly, questions on the impact of information technology on distribution operations as reported by Gainsborough (2005) were also presented to respondents.

5.5.1 Delphi Round One: Panel Results

Most respondents affirmed the importance of SCM in present oil industry supply chains. Moreover, they have varied preferences in its adoption for efficiency, possibly from different operational cycles as expressed by some experts. However, the level of consensus especially from the first 7 questions mentioned above in section 5.3 with an APMO of between 92.31% and 100% suggests that the industry is awakening towards the process of logistics integration through SCM, although oil companies in Nigeria are yet to adopt logistics collaboration for efficiency.

Also, major areas of disagreement observed in the first round were on issues with respect to the implications of SCM on information management systems in questions 13, 14, and 15. On question 13 there was a split decision of 15.38 % with Nigerian oil industry respondents agreeing and disagreeing that there is insufficient application of information systems for effective distribution while 69.23% were unable to comment. Likewise, question 14 produced a similar result with 15.38% agreeing that distribution software's such as SAP were regarded by Nigerian oil executives as insufficient for distribution requirements, while 23.08% disagreed that software's such as SAP were suitable for purpose; with 61.54% unable to comment. Moreover, question 15 on applying IS systems showed that 30.77% of respondents agreed distribution visibility is a major weakness amongst SC partners, while 53.85% were unable to comment. This disparity in response encouraged further questions on information systems adoption in the second round.

Nonetheless, there were further disagreements on demand forecasting, integration, and supply management. Also, question 16 on forecasting crude oil supply requirements for a predetermined demand quantity resulted in an APMO of 46.15%, with respondents unsure on the application of forecasting systems in operations modelling. Similarly, question 17 on logistics integration had mixed results with an APMO of 53.85%. However, respondents agreed unanimously that the effectiveness of SCM in question 4 depends on integration of distribution operations with an APMO of more than 90%. Furthermore, respondent's feedback on issues of supply accessibility achieved an APMO of 46.15% in question 18. Moreover, respondents were undecided as to why Nigeria was considered a feasible supplier of crude oil to China in question 19 and were equally irresolute on procurement contract terms and their effects on sustaining future crude oil demand from China in questions 20. These results and comments from respondents were considered in relation to the survey aim of an APMO level above 60%. In addition, questions with respondent feedback were reassessed incorporating their comments to develop the second round of iteration with 40% of questions in DSR1 answered favourably.

5.5.2 Delphi Round Two: Panel Results

Moreover, iteration in DSR2 concentrated on those areas with less agreement levels. However, applying the survey's aim involved composing questions for the second-round survey by incorporating comments from respondents on areas of disagreement in DSR1. These assisted in developing 22 more questions, which were sent to the 13 respondents who answered the first-round survey questions. Also, more respondents were sought to verify similarity in opinions with the panel. Nevertheless, the second round focused on achieving a consensus of opinions from respondents who had participated in the first round of questioning.

Although, achieving an APMO of 60% in this round was a challenge, as illustrated in Appendix **A4**. For example, an APMO of 83.33% was achieved on question 5.1 to 5.3 in DSR2 on HRM, which was to discover if HRM was essential in the successful implementation and management of SCM in the oil industry.

Furthermore, APMO of 83.33% were observed on inventory management questions number 6.1 to 6.2 in DSR2 on crude oil supply chains with respondents disagreeing unanimously that you cannot have an efficient supply chain without effective inventory management. Likewise, contention in findings was only detected with questions on crude oil logistics which examined the possibility of bottlenecks in the port process, for example if increased demand for crude oil occurs from China in Question 8.1 to 8.3 DSR2. Nonetheless, 83.33% respondents were unable to comment on the adequacy of shipments between the two countries with an APMO 0.00%.

Also, for questions 8.2 and 8.3 respondents were divided in their feedback with an APMO of 50% agreeing that Nigeria could export more crude oil to China, although this may lead to bottlenecks in the export process. Also, feedback for question 9 in DSR2 showed respondents agreed that available vessel capacities were adequate for crude oil transportation with an APMO of 50%, and the panel informed that crude oil demand has surpassed available vessel capacity in question 9.2 with an APMO 66.67%. Besides, questions on Nigeria's attractiveness to supply Crude oil to China were again met with varied responses in DSR2. Moreover, the panel were unsure in question 12.1 if the quality of Nigerian crude affects demand levels from China with 83.33% of respondents unable to comment. Also, opportunities for arbitrage and domestic consumption levels achieved an APMO of 50% for questions 12.2 and 12.3 respectively.

Nonetheless, further iterations on questions number 14 and 15 from DSR1 on the impact of information technology on crude oil distribution achieved more than 60% agreement levels with an APMO of 66.67% in DSR2; especially questions on collaboration between distribution partners in a supply chain. Also, questions 14.2 and 15.2 on the incorporation of tailored electronic data interchange systems to support distribution management were answered favourably. In addition, questions 18 (DSR1) on crude oil supply management achieved 66.67% agreement levels in DSR2, which confirmed that China's interest and demand for Nigerian crude oil has a positive effect on the country's socio–economic development in question 18.1.

Besides, respondents on question 20.1 in the DSR2 recorded an APMO of 66.67% implying that strategic partnership with China is going to grow over the next decade. However, questions 20.2 to 20.4 on Nigeria's Vision 2020 plans, crude oil quality, and pricing and arbitrage opportunities to encourage stronger relationships with China recorded an APMO of 50%.

5.5.3 Delphi Results: Measures of Central Tendency

Moreover, statistical analysis of the central tendency allowed calculations on the average number of agreements from the first and second round Delphi questions. In DSR1 the respondent's median number of agreements was 5.5 from a total of 133 responses illustrated in appendix **A3.1**, while in the second round the mean was 3 from a total of 57 responses in appendix **A4**. These indicated that half the questions asked had more than 5.5 agreements each, and in DSR2 there were 3 agreements each. However, considering the difference in the number of respondents i.e.13 in DSR1 and 6 in DSR2, the number of respondents who agreed with questions asked increased to a fourth quartile range of 13 and IQR of 9.5 in appendix **A3.1**. Overall there was a higher rate of agreement in DSR1 than in the DSR2. Although, the number of respondents dropped to 6 in DSR2, and the fourth quartile range was 4; with an IQR of 2.25 agreements in appendix **A4.1**

Indeed, assessing the homogeneity of respondents using a two-tailed Fischer's exact test in appendix **A5** to corroborate results in section 5.3 entailed an identification of differences in the responses of the first four respondents and the last four respondents in DSR1, which produced a p-value of between 0.4 and 1.0 at a significance level of 0.05 predominately for questions number 1 to 11 i.e. homogeneity of respondents was not significant. However, questions 12 and 19 were considered not quite significant, while questions 13 to 18 and 20 were considered significant. These results were not in contrast to the observations made in section 5.3. Likewise, in appendix **A6** the predominate ρ-value in DSR2 was 1.0 for the first and last two respondents on each question. Moreover, in DSR2 the test of homogeneity between respondents and their outcomes (responses) were either not quite significant or not statistically significant. Also, properties from the main survey i.e. DSR1 in chapter 4, table 4.4 were identified for recommendations in Chapter 6 according to the three major theoretical constructs of the thesis illustrated in table 6.1 in Chapter 6.

5.6 Discussion

At present, China has emerged as a major developing country with substantial demand for crude oil supported by its population of 1.3 billion people (Leung et al., 2011, P.484). Nonetheless, opportunities exist for Chinese oil companies to procure from both MNCs and IDCs operating in Nigeria to support growing crude oil demand. According to EIA (2014, P.11) China's crude oil imports have increased to 6.1 mbpd in 2014 a rise of 1.7 million bbl./d from net imports in 2010, which makes it the largest oil importer in the world. As a result, Chinese oil companies are increasing investments in African oil exploration and production to ensure sustainability of supply, and Nigeria has not been exempted as a supplier. Therefore, the underlying crude oil distribution requisite and common export logistics trend in Nigeria can only be accessed through an empirical investigation of the industry's present state from a few oil industry experts.

Overall achieving consensus was the aim of applying the Delphi technique. Similarly, the possibility to ascertain the current state of the Nigerian oil industry in relation to export efficiency is also of interest. In as much as the advantage of the Delphi technique towards this research has been illustrated, five limitations were encountered during the two rounds of questioning. Firstly, the Delphi technique overstates the need for expert opinions (Sackman, 1974, P16-18). Thus, the level of information from experts may affect scientific quality criteria for transferability (Miles and Huberman, 1994) especially in situations where related topics or future studies may benefit from results. On the other hand, this statement could be disputed, because a concentration of oil industry experts, increases the likelihood of gaining insights into the logistics of crude oil exportation, rather than a complete lack of information, and besides opinions of experts are expected to differ in the oil industry, because there is a lack of uniformity in operating resources amongst oil companies in Nigeria.

Secondly, the panel composition is said to be seldom random, and may lead to manipulation by the researcher, and may also lack expert knowledge. Nonetheless, homogenous samples for this study have proven to be adequate especially when further iterations may occur. However, evolving changes in the oil industry at present especially in Nigeria has allowed response from a pool of industry experts, which also included inexpert (academic) panel with significant opinions on trends in the Nigerian oil industry. Also, the feedback received was adequate for a preliminary assessment on theoretical implications when recommending sustainable logistical procedures.

Similarly, the third limitation of anonymity could induce careless responses and consequently affect research accountability. For these study assumptions, have also been made in regards to the knowledge and experience of respondents. Therefore, feedback from some respondents were more detailed i.e. specific and topic related than the general statements of other respondents, which may be due to different levels of expertise (Altschuld and Thomas, 1991, P.187).

Consequently, this may have influenced the outcome of the survey, because in-depth knowledge increases the likelihood of identifying root causes from a consensus, and may also allow a unified solution when implementing recommendations.

Fourthly, time limitation's is a major consideration, because it took a total of 14 months to gather adequate data and conclude upon findings even though a period of six months was initially allocated with constant revisions and extended deadlines. However, the iterative nature allows slower response with the need to constantly remind respondents on a fortnight basis of the need to reply. This is linked with the fifth limitation which is the low response rate experienced, sometimes discourages further iteration (Rowe and Wright, 1999, P.358-359). However, the number of respondents for both Delphi rounds could be said to be adequate considering the issue investigated is not a general topic, but subjective towards experts or homogeneous groups with interest in crude oil exportation to China (Skulmoski et al., 2007, P.11).

Moreover, real world knowledge is often unpredictable for theoretical recommendations, and the possibility of gaining insight into the current state of Nigerians crude oil logistics can be justified not only from recent literature, but by applying the rational of Hsu and Sandford (2007, P.1) that two or more opinions are better than one opinion when gathering agreements in a Delphi survey. This is an important attribute of the technique that justifies its use in gathering a consensus on the Nigerian oil industry opinions before assessments on current distribution practises for both theoretical and feasible recommendations. Therefore, current SC and logistical trends were assessed to understand prevalent industry issues which were incorporated in the questioning process. Furthermore, this process relied on theoretical implications described by Chima (2007, P.31-33) in the study on improving SC links, which has assisted in developing questions on organisational management, resource allocations, partnerships, geographic characteristics of Nigeria as a crude oil producing country, and the possible benefits of vertical integration in distribution.

Nevertheless, agreement levels by respondents have suggested that there is a need for a further investigation on the possibility of creating efficiency through transformation of existing processes to maximise on current crude oil through-put. Also, the level of agreement on the adoption of information technology and transport systems are encouraging because respondents have recognised the current need to achieve operational compatibility in oil distribution especially in between indigenous oil companies and multinationals. This recognition enables adoption of pragmatic information systems to sustain the need for visibility in crude oil movement, because accountability of produced crude oil is currently a recurring problem (U.S. Energy Information Administration, 2012, P.5). However, respondents informed on their disagreements in regards to the configuration of information systems that will increase productivity. Besides, their disagreement should be expected considering the differing scale of operations and resource dependencies of Nigerian oil companies. Likewise, Chima (2007, P.28) confirms that the most important element in a crude oil supply chain is economics with the possibility of weighing benefits versus costs along the chain. Therefore, the studies overall aim for logistics efficiency, depends on crude oil economics especially when china's oil demand is synthesised with available supply.

According to respondents, the other major areas with low agreement levels were transport geography and infrastructural adequacy. These two areas rely on the current policies of the NNPC and their national objectives towards the country's transformation of oil ports and jetties for distribution efficiency. They were also supported with questions on vessel and port management with respondents undecided on adequate vessel capacities and the possibility of port bottlenecks based on China's increasing demand for crude oil. Although, these issues may remain a predominate problem to the Nigerian oil industry, a third round Delphi was deemed unnecessary to investigate the basis for a consensus on infrastructural improvements which may facilitate oil transport efficiency; considering the reoccurrence of similar problems in the African oil industry (PriceWaterhouse Coopers, 2010, P.4).

Another examination of the Delphi technique may be required for increased empirical knowledge and strategic implementation of distribution strategies because according to Rowe and Wright (1999, P.372) the Delphi technique has not shown clear advantages over other structured procedures for gathering an understanding about a phenomenon. However, it allows a preliminary assessment of related and important issues when attempting to identify the most prevalent problems in an industry or even anticipate future trends rather than offer a supposedly outright solution which may otherwise become irreparable or require unanticipated investments having relied on a structured approach. On the other hand, when in combination with other research methods such as a case study then the Delphi technique will prove to have allowed an elimination of irrelevant issues to encourage a concentrated effort in rectifying common recurring industry problems.

Indeed, the pool or composition of techniques available for an insight into present trends in crude oil logistics are limited and may not readily offer expert knowledge. Besides, the fragmented characteristics of the upstream segment of the oil industry will only allow a focused enquiry system on a particular issue or phenomena. Furthermore, a face to face interviewing process is almost impossible due to geographic limitations and time constraints (Von der Gracht and Darkow, 2010, P.1529). However, considering the limited number of respondents, which is not uncommon especially in recent Delphi surveys (Skulmoski et al., 2007, P.6), sufficient information was gathered from the two rounds of questioning to increase underlying knowledge of current logistical developments that will affect future crude oil demand from China.

In addition, the study's purpose is to understand how to synthesise the present characteristics of crude oil demand from Nigeria to encourage efficient export procedures. Besides, essential management of growing demand from China has allowed respondents to reasonable agree on issues that will benefit from the application of ample theories in logistics and SCM. Likewise, there is also an assurance that the overall judgement on the present state of logistics management in the Nigerian oil industry has not been assumed alone but verified with experts in the oil industry. As a result, the Delphi technique has allowed an insight into operational and strategic implications on the present state of crude oil export distribution from Nigerian ports. Therefore, future research into significant characteristics of crude oil export distribution from Nigeria will definitely benefit from the Delphi technique especially when applied with an emergent mixed research approach.

Chapter 6: Discussion and Appraisal

6.1 Introduction

Overall investigating distribution frequencies and crude oil quantities exported from Nigeria to sustain China's ever-growing interest has allowed assessments into measures to improve on export distribution consistency and vessel categories from Nigerian ports. Moreover, encouraging sustainable demand requires predetermination of quantities of crude oil to satisfy a specific export percentage target to China.

Moreover, exploring the objective reality of crude oil exports as described in Chapter 4 section 4.5.1 involves adopting Liu's (2011, P.10) dynamic SCM framework i.e. understanding the environment or nature of the industry, identifying factors of operations for Nigerian crude oil exports, analysing the frequency or regularity of shipments to China as a destination, and quantifying the performance of existing export structures to China with the possibility to systematically improve on shipment quantities from Nigeria in comparison to consistent imports from the AG.

6.2 Research Aim

Accordingly, the aim of the study is to assess the implications of applying integrated SCM to the logistics of distributing crude oil from Nigeria to China. This was achieved with the two modes of enquiry adopted which has realised convincing results. Besides results from the two Delphi survey rounds and archival study combined with the literature reviews in chapter 2 and 3 has assisted in achieving the objectives (RO1 to RO5) of the study.

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6.2.1 RO1: Identifying Components of a Crude Oil Export SC

Identifying the components of a crude oil export SC has been achieved through relevant literature on crude oil logistics combined with the results of DSR 1 and 2. It was found that SCM has become essential to crude oil logistics especially when adopting Porter's VC, because it creates a focus for both radical organizational development and improvements which support integration. However, the literature review has introduced a theoretical framework which identifies three major components of an SC i.e. Process Organisation, Vertical Integration, and Demand Variability. This was supported with expert judgements solicited in the application of a two-round Delphi survey to confirm consensus on present logistics practice in the Nigerian oil industry reported in chapter 5.

Moreover, respondent feedback from DSR 1 and 2 have verified the essential components of a crude oil export SC. For example, findings in DSR1 showed that components coded in table 6.1 below; SCOD, SCOLM, SCOM, SCOIM, HREIM, IVMLM, and IMLM were significant elements in the export logistics of crude oil to China.

Delphi One: Question Number	Codes	Observed Variable	Latent Variable
1	SCOD	SCM Operations	SCPRO
2	SCOLM	SCM and Logistics	SCPRO
3	SCOM	SCM Operation	SCPRO
4	SCOIM	SCM Operation	VEFF
5	HREIM	HRM	SCPRO
6	IVMLM	Inventory Management	DEMVAR
7	IMLM	Information Logistics Management	SCPRO
8	SFOD	Shipping Frequency	VEFF
9	VCDELD	Vessel Capacity	DEMVAR
10	SRALM	Shipping Route Adequacy	DEMVAR
11	GCOM	Geographic Characteristics	VEFF
12	SUCOD	Supply Capability	DEMVAR
13	ITIOC	IT	VEFF
14	ITCLM	IT	VEFF
15	ISVLC	Information Systems	VEFF
16	FORMLM	Forecasting	DEMVAR
17	SCOIP	SCM Operation	VEFF
18	PORISC	Port Infrastructure	DEMVAR
19	GCOLM	Geographic Characteristics	DEMVAR
20	COPCLC	Crude Oil Procurement	DEMVAR

Table 6.1 Delphi Survey Question and Codes

Predominantly, SCOD, SCOLM, SCOM, and SCOIM were considered important to SC efficacy in the upstream segment of an oil company with respondents agreeing unanimously on their benefits to the distribution process, which supports definitions of relevant authors such as Lambert (1994), Handfield and Nichols (2002), and CSCMP (2005). Likewise, questions on the operational elements and functional constructs of a SC such as HREIM, IVMLM, and IMLM recommended by Mentzer et al. (2001, P.16-17) were equally significant. Furthermore, results from DSR 2 confirmed issues about the remaining 13 questions in DSR 1 which respondents identified as essential to a successful export SC.

6.2.2 RO2: Reviewing the principles of integrated SCM and their implications on upstream crude oil distribution.

RO2 involved understanding current issues which were significant to the phenomenon under study especially VEFF. The literature review in chapters 2 and chapter 3 enabled a dual assessment of its implications to a SC, and the efficiency of both Nigerian crude oil exports and China's oil demand. Moreover, the efficiency of crude oil exports in the upstream segment of the Nigerian oil industry requires a rethink to enable adoption of appropriate theories to enhance integration. Likewise, anticipating DEMVAR in support of China's internal and external organisation for energy sustainability illustrated in chapter 3, section 3.2 benefits VEFF for crude oil export efficiency from Nigeria.

However, findings in chapter 2 section 2.4 indicate that the principle of integration in a crude oil SC depends on the determinant factors of an SC network such as information technology, visibility of best practice, customer preferences, market composition, competition, and time factors (Raman and Shapiro, 2000). Moreover, ensuring cost advantages requires continuous improvement and change which induces better configuration and coordination to allow integration (Mentzer et al., 2001). Importantly, Chima (2007, P.30) has informed that integration requires a SC to be managed in a cohesive form i.e. deciding on internal and external capabilities in an organisation as explained in section 2.4, in chapter 2. This consequently influences decisions on backward and forward integration which add value to the distribution process by maximising processes for efficiency through collaborations on demand requirements with the customer i.e. COCs in a backward integration, and reducing cost by anticipating required inventory levels for future shipments in a forward integration. Besides, organisation of structures in an SC encourages the adoption of benchmarks for optimisation and value creation which consequently sustains integration. Accordingly, Section 2.4 in chapter 2 informs of the underlying behaviour of a SC with complex and numerous moving parts, as observed by Olivia and Watson (2004, P.1). Their observation emphasises the three elements of an SC organisation i.e. strategic, operational, and tactical which are important to the process of integration, because strategic organisation improves long-term capacity planning and SC network orientation, likewise, operational organisation ensures demand management and inventory adequacy, while tactical organisation enhances VEFF by measuring and improving performance of upstream distribution of crude oil exports.

In addition, the possibility to supply crude oil consistently depends on VEFF of the exports logistics process between Nigeria and China illustrated in the conceptual model in chapter 3, figure 3.9. This integration process is influenced by Nigeria's production capacity, transport duration of crude oil exports, and transport limitations as reported by Jenkins and Wright (1998). Moreover, opportunities for logistics alliances or partnerships are not utilised in the Nigerian oil industry whereas efficiency in the upstream distribution of crude oil requires a new philosophy on collaboration and asset-optimisation (Hussain et al 2006). Furthermore, assessing organisational performance through benchmarking and enhancing logistics structures contributes towards managing DEMVAR which increases the possibility to integrate efficiently with COC's explained in chapter 2, section 2.6 and chapter 3, section 3.7.

Also, SCO of Nigeria's oil industry towards SCM integration is encouraged by China's ambitions to incorporate SCM in the logistics of crude oil imports Jiashan and Jingzhing (2005, P.835). Nonetheless, the definitions of SCM in chapter 2 Section 2.2 acknowledge that VEFF increases the competitiveness of a distribution network (Lambert, 1994, CSCMP, 2005, and Stadtler and Kilger, 2008). Similarly, Jiashan and Jigzhing (2005, P.835) show that resource disposition, cost reduction, and enhancing competitive advantages supports SCM adoption among COC's. Likewise, ownership structures, infrastructure, NSI, skill spill over and policy formations affect the possibilities of VEFF in the Nigeria oil industry as explained in chapter 3 section 3.6. In addition, Anyanwu and Erhijakpor (2009, P.104) illustrate the fundamentals of SCPRO when sustaining an integrated SC by examining the three component factors of competitiveness i.e. factor driven, secondary factors; efficiency enhancers, and tertiary factors; innovation and sophistication elements. Finally, Al-Moneef, (1998) reports that value creation, enhancing organisational growth strategies, as well as encouraging strategic alliances are major advantages of incorporating the principles of integration in the Nigeria Oil industry; explained in chapter 3, section 3.8.

6.2.3 RO3: Analysing the demand for Crude Oil in China and its supply from Nigeria

Findings for RO3 have been motivated by China's emergence as a major developing country with substantial demand for crude oil supported by its population of 1.3 billion people (Leung et al., 2011, P.484). Besides, a finding of the literature review in chapter 3 section 3.2 informs that in 2004 China imported

123 MTOE which has increased to 308 MTOE in 2014. This creates opportunities for MNCs and IDCs operating in Nigeria to contribute towards the growing import demand levels of COC's. Additional investigation in figure 3.9 in chapter 3 indicate that China's demand for crude oil has exceeded Nigeria's overall imports at an average of 78 MTOE a year since 2005. Before 2004, Nigeria exported more crude oil than China imported.

Moreover, SIN data between 21/06/2013 and 21/12/2013 informs that China imported a total of 321 shipments in the two vessel categories used i.e. VLCC and Suezmax in appendix **C1.1** to **C6.7**. This consisted of 309 VLCC and 12 Suezmax shipments from three departure points investigated i.e. Nigeria, WA (Group Export), and AG. Besides, the total number of BBLS shipped to China was 84,084,998 (BBLS) which included 130,000 (BBLS) (Suezmax) from Nigeria, 650,000 (BBLS) (Suezmax) from WA, and 1,324,998 (BBLS) (Suezmax) from AG. In addition, 19,500,000 (BBLS) (VLCC) from WA and 62,480,000 (BBLS) (VLCC) from AG were imported by China during this period. These results are equivalent to a single shipment from Nigeria, 80 shipments from WA and 240 shipments from AG. As a result, China's demand for crude oil is neglected by Nigeria when compared to other West African countries and AG for the period of study. Besides, in chapter 3 figure 3.12 which illustrates Nigeria's exports to China in the last ten years supports the findings of the archival study with crude oil exports to China at between 0.43 to 1.7 MMTOE from 2003 to 2012. Moreover, in 2012 the direct export volume of crude oil from Nigeria to China amounted to less than 1% of the total volume of crude oil imported by the country at 0.39%.

