Supply Chain Configurations for the Oil and Gas Industry: A Service Provider Perspective

by

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DECLARATION

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Name in full

15 February 2014

Date

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I dedicate this work to my father, who unfortunately is no longer with us. Thanks for all the support and motivation throughout my academic career.

ABSTRACT

Oil dependency has increased in the past few decades and the search for new reserves is a constant quest within the oil and gas industry. The oil and gas industry is characterised by the separation of fuel production facilities and the intended markets for its derivatives. This separation creates challenges for proper supply chain management and network configuration. A well-balanced network design becomes of utmost importance. The use of third party logistics service providers has further complicated this separation challenges with this increase in distance between the resources and the intended markets. By using various best practices within the field of network configuration, the consolidation of multiple segments of various supply chains can improve efficiency and lead to more streamlined supply chains.

The primary objective of the study is to develop an alternative to the normative methods used in placing of facilities. The secondary objective is to establish whether consolidation of multiple segments of various supply chains within the oil and gas industry is feasible. By using advanced descriptive decision support techniques and technologies, the study showed how the application of these techniques can assist management with improved decision making at a strategic level.

The study is based on a prominent service provider within the oil and gas industry. Both quantitative and qualitative data were used by the researcher to illustrate the complexities involved in serving the direct and indirect supply chains of the oil and gas industry.

The analysis shows that by using advanced descriptive decision support techniques and technologies, management can use the process proposed in the study to great effect in visualizing the current supply chains. Consolidation opportunities were also found across multiple supply chains within the service provider. By looking at the historical data, IT-based descriptive decision support techniques and technologies demonstrated the value of visually representing the supply chain and the decisions that could be made based on the results. A strategic hub, as a network configuration option, can be a feasible option if it serves a defined geographical area and is focused on a specific industry (in this case oil and gas).

Crucial to a successful study of this nature, is the quality of data. During the study, the issue of effective data cleaning, aggregation, categorization and preparation became evident. Strategic studies will only be effective if proper data cleaning and preparations are done on a regular basis and updated regularly.

OPSOMMING

Die afhanklikheid van olie het die afgelope paar dekades toegeneem. Daar is ook ʼn konstante soektog na nuwe reserwes in die olie- en gasindustrie. Die olie- en gasindustrie word gekenmerk deur die skeiding van brandstofproduksiefasiliteite en die beoogde markte vir sy afgeleides. Hierdie skeiding skep uitdagings vir behoorlike voorsieningskettingbestuur en netwerkkonfigurasie. ʼn Goeie, gebalanseerde netwerkontwerp is van uiterste belang. Die gebruik van derde-party logistieke diensverskaffers het hierdie skeidings-uitdagings verder gestrem as gevolg van langer afstande tussen hulpbronne en die beoogde markte. Verskeie beste praktyke in die studieveld van netwerkkonfigurasie en ontwerp aangewend word. Dit kan die konsolidasie van verskeie segmente van verskillende voorsieningskettings se doeltreffendheid aansienlik verbeter en lei tot meer vaartbelynde voorsieningskettings.

Die primêre doel van die studie is om ʼn alternatief tot die normatiewe metodes, wat tans gebruik word vir die plasing van fasiliteite te bepaal. Die sekondêre doel is om vas te stel of konsolidering van verskeie segmente van verskillende voorsieningskettings in die olie- en gasindustrie haalbaar is. ʼn Alternatiewe tot die normatiewe metodes is gevorderde, beskrywende besluitnemingsondersteuningtegnieke en tegnologie. In die studie is getoon hoe die gebruik van hierdie alternatiewe metodes kan help met verbeterde besluitneming op strategiese vlak.

Die studie is gebaseer op 'n prominente diensverskaffer in die olie- en gasindustrie. Beide kwantitatiewe en kwalitatiewe data is deur die navorser gebruik om die kompleksiteit in die bediening van die direkte en indirekte voorsieningskettings in die olie- en gasindustrie te illustreer.

Hierdie studie het uitgewys hoe die voorgestelde proses ontwikkel en die visualisering van voorsieningskettings tot ʼn groot mate kan verbeter met die gebruik van gevorderde, beskrywende besluitnemingsondersteuningtegnieke en tegnologie. Daar is ook konsolidasie geleenthede gevind vir elemente oor verskeie voorsieningskettings van die diensverskaffer. Deur toepaslike historiese data te ondersoek, met behulp van IT-gebaseerde beskrywende besluitnemingsondersteuningtegnieke en tegnologie, kan die waarde van die visuele voorstelling van voorsieningskettings insiggewend gedemonstreer word. Meer ingeligte en effektiewe besluite kan gevolglik geneem word. Daar is gevind dat ʼn strategiese konsolidasiepunt (“hub”), as ʼn netwerk konfigurasie opsie, moontlik lewensvatbaar kan wees binne ʼn bepaalde geografiese area vir ʼn spesifieke bedryf (in die geval olie en gas).

Die kwaliteit van die data is egter van uiterste belang om ’n suksesvolle studie te verseker. Tydens hierdie studie is die belangrikheid van datasuiwering, samevoeging, kategorisering en voorbereiding duidelik uitgewys. Strategiese studies sal slegs effektief wees indien behoorlike datasuiwering en voorbereiding op 'n gereelde basis gedoen en opgedateer word.

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CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Oil and gas exploration and production in Africa have increased since 1980 to 2006 (African Development Bank, 2009:42). The dependency on petroleum products across the globe has accelerated the need for fast, responsive supply chain services to various activities in the oil and gas supply chain. In order to support the industry's day to day activity, numerous products must be delivered to the industry, in either regular or demand based intervals.

Multi-national oil and gas corporations have drilling and production facilities on the West Coast of Africa, with possible new operations being developed on the East Coast (African Development Bank, 2009:44). Most of the ports that serve these regions are under developed, with the exception of South Africa. Supplying these facilities has become a momentous task and companies within the industry have resort to outsourcing of their logistics activities to third party logistics service providers (3PLs)(Hussain, Assavapokee & Khuwmawala, 2006: 93).

Current petro-chemical supply chains have become complex and have been influenced by globalisation of the procurement of goods, services and materials. A critical issue is the adaptability of supply chains that were developed and modified in order to address a specific issue (lowering cost, research and development etc.) at a certain point in time. The historical development of these supply chains could hamper the future development and improvement thereof.

According to Klappich (2010:20), supply chain analytics is currently located at what is termed the "slope of enlightenment" (see Figure 1.1). This means that if a company aspires to be a leader in its respective industry, supply chain analytics become a necessity. Thus, supply chain design and analysis is of great importance in order to be competitive. The oil and gas industry is highly volatile and needs to be on the cutting edge of technology. The need for petroleum based products is currently very high. This means that the industry must be able to adapt and respond to changes in the markets very quickly.

Companies that provide logistics solutions within the industry, such as 3PLs, need to position their service networks in such a way that it could respond to changes in the industry. Flexibility and responsiveness are two of the main performance attributes that their operations should have.

1.2 MOTIVATION

Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities (CSCMP, 2011). With numerous supply chains that exist within a larger supply chain, proper network integration is needed. Internal cross-functional integration as well as external integration across a network of organisations becomes crucial (Pienaar & Vogt, 2009:144).

Supply chain management was defined in the 1990's (Lambert & Cooper, 2000; Bowersox, Closs & Cooper, 2002) and is viewed as sound approach for improving an organisation's competiveness (Ivanov, 2010:1). Supply chain configuration and design is a function within the strategic domain of supply chain management. Strategic decisions focus on aspects such the location of facilities, number of facilities needed and where the target markets are located.

Numerous studies (e.g. Gelareh & Pisinger, 2011; Gelareh & Nickel, 2011; Zäpfel & Wasner, 2002) conducted within the field of network design and network analysis, are focused on normative methods for the placement of these infrastructures. New geographic analytical capabilities have increased dramatically over the past 15 to 20 years, with numerous geographical information systems (GIS) that were developed. These systems enhance the end users' (organisations') ability to visualize, question, analyse, interpret, and understand geographically referenced information to reveal specific relationships, patterns and trends. These systems offer an alternative to the established systems within the field and can be a valuable asset for a company.

Supply chain configuration and design vary from company to company. Each configuration has advantages and disadvantages. Thus, the most appropriate configuration will lead to the most profitable and efficient supply chain (Hicks, 1999:26).

The hub and spoke configuration is such a concept that is available for companies to streamline their supply chains. The hub and spoke concept has been used within air travel and parcel delivery services to great effect (Global Impacts of FedEx, 2001:82). With companies more and more focused on reducing transport costs, the hub and spoke concept has become a viable option especially within industries that need to transport vast amounts of goods and services, such as the oil and gas industry.

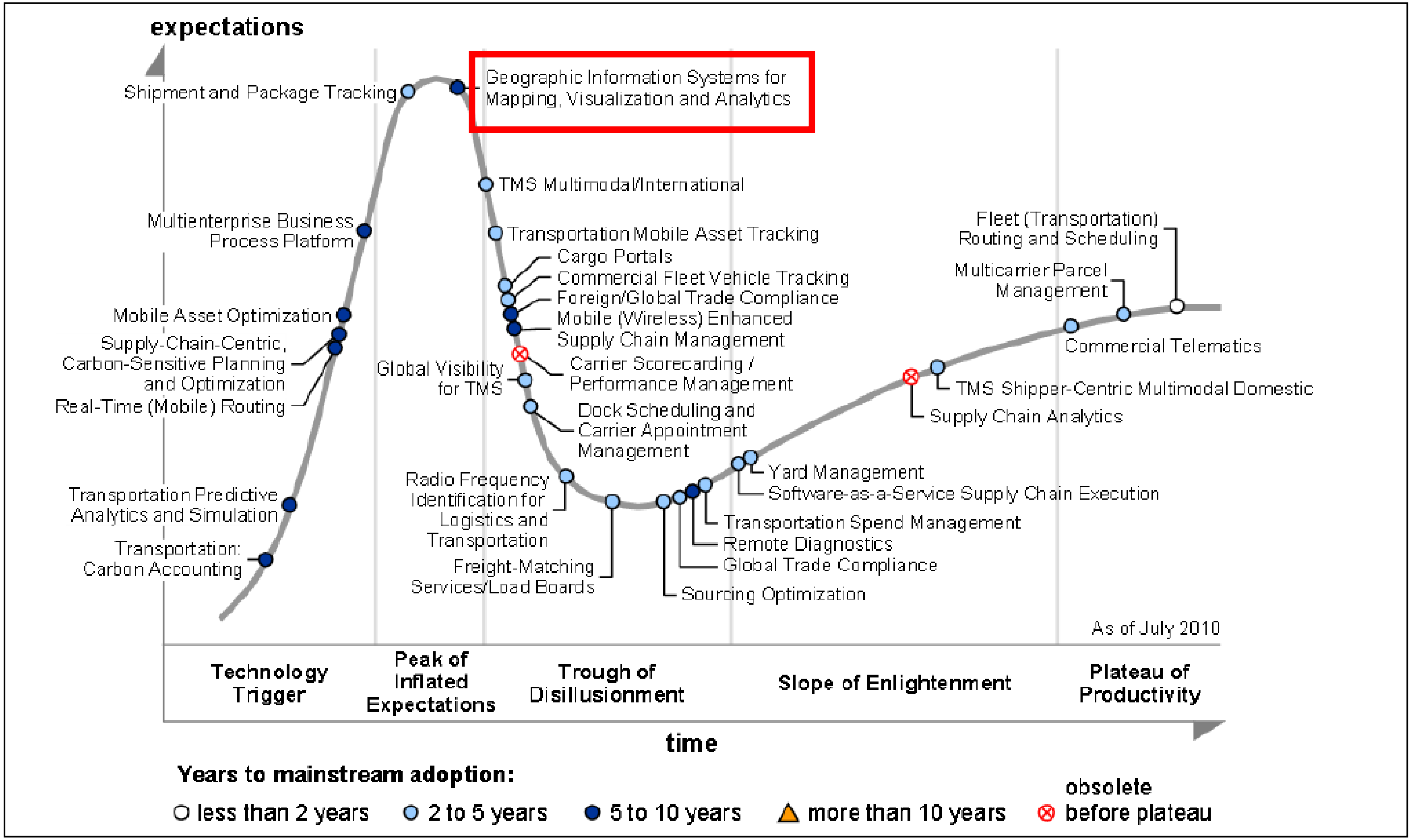

Figure 1.1: Transportation hype cycle, 2011

(Source: Klappich, July 2011: 20)

The oil and gas industry's supply chain can be divided into two major streams. Firstly, the upstream supply chain that serves the various exploration and production facilities. Secondly, the downstream supply chain that serves the various activities surrounding the refining of the crude to the marketing and distribution of petroleum products. These supply chain configurations differ in many ways. Each supply chain needs to be designed in such a way that the products can be delivered in an effective and efficient way.

Goods required in this industry range from a bar of soap to large scale construction equipment. These goods vary in size, volume and density. Shipping of these products and goods requires a wide variety of transport activities, either by sea or air. Due to the nature of modern day freight operations, a single shipment can contain a variety of goods, material and equipment that are needed at a single destination. A cost effective and efficient way is to consolidate these shipments into one large shipment.