6.2.4 RO4: Analysing the efficiency of the logistics of distributing crude oil exports from Nigeria to China

Furthermore, analysing the efficiency of the logistics of distributing crude from Nigeria to China has been identified as lower than anticipated in comparison to other export sources in section 6.2.3 above. This informs that the current export volume to China is not as sustainable to NNPC as exports to the Far-East in figure 3.11 in chapter 3 including other countries illustrated in appendix **B2**.

However, the level of efficiency using the volume of crude oil exports to the Far-East from Nigeria between 2003-2012 is considerable with an average export of 17.79 MMTOE compared to Chinese exports from Nigeria at an average of 0.85 MMTOE for the same period. Likewise, the capacity of the MNCs and IDCs were evaluated in Chapter 3 figure 3.7 which shows that Nigeria's export volume of crude oil between 2003 and 2012 was an average 118.10 MMTOE compared to China's average demand of 179.5 MMTOE which is 65.79% of China's import requirement for the same period.

In addition, in section 3.9.2 Chi-Square test was used to determine the relationship between departure, destination, and vessel size from the SIN data. These relationships were determined using the most frequent crude oil destinations; China, India, UK, USA Gulf, Far East, South America, Europe, and WA against the most regular departure points WA, Africa, and AG including Nigeria as a point of study. Nevertheless, results show that the relationship between vessel size and destination of shipments had a significance of 0.004 ($P < 0.05$) which informs that the two export factors were independent i.e. the size of the vessel has no influence on the destination points described in Chapter 3, section

3.9.2.1. Likewise, in section 3.9.2.2 the relationship between departure and destination point was also independent with a result of .031(P < 0.05); which is similar with the interpretation of the previous result i.e. departure points do not determine destination of shipments. However, further test show that the relationship between WA and AG the two most regular departure points when grouped and evaluated with five frequent destinations i.e. China, Far East, India, UK and USA were not independent unlike the previous chi-square test results. This showed a result of 0.876 (P > 0.05) i.e. the regularity of shipments from the two departure points affects five destination points illustrated in table 3.10 section 3.9.2.2, and appendix **D 7.3a**.

6.2.5 RO5: Assessing the strategies that could raise the efficiency of the logistics of distributing crude oil exports from Nigeria to China

Strategies to increase the level of efficiency of crude oil exports between the two countries rely on the frequency of current shipments. In section 6.2.1 regarding RO1 the three theoretical constructs were acknowledged as important components of a crude oil SC i.e. VEFF, DEMVAR, and SCPRO. Moreover, the endogenous outputs have identified relevant areas for strategic recommendations especially SCPRO mentioned above in Section 6.2.1. Although, DEMVAR and VEFF are both operational and tactical their influence on SCPRO to raise the strategy of crude oil distribution is also significant and evaluated in section 6.2.3. Besides, Nigeria does not currently export adequate quantities of crude to China directly as observed in section 6.2.3, even though there is a correlational fallacy that China’s need for sustainable crude oil supply from African countries will cause increasing volumes of crude oil to be exported from Nigeria.

Incorporation of SCOM in the Nigerian oil industry will require SCPRO to materialise the recommended strategies of Chima (2007, P.33) illustrated in Chapter 2, section 2.4, and explained in section 6.2.2. Likewise, the incorporation of both primary and secondary factors of competitiveness described in section 3.6, chapter 3. In addition, achieving SCPRO will rely on initiating the IDEF0 transformation model of Chidambaram et al. (1999) within organisations exporting crude oil from Nigeria explained in chapter 2 section 2.4. SCOD identifies the significance of SCO on the logistics of distributing crude oil. Besides, observations of Olivia and Watson (2004, P.1) in Chapter 2 section 2.4 will allow sustainable processes for optimization and value creation achievable through strategic, operational, and tactical planning of the Nigerian crude oil export SC.

The importance of HRM on an export SC is noteworthy. This variable incorporates its importance through the PIB in Chapter 3.section 3.5.1.1 on operations transparency, and as a secondary activity in a VCS its effectiveness is paramount towards not only successful implementation of the conceptual framework, but the sustenance of an integrated strategic logistics network (Gowen and Tallon, 2003, P.37).

Fourthly, IVMLM shows the significance of inventory management in a crude oil export SC. Nevertheless, it is a variable which depends on demand patterns of customers to be effective explained in chapter 2 section 2.6. This strategy is realised with the key drivers of a SCM network advised by Raman and Shapiro's (2000) in chapter 2 section 2.4 for a reciprocal and responsive SCM. Also, strategic organisation of IVMLM has both short-term and long-term implications when anticipating demand from China, which also influence the other two exogenous variables examined in Chapter 2 and 3 i.e. DEMVAR and VEFF. Furthermore, the above has enabled succinct strategic recommendations for practice i.e. industry in section 6.2.3 guided by the revised conceptual framework to improve a crude oil export SC between Nigeria and China.

6.3 Implications for Theory

From the literature reviews in chapter 2 and 3 it can be observed that increasing existing knowledge on a phenomenon using established theories enables an understanding of the constructs of that phenomenon (Chen and Paulraj, 2004, P.120). Similarly, the three-distinct theoretic framework i.e. SCPRO, DEMVAR, and VEFF and their implications on China's crude oil demand and Nigeria's capacity to supply identified in the above chapters are significant towards achieving the objectives of this study.

Moreover, the two dominant theories of Lambert and Cooper (2000), and Raman and Shapiro (2000) were significant towards achieving SCPRO in distributing crude oil exports to China from Nigeria. For example, Lambert and Cooper's (2000) contribution supports a thorough appraisal of elements which directs the cause of a study towards realising the benefits of SCM in auditing and augmenting existing logistics structures in Nigerian Crude oil SC's to create manageability and efficiency. Likewise, they advocate a holistic approach towards SCPRO which is applicable to most industries.

However, the present study has isolated each identified level of logistics activity within an SC framework to ensure accountability. In addition, theories by Raman and Shapiro (2000) encourage Nigerian oil industry participants to progress from basic process or stable organisational cultures into responsive cultures moving from Stevens's (1989) stage one gradually through all stages to stage four ensuring the ever changing structures and demands of existing markets are adapted to organisational decisions. However, a probable extension of their theories has been realised with the inclusion of strategic, tactical and operational decisions in the revised conceptual framework in section 6.5 which are required capabilities in an organisation to facilitate recommended transitions.

In addition, a major aspect of crude oil distribution is addressing variable demand levels which has been identified by Chima (2007, P.34) as a recurring problem. Therefore, postponement strategies advised by Pagh and Cooper (1998) can be adopted in crude oil distribution by anticipating crude oil inventory at particular points in the logistics network to satisfy Chinese demand from Nigerian oil producers. This strategy is relevant to sustaining crude oil supply reliability and ensures that China's need for energy security is met. Moreover satisfying demand variability involves incorporating recommendations by Chima (2007, P.34) on external and internal capabilities of existing crude oil export logistics needed to influence efficiency.

Lastly, the requirement for VEFF relies on recommendations by Raman and Shapiro (2000) which include visibility in the export logistics process. Moreover, Olivia and Watson's (2004) theory on SC behaviour has identified the need for continuous appraisal of SC systems for efficiency. This compliment adoption of the three levels of configuration and coordination in an SC i.e. strategic, tactical, and operational; incorporating planning and measurement criteria are operable through internal and external export logistics audits.

6.4 Implications for Policy

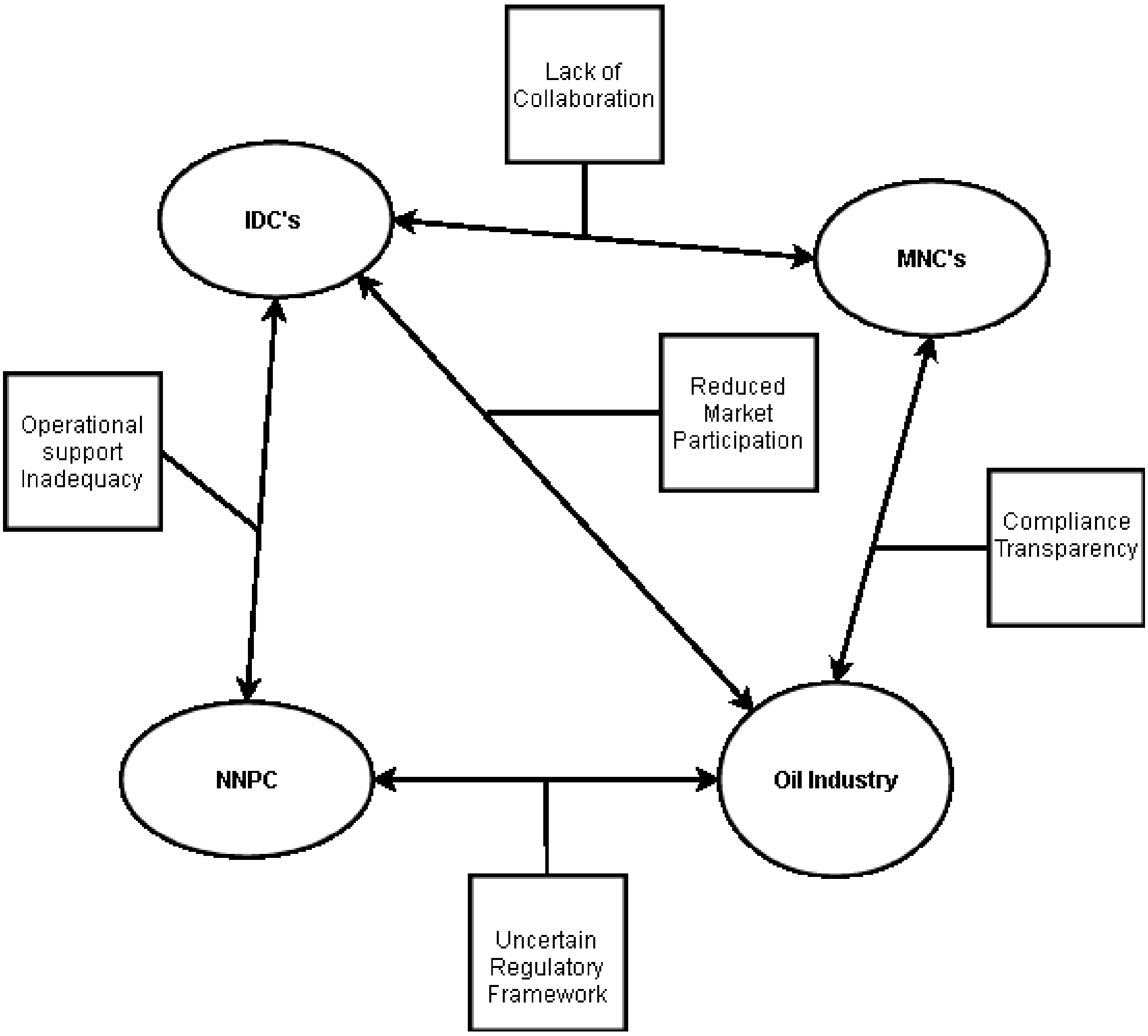


Figure 6.1 Policy Issues: Implication on Industry Participants

Major policy issues identified in chapter 3, sections 3.5 and 3.6 and the results from respondents who replied in DSR1 and DSR2 in chapter 5 section 5.4 are essential in sustaining Nigeria's economic development when exporting crude oil to China are described in figure 6.1 above i.e. uncertain regulatory framework, compliance transparency, operational support inadequacy, reduced market participation, and lack of collaboration.

Firstly, regulatory uncertainty in the Nigerian oil industry is a continuous operational problem. These affect export operations including all endogenous variables identified and related China's crude oil exports to China. However, there is a need to gear oil export policies towards the logistics requirements of importing countries to encourage certainty in export outputs. For example, COC's have a need to import specific targets of crude oil on a weekly, monthly, and yearly basis, with a requirement to enforce certainty in distribution quantities when reacting to DEMVAR. Therefore, oil export policies in response to the effect of DEMVAR will concentrate on the following areas according to the Delphi respondents;

- Inventory Management: allocation of export quantities to fulfil a predetermined target of exports on a scheduled basis for consistency in crude export capabilities.
- Supply Capacity: sustainable allocation of yearly crude oil production quantities by establishing quotas per country of exports. This enables adequate response to contractual obligations especially with Chinese oil companies.
- IT/IS Standardization: Information technology is a conduit of business processes which ensures the flow of information between export functions in an SC. However, there is an overriding requirement in the Nigerian oil industry for a uniform IS to enforce SC accountability in the distribution systems and promote SCO. Also, this factor for oil exports provides visibility to all participants when exporting crude oil to China.
- Port Infrastructure: Accessibility to national port structures is vital to SC efficiency. A joint policy initiative between NNPC and NPA with respect to Crude oil export prioritization will alleviate export disadvantages such as lead-time

fluctuations and demurrage. It is also advised that procedures in relation to port systems are incorporated in a joint initiative to support VEFF.

- Procurement Standardization: will benefit all participants especially IDC's with the need to increase involvement in crude oil exports to countries such as China. Moreover, development of standard procurement procedures will support IS to increase efficiency in the management of export throughput.

Furthermore, operational responsiveness in the Nigerian oil industry requires energy policies to focus not only on the holistic aspect of a regulatory framework, but according to Hunter (2014, P.57) there is a necessity for an objective or principle-based policy framework on the tangible factors mentioned above which impacts the operation of DEMVAR. Also, it supports sustainable SC operations for exports to China.

Secondly, encouraging compliance transparency by NNPC will also lead to increased oil industry participation and efficiency for both MNC's and IDC's as advised by Nwokeji (2007). According to African Business (2012, P.38) NNPC is one of the least transparent companies in the world. Therefore, introduction of the PIB in chapter 3, section 3.5 with independent units of operations for policy formulation, government regulations, and commercial operations monitoring will sustain SC operations if dedicated crude oil export compliance regulators were introduced. This will enable a more responsive policy framework to serve the ever-changing oil market demands and structures (Al-Moneef, 1998, P.207).

Thirdly the capacity of MNC's to dominate Nigerian oil exports surpasses the capabilities of IDC's to sustain participation in oil exports to China due to lack of sufficient support from NNPC. Their capacity to produce more crude oil ensures their preference over IDC's when considering policy issues in the oil industry. However, the requirement for local content in the Nigerian oil industry through the PIB will eventually increase IDC support from NNPC through oil export directives. As a result, Nigerian oil export policies should enforce compliances that will enable sustainable participation of IDC's by creating benchmarks for functional operations involved in oil export logistics. This permits standardization of processes concentrating on potential domestic oil export outputs and not an organisation's exploration and financial capacity to operate in the industry.

Fourthly, participation of IDC's is also reduced because they have lesser institutional capacity and limited ownership of crude oil export infrastructure. This could be improved with support from NNPC through the PIB and policies to sustain and invest in accessible export ports and terminals to reduce reliance on the resources of MNC's. Likewise, collaborative policies to encourage joint export ventures between NNPC and IDC's, comparable to those with MNC's, should be introduced in support of increasing sustainable exports to countries such as China.

Lastly, export partnerships between participants in the Nigerian oil industry are still not elaborate, although there is scope for increased export volumes to countries such as China through joint export initiatives. For example, collaboration between MNC's and IDC's could enable marginal increase in exports to China examined in RO4. These initiatives can possibly be realised when incentivised by NNPC regulations in the form of tax concessions and concise export procedures. Similarly, investment and participation in Nigerian crude oil inventory by COC's can also increase partnerships with both MNC's and IDC's, which is realisable when policies encourage long-term export initiatives with importers and are focused on enhancing VEFF.

6.5 Implications for Practice

Findings in sections 6.2.1 to 6.2.5 above have consequences for the conceptual framework recommended in chapter 3, table 3.9. Besides, the component phenomena described in chapter 4, figure 4.2 have identified the philosophical nature of the study. Likewise, interrelated events and processes for efficient crude oil export logistics to China have assisted in developing and improving on the conceptual framework (Lambert and Cooper, 2000, P.69). Overall the findings above have significant implications for the three areas important to the theoretical constructs of the study which have also been identified by Lambert and Cooper (2000, P.80-81) as important to the strategic, operational, and tactical organisation of logistics business processes to encourage crude oil export efficiency to China illustrated in the revised framework in figure 6.2 below.

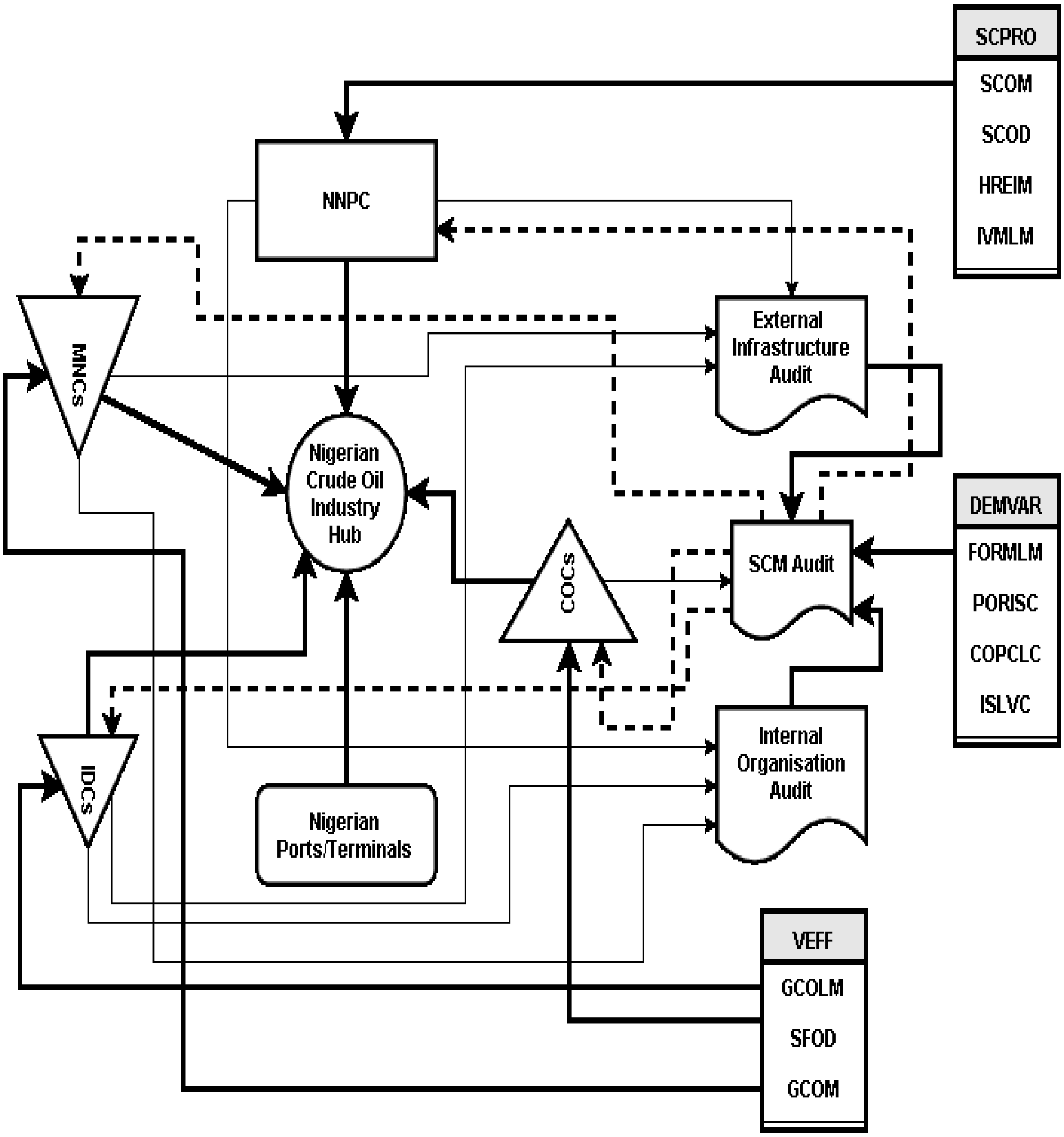


Diagram Symbols

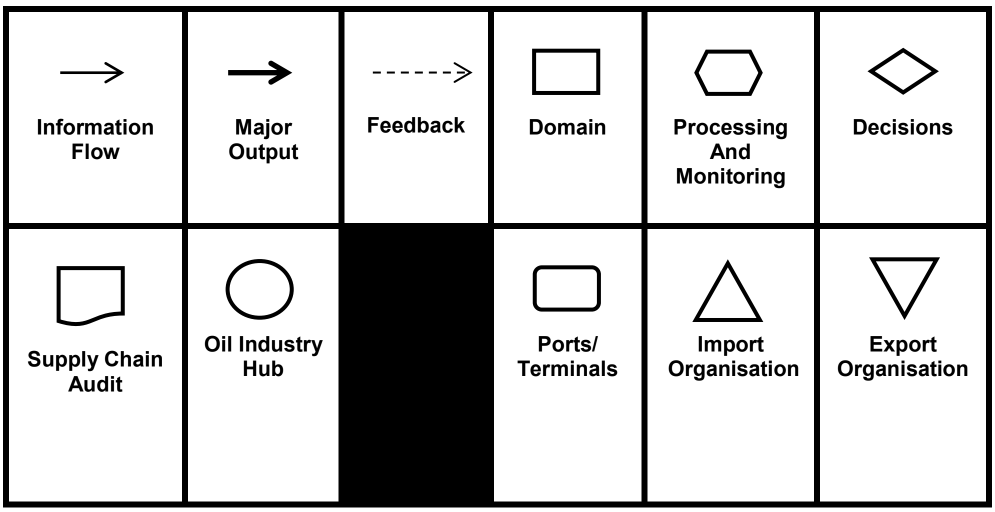
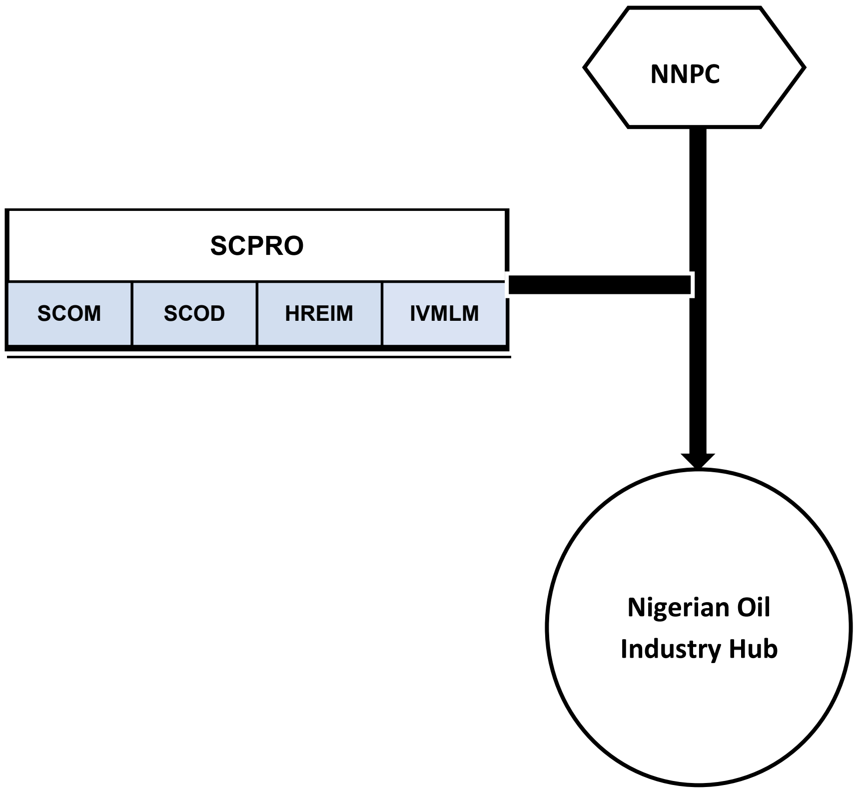


Figure 6.2 Revised Conceptual Framework

6.5.1 Strategic Organisation



Codes	
SCPRO	Supply Chain Process Management
SCOM	Supply Chain Management Adoption
SCOD	Supply Chain Management Significance
HREIM	Human Resource Management Effectiveness
IVMLM	Inventory Management Efficiency

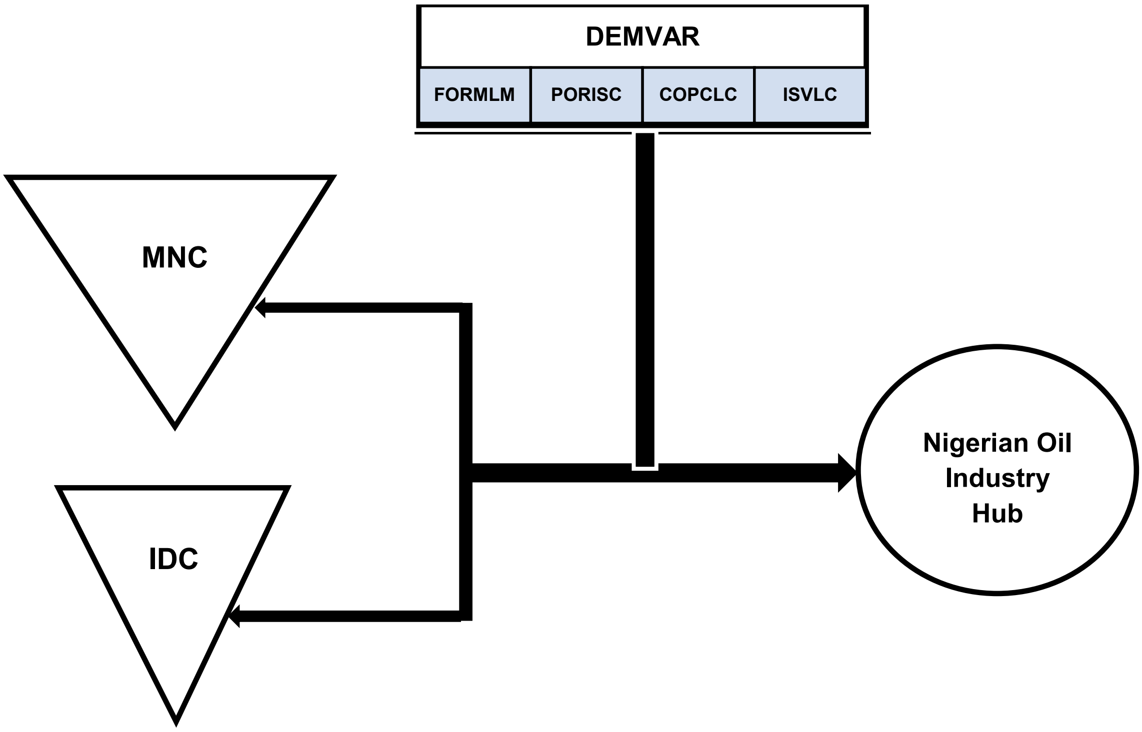
Figure 6.3.1 Strategic Recommendations for Oil Logistics Practice

According to the findings in RO4 there are significant strategic implications for the existing practice of crude oil export logistics to China. This will encourage a reorganisation of the four variables identified as essential towards an effective crude oil export process. These variables are SCOM, SCOD, HREIM, and IVLM in figure 6.3.1 above.