Transporting goods as described above can be troublesome, due to physical and hazardous properties. Certain products need special containers to protect them in transit. This creates consolidation challenges. It is thus crucial for 3PLs to provide transport services within the industry that is flexible, responsive and deliver products without any damages to their respective destinations.

Consolidation practises differ between the two major streams identified within the industry. In order to establish effective methods, these two supply chains must be understood from a demand, supply and product perspective. This will help to understand the complexity involved with serving the industry.

1.3 PROBLEM STATEMENT

"The supply chain of the petroleum industry is extremely complex compared to other industries", as stated by Hussain *et al* (2006: 91). As mentioned in Section 1.2, the supply chain can be divided into two streams, upstream and downstream. These streams are similar but require different goods and services in order to function effectively.

With the complexities of the supply chain within the oil and gas industry, comes its own set of challenges. Supply chains have developed over years and were configured for a specific purpose. The swift to 3PLs for non-core functions such as transport, warehousing etc. (Choy, 2008: 1998), integration is needed to align both supply chain's configuration with each other.

Consolidation of various supply chain segments within the oil and gas industry can lead to synergies that offer mutual benefits to various suppliers within the supply chain. However, due to historical development, current supply chains can be less effective than supply chains developed with a specific intent. With greater emphasis on, e.g. responsiveness, service, lower inventories and overall cost, ineffective supply chains could hamper day to day operations within the industry.

Thus, the research question for this study is: *"How do logistics service providers (3PLs) configure their supply chain capabilities strategically to serve the oil and gas industry?"*

1.4 RESEARCH OBJECTIVES

Due to lack of formal studies surrounding the logistics service providers within the oil and gas industry, such a study would give valuable insight into the challenges associated within the industry regarding the movement of products. Further, the study can assist in establishing a basis for possible future research. The research objectives and questions are as follows:

Table 1.1: Research objectives and Questions

Research Objectives	Research Questions
The primary objective is to establish a generic framework that will support management in conducting a comprehensive strategic study for designing an effective and efficient supply chain.	With all the modern systems available to management, what is the process that needs to be followed in order to conduct a strategic study for designing an effective and efficent supply chain which can be used across all supply chains?
Establish the feasibilty of consolidating various segments of multiple supply chains within the oil and gas industry.	Consolidation of product segments within a domain has been effective in achieving economy of scale in transport of products in other industries. Will consolidation of various supply chain segments within the oil and gas industry have the same impact?
To determine what effect decision support techniques and technologies have on the decision making process.	Decision support techniques and technologies have played an important role in the modern logistics. However, how do these systems enable management to make better strategic decisions?

1.5 RESEARCH APPROACH

As stated in Section 1.4, there are three research objectives within the study. Different research approaches were used in order to answer the various questions and achieve the objectives.

The research approach for the study is both qualitative and quantitative. The quantitative data was obtained from the historical transactions from the service provider. The data obtained from the service provider will provide the backbone for the analysis regarding the feasibility of consolidating various supply chain segments (second question).The qualitative data was obtained from semi-structured informal interviews with the oil and gas business unit of the service provider. These interviews will be used to gauge the current operational efficiency within the service provider.

To guide the researcher in the approach to the study, a comprehensive literature review was done. This literature review was done in order to establish the current research that was done within the field of network configuration and design. This created the theoretical framework to develop a process for a strategic network configuration study. This process was then applied to the quantitative data from the service provider, and evaluated if such a process will aid top management in their decision making process (first question).

With the aid of decision support techniques and technologies, the effectiveness of the process was study as well as the influence of these systems in a decision making process (third question). By using two advanced descriptive decision support techniques and technologies, such as business intelligence systems (BIS) and geographical information systems (GIS), the results were visually represented and analysed accordingly.

Finally, after all the research question were answered and the objectives reached, a conclusion was made based on the literature review, the process that was developed and the application thereof and the effectiveness of using decision support techniques and technologies in strategic decision making.

1.6 RESEARCH SCOPE

The study focuses on a single prominent logistics service provider within South Africa. They have various operation centres located throughout South Africa; however the study was conducted on data from the Cape Town operations centre only. Further, the focus is on their operations within the oil and gas industry. This includes export/import of all related goods and services within the oil and gas domain from across the globe. The study consists of both qualitative and quantitative research. The quantitative research will involve the analysis of transactional data from their Cape Town operations, for the time period between January 2008 and June 2010. The qualitative research involved semi-structured interviews with the personnel of the oil and gas business unit at their Cape Town operations.

1.7 CHAPTER OUTLINE

Figure 1.2 indicates the structure of this document. For each of the chapters, a brief description of the content is discussed. This description will give the reader an indication of what to expect within the chapter.

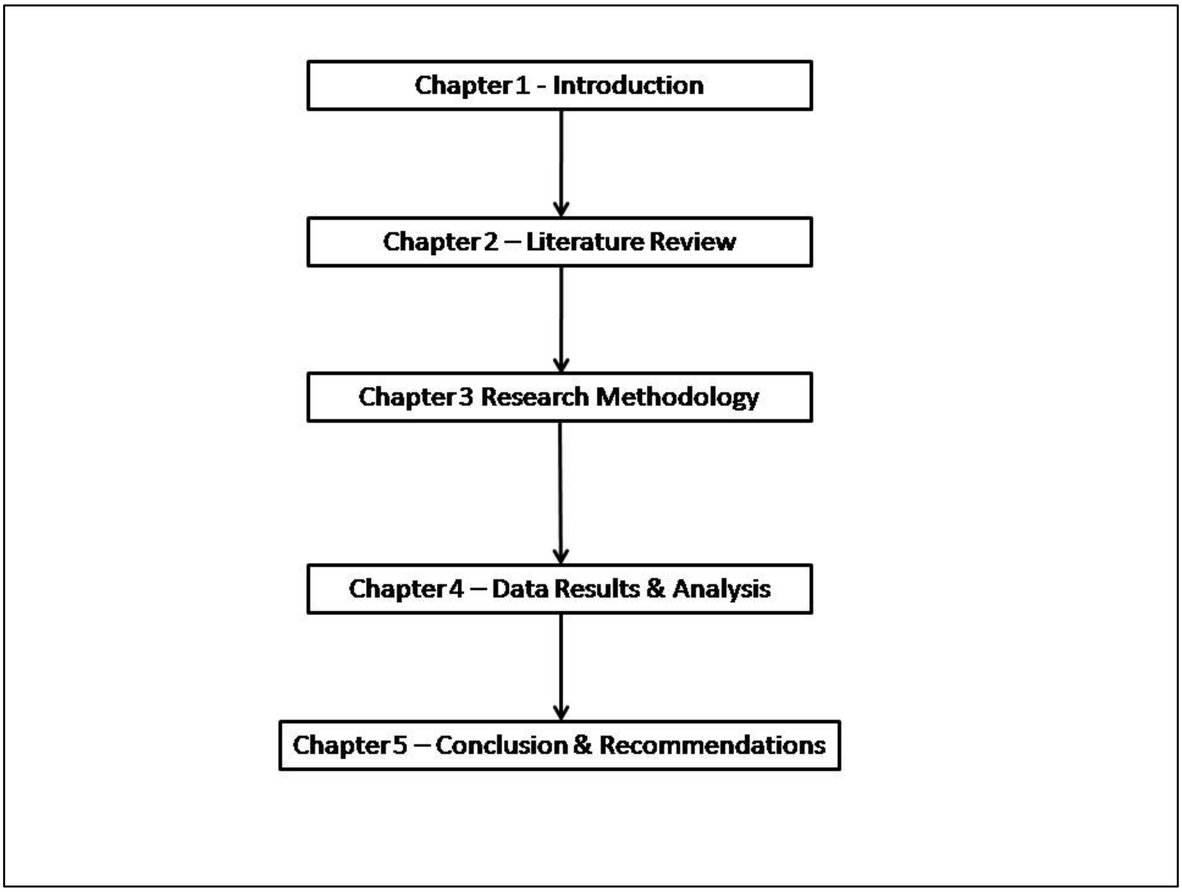

Figure 1.2: Chapter outline

Chapter 1 introduces the reader to the study. A brief overview of the study is discussed and important concepts are highlighted. Furthermore, the chapter defines the study according to the objectives, the research methodology and the scope of the study.

Chapter 2 consists of the literature review. This is the theoretical base from which the study was conducted. Within the chapter, network configuration and design is discussed and the practice of consolidation. The hub and spoke principle is also discussed and viewed from three perspectives. Core characteristics were identified from the perspectives and discussed to highlight their importance in consolidation attempts.

Chapter 3 discusses the research methodology that was used during the study. The study was a case study based on a prominent service provider within the oil and gas industry. Both quantitative (secondary) and qualitative (primary) data were used. Data analysis, data cleaning and categorization became a crucial aspect within the study.

Chapter 4 discusses the findings and analyses the data obtained. Significant results are highlighted from the secondary data from the service provider. The findings and the analyses of the primary data are also discussed.

Chapter 5 contains the conclusion and recommendations that were made regarding the study. Trends that were identified throughout the study are discussed, linking the research problem, theoretical framework, research methodology and the data from the case study.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Network configuration and design form the strategic backbone of every supply chain. Without the correct configuration, supply chains can be inefficient and ineffective. Various configurations are possible, but the question is whether a specific configuration will allow the supply chain to be the most cost effective and efficient.

The oil and gas industry is an industry that is highly influenced by the separation of natural resources and the designated markets. This separation creates longer lead times due to the increase in distance. Network configuration and design play an important role to help role-players within the industry create efficient and effective supply chains.

Role-players within the oil and gas industry are highly dependent on the role that third party logistics service providers' (3PLs) play. They perform a variety of functions for their clients e.g. transport, warehousing, clearing and forwarding. These service providers form a link between various nodes within the supply chain configuration of the respective role players.

In this chapter, the various network configurations found in the literature will be compared with one another. Subsequently the concept of consolidation will be discussed. Consolidation is a practice that is used in order to gain economy of scale and scope within a defined supply chain. The consolidation of elements of a supply chain can have a major impact on the network configuration. One of these consolidation concepts, is the hub and spoke model. In the last Section of the chapter, the hub and spoke concept will be discussed and literature dealing with the concept will be looked at from three perspectives namely:

- Geographical perspective;
- Capacity perspective; and
- Infrastructure perspective.

Each perspective focuses on different aspects that constitute a hub. By looking from these varied perspectives, a holistic view can be obtained. The literature found dealing with hubs is discussed according to these perspectives. Each perspective is discussed individually in order to highlight the differences in what are deemed as important. Core characteristics are then identified and literature dealing with it them is considered as well.

First and foremost, the oil and gas industry's structure and supply chain characteristics must be understood. This background will guide the reader in later chapters with regards to the consolidation process and product classification in relation with the oil and gas industry.

2.2 THE OIL AND GAS INDUSTRY

The oil and gas industry is characterised by the geographical separation of the production facilities and the markets where the demand originate. The increase in global trade and the relatively low flexibility of the oil and gas industry's supply chains create complex and challenging problems that management must overcome.

Commodities such as oil, gas and other petro-chemicals require a specific transportation configuration. Commodities are produced in a specific region, with the demand located across the globe (Hussain *et al*, 2006: 91). Thus, the lead time from production to the final destination is much longer compared to other industries.

Within the industry, classification can be made between upstream and downstream operations (see Figure 2.1). Upstream operations deal with the exploration and production of the oil and gas commodities. Downstream operations take these oil and gas commodities through the refining process to the eventual final distribution.

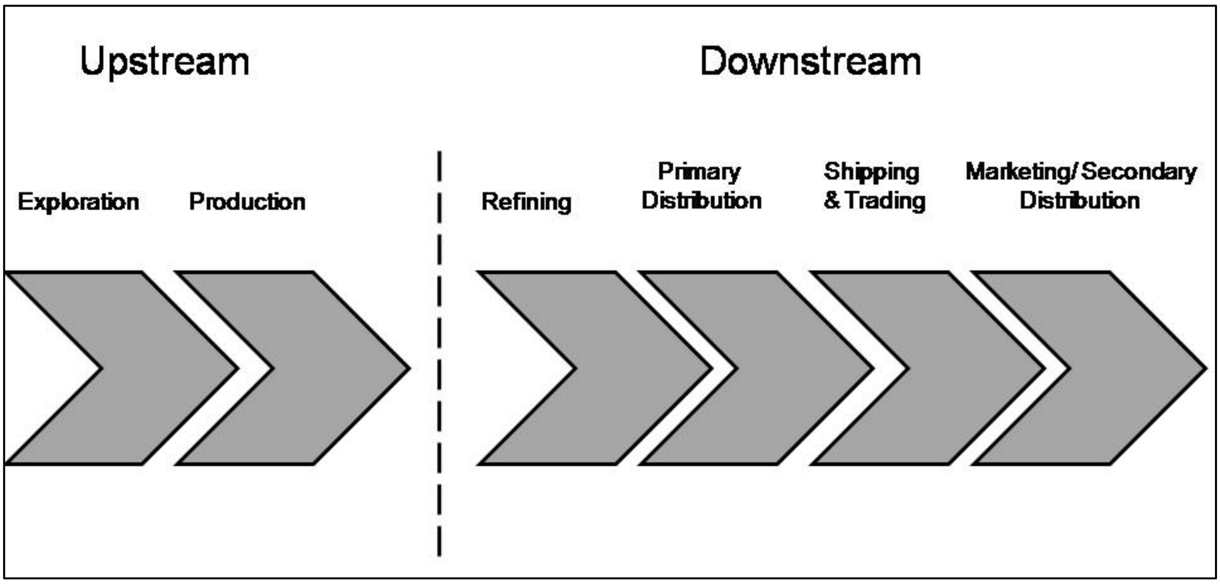

Figure 2.1: Oil and Gas Value Chain

(Source: Adapted from PRTM, 2011)

Within both streams various nodes and links exists and when connected, can result in a number of different supply chains. There are facilities located in each of these nodes that have both direct and indirect supply chains that are essential for their operational success (see Figure 2.2). The direct supply segment focuses on the core function of the facility. For instance, if the facility is a refinery, the direct supply segment focus on receiving the natural resource (A), the refining process to the desired product (B) and finally the distribution of the product to the secondary distribution centres (C). The indirect supply segment is for instance focused on supporting the maintenance activities for the assets utilised in the direct supply chain. Here, supporting goods and services are essential for the facility to function on a day to day basis. These goods and services are wide in variety, from steel pipes for the manufacturing process to office supplies for the workers. This variety in goods and services create opportunities and challenges within both the direct and indirect supply chains.