Mainly, incorporation of SCOM in the Nigerian oil industry will require SCPRO for export logistics of crude oil to China. This requirement will depend on the recommended strategies of Chima (2007, P.33) illustrated in chapter 2, section 2.4.

Secondly, SCM in upstream oil distribution (SCOD) also depends on the SCPRO of Nigerian oil industry participants in the adoption of SCM for crude oil export efficiency to China; recognising the interdependent nature of a VCS as reported by Handfield and Nichols (2002). Thirdly, the variable HREIM indicates prevalence of HRM to effect efficiency in an oil industry SC. Similarly, competences in HREIM dictate the effectiveness of functions and processes within the revised conceptual framework to maximise on SC efficiency. Lastly, IVMLM is a variable which depends on demand patterns of customers to be effective. Also, strategic organisation of this variable involves planning for both short-term and long-term crude oil import demand from China.

6.5.2 Operations Planning



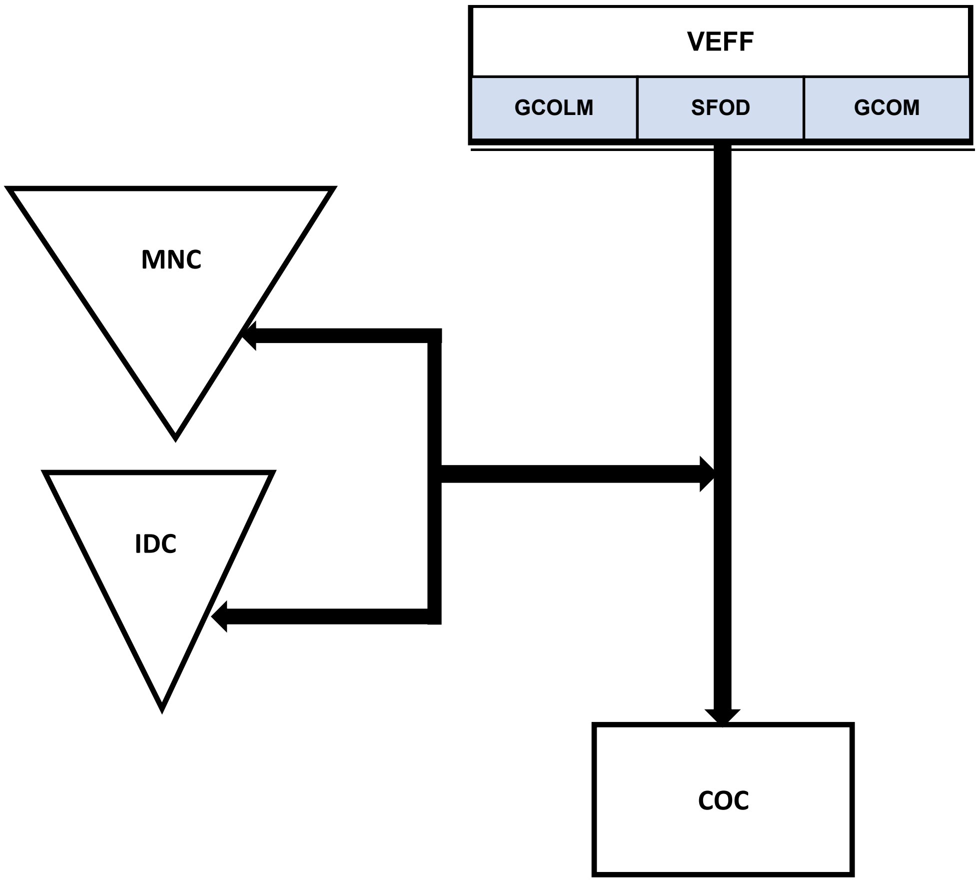
Codes	
DEMVAR	Demand Variability
FORMLM	Forecasting
PORISC	Port Infrastructure
COPCLC	Contract Agreements
ISVLC	Information Systems Visibility

Figure 6.3.2 Operational Recommendations for Crude Oil Export Logistics Practice

Similarly, recommendations for operational planning to manage demand variability in exporting crude oil to China from Nigeria has also identified four factors to raise the efficiency of crude oil exports illustrated in figure 6.3.2 above i.e. FORMLM, PORISC, COPCLC, and ISVLC.

Firstly, FORMLM advocates the use of statistical models to forecast demand characteristics of crude oil imports of COCs to merge with crude oil export ouputs of MNCs and IDCs which augments VEFF. This will support IVMLM in section 6.5.1 by enabling adequate inventory levels at strategic locations in the SC thereby sustaining overall demand levels in the short, medium, and long terms. Secondly, accessibility of supply is the major advantage to China of procuring oil from Nigeria and is affected by port infrastructure and supply adequacy (PORISC). Moreover, enhancing this element of the study will ascertain regularity of vessel movements between the two countries, and may also encourage a joint crude oil export initiative between NNPC and NPA to increase accessibility and frequency of exports. Thirdly, according to findings in section 6.2.1 (RO1) sustaining the distribution relationship between Nigeria and China will depend on the precise demands specified in oil procurement contracts from China (COPCLC). As a result, the impact of international trade risks will be important to COC's when procuring crude oil from Nigeria over a predetermined period. Lastly, improving information management systems for oil distribution visibility with all partners (ISVLC) is significant for the successful implementation of SCM in the Nigerian oil industry. Moreover, reformations in the industry proposed by NNPC and reported in chapter 3, section 3.5.2 will be better achieved with sufficient visibility in the SC of crude oil export logistics to China.

6.5.3 Tactical Recommendation



Codes	
VEFF	Vertical Integration for Efficiency
GCOLM	Geographic Demand Responsiveness
SFOD	Shipping Frequency
GCOM	Geographic Market Responsiveness

Figure 6.3.3 Tactical Organisation for Crude Oil Export Logistics Practice

Also, recommendations for the tactical organisation of crude oil logistics to encourage VEFF for exports to China has identified three factors which are GCOLM, SFOD, and GCOM in figure 6.3.3 above. Initially, GCOLM identifies the importance of Nigeria as a preferred supplier of crude oil depending on the country's ability to comply with the demands of COCs. This will require incorporation of recommendations in section 6.5.1 and 6.5.2 for the management of SCPRO and DEMVAR to develop on competitive advantages.

Secondly, SFOD assesses the adequacy of crude oil shipments from Nigerian ports to China. This has been examined in sections 6.1.3 and 6.1.4. with results informing that at present Nigeria's export to China is limited especially in comparison to other countries. Besides, introduction of SCOM as a strategy towards orientation of Nigerian crude oil export logistics will support VEFF. Likewise, COPCLC in section 6.5.2 should be enhanced with COC's for long-term supply agreements. Thirdly, GCOM investigates the advantages of WA as an appropriate location for crude oil export to China. This follows recent trends reported in chapter 3 section 3.3.1, and on how well IVMLM in section 6.5.1 is controlled to meet the demand requirements of COC's.

6.6 Limitations

Although, the research design was appropriate to answer research aims and objectives there were three major limitations of the study. These were insufficient literature on the research topic, access to organisations or data of actual export logistics records, and the adopted research design. Presently, literature on oil industry issues concentrates on three elements i.e. the history and dominance in oil production and exploration, socio-economic and environmental analysis of the oil industry, and operations modelling in the midstream segment of the industry, which investigates quantitative issues to eliminate process deficiencies in production cycles. However, distribution or logistics of crude oil as a fundamental requirement in the movement of production outputs has limited exposure especially in SCM, logistics, and distribution journals, and are restricted to individual efforts in the form of university dissertations, thesis, unique research papers, and publications originated between 1970 and 1990 i.e. Teece (1976) and Levin (1981). Secondly, there was limited access to actual export logistics records of NNPC, MNCs, and IDCs. This would have assisted investigations on types of crude oil exported; daily production outputs, historical inventory levels, monthly export quantities, procurement and supply contracts, export procedures, and despatch frequency at terminals and ports. Also, the possibility to chart export processes and examine factors that undermine export efficiency using a case study approach was lost for the same reasons which altered the research design to include an archival approach.

Thirdly, adaptation of research design to satisfy the study aim has primarily benefited from the application of a Delphi survey. Moreover, major constructs of an oil industry SC have been examined especially from respondents involved in the export distribution of crude oil from a developing country such as Nigeria. However, the disadvantage of a Delphi survey is that limited number of responses in comparison with questionnaire surveys does not sufficiently allow further statistical assessments when trying to identify operational issues that may yield incremental efficiencies in distribution operations i.e. causation, categorisation, prediction, and diagnosis. Nevertheless, the aim of the study is to assess the implications of applying integrated SCM for the logistics of distributing crude oil from Nigeria to China, which has been guided by the research question and objectives set in chapter 1 section 1.2 to achieve the findings in section 6.2.1 to 6.2.5.

6.7 Summary

In conclusion, the findings in this chapter have elucidated on the empirical outcomes of the research process and their implications to the identified theoretic constructs of the study. This has been guided by the research objectives formed in conjunction with reports by PriceWaterhouseCoopers (2010, P.5) that reliability of African oil companies depends on the development of socio-economic factors which hinders SC and logistics efficiency. Nonetheless, RO1 has allowed an identification of 11 variables in the adopted areas of theoretic relevance i.e. SCPRO, DEMVAR, and VEFF with corresponding strategic, operational, and tactical implications to the aims of the study. In addition, RO2 has relied on the literature review in chapter 2 to increase awareness on the required constituents of an SC when encouraging VEFF in the Nigerian oil industry. Moreover, present structures in the industry and China's need for energy security in chapter 3 has allowed identification of operational factors which may initiate upstream crude oil export integration between the two countries. Similarly, in RO3 China's demand characteristics for crude oil imports in comparison to Nigeria's capacity to supply has shown that present export volumes to China are minor for the period 2003 - 2012. Likewise, RO4 investigating the efficiency of the logistics of distributing crude oil to China has informed that although crude oil exports to China is limited from Nigeria, yet there is still a consistency of shipments to the Far East from Nigeria ports predominately from MNCs. In addition, export factors such as vessel size, destination, and departure points were assessed for their contributions to the frequency of shipments in support of recommendations to increase exports to China from Nigeria. Nevertheless, findings in RO5 have been influenced by the findings of RO1 which components in the form of factors identify strategic, operational and tactical constructs. Furthermore, the implication of the findings in section 6.3 to 6.5 on improvements to theory, practice, and policy produced significant guidelines towards the realisation of an integrated SC for the export distribution of crude oil to China from Nigeria. Also, the study limitations which were beyond the control of the researcher and described in section 6.3, encouraged triangulation of the findings of DSR 1 and DSR 2 with the archival strategy in chapter 3 section 3.8 to justify the studies aims and objectives.

Chapter 7: Conclusion

7.1 Introduction

Investigation into how SCM can be applied to crude oil exports from Nigeria to China suggests the application of an integrated logistics framework to support export distribution consistency. A theoretic framework to justify the research process is illustrated in chapter 2. This includes understanding of SC definitions, organisation, and structures that influence the transformation of crude oil export logistics, and measures to improve the performance of an SC. Further, pertinent socio-economic issues that affect the logistics of crude oil imports by China and its exports from Nigeria were examined in chapter 3 together with their relevance to the study's theoretical framework. This has allowed the organisation of a research design to justify the objectives of the study described in chapter 4. Also, exploring objective reality of crude oil export in combination with the dynamic nature of a SCM framework (Liu, 2011, P.10) has induced triangulation of the aims of the study applying both a Delphi survey and an archival study as research methods. Nonetheless, the results from the two round Delphi surveys were not only sufficient to clarify expert opinions on Nigerian crude oil exports particularly to China, but also assisted in validating the strategic, operational, and tactical orientation of the study's findings. Similarly, oil shipment data from NNPCASB and SIN in a 6-month archival study has informed on the regularity of shipments from Nigeria and the frequency of exports to China from world oil ports. Results from DSR1 allow clarification of the relevant elements required in sustaining export distribution of crude oil to China from Nigeria. Similarly, DSR2 has substantiated agreements from experts on contentious issues in DSR1. Moreover, the SIN data has encouraged a further statistical assessment on the relationships between departure, destination, and vessel size in the form of a chi-square test. Furthermore, the exploratory nature of the study has been justified by the research design adopted to answer the study aims, objectives, and research question.

7.2 Research Objective One

For RO1, the three objectives of the study were identified with the component factors suggested as suitable to support the strategic, operational, and tactical requirements of the study in support of an integrated SC. Besides, the unanimous agreement of respondents on the importance of SCM in the logistics of crude oil in Nigeria is encouraging with the possibility that this will influence NNPC, MNCs, and IDCs to direct resources into its incorporation across the industry. However, from the findings in section 6.2.1, VEFF the geographical location of Nigeria is an advantage to crude oil exports from the WA region. This construct requires NNPC to direct more contractual and logistical efforts to benefit from increasing crude oil export volumes to China comparable to those exported to the Far East from Nigeria illustrated in section 6.2.4. Also, DEMVAR as a recurring logistical problem depends on the structure of both internal resource capabilities of the exporting organisation, and external alignment of the industries export logistics structures to increase responsiveness and visibility in the SC. Moreover, SCPRO creates an awareness not only on the requirement for SC adoption in the Nigeria oil industry, but also on two major attributes of a crude oil SC i.e. the implications of appropriate HR to actualise distribution strategies and organisation of crude oil inventory to satisfy the demands of crude oil export logistics to China. Together the above components allow a concentration of internal and external resources to increase the competitive advantage of Nigeria’s crude oil exporting capabilities to China.

7.3 Research Objective Two

The components identified in section 6.2.2 are essential to the integration of a crude oil SC, because SCPRO, DEMVAR, and VEFF are facilitators of integration. In addition, recommendations by Chima (2007, P.29) cannot be ignored because of the observed need for a cohesive crude oil distribution network between China and Nigeria. Importantly, SCPRO assists in orientating the Nigerian oil industry to adopt SCM in the distribution of crude oil applying the four elements identified in section 6.2.3. Similarly, incorporating SCO ensures resources i.e. DEMVAR is configured and coordinated to increase crude oil export collaboration among industry participants; on production planning, transport durations, and transport limitations advised by Hussain et al (2006, P.91). This should increase the sustainability of export capacity planning by NNPC. Furthermore, VEFF requires NNPC to appropriate policies and regulations to increase the integration of commercial activities recognising the needs of COCs in the adoption of SCM for stability in resource disposition. Likewise, encouraging reduction in cost through export logistics partnerships, and enhancing competitive advantages in the allocation of inventory for exports to China will contribute towards VEFF between Nigeria and China.

7.4 Research Objective Three

Analysing the demand for crude oil in China required appraising the data from SIN for the frequency of exports to China from world crude oil sources. Likewise, Nigerian crude oil exports to China were assessed applying data from NNPCASB. Moreover, results in section 6.2.3 show that China imports considerable crude oil from AG and other West African countries excluding Nigeria. Therefore, supply and exploration agreements signed in the past reported in chapter 3 section 3.2 have not realised sizable exports over the years. However, similar agreements with countries such as Angola, Congo, and South Sudan have seen an increase in crude oil imports by China reported in Fig 3.2 in Chapter 3. Although, AG has considerable crude oil inventory and is the world lead in oil exports, but NNPC still has the potential to satisfy China's need for energy security which can be realised through a reappraisal of the strategic, operational, and tactical implications of its potential to Nigeria's crude oil export stability with an additional emphasis on the present decline in US crude oil imports from Nigeria. This should lead to improvements in long-term export contracts with the possibility to satisfy a predetermined demand level of China's crude oil imports.

7.5 Research Objective Four

Similarly, analysing the logistics of distributing Nigerian crude oil exports to China has been compared with Nigerian exports to the Far East in Chapter 6, Fig. 6.3. Besides, the regularity of shipments to the region recognises the capability and capacity of NNPC to satisfy demand requirements of COCs at the same level as other Far-East destinations. Although, the level of exports to China at present is 4.8% of the total volume exported to the Far-East for the period of 2002- 2013, it is still apparent that the level of crude oil export efficiency to the region is high enough to support an increase in exports to China. In addition, the joint capacity of both MNCs and IDCs show that there is an overall capacity to supply up to 66% of China's crude oil imports, however contractual agreements with other world importers will involve appropriating crude oil inventory to satisfy planned export demand levels to China.

Indeed, the examination of the relationship between vessel size, departure, and destination points shows that WA like AG as a crude oil export region is important to the export demand of five major countries examined which includes

China in section 6.2.4. Therefore, the efficiency of exports from Nigeria as a WA country will be sufficient to promote increased exports to China which serves the interest of NNPC with the possibility to support required export inventory with both MNC and IDC outputs.

7.6 Research Objective Five

Lastly, the three constructs of the study have assisted strategic recommendations to raise the efficiency of crude oil exports from Nigeria to China illustrated in figure 6.6 in chapter 6. Also, this has been supported with operational and tactical recommendations discussed in section 6.5. Nonetheless, of the three constructs SCPRO is the primary variable for the strategic implementation of an integrated SC, because it supports SCO in the organisation of Nigerian crude oil logistics. Consequently, the interrelationships between industry participants will predominately affect resource planning of crude oil exports to China. Nonetheless, Chima's (2007, P.33-35) eight strategies assist in raising the organisation of logistics planning with the following applications:

I. Segmentation of Chinese procuring oil companies by monthly and yearly demand quantities is sustainable with contractual obligations from NNPC i.e. short, medium, and long-term contracts. In addition, crude oil export productivity is supported through segmentation with the possibility to anticipate variable demand levels by forecasts.
II. Customisation of a crude oil logistics network to satisfy monthly demand levels of COCs enhances accessibility and export delivery scheduling. This will enable domestic strategic alliances for the development of a collaborative export logistics system for crude oil distribution between Nigeria and China.

III. Also, monitoring integrated logistics performance through a continuous feedback system augments VEFF.

IV. DEMVAR and VEFF are managed adequately with increased domestic and external crude oil logistics and procurement partnerships to fulfil predetermined demand quantities and cycles (Stadtler, 2005) encouraged through the PIB for operational transparency and sustainable growth.

V. NNPC collaboration with strategic crude oil replenishment planning of Chinese refineries is recommended. This will assist in realising postponement or speculation strategies for increased responsiveness, including a reduction in adverse DEMVAR (Pagh and Cooper, 1998). Also, introduction of both SCO and VEFF should assist in supporting NNPC and IDC growth strategies in the Nigerian oil industry, because it encourages cooperation with Chinese oil refineries to supply according to refinery plans for over a long period of time (5-10 years) (Al-Moneef, 1998, P.213).

VI. Encouraging SCPRO through the implementation of a SC wide information technology should elaborate on primary activities within a VCS in support of SC agility among industry participants with common export resource plans. This will facilitate exchange of information on inventory cycles, pricing structures, export schedules, vessel characteristics and port (terminal) procedures.

VII. Importantly, benchmarking and channel wide performance measures advised by Gunasekaran et al. (2001) and Slack et al. (2009) are required to synchronise SCPRO for internal and external capabilities, which sustains backward and forward SC integration. Also, the possibility to achieve operational and tactical export objectives on quality, speed, dependability, flexibility, and cost reduction is incorporated in the export logistics process. Subsequently, the above strategies enable the adaption of Nigerian crude oil SC operations to absorb innovations in logistics structures incorporating organisational and environmental requirements to increase competitive advantage (Grawe, 2009, P.361).

7.7 Summary

Moreover, the nature of crude oil as an essential energy commodity and the development of market structures enable sustainable SCPRO (Kohli and Jaworski, 1990), especially when SCO directs participant organisations towards common structures to improve on DEMVAR and VEFF (Julka et al., 2002, P.1760-1761). However, the studies principal consideration is to sustain demand characteristics that will promote measurable crude oil export consistency to China (Gainsborough, 2005). Moreover, ensuring that this objective is met requires an SCO as the fundamental platform on which sustainable theories can be implemented and monitored. Nevertheless, HREIM as a secondary activity in a VCS supports not only successful implementation of the revised conceptual framework, but the sustenance of VEFF (Gowen and Tallon, 2003, P.37). In addition, possible barriers to implementing the revised framework is alleviated through HREIM with the possibility for continuous training and monitoring for measurable export outputs (ibid, P.39)

Also, operational planning in a Nigerian crude oil SC will benefit from the following; forecasting systems, supply adequacy, trade risks, and operations visibility. Firstly, appropriate forecasting systems for crude oil export logistics may be either deterministic or stochastic in nature. According to Min and Zhou (2002, P. 239) deterministic models assume all parameters are known with certainty, while stochastic models consider uncertain and random parameters. At present, the Nigerian crude oil export management system is fragmented with insufficient visibility according to DSR1 respondents which may promote chaos in the export logistics process (Wilding,1998, P.4-5), and were unsure about the implications of forecasting systems in predicting demand. However, Cheng and Duran's (2004, P.188) recommendations are more precise for the Nigerian oil industry because of the combined inventory and exports system advised encourages vertical integration. Moreover, uncertainties associated with crude oil prices, demand levels, and distance factors (tanker travel time) are anticipated at the operational level of planning. Similarly, forecasting systems increase the possibility of predicting dramatic change in both production and demand, thereby clarifying predominate short and long-term demand patterns for Chinese crude oil exports, which assists in increasing optimal levels of export distribution in each tier of export operations (Wilding, 1998, P.13). Secondly, export resource planning by the Nigerian oil industry in support of China's crude oil imports will be realisable through negotiated contracts that include predetermined annual demand targets. Likewise, the possibility of bullwhip effects due to varying demands of Chinese oil companies is also offset by intertwining crude oil deliveries with Chinese refineries plans as advised in section 7.6. Thirdly, Nigeria's adequacy to supply is in no doubt considerable in comparison with most countries in Africa. Also, as a member of OPEC the directives of the governing body is followed in support of Nigeria's supply sustainability to countries such as China. For example, in 2013 Nigeria produced over 2.5 mbpd (EIA, 2013) which is equivalent to the export capacity of competing world leading producers. Although, China imports crude oil at an average of 179.5 MMTOE from 2003 to 2012 which is more than Nigeria's average export output at 111 MMTOE for the same period, the Nigerian oil industry can compete with countries such as Angola, Congo, and Gabon with continuous incentives to support supply adequacy (Egbula and Zheng, 2011, P.3-5). Besides, Sino-Nigerian trade will benefit from promoting short and long-term crude oil supply contracts to satisfy a predetermined export quantity.