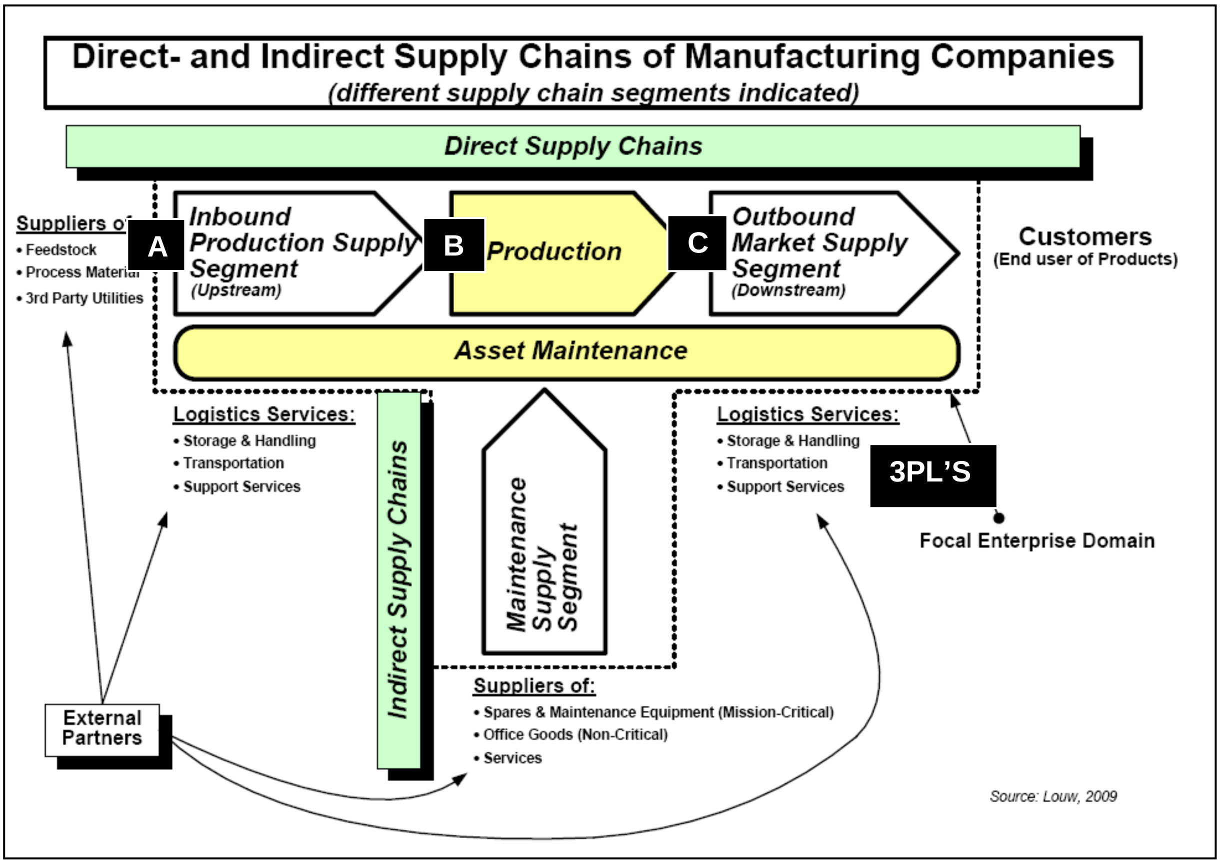

Figure 2.2 : Direct and indirect supply chains

(Source: Adapted from Louw, 2006)

Logistics networks within the oil and gas industry are less flexible compare to other industries such as the fast moving consumer goods (FMCG), with fixed transport modes, long transport lead times and fixed production capabilities of suppliers. Thus, every point within the network represents a challenge (Hussain *et al*, 2006: 91). As stated, the oil and gas industry is characterised by the separation of facilities. In some cases these facilities are continents apart. Thus, distance is a major factor within the industry. In most cases transport modes are relatively fixed, with the dominant modes of transport being ships, trucks, pipelines and railroads (Hussain *et al*, 2006: 91). Companies try to focus on their core business by outsourcing a number of logistics activities to third party logistics service providers (3PLs).

As international trade grew and supply chains expanded around the globe, 3PLs have taken on an increasingly important role for multi-national companies and retailers (Foster & Armstrong, 2012: 1). As indicated in Figure 2.2, the role and type of the service provider can clearly be identified within the industry (see 3PLs). These service providers are an important link between nodes as well as supporting the day to day operations at facilities. They provide a wide variety of services that include:

- Air/sea freight forwarding (door to door);
- Transportation network planning and optimization;
- Transport execution/freight bill payment;
- Carrier management;
- Security systems and control;
- Consolidation/deconsolidation/NVOCC operations; and
- Value-added warehousing, inventory control and supplier management.

These services provided by 3PLs enable the company to focus on the core business activity and the network configuration of their supply chain.

2.3 STRATEGIC PLANNING AND THE SUPPLY CHAIN

Decision making with the emphasis on strategic decision making has a significant impact within an organisation. Strategic decision making can be defined as decisions made by top management and deals with the long term health of the organisation (Harrison, 1996: 47).

Harrison (1996:47) identified the following criteria for strategic decision making:

1. The decision must be directed towards defining the organisation's relationship to its environment.
2. The decision must take the organisation, as a whole, as the unit of analysis.
3. The decision must encompass all the major functions performed in the organisation.
4. The decision must provide constrained guidance for all of the administrative and operational activities of the organisation.
5. The decision must be critically important to the long-term success of the total organisation.

Strategic decision making is the decisions that guide the organisation regarding their external and internal environment and in the long-term. Globalisation has led to organisations that are geographical more dispersed, with decentralised operations. This has a significant impact on the various supply chains that organisations have and their relationships with their suppliers.

Literature regarding strategic management is abundant and topics within the field vary from strategic networks to strategic purchasing (Croom, Romano & Giannakis, 2000:70). Supply chain network design, which is one of the core planning processes within the broader supply chain management field, is also found within this range of topics. Supply chain network design, supply chain planning and scheduling as well as supply chain control form the three major focus areas within supply chain management. Various decision support models exist within the expanded field of supply chain management which helps supply chain managers in their quest to design and implement the most effective and efficient supply chains.

Supply chain modelling can be divided into two broad categories, namely normative and descriptive models (Sapiro 2001: 10-12. As reference by Louw, 2006: 107). They are:

- Normative
  - Optimization models
  - Mathematical programming models
- Descriptive
  - Forecasting models
  - Cost relationships
  - Resource utilization relationship
  - Simulation models

Min & Zhou (2002:240) took this classification further, and divided the models into four categories. They are (also see Figure 2.3):

- Deterministic models
- Stochastic models
- Hybrid models
- IT-driven models

The deterministic models assume all model parameters are known and fixed with certainty, whereas stochastic models take into account uncertain and random parameters (Min & Zhou, 2002: 239). Deterministic models can be further classified into single objective and multiple objective models. Stochastic models can be classified into optimal control theoretic and dynamic programming models. Hybrid models are a combination between the two models and have elements of both.

An important development was the role IT played in supply chain innovations and the re-engineering of the business process (Min & Zhou, 2002: 239). IT-driven models try to integrate and coordinate various supply chain planning activities on a real time basis with the use of software. The integration and coordination can enhance the visibility along the entire supply chain. These models include:

- Warehouse management systems (WMS);
- Transport management systems (TMS);
- Integrated transport tracking;
- Collaborative planning and forecasting replenishment (CPFR);
- Material requirement planning (MRP);
- Distribution resource planning(DRP);
- Enterprise resource planning (ERP); and
- Geographical information systems (GIS).

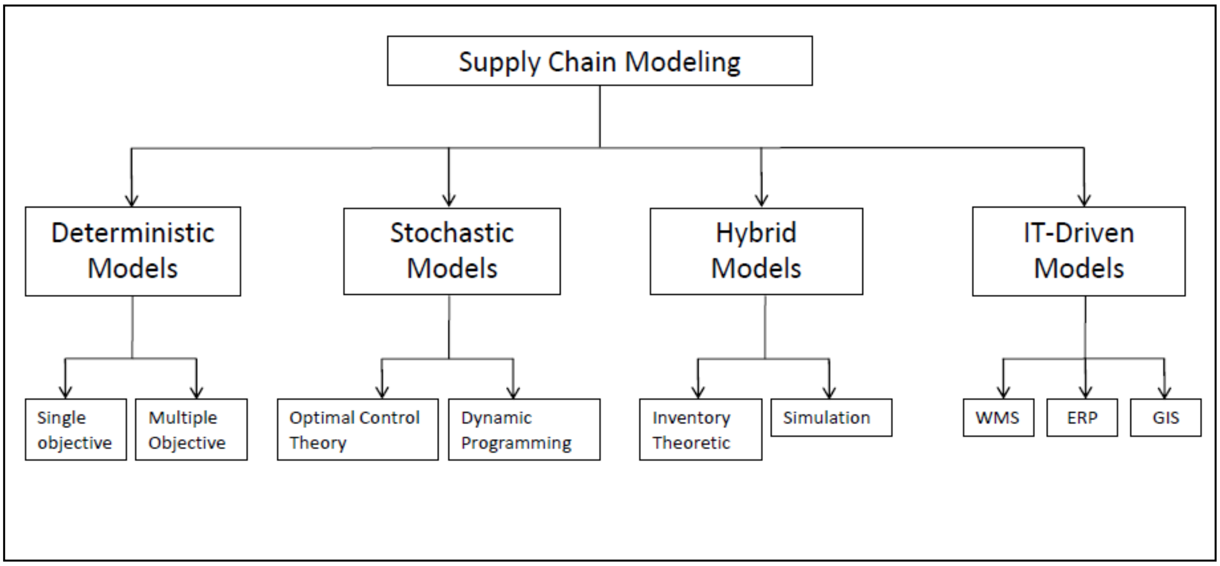

Figure 2.3: Classification of supply chain models

(Source: Adopted from Min & Zhou*, 2002)*

Management of supply chains is a complex task mainly due to the large network and the uncertainties involved (Papageorgiou, 2009:1932). Hicks (1999:26) states that the goal of strategic supply chain planning is "to arrive at the most efficient, highly profitable supply chain that serves the customer in a market." He identifies two supply chain improvements, which is either logistics or information technology. These two approaches are where most of the cost savings could take place. From an IT perspective the goal is to have collaborative planning, sharing of information and getting companies to share information throughout the supply chain. The logistics approach is more of a quantitative approach and is focused on the internal structure (configuration) of the supply chain, and its problems.

Hicks states that the combination of the two approaches is the future of strategic supply chain planning. Hicks (1999:29) recommends a four-step planning process, namely:

- Network optimisation: design the least cost network focusing on customer demand;
- Network simulation: test alternative models to predict supply chain behaviour;
- Policy optimisation: develop best operating rules; and
- Design for robustness: try to anticipate unforeseen circumstances and possibilities.

2.4 NETWORK CONFIGURATION AND DESIGN

Network design relates to decisions about customer service, inventory policy, transport modes, location and the size of stocking points (Pienaar & Vogt, 2009:145). These elements influence the setup of the supply chain as a whole. Network design, which focuses on the attributes of the supply chain, influences the location point of view, decisions regarding outlets, plants/ports, sources of supply, warehouses, consolidation points and the layout of a specific facility within the supply chain. These attributes play an important role in a fast turnaround time within a facility.

Supply chain configuration is concerned with attributes such as the number, size and location of facilities within the supply chain (Pienaar & Vogt, 2009: 146). These decisions are made on a strategic level and could involve large scale capital investments.

Creazza, Dallar i& Melacini (2010:156) identified various supply chain configurations that are currently available within the world (see Figure 2.4). The configurations are (from left to right in Figure 2.4):

1. Multiple suppliers that deliver to multiple regional warehouses in a different country. This configuration can be classified as a *Direct shipment with full container loads (FCL).*
2. Multiple suppliers that group less than container full (LCL) shipments at a loading port, unload them in the destination country and distributed to the regional warehouses. This is classified as a *Direct shipment with groupage LCL.*
3. Multiple suppliers that deliver to a consolidation hub (CH), with the shipment shipped to the destination country and redistributed to the regional warehouses. This is classified as *One echelon with CH*.
4. Multiple suppliers that ship individually to a destination country, with the products moved to a central warehouse (CW) and then redistributed. This is classified as a *One echelon with CW*.