Fourthly, supply, economic, transportation and dependence risks as reported by Zhang et al. (2013, P.88-89) are important for NNPC to consider. For example, supply risk can be avoided with available export output or inventory by NNPC in their joint ventures with MNCs and IDCs. This can be incorporated in joint supply partnerships to satisfy a predetermined level of demand advised in section 7.6. Likewise, economic risks involve the evaluation of purchase cost of crude oil incorporating; exchange and oil price volatility, including ratio of the value of oil imports to GDP (ibid). Similarly, transportation risk involves measures to fulfil export delivery and monitoring contractual trade routes which encourages adherence to shipping lead time schedules (ibid). Also, dependence risk evaluates China's level of crude oil imports as well as diversification of the oil import source which may dictate terms included in crude oil export contracts to sustain adequate energy supply (ibid). Fifthly, processes for optimisation and value creation depend on the visibility of operations as examined in the variable SCOM. Nonetheless, sustaining best practice advised in section 7.6 requires all inputs of participants in an SC to be measurable which consequently encourages value creation. In addition, Chima's (2007, P.29) recommendation on configuration, coordination, and improvement in chapter 2, section 2.3 is realised through technology adoption. Moreover, incorporation of VEFF should assist in developing internal and external organisational capabilities adopting recommendation's above to enhance crude oil exports to China from Nigeria.

Lastly, tactical planning should concentrate on Nigeria's crude oil demand and supply responsiveness as well as shipment frequency. Firstly, the country's major attribute in oil production remains its reserves which currently stand at 37.06 BBL of crude oil (Department of Petroleum Resource, 2015, P.23). Therefore, increasing investments in Nigerian crude oil reserves by COCs as well as developing supply partnerships may support diversification plans for energy security (Kolas, 2007, P.2). Moreover, investigations during DSR1 informs that most respondents were unable to comment about this tactical element, which is essential when identifying the basis of competitive advantage for increased supply of crude oil to China in comparison to AG and other WA countries. Nevertheless, complying with the demands of COCs and sustaining logistics competitive advantage through GCOLM requires management of production capacity to support export inventory, shipping routes, and delivery limitations (Hussain et al., 2006) i.e.

I. Nigerian crude oil export inventory will depend on COCs in anticipation of predetermined weekly, monthly, and yearly delivery schedules.

II. Moreover, the Malacca Strait is considered a chokepoint for most crude oil destined for the Far East, while alternative routes such as the Lombok and Sunda straits may be sufficient in reducing lead times (Sharan and Thiher, 2011, P12).

III. Furthermore, developing partnerships should elevate delivery limitations by encouraging visibility of operations. According to Jiashan and Jingzhing, 2005, P. 835-837) reported in chapter 3 section 3.7 adoption of SCM by COCs is encouraged by resource disposition, cost reduction, and enhancing existing competitive advantages, which should be considered in value propositions towards SC partnerships by NNPC for crude oil exports to China.

Furthermore, according to Hellstrom (2009, P.11-13) there are major arguments regarding Nigeria's geographical characteristics in support of China's interest in the WA region for the supply of crude oil. Primarily, crude oil reserves in the WA zone are a major attraction in support of China's need for energy security. Secondly, foreign direct investments sought by WA countries have created favourable conditions for COCs to extend relations into oil exploration in the region. Thirdly, COCs have increased expansion in WA countries which sustains a drive towards continued investments in long term projects. Lastly, NOCs and IDCs dominate local oil investments in WA, although there is support in the form of foreign direct investments from European and American organisations. However, COCs perceive high growth potentials when there is a possibility to collaborate with domestic companies (Hellstrom, 2009, P.12). These factors together with VEFF should promote sustainable interest in Nigeria's oil infrastructure as a producing country in the WA region, and should consequently increase import demand of crude oil from China.

7.8 Future Research

In conclusion, Chen and Paulraj (2004, P.151) have reported that the relative importance and interrelationships among various initiatives and constructs in an SCM including the direct, mediating, and moderating effect on SC performance have been hardly explored and are thus not well understood. Therefore, to encourage extension of theory on the three theoretic constructs of the study it will be useful to apply statistical methods such as CFA and SEM on the results of a questionnaire survey with grouped questions exploring identified SC components, and their functional effects to recommend sustainable improvements in Nigerian crude oil export logistics to countries such as China.

Appendix A: Delphi Survey Results

A1: Delphi Survey Questionnaire Round One

Survey Questionnaire Round One

Dear Sir /Madam,

I am investigating the scope for applying process improvement techniques in managing the supply chain for distributing Crude oil from Nigeria to China in the upstream segment, as part of my PhD research within the International Shipping and Logistics Group at the University of Plymouth Business School, England. This research aims to assess:

- Levels of involvement by logistics and distribution managers in oil companies and related organisations in monitoring the processes involved within a logistics network, regarding efficiency improvements.
- Effectiveness of supply chain management in facilitating product and service delivery.
- Efficiency of the existing distribution network and possible suggestions for improvement.

The study requires a survey using the Delphi Technique which involves two or sometimes more rounds of questioning. The results of the first round will determine the questions to be incorporated in the second round. If required, further iterations may occur. However, both rounds of questioning will require *comments on each statement in the questionnaire by circling one of the options provided*, labelled as 'Agree', 'Disagree', and 'Unable to Comment'. If your response to a statement is 'Disagree' you are requested to provide further comments as to why you disagree. These comments will form the basis of the second round of questioning.

All responses are strictly confidential and no names of individuals or organisations will be published or provided to any third parties, although the aggregate results of the overall survey may eventually be published. After you have responded to the first round of the survey, I will send you a copy of the general results upon request.

As an expert in this area, your opinions will add significantly to the usefulness of the research findings. I very much hope that you will be able to take part in the survey, and I look forward to receiving your reply within two weeks. Please return to:

Mervyn Shiwoku

PhD Researcher

School of Management

Room 405b

Cookworthy Building

Drake Circus
Plymouth

Devon

PL4 8AA

Email address: mshiwoku@plymouth.ac.uk or mervshiwoku@hotmail.com

If you have any questions or would like further details, please do not hesitate to contact me.

ANSWERS FOR ALL QUESTIONS SHOULD RELATE TO CRUDE OIL DISTRIBUTION BETWEEN NIGERIA AND CHINA

1) Supply chain management is an essential operation within the upstream segment operations of an oil company.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

2) The efficiency of most downstream operations within an oil distribution system depends on an ability to manage the logistics function effectively.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

3) Because the organisation of a supply chain needs to be tailored to the precise market needs of each customer each supply chain solution for a particular product or service is unique.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

4) The effectiveness of a supply chain within an organisation depends on a capability to integrate all elements in a distribution system.

Agree? Disagree? Unable to comment?

If you <u>disagree</u> please comment as to <u>why</u>-

5) Planned human resource management and development is essential to underpin effective supply chain management.

Agree? Disagree? Unable to comment?

If you <u>disagree</u> please comment as to <u>why</u>-

6) Without efficient inventory management systems supply chain management is inevitably ineffective.

Agree? Disagree? Unable to comment?

If you <u>disagree</u> please comment as to <u>why</u>-

7) Effective management of information flows is integral to an efficient supply chain management system.

Agree? Disagree? Unable to comment?

If you <u>disagree</u> please comment as to <u>why</u>-

8) The frequency of shipments of crude oil from Nigerian ports to destinations in China is adequate to meet current demand levels.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

9) The available vessel capacity offered by shipping companies to distribute crude oil from Nigeria to china is sufficient to meet current demand levels.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

10) The routes currently used to ship crude oil from West Africa to ports in China are sufficient to ensure that lead time requirements are met.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

11) The location of organisations which produce oil in West Africa, in particular Nigeria is appropriate to respond effectively to current crude oil market demand from China.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

12) Oil companies currently operating in Nigeria are currently capable of meeting crude oil market demand in China.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

13) The information technology required to distribute crude oil from West Africa is currently not sufficiently tailored to suit distribution operations.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

14) SAP and related information management systems are not sufficiently precise to promote collaboration between distribution partners in a supply chain.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

15) The major weakness in existing information management systems for oil distribution is an inability to provide visibility on all distribution functions for all partners involved in a network.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

16) A simulation model of networks for distributing oil from Nigeria to China will inevitably use a combination of deterministic and stochastic methods.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

17) A more integrated and cohesive supply chain for distributing oil from Nigeria to China will benefit all partners through reducing total distribution costs.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

18) Accessibility of supply is the major advantage to China of procuring oil from Nigeria .

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

19) Nigeria is a preferred supplier of crude oil to China because it is best able to comply with the demands of national oil companies in China.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

20) To sustain the distribution relationship between Nigeria and China will depend on how well oil companies in Nigeria are able to meet the precise demands specified in oil contracts

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

Thank you for your help. Please confirm the following contact details for the second round of the survey :

Personal Data

Your company name:

Your position within the company:

Years of experience in your current role:

Years of experience in oil distribution:

Any other comments:

A2: Delphi Survey Questionnaire Round Two

Survey Questionnaire Round Two

Dear Oil Executives,

Thank you for your contributions in the first round of my survey investigating the application of process improvement techniques in managing a supply chain for distributing crude oil from Nigeria to China in the upstream segment of the oil industry; under the thesis titled:

Supply Chain Management and Logistical Improvements in Distributing Crude oil from Nigeria to China, and also part of fulfilling my PhD research with the International Shipping and Logistics Group at the University of Plymouth Business School, United Kingdom.

I am grateful for your kind responses in which most questions were answered with 13 valuable statements out of 20 questions; from a total of 13 panellists.
There was a general consensus in 10 questions posed, while the remaining 10 questions had equal disagreements; which has led to this second round of questions with 20 questions developed from the comments of panellists.

In order to achieve a consensus on the remaining 10 questions, I will appreciate your further contribution with this second-round survey as was mentioned in the first round of questioning.

Please consider the original statements and comments of the panellists, and state if you agree, disagree or are unable to comment. In regards to questions you disagree with, please comment as to why you disagree.

Also, please read the questions carefully before answering, as the study aims to assess:

- Effectiveness of supply chain management in facilitating product and service deliveries.

- Efficiency of existing distribution networks and possible suggestions for improvements.

- Levels of involvement by logistics and distribution managers in oil companies and related organisations in monitoring a logistics network for efficiency.

As in the first round all responses are strictly confidential and no names of individuals or organizations will be published or provided to third parties, although the aggregate results of the overall survey may eventually be published. A copy of the general results will be sent to you upon request.

Furthermore, as an expert in this area, your opinions will add significantly to the research findings. I hope that you will be able to take part again in the attached survey, and look forward to receiving your reply within two weeks.

Please return all answers to the following address:

Mervyn Shiwoku

PhD Researcher

School of Management

Room 405b

Cookworthy Building

Drake Circus
Plymouth

Devon

PL4 8AA

Email address: mervyn.shiwoku@plymouth.ac.uk or mervshiwoku@hotmail.com

If you have any questions or would like further details, please do not hesitate to contact me.

ALL ANSWERS SHOULD RELATE TO CRUDE OIL DISTRIBUTION IN BETWEEN NIGERIA AND CHINA.

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5. Original statement: Planned human resource management and development is essential to underpin effective supply chain management.

The panellists have expressed the following opinions disagreeing with the above statement.

5.1 In a crude oil supply chain the right personnel is needed in related distribution functions with skills suited to their roles.

Agree Disagree Unable to Comment

If you disagree please comment as to why-

5.2 Human resource is important in developing crude oil supply chains, however in more established supply chains this function is less important.

Agree Disagree Unable to Comment

If you disagree please comment as to why-

5.3 In the oil industry there are more important factors than human resource management to consider.

Agree Disagree Unable to Comment

If you <u>disagree</u> please comment as to <u>why</u>-

----

6. **<u>Original statement</u>: Without efficient inventory management systems supply chain management is inevitably ineffective.**

The panellists have expressed the following opinions disagreeing with the above statement.

6.1 You can still have an effective supply chain without effective inventory management.

Agree Disagree Unable to Comment

If you <u>disagree</u> please comment as to <u>why</u>-

6.2 There may be some financial implications without effective inventory management, such as tying up capital in stock for effective contingency.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

----

8. **Original statement: The frequency of shipments of crude oil from Nigerian ports to destinations in China is adequate to meet current demand levels.**

The panellists have expressed the following opinions disagreeing with the above statement.

8.1 The frequency of crude oil shipments in between the two continents is simply not adequate.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

8.2 Nigeria has the capacity to encourage more crude oil shipments than present.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

8.3 It is possible for China to allow more crude oil imports, but there will be bottle-necks in the port process.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

----

9. **Original statement: The available vessel capacity offered by shipping companies to ship crude oil from Nigeria to China is sufficient to meet current demand levels.**

The panellists have expressed the following opinion disagreeing with the above statement.

9.1 The available vessel capacities are currently not adequate.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

9.2 The capacity of vessels has been outgrown by current demand.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

----

12. **Original statement: Oil companies currently operating in Nigeria are incapable of meeting crude oil market demands in China.**

The panellists have expressed the following opinion disagreeing with the above statement.

12.1 The quality of crude oil from Nigeria currently affects demand levels form China.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

12.2 Opportunities for arbitrage often increase crude oil demand levels.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

12.3 China's domestic oil consumption directly affects crude oil demand levels from Nigeria.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

----

14. **Original statement: SAP and related information management systems are not sufficiently precise to promote collaboration between distribution partners in a supply chain.**

The panellists have expressed the following opinion disagreeing with the above statement.

14.1 There are better applied information management systems in the market to promote collaboration between supply chain partners.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

14.2 Tailored Electronic Data Interchange systems (EDI) are particularly better for crude oil companies to promote collaboration in between supply chain partners.

Agree? Disagree? Unable to comment?

If you disagree please comment as to why-

----

15. **<u>Original statement</u>: The major weakness in existing information management systems for oil distribution, is the inability to provide visibility on all distribution functions for all partners involved in the supply chain process.**

The panellists have expressed the following opinion disagreeing with the above statement.

15.1 Current management information systems are adequate to support an organisations need for visibility in a crude oil supply chain.

Agree? Disagree? Unable to comment?

If you <u>disagree</u> please comment as to <u>why</u>-

15.2 Tailored Electronic Data Interchange systems (EDI), enables better information sharing amongst supply chain partners in the oil industry**.**

Agree? Disagree? Unable to comment?

If you <u>disagree</u> please comment as to <u>why</u>-

----

18. **<u>Original statement</u>: Accessibility of supply is the major advantage to China of procuring oil from Nigeria.**

The panellists have expressed the following opinion disagreeing with the above statement.

18.1 China's interest and demand in crude oil has had a positive effect on Nigeria's socio-economic development.

Agree? Disagree? Unable to comment?

If you <u>disagree</u> please comment as to why-

----

20. **<u>Original statement</u>: Sustaining distribution relationships between Nigeria and China, will depend on how well oil companies in Nigeria are able to meet the precise demands specified in oil contracts.**

The panellists have expressed the following opinion disagreeing with the above statement.

20.1 Nigeria's strategic partnership with China is going to strengthen over the next decade

Agree? Disagree? Unable to comment?

If you <u>disagree</u> please comment as to why-

20.2 The achievement of infrastructural economic and social goals in the Nigerian vision 2020 plan largely depends on crude oil exports to China.

Agree? Disagree? Unable to comment?

If you <u>disagree</u> please comment as to why-

20.3 China's interest in Nigerian oil is because of its excellent blending qualities.

Agree? Disagree? Unable to comment?

If you <u>disagree</u> please comment as to why-

20.4 Adequate crude oil grades, pricing, and arbitrage opportunities encourage stronger relationships in between the two countries.

Agree? Disagree? Unable to comment?

If you <u>disagree</u> please comment as to why-

A3: Delphi Survey One Results

DSR1 Expert Feedback Results															
Q	*A*	*DA*	*UC*	*C*	*SQ*	*TR*	*APMO*	*AP*	*DAP*	*UCP*	*CP*	*SP*	*60% A*	*60% DA*	60% UC
1	13	0	0	0	0	13	100.00	100.00	0.00	0.00	0.00	0.00	1	0	0
2	13	0	0	0	0	13	100.00	100.00	0.00	0.00	0.00	0.00	1	0	0
3	12	1	1	0	0	13	100.00	92.31	7.69	7.69	0.00	0.00	1	0	0
4	12	0	0	0	1	13	92.31	92.31	0.00	0.00	0.00	7.69	1	0	0
5	11	2	0	1	0	13	100.00	84.62	15.38	0.00	7.69	0.00	1	0	0
6	10	3	0	1	0	13	100.00	76.92	23.08	0.00	7.69	0.00	1	0	0
7	13	0	0	0	0	13	100.00	100.00	0.00	0.00	0.00	0.00	1	0	0
8	1	2	10	1	0	13	23.08	7.69	15.38	76.92	7.69	0.00	0	0	1
9	0	2	10	1	0	13	15.38	0.00	15.38	76.92	7.69	0.00	0	0	1
10	9	0	4	0	0	13	69.23	69.23	0.00	30.77	0.00	0.00	1	0	0
11	3	0	10	0	0	13	23.08	23.08	0.00	76.92	0.00	0.00	0	0	1
12	3	1	8	2	1	13	30.77	23.08	7.69	61.54	15.38	7.69	0	0	1
13	2	2	9	0	0	13	30.77	15.38	15.38	69.23	0.00	0.00	0	0	1
14	2	3	8	2	0	13	38.46	15.38	23.08	61.54	15.38	0.00	0	0	1
15	4	2	7	1	0	13	46.15	30.77	15.38	53.85	7.69	0.00	0	0	0
16	6	0	7	0	0	13	46.15	46.15	0.00	53.85	0.00	0.00	0	0	0
17	7	0	6	0	0	13	53.85	53.85	0.00	46.15	0.00	0.00	0	0	0
18	5	1	7	1	0	13	46.15	38.46	7.69	53.85	7.69	0.00	0	0	0
19	2	1	10	1	0	13	23.08	15.38	7.69	76.92	7.69	0.00	0	0	1
20	5	1	7	2	0	13	46.15	38.46	7.69	53.85	15.38	0.00	0	0	0
Total	133	21	104	13	2	260	59.23	51.15	35.45	[redacted]			8	0	7

List of Codes

Q = Question	A = Agree AP=Agree Percentage	DA = Disagree
UC = Unable to Comment	C = Comment	SQ = Skipped Question
TR = Total Respondents	APMO = Average Percent of Majority Opinion	DAP = Disagree Percentage
UCP = Unable to Comment	CP = Comment Percentage	SP = Skipped Percentage

A3.1: Level of Agreements: DSR1

Agreements	Median
1	0
2	1
3	2
4	2
5	2
6	3
7	3
8	4
9	5
10	5
11	6
12	7
13	9
14	10
15	11
16	12
17	12
18	13
19	13
20	13
Total Respondents	**13**
Total Responses	**133**
Median	**5.5**
First Quartile	**2.75**
Second Quartile	**5.5**
Third Quartile	**11.5**
Fourth Quartile	**13**
Inter Quartile	**9.5**
Range	**1 to 13**

A4: Delphi Survey Two Results

DSR 2 Expert Feedback Results																
OQ	**Q**	**A**	**DA**	**UC**	**C**	**SQ**	**TR**	**APMO**	**AP**	**DAP**	**UCP**	**CP**	**SP**	**60% A**	**60% DA**	**60% UC**
5.1	1	4	1	1	0	0	6	83.33	66.67	16.67	16.67	0.00	0.00	0	0	0
5.2	2	1	4	1	3	0	6	83.33	16.67	66.67	16.67	50.00	0.00	0	0	0
5.3	3	2	3	0	2	1	6	83.33	33.33	50.00	0.00	33.33	16.67	0	0	0
6.1	4	1	4	0	4	1	6	83.33	16.67	66.67	0.00	66.67	16.67	0	1	0
6.2	5	4	1	0	1	1	6	83.33	66.67	16.67	0.00	16.67	16.67	1	0	0
8.1	6	0	0	5	0	1	6	0.00	0.00	0.00	83.33	0.00	16.67	0	0	1
8.2	7	3	0	2	0	1	6	50.00	50.00	0.00	33.33	0.00	16.67	1	0	0
8.3	8	2	1	2	2	1	6	50.00	33.33	16.67	33.33	33.33	16.67	0	0	0
9.1	9	1	2	2	2	1	6	50.00	16.67	33.33	33.33	33.33	16.67	0	0	0
9.2	10	3	1	1	2	1	6	66.67	50.00	16.67	16.67	33.33	16.67	0	0	0
12.1	11	0	0	5	0	1	6	0.00	0.00	0.00	83.33	0.00	16.67	0	0	1
12.2	12	3	0	2	0	1	6	50.00	50.00	0.00	33.33	0.00	16.67	0	0	0
12.3	13	3	0	1	0	2	6	50.00	50.00	0.00	16.67	0.00	33.33	1	0	0
14.1	14	3	1	0	1	2	6	66.67	50.00	16.67	0.00	16.67	33.33	1	0	0
14.2	15	4	0	0	0	2	6	66.67	66.67	0.00	0.00	0.00	33.33	1	0	0
15.1	16	3	1	0	2	2	6	66.67	50.00	16.67	0.00	33.33	33.33	1	0	0
15.2	17	4	0	0	0	2	6	66.67	66.67	0.00	0.00	0.00	33.33	1	0	0
18.1	18	4	0	1	0	1	6	66.67	66.67	0.00	16.67	0.00	16.67	1	0	0
20.1	19	4	0	1	0	1	6	66.67	66.67	0.00	16.67	0.00	16.67	1	0	1
20.2	20	2	1	2	1	1	6	50.00	33.33	16.67	33.33	16.67	16.67	0	0	0
20.3	21	3	0	2	0	1	6	50.00	50.00	0.00	33.33	0.00	16.67	0	0	0
20.4	22	3	0	2	0	1	6	50.00	50.00	0.00	33.33	0.00	16.67	0	0	0
	Total	**57**	**20**	**30**	**20**	**23**	**120**	**64.17**						**9**	**1**	**3**

List of Codes

Q = Question OQ= Original Question	A = Agree AP = Agree Percentage	D = Disagree
UC = Unable to Comment	C = Comment	SQ = Skipped Question
TR = Total Respondents	APMO = Average Percent of Majority Opinion	DP = Disagree Percentage
UCP = Unable to Comment	CP = Comment Percentage	SP = Skipped Percentage

A4.1: Level of Agreements DSR 2

Quartiles	Agreed
1	0
2	0
3	1
4	1
5	1
6	2
7	2
8	2
9	3
10	3
11	3
12	3
13	3
14	3
15	3
16	3
17	4
18	4
19	4
20	4
21	4
22	4
Total Respondents	**6**
Total Responses	**63**
Median	**3**
First Quartile	**1.75**
Second Quartile	**3**
Third Quartile	**4**

A5: Chi-Square Test of Homogeneity: DSR1

DSR1 Test of Homogeneity

DSR1	Total Number of Respondents: 13		
Quartiles	**First Four Responses**		**Last Four responses**
Question 1			
Respondent A	Agree	Respondent K	Agree
Respondent B	Agree	Respondent L	Agree
Respondent C	Agree	Respondent M	Agree
Respondent D	Agree	Respondent N	Agree
Success Rate	1.00		1.00
Question 2			
Respondent A	Agree	Respondent K	Agree
Respondent B	Agree	Respondent L	Agree
Respondent C	Agree	Respondent M	Agree
Respondent D	Unable to comment	Respondent N	Agree
Success Rate	0.75		1.00

Code	
Agree=2	**DA/UC=1**

Q1	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FF	8	0	8	**1**
LF	8	0	8	
Total	16	0	16	

Q2	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FF	6	1	7	**0.466667**
LF	8	0	8	
Total	14	1	15	

Question 3			
Respondent A	Agree	Respondent K	Agree
Respondent B	Agree	Respondent L	Agree
Respondent C	Agree	Respondent M	Agree
Respondent D	Agree	Respondent N	Agree
Success Rate	1.00		1.00

Q3	Agree	Disagree/UC	Total	F-Test
FF	8	0	8	**1**
LF	8	0	8	
Total	16	0	16	

Question 4			
Respondent A	Agree	Respondent K	Agree
Respondent B	Agree	Respondent L	Agree
Respondent C	Agree	Respondent M	Agree
Respondent D	Agree	Respondent N	Agree
Success Rate	1.00		1.00

Q4	Agree	Disagree/UC	Total	F-Test
FF	8	0	8	**1**
LF	8	0	8	
Total	16	0	16	

Question 5			
Respondent A	Agree	Respondent K	Agree
Respondent B	Agree	Respondent L	Agree
Respondent C	Agree	Respondent M	Agree
Respondent D	Agree	Respondent N	Agree
Success Rate	1.00		1.00

Q5	Agree	Disagree/UC	Total	F-Test
FF	8	0	8	**1**
LF	8	0	8	
Total	16	0	16	

Question 6			
Respondent A	Agree	Respondent K	Agree
Respondent B	Agree	Respondent L	Agree
Respondent C	Agree	Respondent M	Disagree
Respondent D	Agree	Respondent N	Agree
Success Rate	1.00		0.75

Q6	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FF	8	0	8	**0.466667**
LF	6	1	7	
Total	14	1	15	

Question 7			
Respondent A	Agree	Respondent K	Agree
Respondent B	Agree	Respondent L	Agree
Respondent C	Agree	Respondent M	Agree
Respondent D	Agree	Respondent N	Agree
Success Rate	1.00		1.00

Q7	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FF	8	0	8	**1**
LF	8	0	8	
Total	16	0	16	

Question 8			
Respondent A	Disagree	Respondent K	Unable to Comment
Respondent B	Agree	Respondent L	Unable to Comment
Respondent C	Unable to Comment	Respondent M	Disagree
Respondent D	Unable to Comment	Respondent N	Disagree
Success Rate	0.5		0

Q8	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FF	2	3	5	**0.444444**
LF	0	4	4	
Total	2	7	9	

Question 9			
Respondent A	Disagree	Respondent K	Unable to Comment
Respondent B	Disagree	Respondent L	Unable to Comment
Respondent C	Unable to Comment	Respondent M	Disagree
Respondent D	Unable to Comment	Respondent N	Disagree
Success Rate	0		0

Q9	Agree	Disagree/UC	Total	F-Test
FF	0	4	4	**1**
LF	0	4	4	
Total	0	8	8	

Question 10			
Respondent A	Agree	Respondent K	Agree
Respondent B	Agree	Respondent L	Agree
Respondent C	Agree	Respondent M	Agree
Respondent D	Unable to comment	Respondent N	Agree
Success Rate	1.00		1.00

Q10	Agree	Disagree/UC	Total	F-Test
FF	6	1	7	**0.466667**
LF	8	0	8	
Total	14	1	15	

Question 11			
Respondent A	Agree	Respondent K	Unable to comment
Respondent B	Unable to comment	Respondent L	Unable to comment
Respondent C	Unable to comment	Respondent M	Unable to comment
Respondent D	Unable to comment	Respondent N	Unable to comment
Success Rate	0.25		0

Q11	Agree	Disagree/UC	Total	F-Test
FF	2	3	5	**0.444444**
LF	0	4	4	
Total	2	7	9	

Question 12			
Respondent A	Agree	Respondent K	Unable to comment
Respondent B	Agree	Respondent L	Unable to comment
Respondent C	Disagee	Respondent M	Unable to comment
Respondent D	Unable to Comment	Respondent N	Unable to comment
Success Rate	0.5		0

Q12	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FF	4	2	6	**0.0762**
LF	0	4	4	
Total	4	6	10	

Question 13			
Respondent A	Agree	Respondent K	Unable to comment
Respondent B	Agree	Respondent L	Unable to comment
Respondent C	Agree	Respondent M	Unable to comment
Respondent D	Unable to Comment	Respondent N	Unable to comment
Success Rate	0.75		0

Q13	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FF	6	1	7	**0.0152**
LF	0	4	4	
Total	6	5	11	

Question 14			
Respondent A	Agree	Respondent K	Unable to comment
Respondent B	Agree	Respondent L	Unable to comment
Respondent C	Agree	Respondent M	Unable to comment
Respondent D	Disgaree	Respondent N	Unable to comment
Success Rate	0.75		0

Q14	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FF	6	1	7	**0.0152**
LF	0	4	4	
Total	6	5	11	

Question 15			
Respondent A	Agree	Respondent K	Unable to comment
Respondent B	Agree	Respondent L	Unable to comment
Respondent C	Agree	Respondent M	Unable to comment
Respondent D	Agree	Respondent N	Unable to comment
Success Rate	1.00		0

Q15	Agree	Disagree/UC	Total	F-Test
FF	8	0	8	**0.002**
LF	0	4	4	
Total	8	4	12	

Question 16			
Respondent A	Agree	Respondent K	Unable to comment
Respondent B	Agree	Respondent L	Unable to comment
Respondent C	Agree	Respondent M	Unable to comment
Respondent D	Agree	Respondent N	Unable to comment
Success Rate	1.00		0

Q16	Agree	Disagree/UC	Total	F-Test
FF	8	0	8	**0.002**
LF	0	4	4	
Total	8	4	12	

Question 17			
Respondent A	Agree	Respondent K	Unable to comment
Respondent B	Agree	Respondent L	Unable to comment
Respondent C	Agree	Respondent M	Unable to comment
Respondent D	Agree	Respondent N	Unable to comment
Success Rate	1.00		0

Q17	Agree	Disagree/UC	Total	F-Test
FF	8	0	8	**0.002**
LF	0	4	4	
Total	8	4	12	

Question 18			
Respondent A	Agree	Respondent K	Unable to comment
Respondent B	Agree	Respondent L	Unable to comment
Respondent C	Agree	Respondent M	Unable to comment
Respondent D	Agree	Respondent N	Unable to comment
Success Rate	1.00		0

Q18	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FF	8	0	8	**0.002**
LF	0	4	4	
Total	8	4	12	

Question 19			
Respondent A	Agree	Respondent K	Unable to comment
Respondent B	Agree	Respondent L	Unable to comment
Respondent C	Unable to comment	Respondent M	Unable to comment
Respondent D	Unabe to comment	Respondent N	Unable to comment
Success Rate	1.00		0

Q19	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FF	4	2	6	**0.0762**
LF	0	4	4	
Total	4	6	10	

Question 20			
Respondent A	Agree	Respondent K	Unable to comment
Respondent B	Agree	Respondent L	Unable to comment
Respondent C	Agree	Respondent M	Unable to comment
Respondent D	Agree	Respondent N	Unable to comment
Success Rate	0.00		0

Q20	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FF	8	0	8	**0.002**
LF	0	4	4	
Total	8	4	12	

A6: Chi-Square Test of Homogeneity: DSR2

	DSR2 Test of Homogeneity							
Delphi 2	**Total Number of Respondents: 6**			**Score**				
Quartiles	**First Two Responses**		**Last Two Responses**	**Agree=2**	**DA/UC=1**			
Question 1				**Q1**	**Agree**	**Disagree/UC**	**Total**	**F-Test**
Respondent A	Agree	Respondent E	Disagree	FT	4	0	4	**0.0667**
Respondent B	Agree	Respondent F	Unable to Comment	LT	0	2	2	
				Total	4	2	6	
Success Rate	1		0					
Question 2				**Q2**	**Agree**	**Disagree/UC**	**Total**	**F-Test**
Respondent A	Agree	Respondent E	Disagree	FT	2	1	3	1
Respondent B	Unable to comment	Respondent F	Disagree	LT	1	1	2	
				Total	3	2	5	
Success Rate	0.5		0					
Question 3				**Q3**	**Agree**	**Disagree/UC**	**Total**	**F-Test**
Respondent A	Agree	Respondent E	Disagree	FT	4	0	4	**0.0667**
Respondent B	Agree	Respondent F	Disagree	LT	0	2	2	
				Total	4	2	6	
Success Rate	1		0					

Question 4			
Respondent A	Agree	Respondent E	Disagree
Respondent B	Diagree	Respondent F	Disagree
Success Rate	0.5		0

Q4	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FT	2	1	3	**1**
LT	1	1	2	
Total	3	2	5	

Question 5			
Respondent A	Agree	Respondent E	Agree
Respondent B	Agree	Respondent F	Disagree
Success Rate	1		0.5

Q5	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FT	4	0	4	**0.4286**
LT	2	1	3	
Total	6	1	7	

Question 6			
Respondent A	Unable to comment	Respondent E	Unable to comment
Respondent B	Unable to comment	Respondent F	Unable to comment
Success Rate	0		0

Q6	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FT	0	2	2	**1**
LT	0	2	2	
Total	0	4	4	

Question 7			
Respondent A	Agree	Respondent D	Unable to comment
Respondent B	Agree	Respondent E	Unable to comment
Sucess Rate	1		0

Q7	**Agree**	**Disagree/UC**	**Total**	**F-Test**
FT	4	0	4	**0.0667**
LT	0	2	2	
Total	4	2	6	

Question 8			
Respondent A	Agree	Respondent D	Unable to comment
Respondent B	Agree	Respondent E	Disagree
Success Rate	1		0

Q8	Agree	Disagree/UC	Total	F-Test
FT	4	0	4	**0.0667**
LT	0	2	2	
Total	4	2	6	

Question 9			
Respondent A	Agree	Respondent D	Unable to comment
Respondent B	Unable to comment	Respondent E	Unable to comment
Success Rate	1		0

Q9	Agree	Disagree/UC	Total	F-Test
FT	2	1	3	**1**
LT	1	1	2	
Total	3	2	5	

Question 10			
Respondent A	Agree	Respondent D	Disagree
Respondent B	Agree	Respondent E	Unable to comment
Success Rate	1		0

Q10	Agree	Disagree/UC	Total	F-Test
FT	4	0	4	**0.0667**
LT	0	2	2	
Total	4	2	6	

Question 11			
Respondent A	Unable to comment	Respondent D	Unable to comment
Respondent B	Unable to comment	Respondent E	Unable to comment
Success Rate	0		0

Q11	Agree	Disagree/UC	Total	F-Test
FT	0	2	2	1
LT	0	2	2	
Total	0	4	4	

Question 12			
Respondent A	Agree	Respondent D	Unable to comment
Respondent B	Agree	Respondent E	Unable to comment
Success Rate	1		0

Q12	Agree	Disagree/UC	Total	F-Test
FT	4	0	4	**0.0667**
LT	0	2	2	
Total	4	2	6	

Question 13			
Respondent A	Agree	Respondent D	Agree
Respondent B	Agree	Respondent E	Unable to comment
Success Rate	1		1

Q13	Agree	Disagree/UC	Total	F-Test
FT	4	0	4	**0.4286**
LT	2	1	3	
Total	6	1	7	

Question 14			
Respondent A	Agree	Respondent D	Unable to comment
Respondent B	Agree	Respondent E	Agree
Success Rate	1		1

Q14	Agree	Disagree/UC	Total	F-Test
FT	4	0	4	**0.4286**
LT	2	1	3	
Total	6	1	7	

Question 15			
Respondent A	Agree	Respondent D	Unable to comment
Respondent B	Agree	Respondent E	Unable to comment
Success Rate	1		0

Q15	Agree	Disagree/UC	Total	F-Test
FT	4	0	4	**0.0667**
LT	0	2	2	
Total	4	2	6	

Question 16			
Respondent A	Agree	Respondent D	Agree
Respondent B	Agree	Respondent E	Unable to comment
Success Rate	1		1

Q16	Agree	Disagree/UC	Total	F-Test
FT	4	0	4	**0.4286**
LT	2	1	3	
Total	6	1	7	

Question 17			
Respondent A	Agree	Respondent D	Agree
Respondent B	Agree	Respondent E	Agree
Success Rate	1		1

Q17	Agree	Disagree/UC	Total	F-Test
FT	4	0	4	**1**
LT	4	0	4	
Total	8	0	8	

Question 18			
Respondent A	Agree	Respondent D	Unable to comment
Respondent B	Agree	Respondent E	Agree
Success Rate	1		1

Q18	Agree	Disagree/UC	Total	F-Test
FT	4	0	4	**0.1429**
LT	1	2	3	
Total	5	2	7	

Question 19			
Respondent A	Agree	Respondent D	Agree
Respondent B	Agree	Respondent E	Unable to comment
Sucess Rate	1		1

Q19	Agree	Disagree/UC	Total	F-Test
FT	4	0	4	**0.1429**
LT	1	2	3	
Total	5	2	7	

Question 20				Q20	Agree	Disagree/UC	Total	F-Test
Respondent A	Agree	Respondent D	Unable to comment	FT	4	0	4	**0.1429**
Respondent B	Agree	Respondent E	Agree	LT	1	2	3	
				Total	5	2	7	
Success Rate	1		1					

Question 21				Q21	Agree	Disagree/UC	Total	F-Test
Respondent A	Agree	Respondent D	Unable to comment	FT	4	0	4	**0.3333**
Respondent B	Agree	Respondent E	Unable to comment	LT	1	1	2	
				Total	5	1	6	
Success Rate	1		0					

Question 22				Q22	Agree	Disagree/UC	Total	F-Test
Respondent A	Agree	Respondent D	Unable to comment	FT	4	0	4	**0.0667**
Respondent B	Agree	Respondent E	Unable to comment	LT	0	2	2	
				Total	4	2	6	
Success Rate	1		0					

Appendix B: NNPC ASB Data

B1: NNPC Oil Export (Lifting) Chart

Crude Oil Lifting Chart 2012						
COMPANY	**Domestic Allocation**	**Export (FED. ACCOUNT)**	**NNPC TOTAL**	**COMPANY LIFTINGS**	**TOTAL LIFTINGS**	**%**
JV :						
SPDC	28,023,728.00	33,740,206.00	66,763,934.00	57,486,285.00	124,250,219.00	
EXXONMOBIL	15,006,947.00	55,408,849.00	70,475,796.00	50,464,263.00	120,940,059.00	
CHEVRON	30,567,114.00	15,600,087.00	46,167,201.00	32,369,457.00	78,536,658.00	
ELF	1,199,076.00	14,323,452.00	15,522,528.00	12,291,857.00	27,814,385.00	
NAOC/ PHILLIPS	2,386,018.00	15,021,987.00	17,408,005.00	11,743,307.00	29,151,312.00	
TEXACO -	0.00	1,984,806.00	1,984,806.00	1,881,677.00	3,866,483.00	
PAN-OCEAN -	0	1,074,450.00	1,074,450.00	716,300.00	1,790,750.00	
Sub - Total	**77,242,883.00**	**142,153,837.00**	**219,396,720.00**	**166,953,146.00**	**386,349,866.00**	**44.58**
Calculated Total	**77,182,883.00**	**137,153,837.00**				
AF-JV						
SPDC	948,813.00	4,616,283.00	5,565,096.00	15,265,233.00	20,830,329.00	
EXXONMOBIL -	0.00	21,363,238.00	21,363,238.00	13,896,711.00	35,259,949.00	
CHEVRON	3,714,544.00	2,081,192.00	5,795,736.00	3,241,638.00	9,037,374.00	
ELF	1,099,571.00	9,720,316.00	10,819,887.00	10,195,531.00	21,015,418.00	
NAOC/ PHILLIPS - - -						

- -						
TEXACO - - - - -						
PAN-OCEAN - - - - -						
Sub - Total	**2,685,258.00**	**37,781,029.00**	**43,543,957.00**	**42,599,113.00**	**86,143,070.00**	**9.94**
JVC TOTAL	**79,928,141.00**	**179,934,866.00**	**262,940,677.00**	**209,552,259.00**	**472,492,936.00**	**54.52**
PSC :						
CHEVRON	974671	16,522,299.00	17,496,970.00	67,719,377.00	85,216,347.00	
ADDAX -		12,762,248.00	12,762,248.00	16,790,523.00	29,552,771.00	
ESSO EXP&PROD NIG LTD		24,274,000.00	24,274,000.00	22,137,568.00	46,411,568.00	
NAE -		3,955,311.00	3,955,311.00	4,363,553.00	8,318,864.00	
SNEPCO -		33,459,600.00	33,459,600.00	30,823,529.00	64,283,129.00	
SA Petrol/Total Up-stream Nigeria -		13,008,567.00	13,008,567.00	44,421,314.00	57,429,881.00	
SEEPCO		150000	150000	2,132,939.00	2,282,939.00	
TUPNI		10949193	10949193	16,993,401.00	27,942,594.00	
Total	**974671**	**115,081,218.00**	**116,055,889.00**	**205,382,204.00**	**321,438,093.00**	**37.09**
SERVICE CON-TRACT:						
AENR -	160000	1,469,531.00	1,629,531.00	1,095,000.00	2,724,531.00	
AENR (OKONO)				1,349,804.00	1,349,804.00	
Sub - Total	**160,000.00**	**1,469,531.00**	**1,629,531.00**	**2,444,804.00**	**4,074,335.00**	**0.47**
INDEPENDENT/SOLE RISK: (IDCs)						
NPDC (OKONO) - - -				15,280,468.00	15,280,468.00	
NPDC				3,063,470.00	3,063,470.00	
NPDCSEPLATJV				5,892,192.00	5,892,192.00	
SEPLAT				5,187,409.00	5,187,409.00	

NPCD-First Hydrocar-bon				864,225.00	864,225.00	
First Hydrocarbon				965,571.00	965,571.00	
NPDC-NECONDE				1,110,410.00	1,110,410.00	
NPDC-SHORELINE				1,664,058.00	1,664,058.00	
SHORELINE				665,675.00	665,675.00	
NPDC ND WESTERN				133,700.00	133,700.00	
ND Western				400,000.00	400,000.00	
CONSOLIDATED				560,000.00	560,000.00	
EXPRESS PETRO-LEUM				429,835.00	429,835.00	
AMNI				67,188,129.00	67,188,129.00	
CAVENDISH				0.00	0.00	
ATLAS				375,000.00	375,000.00	
CONTINENTAL				4,926,084.00	4,926,084.00	
MONI PULO				1,394,825.00	1,394,825.00	
DUBRI				130,000.00	130,000.00	
NIG AGIP EXPL/ALLIED/CAMAC - - -				1,015,747.00	1,015,747.00	
Calculated Total				**111,246,798.00**	**111,246,798.00**	
Sub-Total				**50,777,488.00**	**50,777,488.00**	**5.86**
MARGINAL FIELDS						
NIG.DELTA PET . RES. LTD				485,050.00	485,050.00	
PLATFORM PETRO-LEUM				682,000.00	682,000.00	
MIDWESTERN OIL & GAS CO. PLC				3,559,552.00	3,559,552.00	

WALTER SMITH PETR. OIL LTD				667,816.00	667,816.00	
PILLAR OIL				475,000.00	475,000.00	
MOVIDO E & P NIG LTD				0	0.00	
ENERGIA LTD				613,000.00	613,000.00	
BRITTANIA U				322,500.00	322,500.00	
ORIENTAL ENERGY				11,063,289.00	11,063,289.00	
Sub - Total :				17,868,207.00	17,868,207.00	**2.06**
Calculated Grand Total	79,928,141.00					
GRAND-TOTAL	**84,140,482.00**	**296,485,615.00**	**380,626,097.00**	**486,024,962.00**	**866,651,059.00**	**100**

Out of 84,140,482 bblsfor domestic allocation, 34,926,533 bbls was deliverd to the local Refineries. II) Total lifting for Fed. Accounts include 9,951,474 bbls(TMP), 11,496,629 bbls(Qua-IboeMCA), 6,650,259 bbls(Qua-Iboesatellite lifting), 6,477,826 bbls(DPR), 88,523,487 bbls(FIRS), 22,755,412 bbls(Off shore Processing), 55,447,262 bbls(Crude Exchange) and 13,802,849 bbls(NPDC lifting from NNPC forcadosequity in SPDC JV).