5. Multiple suppliers that that deliver to a CH, with the shipment shipped to a CW and then redistributed in the destination country. This is classified as *Two echelons with both CH and CW*

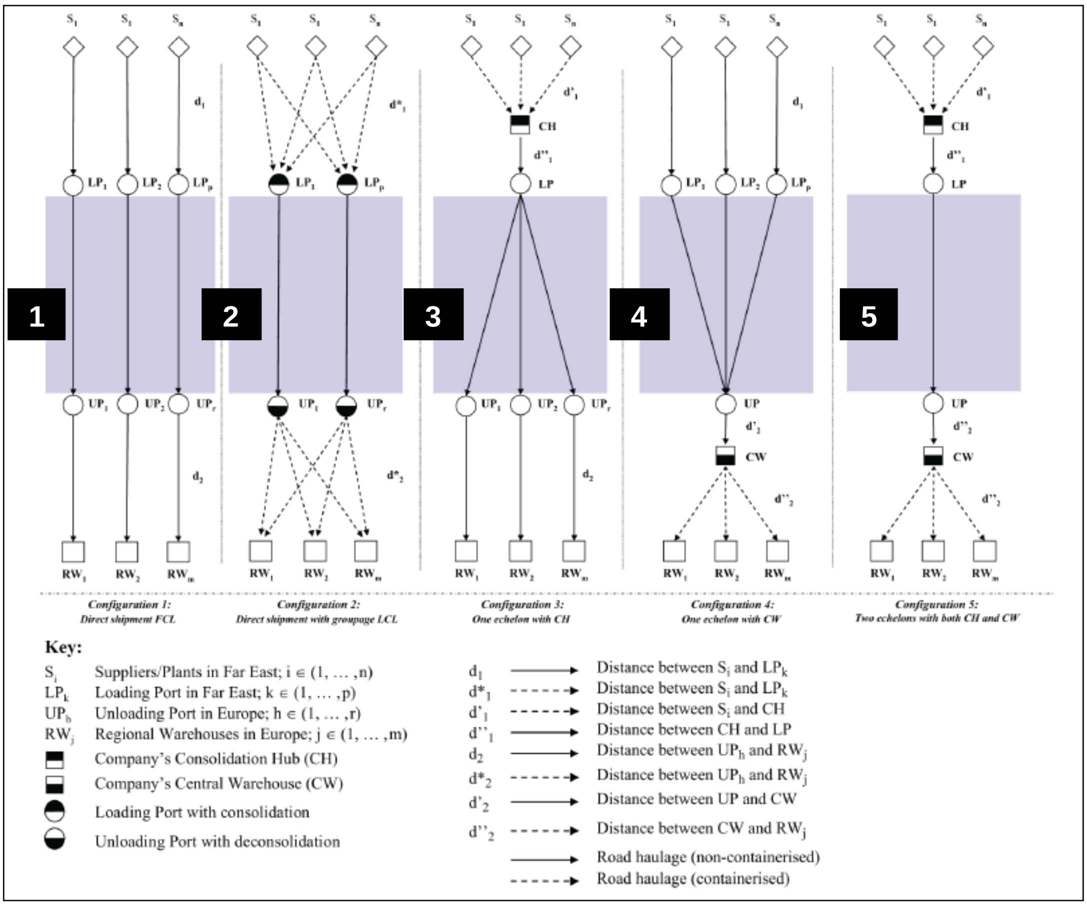

Figure 2.4: Supply chain network configurations

(Source: Adopted from Creazza *et al*., 2010:157)

By evaluating each of the configurations the following can be concluded:

- In configuration 1, no form of consolidation takes place due to the full container loads that are shipped.

- In configuration 2, consolidation takes place by product. Here the suppliers consolidate by possibly looking at the various products and modes of transport.

- In configuration 3, consolidation is done by the company itself and shipped accordingly. Here economy of scale plays a role and deconsolidation takes place for the various destinations.

- In configuration 4, consolidation takes place at the destination and transported to various secondary distribution centres.

- In configuration 5, consolidation takes place at both the origin and destination and distribution takes place accordingly.

Configurations 2 – 5 are all examples of a hub network configuration. They all have some sort of consolidation within the supply chain. They vary in where the consolidation takes place and how many consolidation points exist.

Current supply chain configuration may be outdated and in order to optimise the supply chain some of the following decisions must be made:

- To expand the facility rather than moving it;
- To maintain the current facility and just adding a new site;
- To close a facility and move to another; and
- Redesign the facility layout.

Global sourcing and procurement changed companies' supply chains dramatically over the past decade or so. Products may have a longer lead time due to the geographical distance it must travel. Configuration of these supply chains has become more difficult due to the numerous external factors that must be taken into account such as customs, the weather and production delays.

The oil and gas industry has facilities located in some of the worst environments around the world from freezing cold temperatures to sites located in the desert. The correct supply chain configuration can significantly decrease cost for companies. There are various characteristics that stay the same throughout any configuration. (Creazza *et al*., 2010:157) These are:

- Demand characteristics: Number of items, average item volume, product density and demand; and
- Supply characteristics: Number, location and the number of supplied items.

These characteristics influence the decisions surrounding what practices should be used regarding the mode of transport and also the consolidation of shipments. From a logistics service provider point of view, capacity to move the required products will be the main concern. Thus, the focus should be on the consolidation of shipments in order to achieve economy of scale.

2.5 CONSOLIDATION PRACTICE

Consolidation practices can be classified as a tactical transport management tool (Pienaar & Vogt, 2009: 369). The concept has its roots in the tactical decision sphere, but it can be used as a strategic tool to gain a competitive advantage over one's competitors.

Basically there are three methods of consolidating shipments:

- Consolidation through movements;
- Traffic pooling and distribution; and
- Reducing trip frequency.

Consolidation through movements is based on the notion that if there are multiple origins with a single destination, consolidation can take place close to the origins, and with a single movement shipped to the destination. Figure 2.5 indicates the difference when consolidation takes place from multiple origins to a single destination. The difference in the total movements is quite evident.

Traffic pooling and redistribution as based on the notion of avoiding overlapping movement. Movement can be directed to a single concentration point, where the collective shipments are moved to another concentration point, sorted by destination and then redistributed to their destination. Figure 2.6 indicates the difference that can be achieved when consolidation takes place where there were multiple origins and multiple destinations.

In much the same way as traffic pooling and redistribution, reducing trip frequency can help when shipments do not take the whole volume of the transport mode, and by consolidating the various smaller shipments, one fully loaded shipment can be moved from the origins to the destinations (also see Figure 2.6).

These consolidation methods have an influence on the network design and configuration as discussed in Section 2.4. Thus, when decisions are made regarding the strategic implication of the configuration of the supply chain, if consolidations of shipments are to take place, clarity should exist regarding the method of consolidation. The method of consolidation will be enforced by the network design of the supply chain.

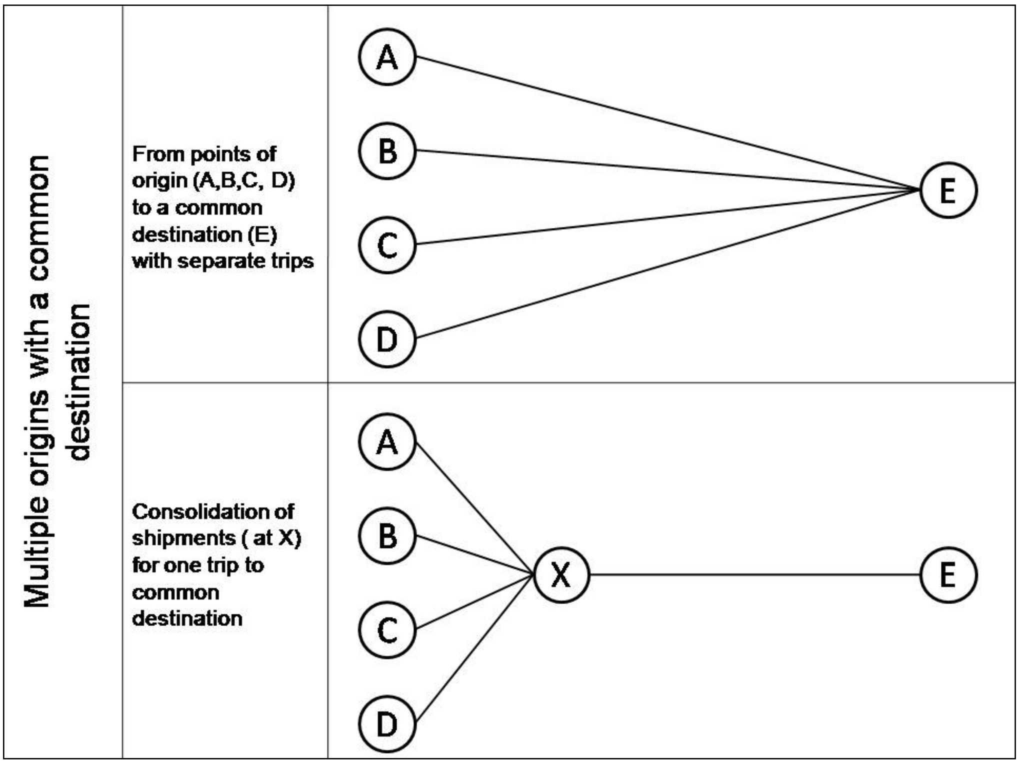

Figure 2.5: Multiple origins to a single destination – consolidation

(Source: Adopted from Pienaar & Vogt, 2009: 370)

2.6 HUB ANDSPOKE

The hub and spoke concept has started to attract more attention due to the movement towards the globalisation of distribution networks and flows. Cisic, Komadina & Hlaca (2007:212) noted that the global shipping network is moving from a multi-port calling system to a hub and spoke system. Numerous container hubs are located across the world, with the majority of the largest hubs located in the Northern Hemisphere (Wang & Wang, 2011:56). Historical development of trade routes also helped in establishing hubs over time. These hubs all have similar characteristics regarding physical infrastructure, location and function within their respective regions. So, what is the hub and spoke concept/model, and what characteristics set it apart from other network configurations?

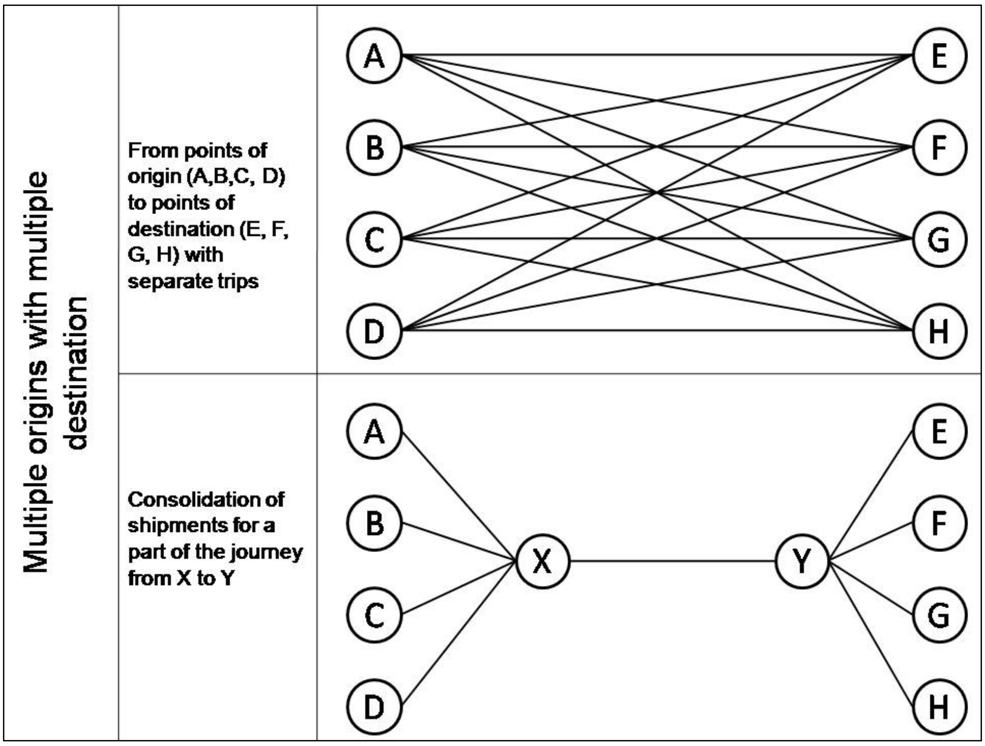

Figure 2.6: Multiple origin's to multiple destinations – consolidation

(Source: Adopted from Pienaar & Vogt, 2009: 370)

2.6.1 Hub and spoke concept -definition

The concept of hubs differ in variety and size, from virtual hubs to large freight sorting facilities which employ vast amounts of people with loading docks, planes, trucks and logistics racking systems (O' Kelly, 1998:171). These hubs are special nodes that form part of a logistics network, which connects various nodes within the network with each other.

Hubs, according to geographers, can be described as special nodes that facilitate connectivity between nodes. These nodes are the tangible manifestation of a process (O'Kelly, 1998:172). Hubs are geographical in that they serve a specific region. They bring possible benefits to a region with agglomeration of specific industries which try to obtain both economies of scale and scope. A hub is thus a physical manifestation of clusters of industry specific entities, within a defined geographical area, in order to obtain some competitive advantage. A spin-off effect of such geographical clusters is improved seller-buyer relationships, active strategic alliances, research and development, etc. within the region.

Another definition of a hub according to Jorgensen is "Integrated centres for transhipment, storage, collection and distribution of goods" (Jorgensen, 2007). This definition is from an infrastructure perspective. It focus on the physical attributes of a hub where products can be stored (warehousing), collected (docking bays) and distributed (road/rail networks) to the various destinations.

As stated earlier, hubs manifest themselves in various forms and sizes. Hubs can be large ports, such as seaports/airports, which distribute the vast amount of freight that move through them to the end customers. Examples of such hubs are Hong Kong, Rotterdam, Dubai, and Singapore. These hubs are critical in the physical distribution of products throughout the world (Wang & Wang, 2011:59).

The hub and spoke principle revolves around the idea of multiple pick up points (origins), which are routed to a central distribution point for sorting, and then rerouted and loaded onto a transport media to reach their final destination points (see Figure 2.7).Hubs consolidate intermediate cargo between multiple origins and multiple destination points. This principle holds true whether the size of the hub is small or a large seaport moving thousands of tons of cargo.

Figure 2.7 indicates the movement of various products from their pick up points, to the hub, where it is rerouted and finally delivered at their destination points. The arrows indicate the movement of the package. Numerous large companies that specialise in the movement of goods especially parcel service use the principle to great effect. Companies such as DHL, FedEx and UPS have used this principle to their advantage to deliver a wide variety of services to various countries across the globe.

In the following Section, the hub and spoke concept is looked at from three perspectives. They are: a geographical perspective, a capacity perspective and finally an infrastructure perspective. These perspectives were chosen in order to illustrate the different complexities characterising the concept.

2.6.2 Geographic perspective

Physical distribution of products forms the core of most logistics activities. Approximately 80% of all logistics activity has a geography association to it (Pienaar & Vogt, 2009:150). It is therefore necessary to understand how the spatial distribution of the entities within a supply chain, influence each other. The modern day global economy has changed the traditional supply chain towards an integrated network of supply chains, located across the globe. This increase in distance within a supply chain has created new challenges that need to be addressed.

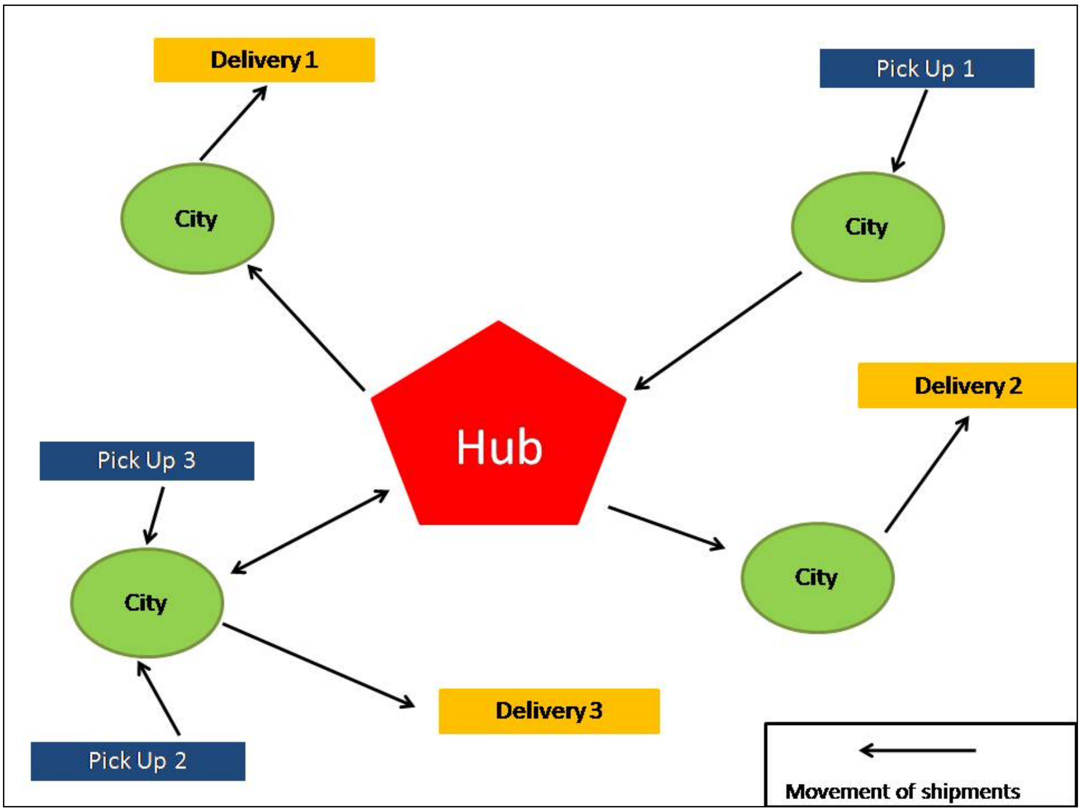

Figure 2.7: Hub and spoke principle

(Source: Adapted from Global Impacts of FedEx, 2001: 83)

A typical supply chain consists of various nodes of production locations, connected by product flows and information networks (Hesse & Rodrigue, 2004:171). Transport networks connect the nodes physically, with the information network connecting them in a virtual world. For geographers, it is the location of the nodes, the distance between nodes and the obstacles that hamper the seamless movement of goods that are of interest to them.

As stated earlier, supply chains consists of production nodes, product flows and information networks. From a geographic perspective, the spatial distribution of these entities can help in the understanding of the current global freight movement, the network configuration of supply chains and why certain geographical regions are more suitable for hubs than other.

O'Connor (2010: 354) conducted a study in order to establish the relationship between what he called global city regions and logistics activities. In his study he compared various major cities to the amount of logistics activity that takes place within the urban area, and the influence the city have on the hinterland. Factors that were included in the study were the availability of seaports, airports, either multiple or single, and the volume of global freight that pass through the ports (capacity). From the study, O'Connor noticed that a small number of global cities, account for approximately 25% of global trade. Furthermore, some of the cities, due to the commercial and industrial significance, play an important role. These cities are also the capitals of their respective countries and explain the concentration of logistics activities within the city boundary.

Historical influence cannot be ignored in some cases which was evident from the study conducted by O'Connor. Trade routes play an important role in the development of geographical regions (Wang & Wang, 2011:56).

Wang & Wang (2011:60) noticed that not only do certain geographical areas account for the majority of global trade, but also the concentration of trade within the Northern Hemisphere. Wang & Wang conducted a study in order to establish the global pattern of the shipping network and its hub and spoke system. From the study, it was clear that five regions account for the majority of trade. These regions are:

- Northwest Europe;
- East Asia;
- Southeast Asia;
- Mediterranean Sea; and
- North America.

This was done by establishing the frequency a vessel calls at a port, as well as the volume that moves through the port. Thus, by looking at these two factors, the importance of ports was established within the global shipping network. Wang & Wang (2011:59) also concluded that trade does not only occur from these regions, to the rest of the world, but also between these regions. They are responsible for the majority of trade in the world today. These regions not only develop as a result of interaction between each other, but also due to internal growth of each of the regions.

These regions form the core economic regions within the global market. South America and Africa are less significant within the global trade routes. These two regions are seen as feeder trade regions, with feeder trade routes moving towards the core trade regions and trade routes (Wang & Wang, 2011:59).

These core regions coincide with the study that O'Connor did regarding global city regions, in that the major regions in both studies are similar. This proves that global economic trade is located within a few regions, with a few cities that influence the trade in a real way.

O'Connor (2010:358) found that within the global city region, few cities have multiple seaports and airports. Some cities have a single airport with multiple seaports, and some have multiple airports with a single seaport. The majority of the cities have a single seaport with a single airport. Some exceptions exist due to the size of some the geographical regions such as Los Angeles-Long Beach, Osaka- Kobe and Amsterdam-Rotterdam etc, where the proximity of these ports influences the other ports.

These city regions can also be seen as hubs for international trade. The movement of the freight through these ports create an ideal location for hubs. As defined earlier in the chapter, hubs are "the physical manifestation of industry specific clusters of entities, within a geographical area to gain some competitive advantage. From logistics and geographic perspectives these global city regions are ideally located for the creation of hubs, due to the amount of trade that pass through these regions as well as the location of an industry specific knowledge base within a region.

Hubs are created to gain both economy of scope and scale. Wang & Wang (2011:60) identified various hubs that service a specific geographical area. In the study, it became clear that within the global shipping network, there could not be a single hub that serves the entire world, but rather various smaller hubs (in some case two) that serve a geographical area (see Figure 2.8). It is notable that some of the largest cities in the world are feeder hubs to other hubs that are closely located.

2.6.3 Capacity perspective

Hubs' primary function is to consolidate intermediate cargo from a variety of different locations, so that the transport of these various shipments can be done in an efficient and effective way. Therefore, an important characteristic of a hub is that it should be able to process the volume which is required. Thus, capacity capability will distinguish it from competing hubs.

Capacity can be evaluated on four levels. These are:

- Global trade level;
- Regional trade level;
- Industry trade level; and
- Business trade level.

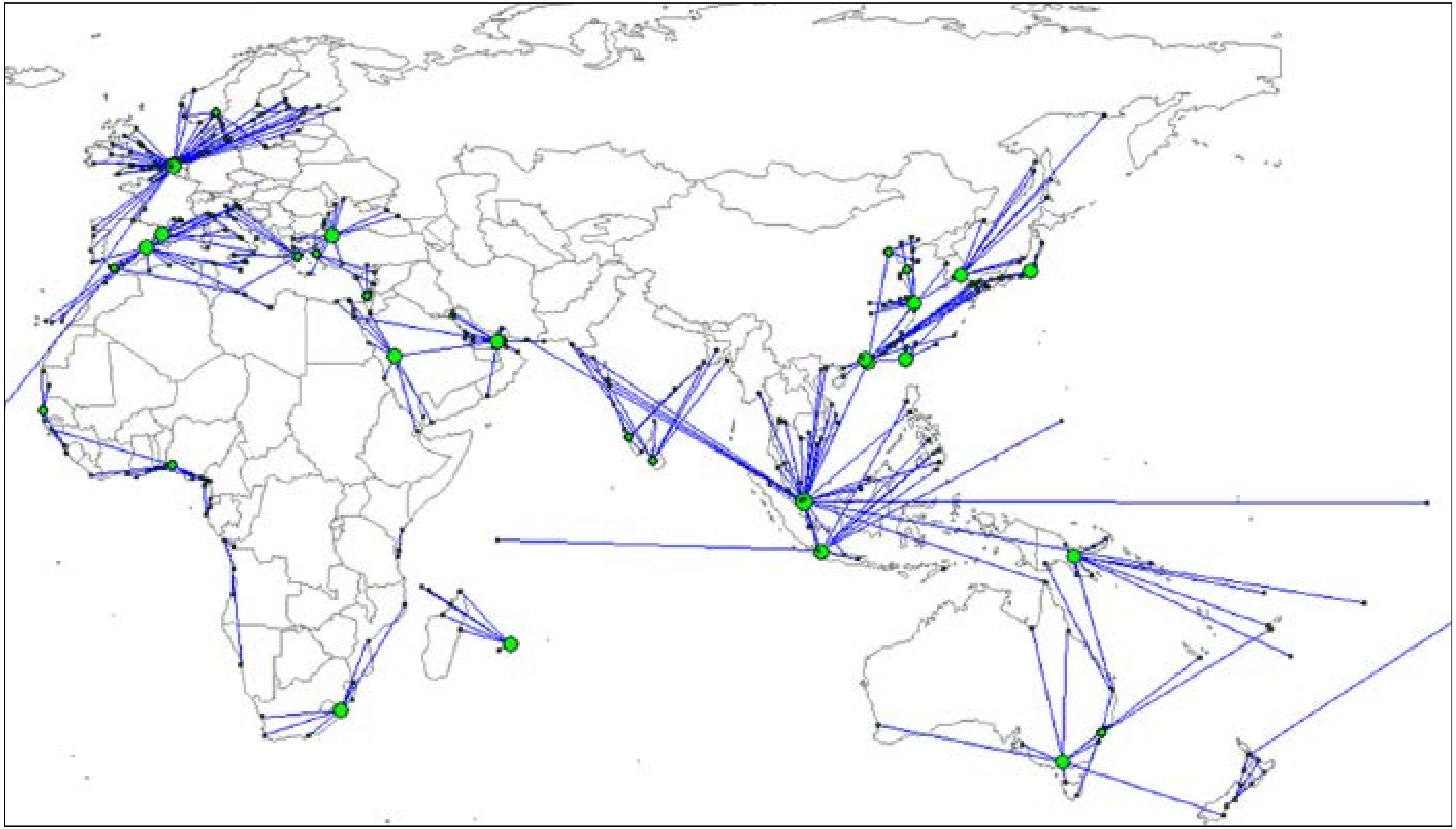

Figure 2.8: Regional shipping systems in Asia, Europe, Africa and Oceania

(Source: Adopted from Wang & Wang, 2011: 61)

Global trade has increased from the 1980's to the end of the century. This was led by the economic growth of China and other developing nations. However, the various economic downturns that happened at the end of the decade influenced global trade in a significant way. However, global trade is expected to increase again, with the shift from developed nations to developing nations (Selfin & Hope, 2011:6). This shift in global trade will influence the movement of products.