NNPC ASB Data (2012, P.25)

IDCs:

B2: Crude Oil Exports by Country

10 – Year Crude Oil Export by Region (Barrels)								
YEAR	North America	South America	CENTRAL AMERICA	EUROPE	ASIA & FAR EAST	OCENIA/ PACIFIC	AFRICA	TOTAL
2003	329,233,145	64,030,369	0	175,518,968	153,187,639	0	69,046,139	791,018,263
2004	408,856,070	102,778,610	0	114,977,451	176,284,313	0	68,390,150	871,288,598
2005	427,662,710	50,575,726	0	148,046,980	147,967,459	0	69,280,456	843,535,336
2006	401,040,785	68,081,235	0	162,917,829	116,166,923	0	69,181,185	817,389,963
2007	432,051,483	73,848,033	0	120,741,036	99,067,734	0	68,061,569	793,771,862
2008	342,566,123	61,582,276	2,190,566	172,126,638	77,096,968	0	68,917,225	724,481,804
2009	276,990,009	78,963,074	300,828	163,627,724	111,371,037	0	137,942,533	769,197,214
2010	352,265,421	77,012,515	0	172,875,067	147,376,118	9,453,755	105,719,225	864,704,111
2011	271,462,697	79,579,804	0	246,626,085	136,032,999	18,092,657	70,287,982	822,084,235
2012	173,496,781	86,831,358	0	333,895,453	140,121,668	20,915,856	75,510,932	830,774,060
TOTAL	**4,393,250,731**	**847,087,029**	**2,491,394**	**1,764,571,475**	**2,165,269,683**	**27,546,412**	**933,124,436**	**10,133,341,160**

NNPC ASB Data (2012, P.26)

Appendix C: Shipping Intelligence Network (SIN) Abridged Data

C1.1 Clarksons Log 21-06-13 to 21-07-13

Clarksons Log 21-06-13 to 21-07-13					
Tanker Type	**Departure**	**Destination**	**Number of Shipment**	**Average Quantity (BBLS)**	**Total Quantity**
VLCC	West Africa	China	21	260,000	5,460,000
VLCC	West Africa	India	1	260,000	260,000
VLCC	West Africa	UKC	0	260,000	0
VLCC	West Africa	USG	0	260,000	0
VLCC	Arzew	China	1	260,000	260,000
VLCC	Akpo Terminal (Nigeria)	India	1	260,000	260,000
Total			24		6,240,000
VLCC	AG	China	57	265,856	15,187,500
VLCC	AG	India	12	267,514	3,182,000
VLCC	AG	UKC	1	280,000	280,000
VLCC	AG	USG	17	280,000	4,760,000
Total			87		23,409,500
Suez	West Africa	China	0	0	0
Suez	West Africa	UKC	0	0	0
Suez	West Africa	INDIA	3	130,000	390,000
Suez	West Africa	USG/AC	0	0	0
Suez	Algeria	China	1	130,000	130,000
Total			4		520,000

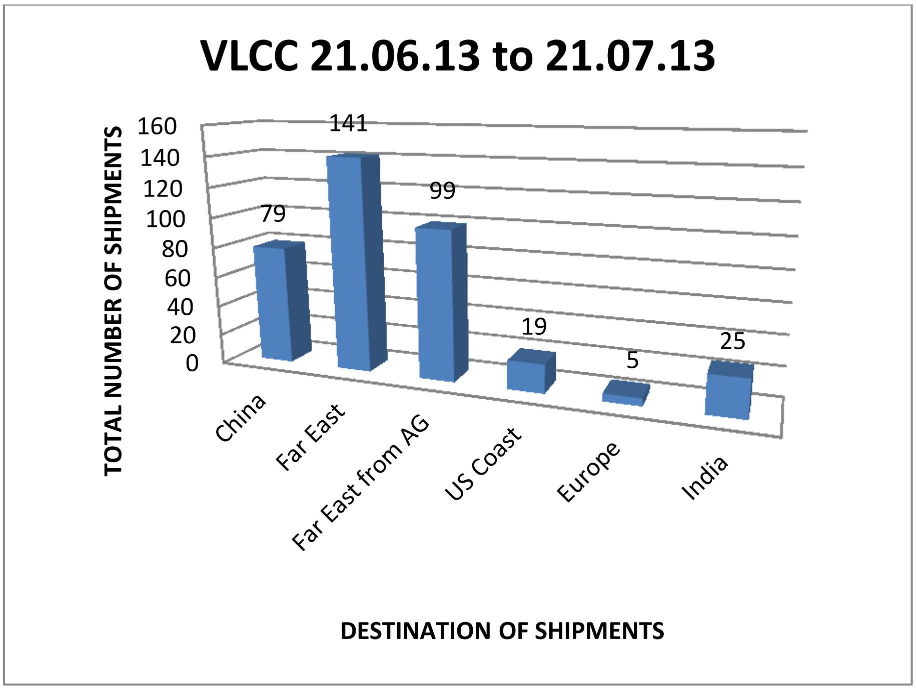
C1.2 VLCC Vessel Shipments: 21-06-13 to 21-07-13

VLCC Vessel Shipments: 21-06-13 to 21-07-13	
Total Number of Shipments	**194**
Total Shipments to China	79
Total Shipments to Far East	141
Total Shipments to the Far East from AG	99
Total Shipments from West Africa to China	21
Total Shipments from West Africa	25
Total Shipments from Africa	26
Total Shipments to the US Coast	19
Total Shipments from AG	132
Total Shipments from South America	1
Total Shipments to South America	0
Total Shipments from Europe	6
Total Shipments to Europe	5
Total Shipments to India	25
Total Shipments from India	0
Total Shipments from Caribbean	10
Total Shipments to Caribbean	0

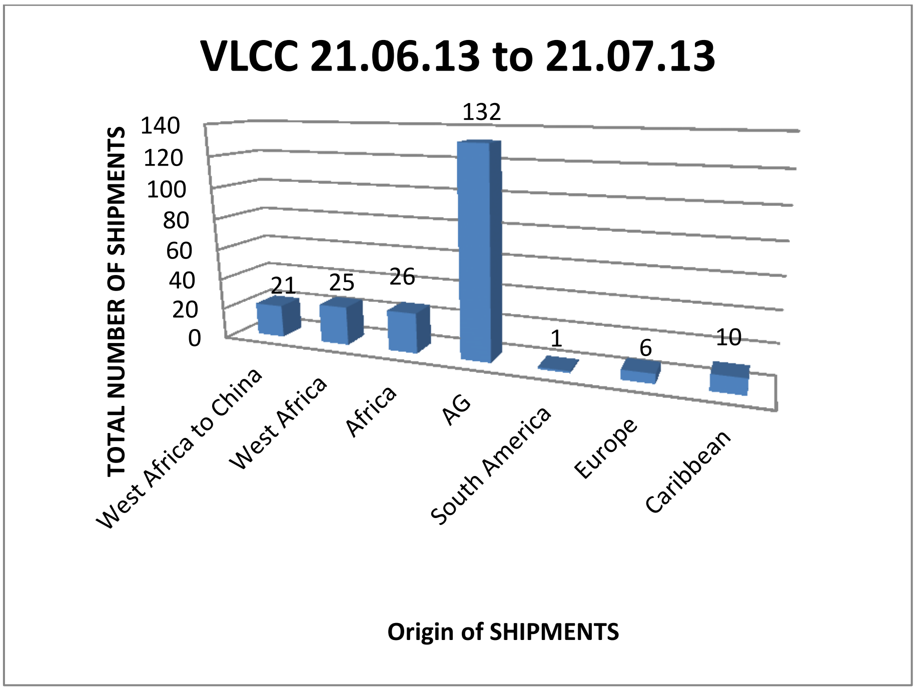
C1.3 Suezmax Vessel Shipments: 21-06-13 to 21-07-13

Suezmax Vessel Shipments: 21-06-13 to 21-07-13	
Total Number of Shipments	**216**
Total Shipments to China	8
Total Shipments to Far East	10
Total Shipments to the Far East from AG	3
Total Shipments from West Africa to China	0
Total Shipments from West Africa	61
Total Shipments from Africa	7
Total Shipments to the USA Gulf	68
Total Shipments from AG	46
Total Shipments from South America	0
Total Shipments to South America	4
Total Shipments from Europe	16
Total Shipments to Europe	14
Total Shipments to India	1
Total Shipments from India	0

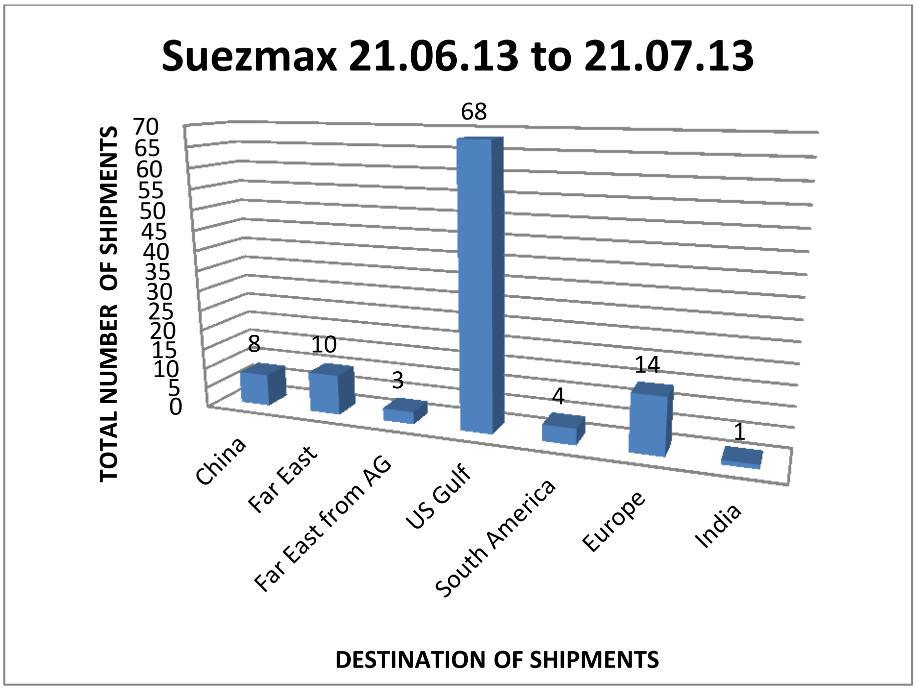
C1.4 Destination of VLCC Vessel Shipments: 21-06-13 to 21-07-13



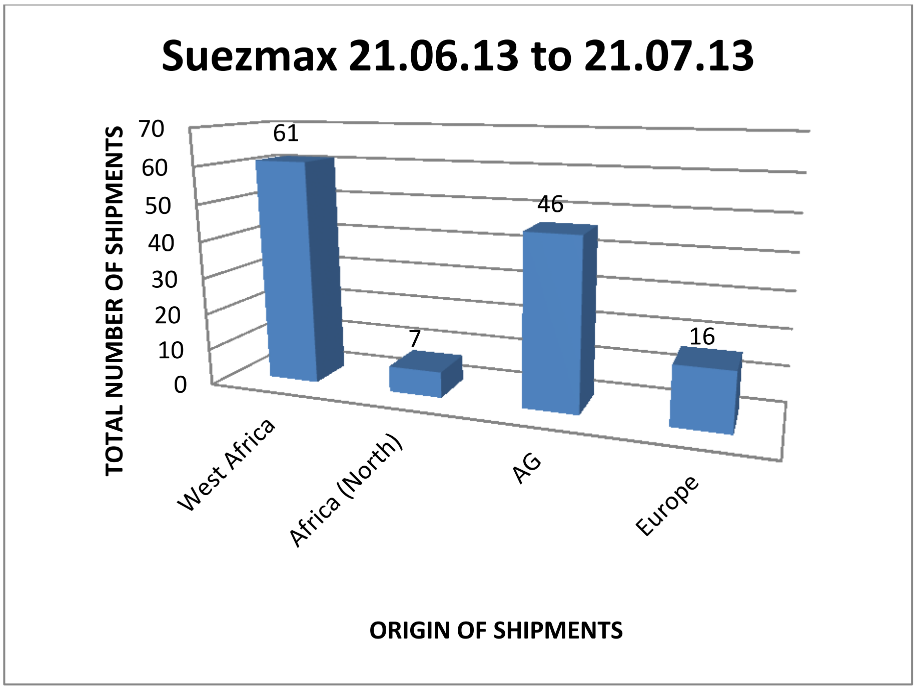
C1.5 Origin of VLCC Vessel Shipments: 21-06-13 to 21-07-13



C1.6 Destination of Suezmax Vessel Shipments: 21-06-13 to 21-07-13



C1.7 Origin of Suezmax Vessel Shipments: 21-06-13 to 21-07-13



C2.1 Clarksons Log 21-07-13 to 21-08-13

Clarksons Log 21-07-13 to 21-08-13					
Tanker Type	**Departure**	**Destination**	**Number of Shipment**	**Quantity Average**	**Total Quantity**
VLCC	West Africa	China	8	260,000	2,080,000
VLCC	West Africa	India	6	260,000	1,560,000
VLCC	West Africa	UKC	2	260,000	520,000
VLCC	West Africa	USG	3	260,000	780,000
VLCC	Libya	China	1	260,000	260,000
Total			20		5,200,000
VLCC	AG	China	32	265,000	8,510,000
VLCC	AG	India	15	250,000	3,750,000
VLCC	AG	UKC	2	280,000	560,000
VLCC	AG	USG	14	280,000	3,920,000
Total			63		16,740,000
Suez	West Africa	China	2	130,000	260,000
Suez	West Africa	UKC	3	130,000	390,000
Suez	West Africa	USG/AC	15	130,000	1,950,000
Total			20		2,600,000
Suez	Nigeria	China	1	130,000	130,000
Suez	Nigeria	India	3	130,000	390,000
Total			4		520,000
Suez	Algeria	China	1	130,000	130,000
Suez	Angola	India	3	130,000	390,000
Total			4		520,000
Suez	AG	China	1	130,000	130,000
Suez	AG	India	21	110,143	2,313,000
Suez	AG	UKC	1	100,000	100,000
Suez	AG	USG/WC	3	131,667	395,000
Total			26		2,808,000

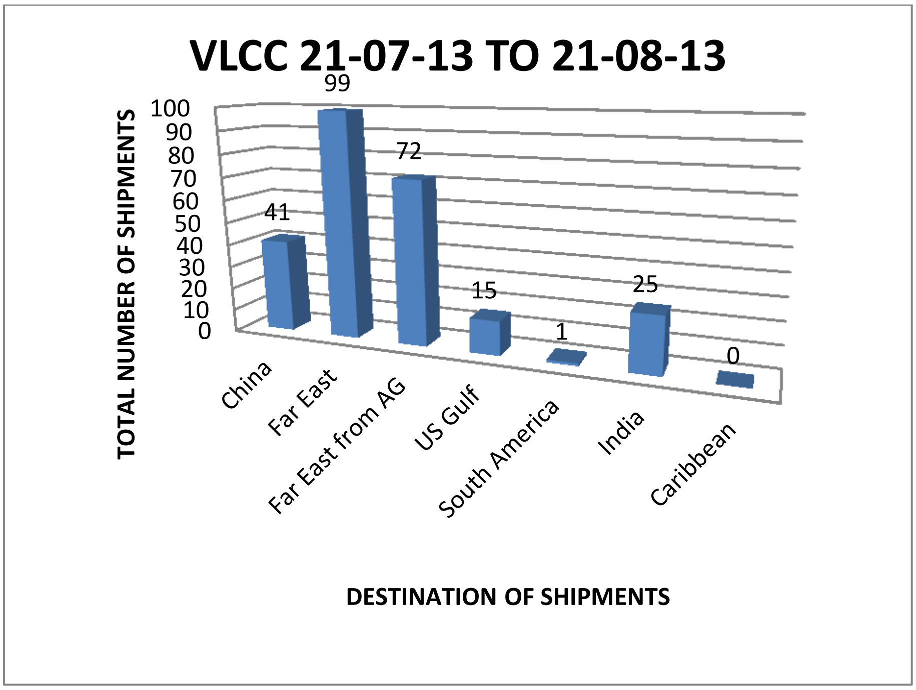
C2.2 VLCC Vessel Shipments: 21-07-13 to 21-08-13

VLCC Vessel Shipments: 21-07-13 to 21-08-13	
Total Number of Shipments	160
Total Number of Shipments to China	41
Total Number of Shipments to Far East	99
Total Number of Shipments to the Far East from AG	72
Total Shipments from West Africa to China	9
Total Shipments to the USA Gulf	15
Total Shipments from West Africa	20
Total Shipments from Africa	21
Total Shipments to the US Coast	19
Total Shipments from AG	113
Total Shipments from South America	2
Total Shipments to South America	1
Total Shipments to India	25
Total Shipments from India	30
Total Shipments from Caribbean	14
Total Shipments to Caribbean	0

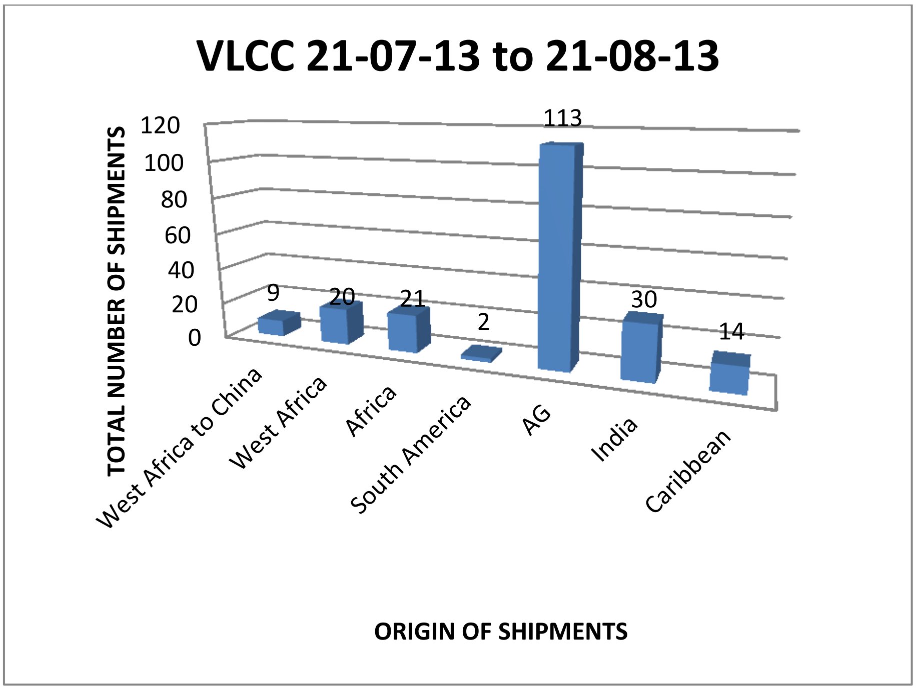
C2.3 Suezmax Vessel Shipments: 21-07-13 to 21-08-13

Suez Vessel Shipments: 21-07-13 to 21-08-13	
Total Number of Shipments	204
Total Number of Shipments to China	1
Total Number of Shipments to Far East	4
Total Number of Shipments to the Far East from AG	3
Total Shipments from West Africa to China	2
Total Shipments to the USA Gulf	45
Total Shipments from West Africa	47
Total Shipments from Africa	63
Total Shipments from AG	43
Total Shipments from South America	20
Total Shipments to South America	13
Total Shipments to India	25
Total Shipments from India	2
Total Shipments from Caribbean	6
Total Shipments to Caribbean	1

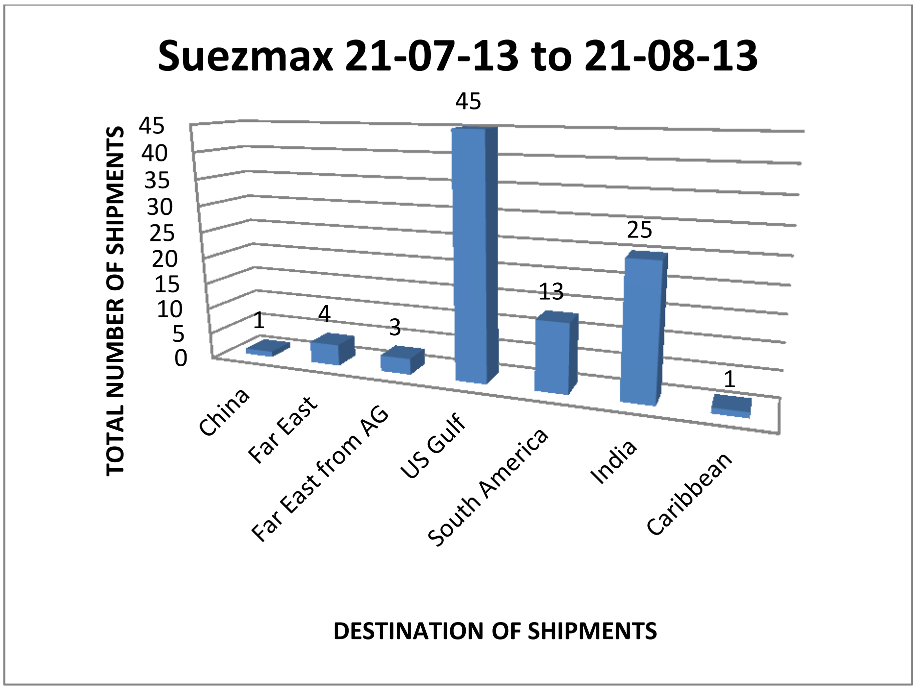
C2.4 Destination of VLCC Vessel Shipments: 21-07-13 to 21-08-13



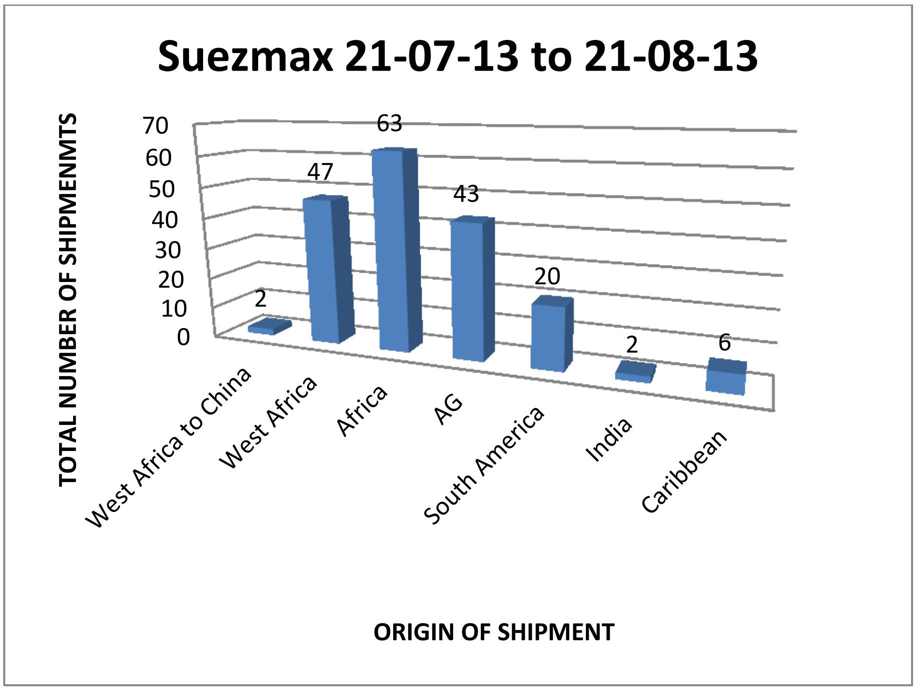
C2.5 Origin of VLCC Vessel Shipments: 21-07-13 to 21-08-13



C2.6 Destination of Suezmax Vessel Shipments: 21-07-13 to 21-08-13



C2.7 Origin of Suezmax Vessel Shipments: 21-07-13 to 21-08-13



C3.1 Clarksons Log 21-07-13 to 21-08-13

Clarksons Log 21-08-13 to 21-09-13					
Tanker Type	Depature	Destination	Number of Shipment	Quantity Average	Total Quantity
VLCC	West Africa	China	9	260,000	2,340,000
VLCC	West Africa	India	4	260,000	1,040,000
VLCC	West Africa	UKC	1	260,000	260,000
VLCC	West Africa	USG	0	0	0
Total			14		3,640,000
VLCC	AG	China	27	267,115	7,219,000
VLCC	AG	India	11	263,273	2,896,000
VLCC	AG	UKC	1	280000	280,000
VLCC	AG	USG	4	280000	2,240,000
Total			43		16,275,000
Suez	West Africa	China	0	0	0
Suez	West Africa	India	5	130,000	650,000
Suez	West Africa	UKC	1	130,000	130,000
Suez	West Africa	Europe	22	130,000	2,860,000
Suez	West Africa	USG	10	130,000	1,300,000
Suez	West Africa	South America	2	130,000	260,000
Suez	West Africa	Far East	2	130,000	260,000
Suez	West Africa	Durban	2	130,000	260,000
Suez	West Africa	Dakar	1	130,000	130,000
Total			45		5,850,000
Suez	AG	Far East	13	193,462	2,515,006
Suez	AG	China	6	220,833	1,324,998
Suez	AG	India	16	105,188	1,683,008
Suez	AG	UKC	1	280,000	280,000
Suez	AG	USA	9	280,000	2,520,000
Total			45		8,323,012

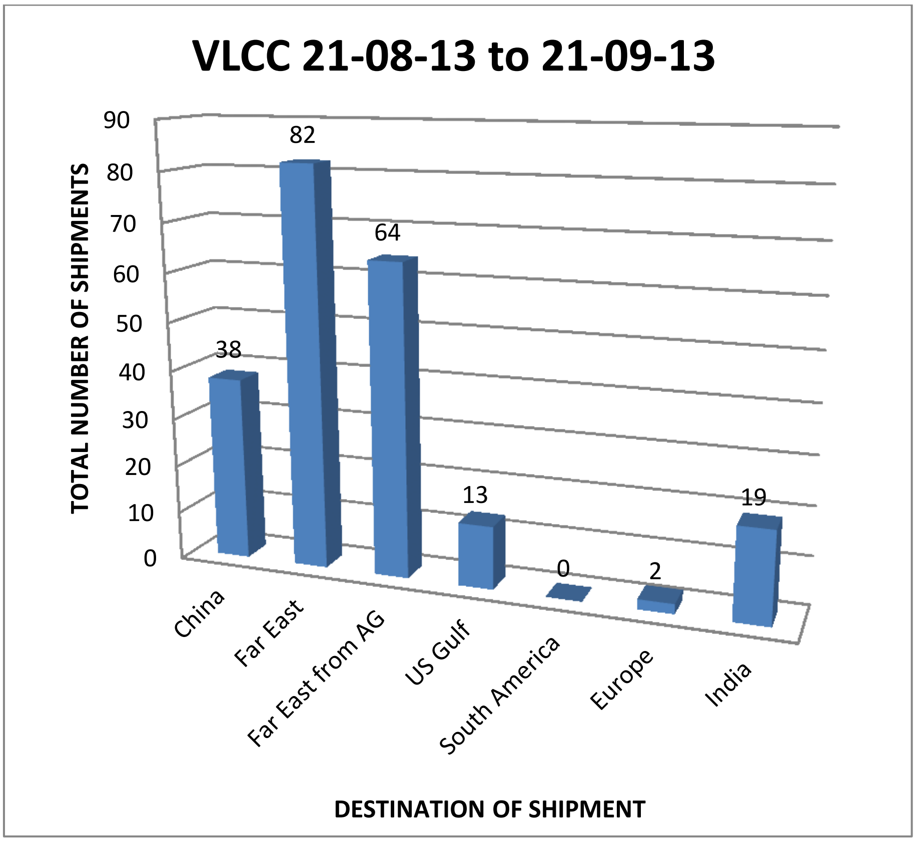
C3.2 VLCC Vessel Shipments: 21-08-13 to 21-09-13