Predictions have shown that China will overtake the United States and dominate global trade by 2030 (Selfin & Hope, 2011:5). According to them, four areas of opportunity for logistics companies will arise:

- Asia-Pacific region;
- Emerging economies and developed nations;
- Trade between emerging economies; and
- Trade between China and Africa.

These trade regions will provide opportunities for companies involved in logistics. With the increase in trade (capacity), infrastructure will be needed to fulfil these needs. Hubs could become a viable option in the future. Trade between emerging economies and trade between China and Africa are predicted to increase. With most of the emerging economies located within Latin America and Africa, freight capabilities will have to be improved.

Wang & Wang (2011:60) noted that although most of the global trade is located in the northern hemisphere, regions such as South America and Africa are feeder routes to these dominant trade routes. These regions have internal trade within them as well. A prominent example is how South Africa is the dominant economy in Africa.

South Africa (RSA) is the largest economy in Africa. RSA's GDP was estimated around $282,754,441,020 in 2009 (Worldbank, 2010). This is by far the largest on the African continent (See Table 2.1). As the economic leader on the continent, RSA exports a large percentage of products to the rest of Africa. Exports accounted for approximately 20% of the GDP in 2010 (DG Trade Statistics, 2011). From a regional perspective, this means that numerous products that are made within RSA are exported. Approximately 54% of the exports are manufactured goods.

The main export regions for manufactured goods from the RSA on the African continent are the Southern Africa Development Community (SADC) and West Africa. Within these sub-regions, the oil and gas industry plays a significant role.

Table 2.1 : Selected Africa GDP, 2009 – 2010

	GDP (US $ '000 000)	2010 Classification
Country Name	**2009**	**2010**
South Africa	283 000	364 000
Egypt, Arab Rep.	189 000	219 000
Nigeria	169 000	194 000
Algeria	141 000	159 000
Morocco	91 000	91 000
Angola	75 000	84 000
Kenya	29 000	31 000
Ghana	26 000	31 000
Cote d'Ivoire	23 000	23 000
Cameroon	22 000	22 000
Uganda	16 000	17 000
Zambia	13 000	16 000
Botswana	11 000	15 000
Equatorial Guinea	12 000	14 000
Congo, Dem. Rep.	11 000	13 000
Gabon	11 000	13 000
Senegal	13 000	13 000
Namibia	9 000	12 000

(Source: Worldbank, 2010)

The oil and gas industry have numerous facilities located around the world. A prominent location is the African continent. Libya, Nigeria, Algeria, Angola and Sudan account for approximately 90% of the oil reserves on the continent. Proven natural gas reserves are mainly located in Algeria, Egypt, Libya and Nigeria (African Development Bank, 2009:60).

Africa is the only continent where new reserves are still discovered regularly. Oil reserves have increased over the past 20 years by 25% and natural gas by 100% (African Development Bank, 2009:72). Global consumption is set to increase in the near future, with demand set to increase by 57% by 2025. Thus, a strategic hub in Africa could be ideally located to serve the industry.

The oil and gas industry is dominated by a selected number of companies, which operates both in the up and downstream environments of the oil and gas value chain. Companies such as ExxonMobil, Royal Dutch Shell, BP, Chevron and ConocoPhillips have numerous production facilities across the globe. These companies need a variety of supporting services in order to function at a high level of production. A strategic hub within a specific geographical region could help with this momentous task.

These companies rely on the outsourcing of various logistics activities that do not form part of their core business activities. These logistics activities are normally outsourced to third party logistics service providers (3PLs), who specialise in the transport of products. A hub would greatly improve the movement of supporting products, with the possible benefit of both economies of scale and scope.

2.6.4 Infrastructure perspectives

Numerous studies that were found during the literature review with regards to the creation of a strategic hub, focused on investigating the infrastructure of a specific region/city for establishing a hub. These studies are discussed at the hand of two studies which focus on the infrastructure capabilities within a region/city. According to Botha (2008:63-66), various key attributes were highlighted that she identified as crucial for the establishment of a hub.

From the study that was conducted by Botha (2008:63-66), most of the attributes were concerned with the physical attributes of the city and the condition of the necessary transport infrastructure. Here are some of the attributes that were identified within the study:

- Good telecommunications infrastructure;
- Reasonable port charges;
- Cargo handling facilities;
- Rail and road connections;
- Transport and warehousing facilities;
- A sizeable workforce;
- Highway access;
- Road density and congestion;
- Road infrastructure; and
- Air cargo infrastructure. (Botha, 2008:63-66)

Furthermore, a study that was conducted regarding the creation of a hub in Madrid also focused on attributes that include:

- Population growth of the city;
- City's contribution to the country's economic position;
- The city's average income;
- The various job markets and job creation opportunities;
- The city's function in the global arena;

- The role the city plays in international trade;
- The economic structure of the city; and
- The various industry sectors within the city.

(OECD Territorial Reviews, 2007: 52)

The definition of hub by Jorgensen (2007) as defined in Section 2.6.1, focused on the physical unit where shipments are stored and redistributed. The characteristics mentioned above focus on the physical and socio-economic nature of the location. These characteristic are functions of a country's government. By focusing on these characteristics, the county's government can create a suitable environment for the possible location of a hub within its borders.

2.7 CORE CHARACTERISTICS OF HUBS

The three perspective that were discussed in Section 2.1, gave an indication of the complexity surrounding the decision making process. From these perspectives, core characteristics were identified. These core characteristics influence decisions surrounding the investment into strategic facilities with a focus on the capability of the facility, the function within the supply chain and the operational characteristics of the facility.

The following characteristics were identified:

- Capacity capability;
- Transport decisions; and
- Technologies and processes.

Each of these characteristics will be examined and their importance will be highlighted.

2.7.1 Capacity capability

Capacity and throughput has become critical concepts in a variety of literature studies. It has a central role in a "theory of constraints" perspective used in operations management. "Theory of constraints" is a management theory used to measure and control an organisation by looking at three measures namely, throughput (T), operational expense (OE) and inventory (I).

Throughput (T) is the rate at which systems (e.g. the supply chain) generate money through sales. Operational expense (OE) is the money spent in creating inventory into throughput. Inventory (I) is all the money that the system has invested in things that it wish to sell.

The theory is based on the assumption that the rate of goal achievement is limited by at least one constraining process. This means that if an organisation is not functioning at an optimal level, there is at least one process that is hampering the organisation (Gupta & Boyd, 2008:999).

Capacity capability is influenced by throughput. Throughput is a function within capacity as it determines the rate of turnover within a system. Within the logistics service provider domain, throughput entails the quick turnaround time of transport capital. With a shorter turnaround time, the utilisation of the transport capital will increase and thus increase the return on investment. This increase in capacity is crucial within a strategic hub, as it ensure that the facilities that were developed are being used regularly.

Capacity and capacity planning are crucial functions within an organisation and especially important on a strategic level. This function determines the network design and configuration for the organisation and the possible reach in a geographical area. Thus, to assess the viability of a hub, capacity and capacity planning should be one of the key elements within in an advanced study.

The concept of a hub for the oil and gas industry is somewhat different. Due to the nature and the variety of products that are needed throughout the value chain, the hub must be a combination of a number of hubs. The hub needs to be able to handle products with long lead times, long transport legs, low frequency due to the nature of the product, possibly very high volumes, due to a growing demand in a specific area, and vice versa.

Thus, due to the variable volume and frequency which can be encountered within the industry, capacity planning and capacity building will be a crucial component within an organisation's strategic decision making sphere. Capacity is the cornerstone of a hub in that if the capacity is too low to make it viable, it will be a better option to look at the current transport configuration and network design to gain competitive advantage.

2.7.2 Transport decisions

There is a fine balance between strategic planning and operational excellence. A crucial aspect of operational excellence is transport. Transport is a key element to the success of a company. In order to perform efficiently, transport must be looked at from an integrated approach, not as a function of the supply chain. Stank and Goldsby (2000:71) identified five key decision making areas for transport in an integrated supply chain (see Figure 2.9). They are:

- Total network and lane design decisions(strategic);
- Lane operation decisions;
- Mode/carrier assignment decisions;

- Service negotiations; and
- Dock level decisions (operational).

According to Stank and Goldsby (2000:71, decision makers (supply chain managers and developers) should constantly be aware of these elements regarding their transport decisions. Historical influence on how business is done cannot be ignored. Old business models and decision making processes still influence day to day activities as well as strategic decisions. A critical element identified by Stank and Goldsby (2000:72) was the mode/carrier decisions.

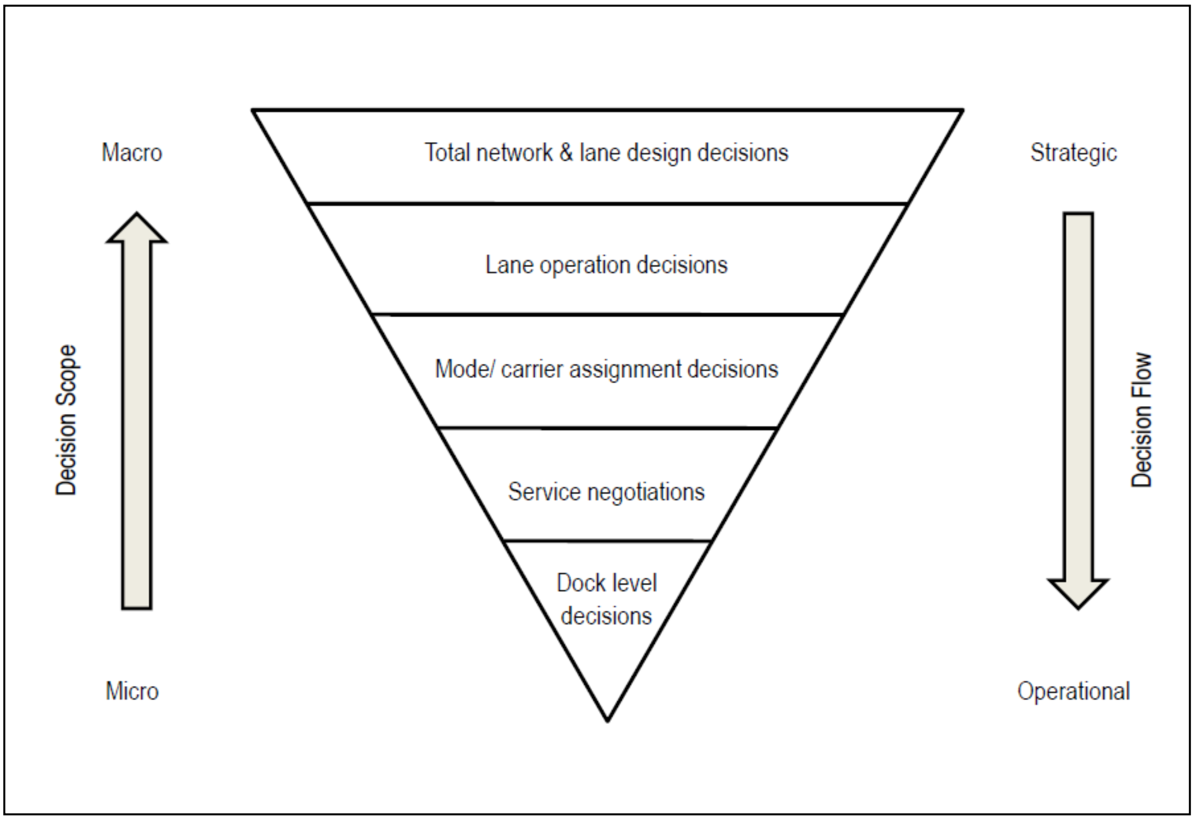

Figure 2.9: Transport decision making in an integrated supply chain

(Source: Adopted from Stank & Goldsby, 2000:73)

Conventional mode/carrier decision making was based on a three step process. Firstly, the mode of transport was chosen, followed by the type of carrier and lastly the individual carrier. (Stank & Goldsby, 2000:75) This process is solely based on the consideration of cost. Although, not wrong, other elements could be considered in order to decide on an appropriate carrier. These elements are:

- Customer service levels/transit time;
- Market/product characteristics; and

- Transportation cost constraints.

In considering these elements, the decision of the mode/carrier could change by looking at the overall value added to the product rather than just a achieving the lowest possible cost. Transport is a crucial element in the configuration of a supply chain. If the chosen mode of transport is not suitable for the configuration, the supply chain will be inefficient and problematic.

Modern enabling technologies are available for decision makers to use in order for them to achieve operational excellence. These technologies could be used to look at transport on a more strategic level than an operational level and even do some simulation in order to predict possible changes to the design and eventually the configuration of the supply chain.

These technologies can create intelligence from the data that is generated from everyday recorded transactions from a company's enterprise resource planning (ERP) systems. The systems capture almost any type of data which, if used correctly, could enable transport strategies to be more pro-active that reactive.

2.7.3 Technology and processes

Technology has always played an important role in business structures, and with the IT revolution, the influence of technology has increased significantly. From container tracking systems to global positioning systems, technology has changed the face of logistics in general.

Technology, from a value chain perspective, facilitates primary management processes such as R&D, in- and outbound logistics, production, marketing etc., which creates value for the operational systems (Cheng, Gibson, Carillo & Fitch, 2011:511). This means that technology is an enabler in the organizational structure and does not create insight into the organization. However, modern systems are moving away from the traditional role, towards a role where technology can be used to create insight in operational practices.

Technology, organizational structures and business processes influence each other. With numerous technology systems available to organizations, the historical structures and business processes have been left behind. This means that although the best technology is used, the core functions within the organizations cannot cope with the increased volume of business that is conducted. Thus, the role of technology must be clearly defined and the impact on the other two processes understood (Cheng *et al*., 2011:515).

Information flow is the spin-off from effective technology within an organization. In the current IT centric business environment data is the one aspect that there is plenty of. The question is how the vast volume of data is used to the advantage of the organization and what intelligence can be gained from it. Technologies such as GIS and business intelligence systems (Klappich, 2011:20) will become more and more relevant within an organization, and especially within the logistics sphere, due to the nature of the logistics movements around the globe.

Various systems are available which can be used by top level management to assist them in the decision making process. Due to the nature of logistics data, which has a large geographical component to it, it must be stated that some sort of visualisation tool could have a significant impact in understanding a supply chain. According to Klappich in the "Transportation Hype cycle for 2011" (also see Figure 1.1), GIS systems are an important new technology to analyse a supply chain and transportation movements. Thus, GIS systems are ideally suited for top level management to make strategic decisions.

These decision support systems (BI systems) ease the analysis of the data. There is an increase in the struggle between user friendliness and IT's requirement for standards and control over the information systems within a company (Klappich, 2011:20). Combined with a GIS system, BI systems can generate valuable insight from any data set and visually represent it in a way that is compacted and to the point for top-level management.

2.8 CHAPTER SUMMARY

Within the chapter various key perspectives and characteristics were discussed that were seen as an integral part for the creation of a hub. From the geographical and capacity perspectives that were discussed, it is clear that for a hub to be functional, it must fulfil a need with a defined geographical area. This need is dependent of the volume and frequency of freight within the region. Certain regions play a more prominent role in global trade than others. As regions developed, such as Africa, and industries (oil and gas) develop within such regions, the role of strategic hubs could increase. Strategic decisions are complex and have to take numerous factors into account.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

Research methodology is an important aspect of any study. The correct methodology will inevitably produce the most concise results. A main focus of the study was to evaluate a logistics service provider's top management decisions regarding the concepts of consolidation and the establishment of a strategic hub with the focus on the oil and gas industry. The correct research methodology and how the desired results were obtained will now be discussed.

Firstly, the research design was of an explorative nature. Due to the lack of information regarding decision making within a logistics service provider, the researcher tried to explore various avenues in order to understand the process. Once the process was understood, the researcher tried to create a process that would help top management in future strategic decision making.

Firstly, a literature review was conducted in order to assess if there is any relevant material available that is related to the study. The literature also helped to identify various key aspects that were necessary to be looked at in order to conduct a study of such nature.

Secondly, the historical data of specific case was examined to establish the nature of the data as well as identifying possible shortcomings with regards to the data. This guided the researcher in determining what could be extracted from the data and the possible results that it could deliver. In combination with the analysis of the historical data, interviews were also conducted. This was done to establish the operational/transactional process, in order to gain a proper understanding with regards to the placement of orders.

Finally, by using descriptive decision support techniques and technologies, the clean and adapted data was visually represented.

3.2 METHODOLOGY

As stated in Section 1.3, Research Objectives, three key research question and objectives were identified. By combining various methodologies, these questions were answered and the corresponding objectives were reached.

The literature review in Chapter 2 gave the researcher the theoretical framework to develop the most appropriate research methodology and to develop the process by which the study was conducted.

The research approach for the study is both qualitative and quantitative. The quantitative data was obtained from the historical transactions from the service provider. The data characteristics will be discussed in Section 3.2.1. In conjunction with the theoretical base from the literature, a process for a strategic network configuration study was created.

The qualitative data was obtained from semi-structured informal interviews with the oil and gas business unit of the service provider will be used to gauge the current operational efficiency within the service provider (Section 3.2.2).

By using a descriptive decision support system, as identified in Section 2.3, and especially IT-driven supply chain modelling, a predefined process was apply in order the collect, analyse and represent the historical data from the service provider (Section 3.3). Here the data cleaning, preparation and aggregation process are also discussed.

Finally, the process that was used was reviewed according to questions that were raised from feedback from the logistics service provider. This review process is discussed in more depth in Chapter 4. This process was developed with company view and was only applied to one operation point (Cape Town).

Due to the sensitivity of the data obtained from the service provider, the researcher gained the necessary clearance to use it, and desensitised the data in order to protect the service provider and its clients.

3.2.1 Quantitative methodology

The quantitative methodology involved the analysis of historical data from the service provider. This historical data was recorded over approximately two years of transactions within the oil and gas business unit, from their Cape Town operations. It included both export and import transactions.

The data include the following attributes:

- Transport method;
- Goods description;
- Gross weight;
- Volume;
- Charge weight;
- Destination/Origin Country; and
- Number of containers.

Data can be viewed from various perspectives. The first perspective that was used is a geographical perspective. The perspective is used to identify the geographical dispersion within a company. This means that an in-depth look is taken into where, how much volume and frequency of products are shipped to a specific country, region or continent.

Secondly, the data was looked from a demand, supply and product perspective (see Figure 3.1). This perspective was used to analyse the transactions with regards to the products that were shipped. From this perspective, patterns could be established regarding what products are shipped and together with the geographical perspective; the service provider's supply chain could be established.

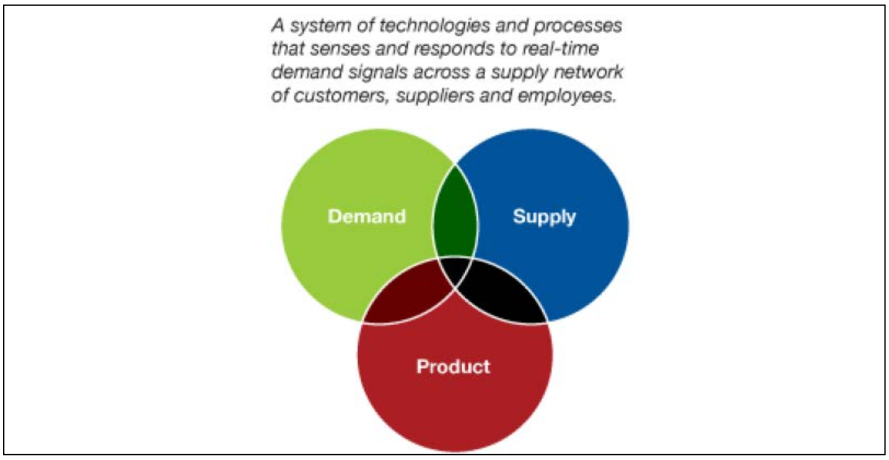

Figure 3.1: Demand, supply and product perspective

(Source: Hofman & Aronow, 2012:11)

3.2.2 Qualitative methodology

The qualitative data that was obtained came from semi-structured informal interviews with the oil and gas business unit of the service provider. The business unit was selected as focus group due to their knowledge regarding the operational process and their various perspectives and experience within the industry. Within the business unit, seven interviews where held with the following job descriptions: Operations Manager for the oil and gas, Project specialist, Expeditor – key account, three Senior Controllers – key accounts and Controller – admin/accounts. Questions focused on the following:

1. Operational process followed for orders (import/export)
2. Problems associated with operational process
3. System used for input of order

4. Advantages/Shortcomings order input process

5. Time frame for orders (how well in advance must an order be placed)

6. Process for any changes to specific order (VOC)

7. Advantages/Shortcomings of VOC process

These questions were devised in order for the researcher to get a better understanding of the ordering and execution process. By looking at the processes, the researcher got a better understanding of the historical development of the processes, the bottlenecks that occur and the strengths/weaknesses of the processes. The researcher also had informal discussions with oil and gas Business Manager and the Regional Director, regarding the industry as well as the transactional process. Furthermore, the interviews also gave the researcher an opportunity to personally observe the work environment and the transactional processes.

These results obtained during the study will be discussed in Chapter 4. The results will indicate the current perception of the employees within the business unit have regarding the operational and transactional process.

3.3 DATA ANALYSIS METHODOLOGY

The quantitative data, which consist of historical transactional data from the service, was viewed from two perspectives as stated in Section 3.2.1. Furthermore, decision support techniques and technologies (DSTT) were used in the analysis process. One of the techniques that were used was to establish the geographical dispersion of the shipments. This was done with the help of a geographical information system (GIS). There are key steps when such a technique was to be used and it is highlighted in Figure 3.2. By using the data from the service provider, and the strong focus on the geographical dispersion, attributes such as identified in Section 3.2.1, can be mapped and analysed in a spatial context which can support decision making (Vlachopoulou, Silleos & Manthou, 2001: 205)

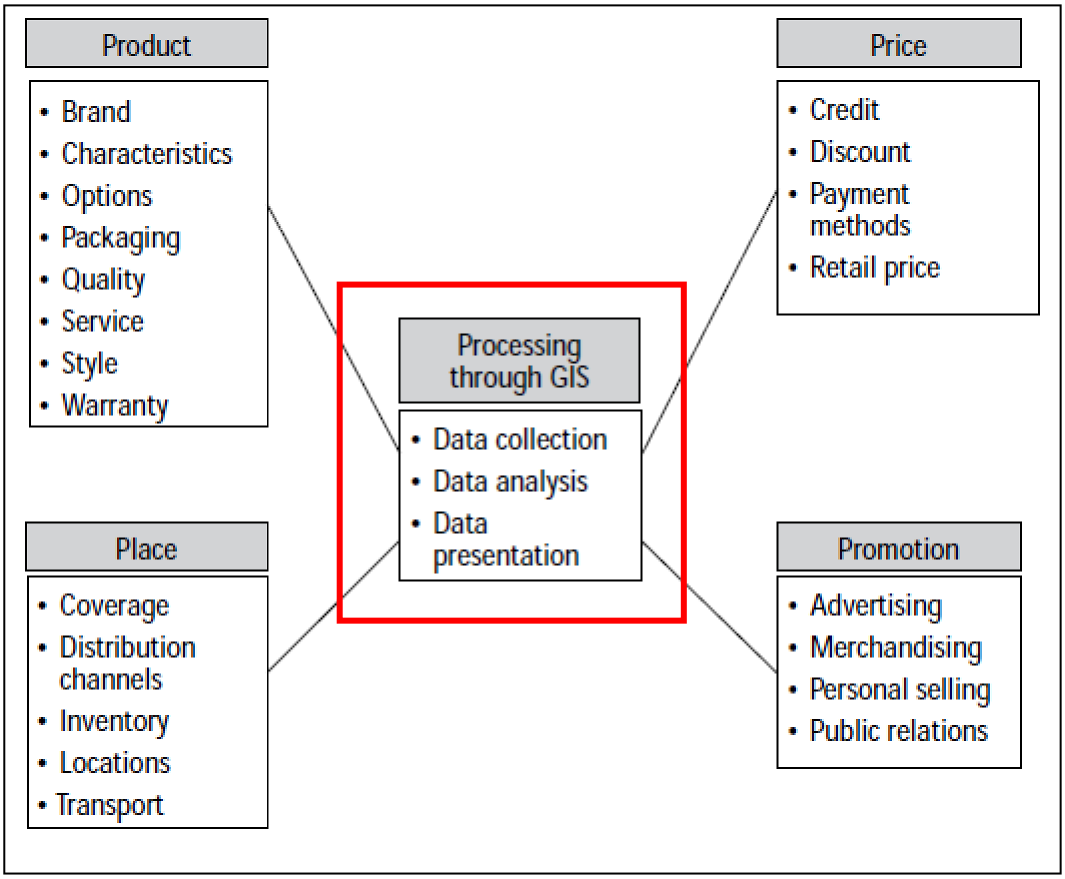

Figure 3.2: GIS Processing

(Source: Adopted from Vlachopoulou *et al*, 2001: 205)

The following section indicates the analysis process that was used during the study and the steps that were followed. The data analysis methodology that was followed for the historical data was:

1. Establish data attributes
2. Collection of data set from service provider
3. Verification of attributes
4. Data management
5. Analysis of data with decision support technologies
6. Visualisation of results

The methodology will be briefly discussed in order to indicate the bottlenecks and the complexity of data that was received.

3.3.1 Establishing data attributes

Establishing the attributes for the data in this study was done by looking from a geographical perspective. Within this perspective, attributes such as origin/destination points and volume/weight shipped. These attributes were chosen in order to answer the questions of where the products are being shipped and what volume/weight is being shipped to these points (geographical). With the identification of the various attributes, the question was whether these attributes were available from the captured data from the service provider.

3.3.2 Collection of data from service provider

This involved the physical collection of the various datasets according to the attributes identified in Step 1. Once the dataset were received, a general overview of the data was obtained in order to establish whether the attributes identified in Section 3.3.1 will answer the questions that were set.