VLCC Vessel Shipments: 21-08-13 to 21-09-13	
Total Number of Shipments	**131**
Total Number of Shipments to China	38
Total Number of Shipments to Far East	82
Total Number of Shipments to the Far East from AG	64
Total Shipments from West Africa to China	9
Total Shipments from West Africa	12
Total Shipments from Africa	15
Total Shipments to the USA Gulf	13
Total Shipments from AG	100
Total Shipments from South America	4
Total Shipments to South America	0
Total Shipments from Europe	0
Total Shipments to Europe	2
Total Shipments to India	19
Total Shipments from India	0

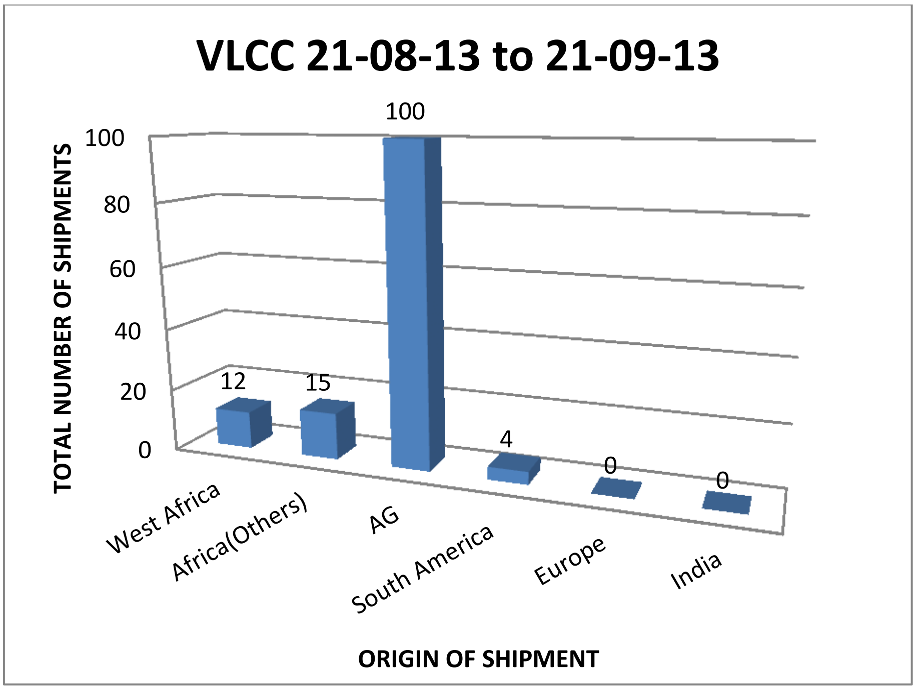
C3.3 Suezmax Vessel Shipments: 21-08-13 to 21-09-13

Suez Vessel Shipments: 21-08-13 to 21-09-13	
Total Number of Shipments	**149**
Total Number of Shipments to China	9
Total Number of Shipments to Far East	18
Total Number of Shipments to the Far East from AG	11
Total Shipments from West Africa to China	0
Total Shipments from West Africa	41
Total Shipments from Africa	54
Total Shipments to the USA Gulf	24
Total Shipments from AG	52
Total Shipments from South America	9
Total Shipments to South America	6
Total Shipments from Europe	16
Total Shipments to Europe	51
Total Shipments to India	26
Total Shipments from India	0

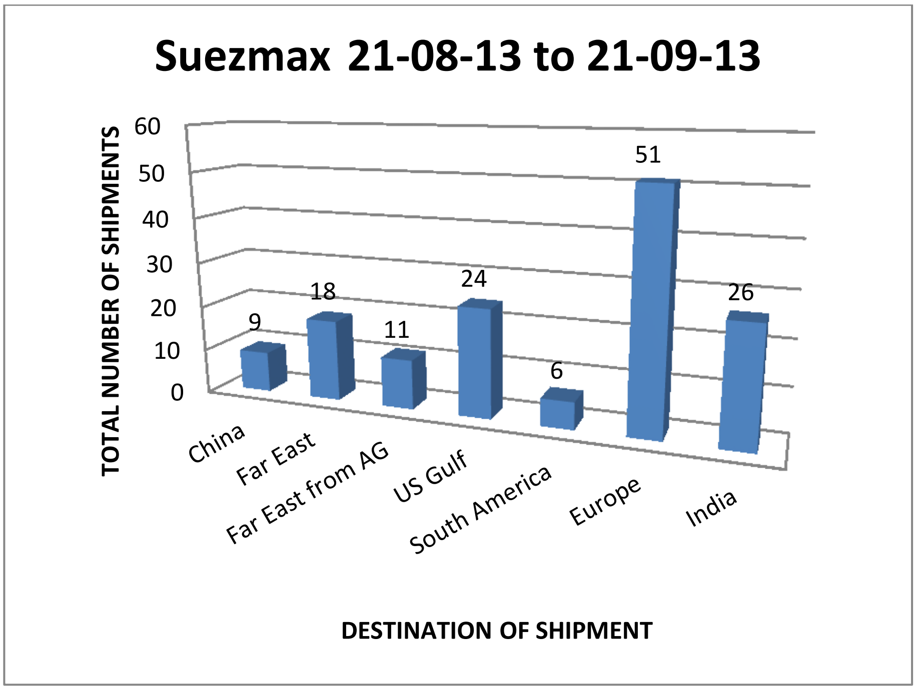
C3.4 Destination of VLCC Vessel Shipments: 21-08-13 to 21-09-13



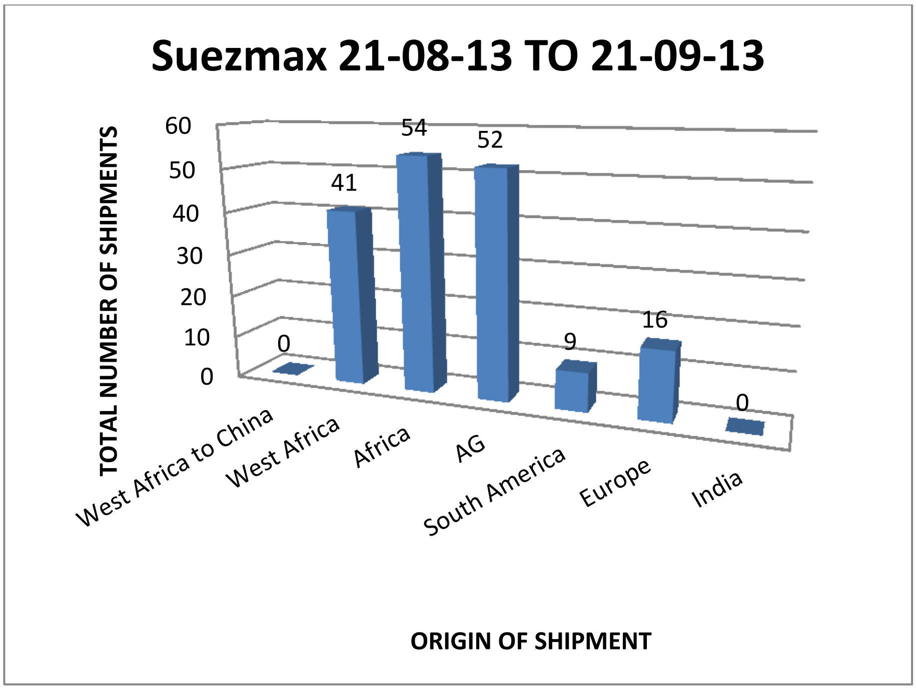
C3.5 Origin of VLCC Vessel Shipments: 21-08-13 to 21-09-13



C3.6 Destination of Suezmax Vessel Shipments: 21-08-13 to 21-09-13



C3.7 Origin of Suezmax Vessel Shipments: 21-08-13 to 21-09-13



C4.1 Clarksons Log 21-09-13 to 21-10-13

Clarksons Log 21-09-13 to 21-10-13					
Tanker Type	**Depature**	**Destination**	**Number of Shipment**	**Quantity Average**	**Total Quantity**
VLCC	West Africa	China	17	260,000	4,420,000
VLCC	West Africa	India	5	260,000	1,300,000
VLCC	West Africa	UKC	1	260,000	260,000
VLCC	West Africa	USG	0	0	0
VLCC	Nigeria	India	5	260,000	1,300,000
VLCC	Nigeria	China	1	260,000	260,000
Total			29		7,540,000
VLCC	AG	Far East	89	268,529	23,903,500
VLCC	AG	China	35	266,143	9,315,000
VLCC	AG	India	17	264,647	4,499,000
VLCC	AG	UKC	2	270,000	540,000
VLCC	AG	USG	4	280,000	1,120,000
Total			147		46,917,500
Suez	West Africa	Far East	7	130,000	910,000
Suez	West Africa	China	0	0	0
Suez	West Africa	India	7	130,000	910,000
Suez	West Africa	UKC	2	130,000	260,000
Suez	West Africa	Europe	24	130,000	3,120,000
Suez	West Africa	USG	8	130,000	1,040,000
Suez	West Africa	South America	2	130,000	260,000
Suez	Nigeria	Abidjan	3	130,000	390,000
Total			46		5,980,000
Suez	AG	Far East	5	130,000	650,000
Suez	AG	India	4	130,500	532,000
Suez	AG	UKC	0	0	0
Suez	AG	USA	6	132,500	795,000
Total			15		1,977,000

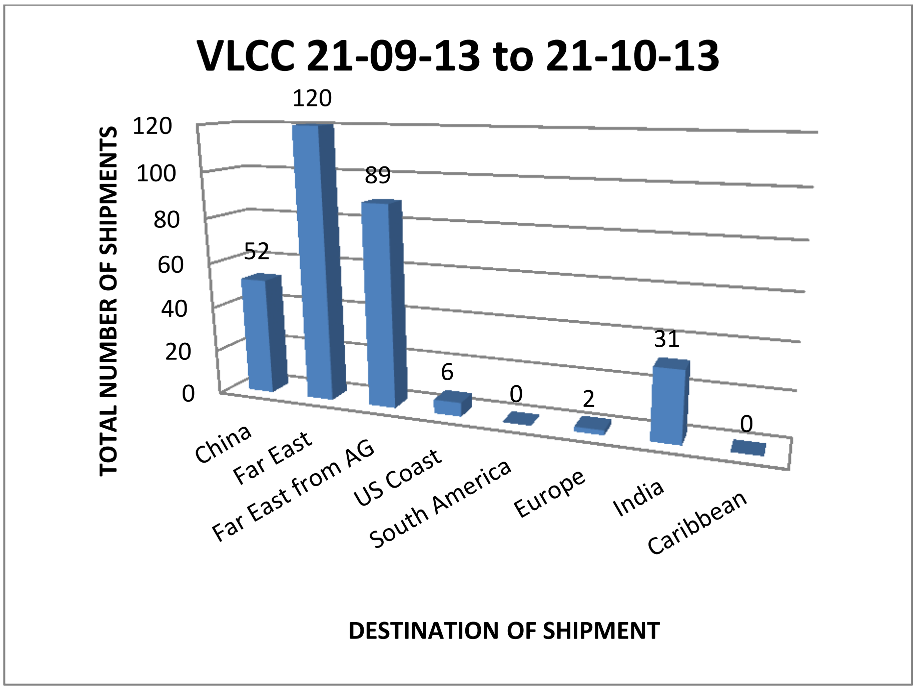
C4.2 VLCC Vessel Shipments: 21-09-13 to 21-10-13

VLCC Vessel Shipments: 21-09-13 to 21-10-13	
Total Number of Shipments	169
Total Number of Shipments to China	52
Total Number of Shipments to Far East	120
Total Number of Shipments to the Far East from AG	89
Total Shipments from West Africa to China	17
Total Shipments from West Africa	23
Total Shipments from Africa	25
Total Shipments to the US Coast	6
Total Shipments from AG	125
Total Shipments from South America	7
Total Shipments to South America	0
Total Shipments from Europe	0
Total Shipments to Europe	2
Total Shipments to India	31
Total Shipments from India	0
Total Shipments from Caribbean	13
Total Shipments to Caribbean	0

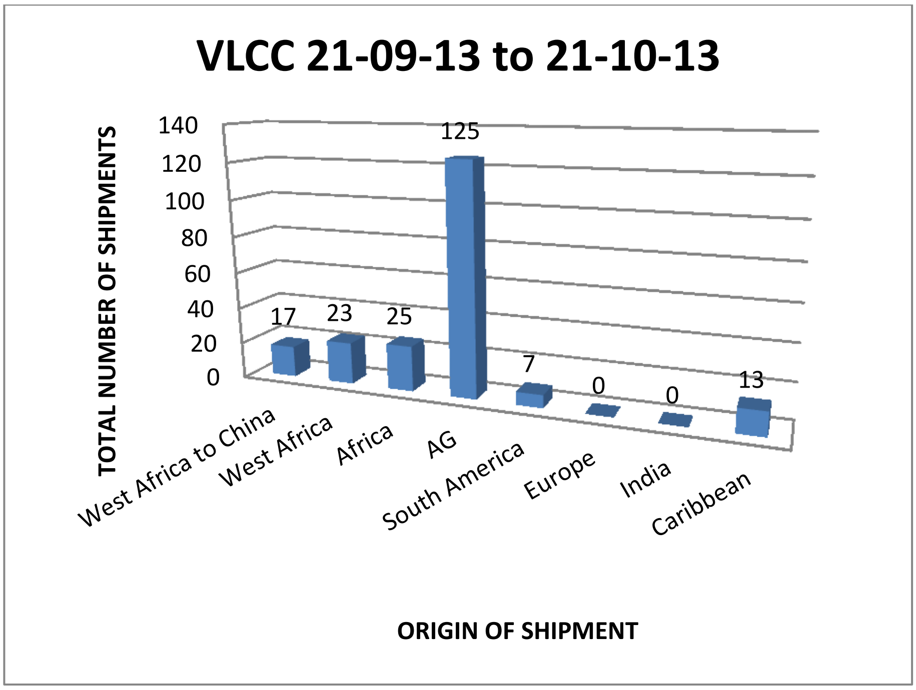
C4.3 Suezmax Vessel Shipments: 21-09-13 to 21-10-13

Suezmax Vessel Shipments: 21-09-13 to 21-10-13	
Total Number of Shipments	195
Total Number of Shipments to China	5
Total Number of Shipments to Far East	47
Total Number of Shipments to the Far East from AG	7
Total Shipments from West Africa to China	0
Total Shipments from West Africa	56
Total Shipments from Africa	72
Total Shipments to the US Coast	38
Total Shipments from AG	35
Total Shipments from South America	17
Total Shipments to South America	8
Total Shipments from Europe	42
Total Shipments to Europe	56
Total Shipments to India	18
Total Shipments from India	4
Total Shipments from Caribbean	8
Total Shipments to Caribbean	1

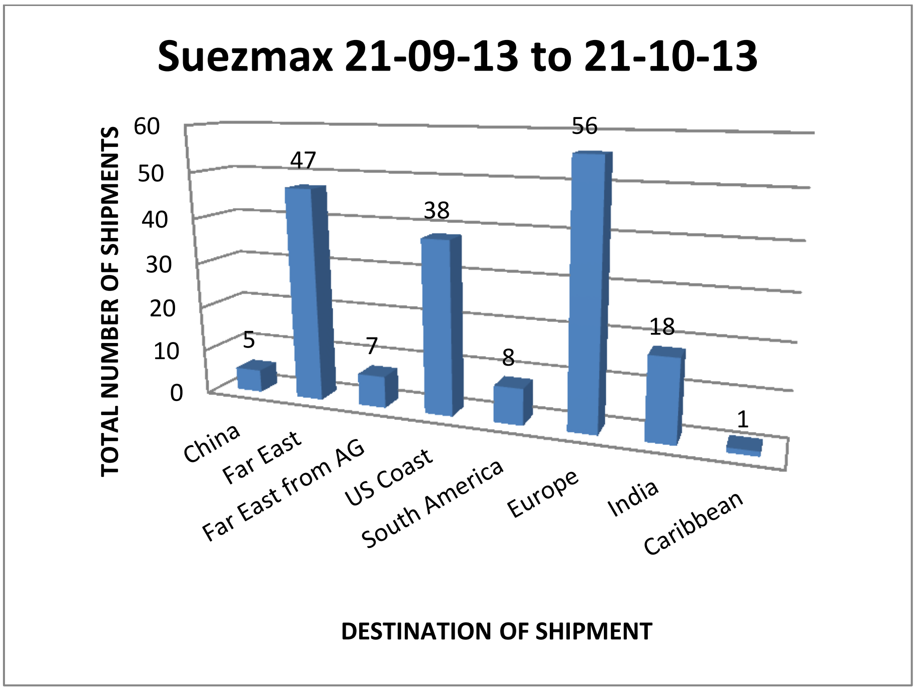
C4.4 Destination of VLCC Vessel Shipments: 21-09-13 to 21-10-13



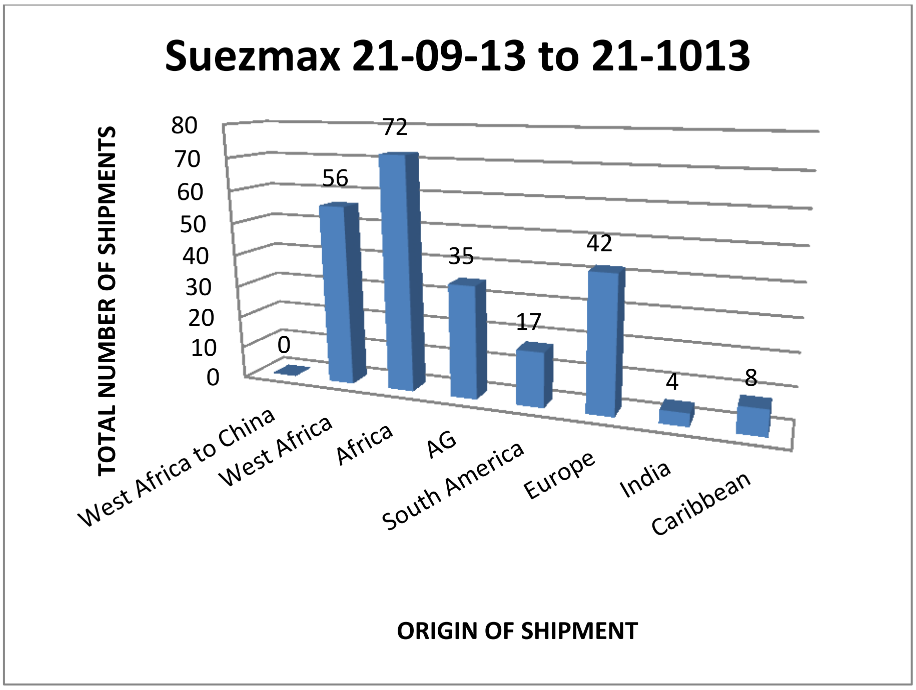
C4.5 Origin of VLCC Vessel Shipments: 21-09-13 to 21-10-13



C4.6 Destination of Suezmax Vessel Shipments: 21-09-13 to 21-10-13



C4.7 Origin of Suezmax Vessel Shipments: 21-09-13 to 21-10-13



C5.1 Clarksons Log 21-10-13 to 21-11-13

Clarksons Log 21-10-13 to 21-11-13					
Tanker Type	Depature	Destination	Number of Shipment	Quantity Average	Total Quantity
VLCC	West Africa	China	8	260,000	2,080,000
VLCC	West Africa	India	10	260,500	2,605,000
VLCC	West Africa	UKC	0	0	0
VLCC	West Africa	USG	0	0	0
Total			18		4,685,000
VLCC	AG	Far East	77	269,143	20,724,000
VLCC	AG	China	44	268,432	11,811,000
VLCC	AG	India	10	249,200	2,492,000
VLCC	AG	UKC	1	280000	280,000
VLCC	AG	USG	9	275555	2,480,000
Total			141		37,787,000
Suez	West Africa	Far East	5	130,000	650000
Suez	West Africa	China	1	130,000	130000
Suez	West Africa	India	12	130,000	1560000
Suez	West Africa	UKC	1	130,000	130000
Suez	West Africa	Europe	25	130,000	3250000
Suez	West Africa	USG	8	130,000	1040000
Suez	West Africa	South America	5	130,000	650000
Total			57		7,410,000
Suez	AG	Far East	5	130,000	650,000
Suez	AG	China	0	0	0
Suez	AG	India	9	112,889	1,016,000
Suez	AG	UKC	0	0	0
Suez	AG	USA	4	130,000	525,000
Total			18		2,191,000

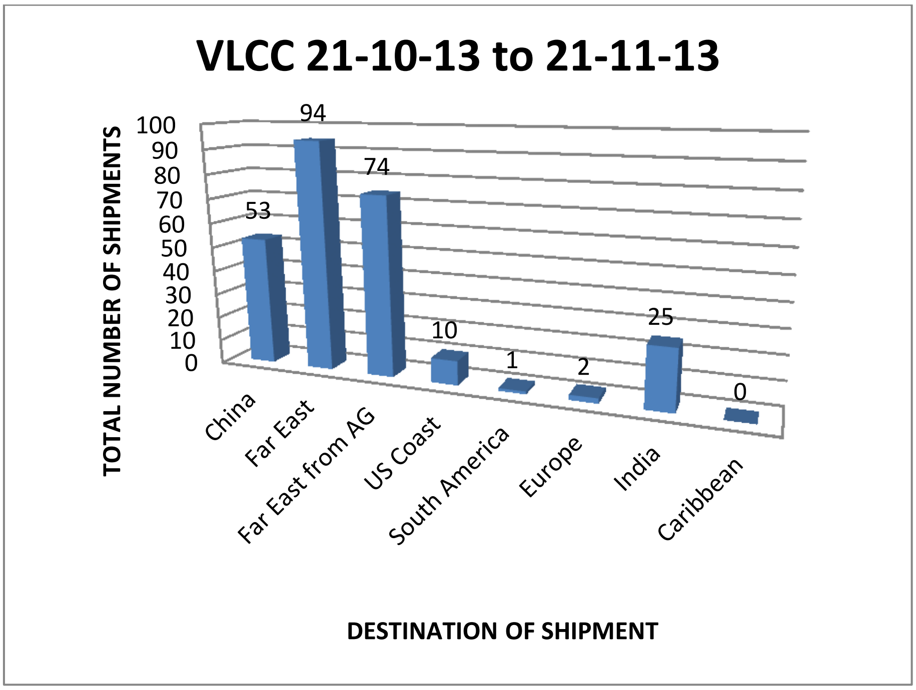
C5.2 VLCC Vessel Shipments: 21-10-13 to 21-11-13

VLCC Vessel Shipments: 211013 to 211113	
Total Number of Shipments	151
Total Number of Shipments to China	53
Total Number of Shipments to Far East	94
Total Number of Shipments to the Far East from AG	74
Total Shipments from West Africa to China	8
Total Shipments from West Africa	13
Total Shipments from Africa	18
Total Shipments to the US Coast	10
Total Shipments from AG	109
Total Shipments from South America	6
Total Shipments to South America	1
Total Shipments from Europe	2
Total Shipments to Europe	2
Total Shipments to India	25
Total Shipments from India	0
Total Shipments from Caribbean	15
Total Shipments to Caribbean	0

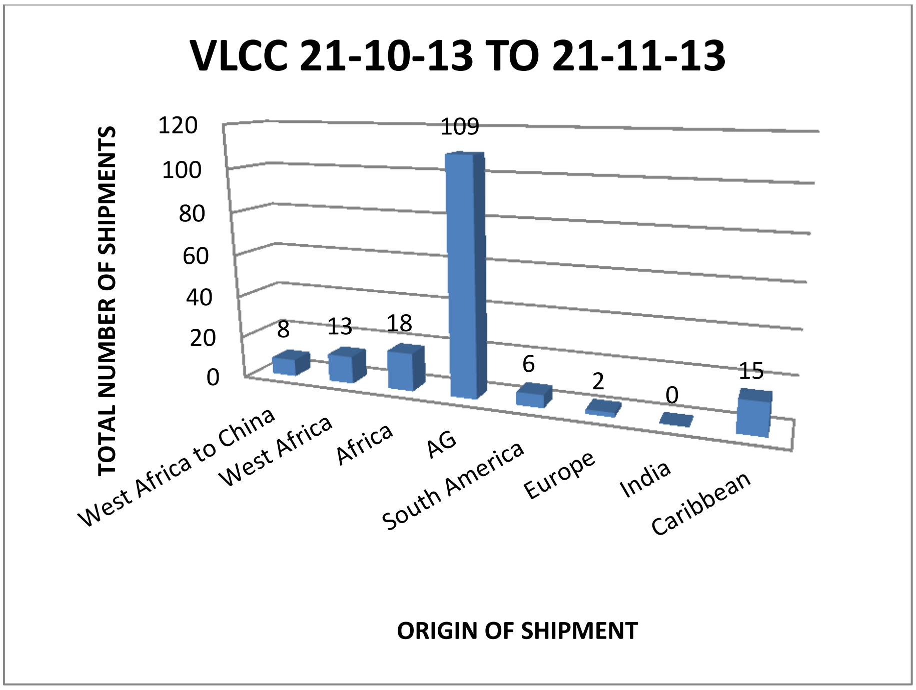
C5.3 Suezmax Vessel Shipments: 21-10-13 to 21-11-13

Suezmax vessel Shipments: 211013 to 211113	
Total Number of Shipments	210
Total Number of Shipments to China	8
Total Number of Shipments to Far East	23
Total Number of Shipments to the Far East from AG	1
Total Shipments from West Africa to China	2
Total Shipments from West Africa	72
Total Shipments from Africa	3
Total Shipments to the US Coast	8
Total Shipments from AG	32
Total Shipments from South America	1
Total Shipments to South America	2
Total Shipments from Europe	39
Total Shipments to Europe	60
Total Shipments to India	34
Total Shipments from India	0
Total Shipments from Caribbean	1
Total Shipments to Caribbean	0

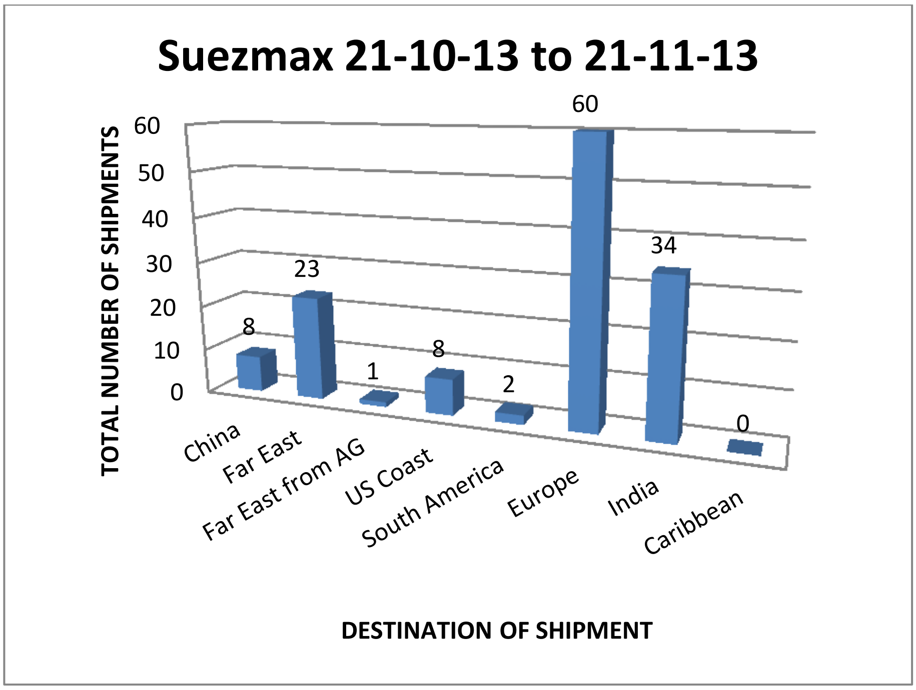
C5.4 Destination of VLCC Vessel Shipments: 21-10-13 to 21-11-13



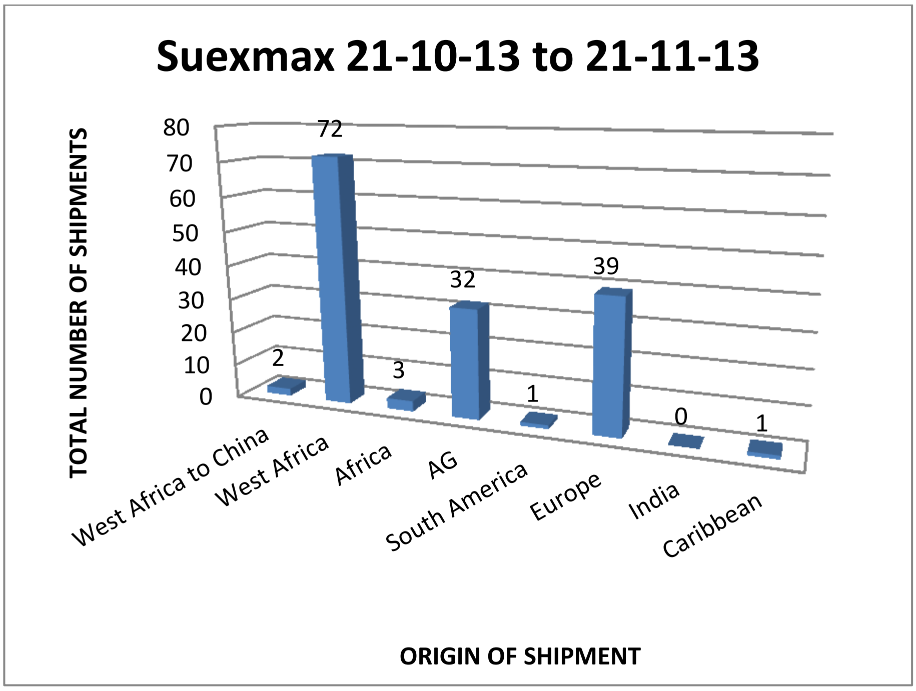
C5.5 Origin of VLCC Vessel Shipments: 21-10-13 to 21-11-13



C5.6 Destination of Suezmax Vessel Shipments: 21-10-13 to 21-11-13



C5.7 Origin of Suezmax Vessel Shipments: 21-10-13 to 21-11-13



C6.1 Clarksons Log 21-10-13 to 21-11-13

Clarksons Log 24-11-13 to 21-12-13					
Tanker Type	Depature	Destination	Number of Shipment	Quantity Average	Total Quantity
VLCC	West Africa	Far East	14	260,000	3,640,000
VLCC	West Africa	China	12	260,000	3,120,000
VLCC	West Africa	India	6	238,333	1,429,998
VLCC	West Africa	UKC	0	0	0
VLCC	West Africa	USG	1	260,000	260,000
VLCC	Nigeria Agbami	India	2	185,000	370,000
VLCC	Nigeria Bonny	India	1	260,000	260,000
VLCC	Nigeria EA	India	1	260,000	260,000
VLCC	Nigeria Qua Iboe	India	1	260,000	260,000
VLCC	Nigeria Yoho	India	1	260,000	260,000
Total			39		9,859,998
VLCC	AG	China	39	267,628	10,437,492
VLCC	AG	Far East	66	268,599	17,727,534
VLCC	AG	India	5	267,000	1,335,000
VLCC	AG	UKC	1	280,000	280,000
VLCC	AG	USG	4	280,000	1,120,000
Total			115		30,900,026
Suez	West Africa	Far East	7	130,000	910,000
Suez	West Africa	China	2	130,000	260,000
Suez	West Africa	India	6	130,000	780,000
Suez	West Africa	UKC	1	130,000	130,000
Suez	West Africa	USG	6	130,000	780,000
Suez	West Africa	Europe	27	130,000	3,510,000
Suez	North Africa	Europe	6	133,000	798,000
Suez	North Africa	Far East	5	133,000	665,000
Total			60		7,833,000
Suez	AG	Far East	10	130,555	1,305,550
Suez	AG	China	0	0	0
Suez	AG	India	4	123,750	495,000
Suez	AG	USA	2	132,500	265,000
Suez	AG	Europe	9	137,222	1,234,998
Total			25		3,300,548

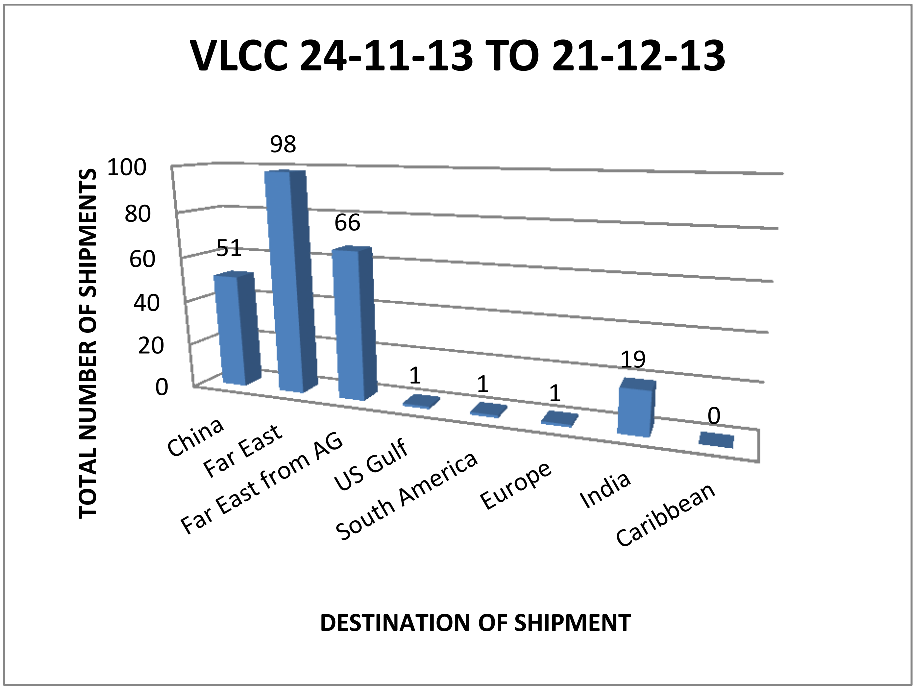
C6.2 VLCC Vessel Shipments: 24-11-13 to 21-12-13

VLCC Vessel Shipments: 241113 to 211213	
Total Number of Shipments	132
Total Number of Shipments to China	51
Total Number of Shipments to Far East	98
Total Number of Shipments to the Far East from AG	66
Total Shipments from West Africa to China	12
Total Shipments from West Africa	21
Total Shipments from Africa	21
Total Shipments to the USA Gulf	1
Total Shipments from AG	67
Total Shipments from South America	3
Total Shipments to South America	1
Total Shipments from Europe	1
Total Shipments to Europe	1
Total Shipments to India	19
Total Shipments from India	0
Total Shipments from Caribbean	16
Total Shipments to Caribbean	0

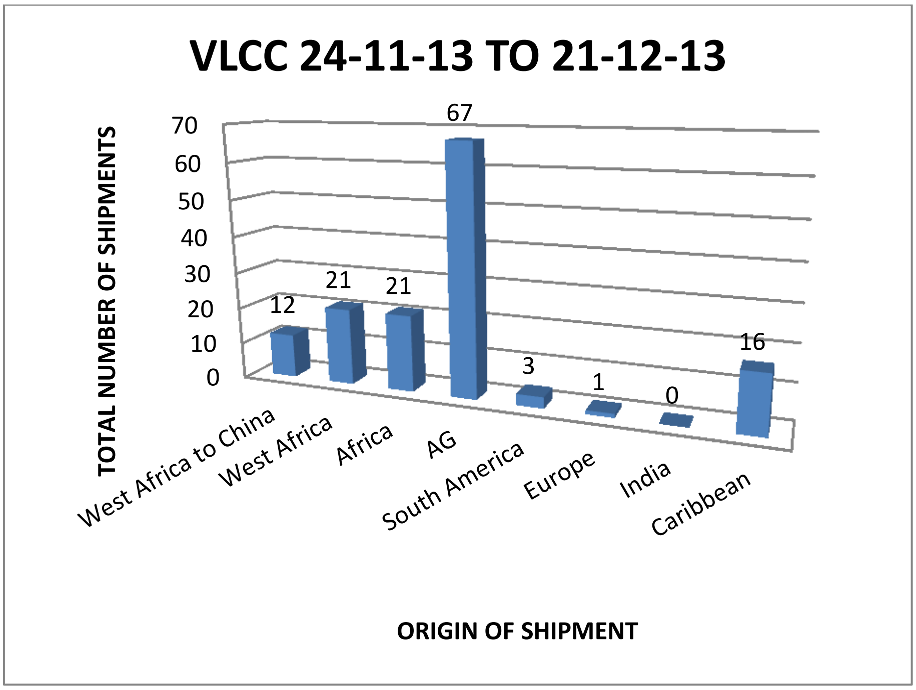
C6.3 Suezmax Vessel Shipments: 24-11-13 to 21-12-13

Suezmax Vessel Shipments: 241113 to 211213	
Total Number of Shipments	212
Total Number of Shipments to China	11
Total Number of Shipments to Far East	41
Total Number of Shipments to the Far East from AG	12
Total Shipments from West Africa to China	2
Total Shipments from West Africa	51
Total Shipments from Africa	80
Total Shipments to the USA Gulf	7
Total Shipments from AG	5
Total Shipments from South America	7
Total Shipments to South America	11
Total Shipments from Europe	36
Total Shipments to Europe	17
Total Shipments to India	30
Total Shipments from India	1
Total Shipments from Caribbean	10
Total Shipments to Caribbean	0

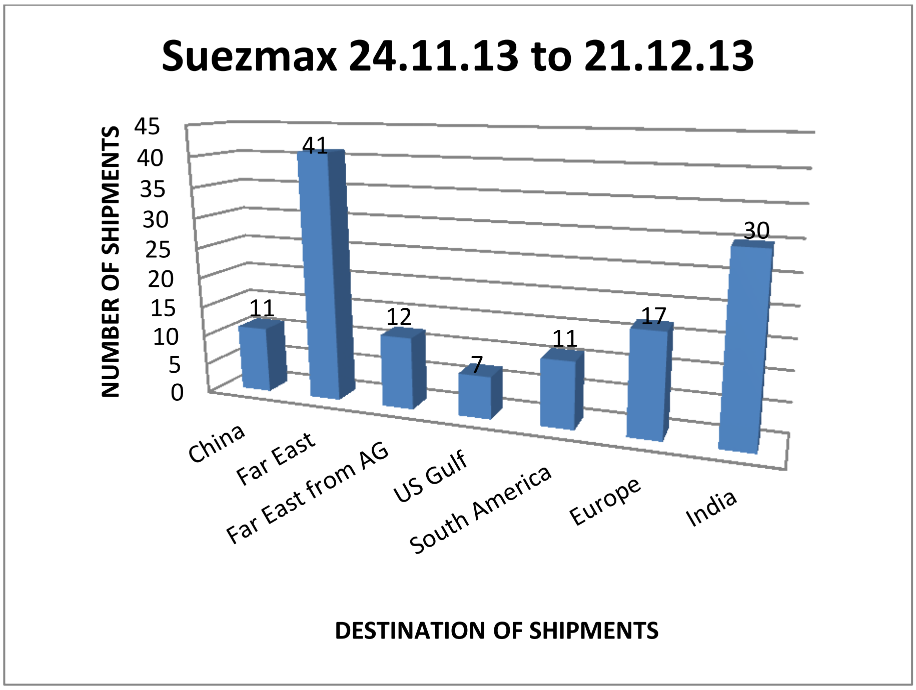
C6.4 Destination of VLCC Vessel Shipments: 24-11-13 to 21-12-13



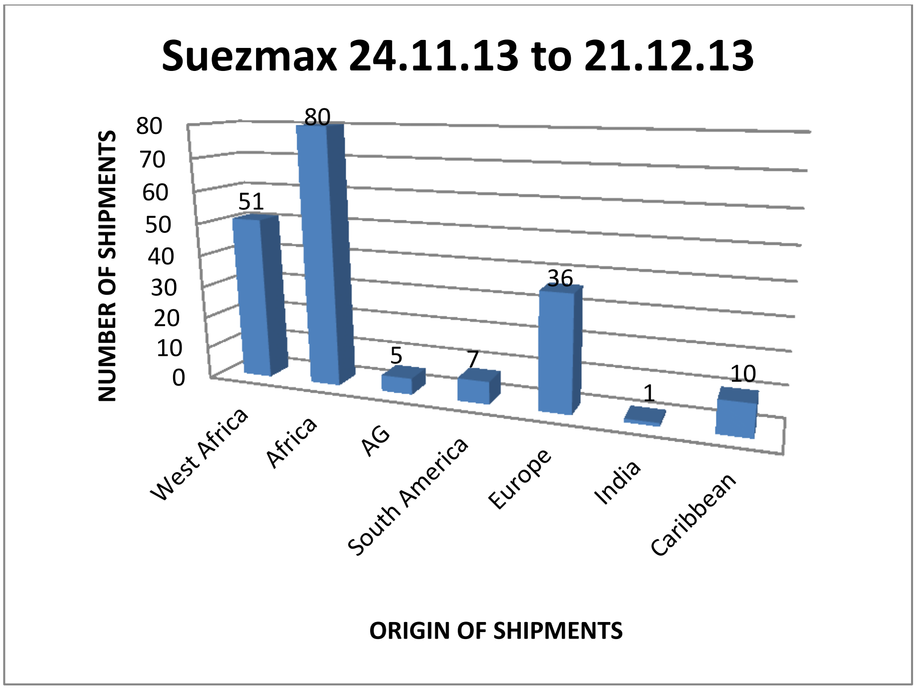
C6.5 Origin of VLCC Vessel Shipments: 24-11-13 to 21-12-13



C6.6 Destination of Suezmax Vessel Shipments: 24-11-13 to 21-12-13



C6.7 Origin of Suezmax Vessel Shipments: 24-11-13 to 21-12-13



Appendix D: Chi-Square Test of Independence

D7.1 Vessel * Destination Cross Tabulation

Crosstab

			Destination								Total
			Africa	China	Europe	Far East	India	SAmerica	UKC	USA	
Vessel	Suez	Count	3	6	6	9	10	3	6	9	52
		Expected Count	1.5	10.2	2.9	6.3	14.1	1.5	7.3	8.3	52.0
		% within Vessel	5.8%	11.5%	11.5%	17.3%	19.2%	5.8%	11.5%	17.3%	100.0%
		% within Destination	100.0%	28.6%	100.0%	69.2%	34.5%	100.0%	40.0%	52.9%	48.6%
		% of Total	2.8%	5.6%	5.6%	8.4%	9.3%	2.8%	5.6%	8.4%	48.6%
	VLCC	Count	0	15	0	4	19	0	9	8	55
		Expected Count	1.5	10.8	3.1	6.7	14.9	1.5	7.7	8.7	55.0
		% within Vessel	0.0%	27.3%	0.0%	7.3%	34.5%	0.0%	16.4%	14.5%	100.0%
		% within Destination	0.0%	71.4%	0.0%	30.8%	65.5%	0.0%	60.0%	47.1%	51.4%
		% of Total	0.0%	14.0%	0.0%	3.7%	17.8%	0.0%	8.4%	7.5%	51.4%
Total		Count	3	21	6	13	29	3	15	17	107
		Expected Count	3.0	21.0	6.0	13.0	29.0	3.0	15.0	17.0	107.0
		% within Vessel	2.8%	19.6%	5.6%	12.1%	27.1%	2.8%	14.0%	15.9%	100.0%
		% within Destination	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	2.8%	19.6%	5.6%	12.1%	27.1%	2.8%	14.0%	15.9%	100.0%

D7.2 Departure * Destination Cross Tabulation

Crosstab

			Destination								
			Africa	China	Europe	Far East	India	South America	UKC	USA	Total
Departure	Africa	Count	0	3	1	1	0	0	0	0	5
		Expected Count	.1	1.0	.3	.6	1.4	.1	.7	.8	5.0
		% within Departure	0.0%	60.0%	20.0%	20.0%	0.0%	0.0%	0.0%	0.0%	100.0%
		% within Destination	0.0%	14.3%	16.7%	7.7%	0.0%	0.0%	0.0%	0.0%	4.7%
		% of Total	0.0%	2.8%	0.9%	0.9%	0.0%	0.0%	0.0%	0.0%	4.7%
	AG	Count	0	7	1	7	10	0	7	10	42
		Expected Count	1.2	8.2	2.4	5.1	11.4	1.2	5.9	6.7	42.0
		% within Departure	0.0%	16.7%	2.4%	16.7%	23.8%	0.0%	16.7%	23.8%	100.0%
		% within Destination	0.0%	33.3%	16.7%	53.8%	34.5%	0.0%	46.7%	58.8%	39.3%
		% of Total	0.0%	6.5%	0.9%	6.5%	9.3%	0.0%	6.5%	9.3%	39.3%
	Nigeria	Count	1	2	0	0	8	0	0	0	11
		Expected Count	.3	2.2	.6	1.3	3.0	.3	1.5	1.7	11.0
		% within Departure	9.1%	18.2%	0.0%	0.0%	72.7%	0.0%	0.0%	0.0%	100.0%
		% within Destination	33.3%	9.5%	0.0%	0.0%	27.6%	0.0%	0.0%	0.0%	10.3%
		% of Total	0.9%	1.9%	0.0%	0.0%	7.5%	0.0%	0.0%	0.0%	10.3%
	West Africa	Count	2	9	4	5	11	3	8	7	49
		Expected Count	1.4	9.6	2.7	6.0	13.3	1.4	6.9	7.8	49.0
		% within Departure	4.1%	18.4%	8.2%	10.2%	22.4%	6.1%	16.3%	14.3%	100.0%
		% within Destination	66.7%	42.9%	66.7%	38.5%	37.9%	100.0%	53.3%	41.2%	45.8%
		% of Total	1.9%	8.4%	3.7%	4.7%	10.3%	2.8%	7.5%	6.5%	45.8%
Total		Count	3	21	6	13	29	3	15	17	107
		Expected Count	3.0	21.0	6.0	13.0	29.0	3.0	15.0	17.0	107.0
		% within Departure	2.8%	19.6%	5.6%	12.1%	27.1%	2.8%	14.0%	15.9%	100.0%
		% within Destination	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	2.8%	19.6%	5.6%	12.1%	27.1%	2.8%	14.0%	15.9%	100.0%

D7.3 Departure Point (Grouped) and Destination Chi-Square Test: Count Summary

Case Processing Summary

AG and WA Departure points	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Departure * Destination	81	100.0%	0	0.0%	81	100.0%

D7.3a Departure Point (Grouped) and Destination Chi-Square Test

Departure * Destination Crosstabulation

			Destination					Total
			China	Far East	India	UKC	USA	
Departure	AG	Count	7	7	10	7	10	41
		Expected Count	8.1	6.1	10.6	7.6	8.6	41.0
		% within Departure	17.1%	17.1%	24.4%	17.1%	24.4%	100.0%
		% within Destination	43.8%	58.3%	47.6%	46.7%	58.8%	50.6%
		% of Total	8.6%	8.6%	12.3%	8.6%	12.3%	50.6%
	West Africa	Count	9	5	11	8	7	40
		Expected Count	7.9	5.9	10.4	7.4	8.4	40.0
		% within Departure	22.5%	12.5%	27.5%	20.0%	17.5%	100.0%
		% within Destination	56.3%	41.7%	52.4%	53.3%	41.2%	49.4%
		% of Total	11.1%	6.2%	13.6%	9.9%	8.6%	49.4%
Total		Count	16	12	21	15	17	81
		Expected Count	16.0	12.0	21.0	15.0	17.0	81.0
		% within Departure	19.8%	14.8%	25.9%	18.5%	21.0%	100.0%
		% within Destination	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	19.8%	14.8%	25.9%	18.5%	21.0%	100.0%

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