3.3.3 Verification of attributes

The answers generated from any dataset are only as good as the data captured during the transactional process. By verifying the various attributes, some attributes were discarded if they did not contribute to the question at hand.

When the data was examined, it was clear that in order to make sense of the data, some sort of data cleaning, aggregation and preparation would be necessary(see Appendix A).This data cleaning, aggregation and preparation involved the creation of various hierarchies in order to create a data structure for the various levels of management.

3.3.4 Data cleaning, aggregation and preparation

The data cleaning, aggregation and preparation and creation of hierarchies were based on the notion that every level of management needs different levels of data detail. These different levels of data hierarchies can be seen in Figure 3.3. Each level of data hierarchy is a summation of the data level below it. Thus, by moving up or down the hierarchies, the necessary information for each level can be extracted.

3.3.5 Data analysis with descriptive decision support systems

When the data cleaning, aggregation and preparation were complete and the data was in a desired state, it was analysed with decision support techniques and technologies. Firstly, the data was looked at from a spatial distribution (geographical perspective) and with the help of GIS, the data was mapped accordingly. Numerous software systems are available to companies, for example MapInfo Professional and ArcGIS for the GIS systems. This was followed the used of BI systems, which helped with the demand, supply and product perspective. Here the various patterns that occur could be visually illustrated. Systems such as Tableau and Qlikview are systems that are used for such a process.

As stated in Section3.3.4, attributes were created in order to create a data structure for the various levels of management.

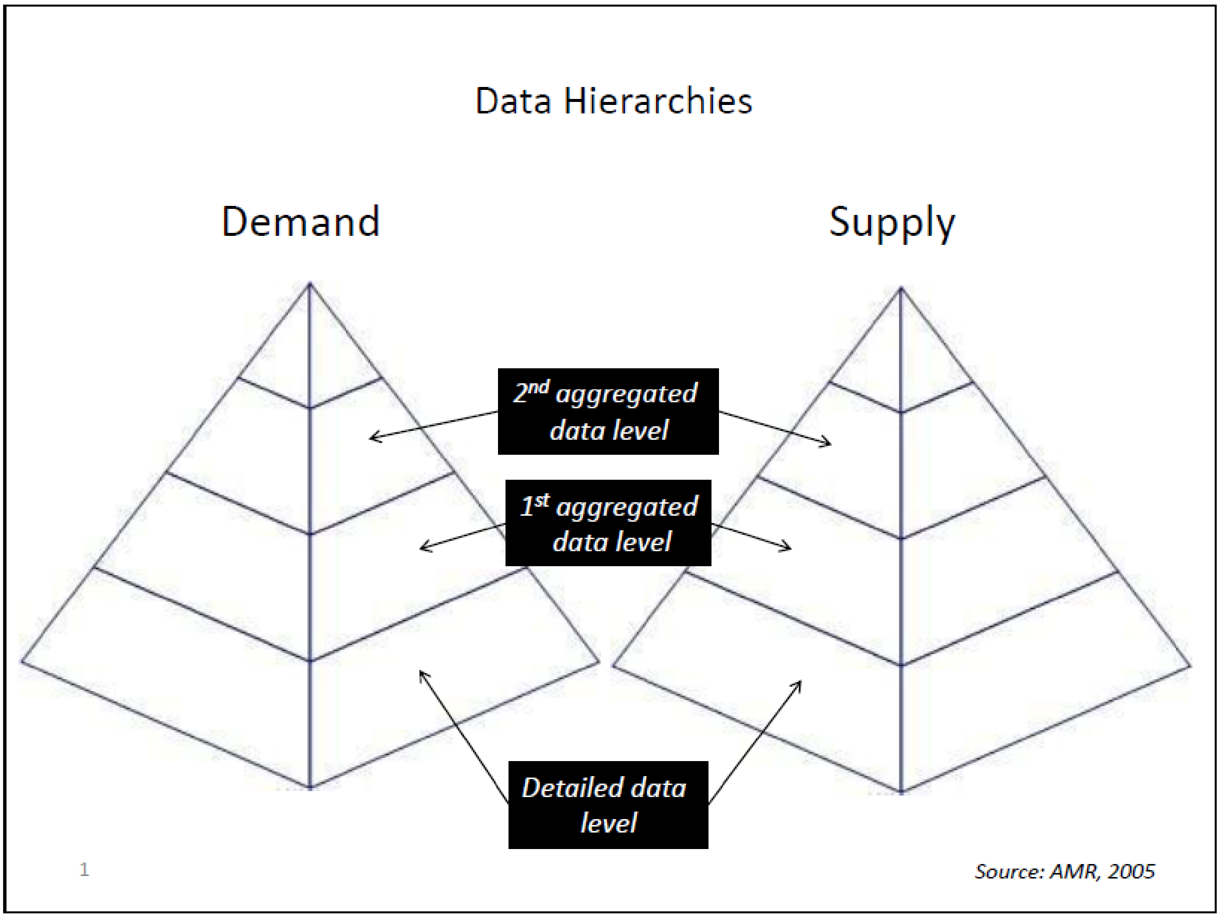

Figure 3.3: Data structure for different levels of management

(Source: Cecere *et al*, 2005:10)

3.3.6 Visualisation of results

When the analysis was completed, the decision support systems were used to visually represent the data. From the geographical perspective, the data was mapped accordingly to the number of transactions to/from the various countries as well as the volume that was shipped to/from the various countries. This was done for each of the classifications as discussed in Section 3.2.1. Further, these classifications were visually represented within the BI system, together with various attributes that was created during the data management process. These attributes were created in order to simplify the data to the level for top level management.

3.4 CHALLENGES DURING THE STUDY

Such a study is not without problems and challenges. Problems that were expected included quality of the data, the correct capture of the data from the system, problems with entries such as correct numerical entries within the data set as well as the size of the data set that was available to be used.

Problems associated with the interviews could possibly be that the interviewees were intimidated to answer the question or that the interviewees misinterpreted some of the questions. Problems with the use of the modern technologies were also a concern. Problems that could be encountered during the use of modern technologies include the compatibility of the data with the program that was chosen to represent the data. The systems that were chosen could also possibly not deliver the required outcome, due to the lack of key data.

These problems and challenges are to be expected for any study. However, once the problems were identified, the necessary adjustments were made to address the various issues and the desired results were obtained from the data.

3.5 RESULTS FROM DATA ANALYSIS METHODOLOGY

Designing and implementing a supply chain network can be complex, since various factors must be taken into account. Developing a supply chain network within the logistics service provider domain can be more arduous as you have to develop a supply chain that not only will function within the greater organisational structure, but also, as in this case, develop one with a specific industry in mind. Various modelling and analysis techniques and technologies have been developed which help with these decisions .According to Vlachopoulou *et al*. (2001: 206), “These decision support systems (DSS) incorporate both data and models. They couple the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions and to support managerial judgement”.

The initial data analysis methodology was used in order to establish whether ina strategic study of such a nature, answers can be obtained from a high level view at the various movements of products. The process that was used was a simple geographical visualisation exercise of the historical data obtained from the logistics service provider. By using some of the attributes as indicated in Section 3.2.1, the research identified the movement patterns within the service provider.

After the visualisation exercise, and the appropriate data cleaning, aggregation and preparation was done, the data was used in a BI system in order to gain more information regarding possible consolidation opportunities from a geographical and product perspective. Thus the process that was used during the study was:

- Data gathering;
- Data cleaning, aggregation and preparation;
- Data visualisation by the use of descriptive decision support systems - GIS and BI; and
- Data interpretation.

By answering question related to product movement, volume that were shipped and the frequency of product movement, the researcher indicated the advantages of using modern descriptive decision support systems in a strategic study. These results will be discussed in Chapter 4 and further development of the data analysis methodology in Chapter 5.

CHAPTER 4: DATA ANALYSIS AND RESULTS DISCUSSION

4.1 INTRODUCTION

In this chapter, the significant results will be visually represented by the use of the decision support techniques and technologies. These techniques and technologies were chosen in order to illustrate the advantages of using systems with strong geographical and descriptive analytical capabilities.

Data cleaning, preparation and aggregations were crucial aspects that were noted during the study. The results from the data cleaning, preparation and aggregations process will be discussed first, followed by the results obtained from the data analysis. Lastly, the results from the informal interviews with the oil and gas business unit will be discussed. But first, some background regarding the case study.

4.2 BACKGROUND – CASE STUDY

The study was based on the activities of a third party logistics service provider (3PL) which focuses on supply chain management and consulting services, systems integration and custom clearing, forwarding, logistics and financial services. The company has over 100 years' experience in the freight industry. They serve a number of industries, with the oil and gas industry being one of their more important industries. They have offices in Cape Town, Port Elizabeth, Durban and Johannesburg. The study was demarcated to the Cape Town operations.

The service provider accommodates their clients by providing two primary forms of transport - air and ocean freight. The company can be described as a NVOCC - non-vessel operating common carrier. This means that the company does not own any vessels, but functions as carrier by issuing its own bill of lading or air waybills and assuming responsibility for the shipments.

The oil and gas industry in Africa is a major focus for service providers' in this case study. They need to fulfil in a variety of needs for their clients within the industry. The oil and gas industry can be divided into two domains, up and downstream (see Figure 4.1).

Upstream within the oil and gas industry refers to on the exploration and production of oil based products. Downstream refers to refining, primary distribution, shipping and trading as well as marketing/secondary distribution of fuel and oil based products. In the oil and gas industry, however, is difficult to predict what the flow of product movement will be.

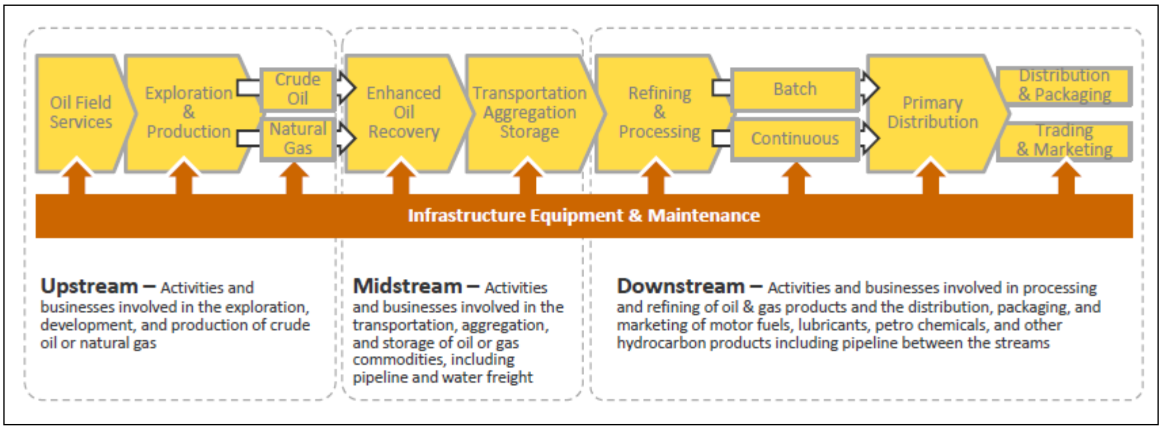

Figure 4.1: Oil and gas value chain – detailed view

(Source: PRTM, 2011:4)

Within each of these streams, support products are needed to fulfil day to day operations. These products vary from a bar of soap to steel pipes needed for drilling. It is, therefore, crucial for the service provider to have a well-functioning supply network to service their clients in the best possible and responsive way.

The variable demand and the ever changing nature within the oil and gas industry can cause problems for companies that serve. Network configuration and design play an important role and the correct configuration will have a significant impact. Demand for products can be high in the initial exploration phase and slow down as the activity at the site moves down the value chain. In order to be a leader within the industry, the service provider's network design should set up to accommodate such variable demand. This variable demand and the necessity of an adaptable service beg the question: *"Is it feasible to create a strategic hub for the oil and gas industry*?"

4.2 DATA SOURCING AND PREPERATION

The oil and gas value chain can typically be divided between upstream and downstream segments (see Figure 4.1). The upstream value chain focuses on the acquisition of crude oil. The downstream value chain starts at the refining process and ends at the final delivery to the consumer .A further breakdown is along the various stages in the production process and then finally into the major activities within the various stages as seen in Table 4.1.

From the major activities that occur within the value chain, it is evident that various products are needed to assure its proper functioning. This is evident in the data from the service provider, in that the range of products that are being shipped is highly diverse in nature. It can range from food to cement to lubricants needed for the operation of machinery (see Appendix B).

Table 4.1: Stages and major activities – oil and gas value chain

	Stages	Major Activities
Upstream	Exploration	•Seismic, Geophysical , Geological Analysis •Identification of Prospects
Upstream	Production	•Drilling, Supply & Support Vessels Operators •Reservoir, Production, Engineering •Facilities Engineering (Oilfield, Service & Supply Companies, Construction Companies)
Downstream	Refining	•Output to Marketing •Plants & Refineries
Downstream	Marketing	•Retail Sales, Branded Gas Stations •Gasoline, Engine oil, Refined products (Lubricants, Additives)
Downstream	Consumer	•End user

The hierarchies used (see Figure 4.2) to analyse the data, created the opportunity to establish a product catalogue for the service provider that currently does not exist. The product catalogue was created in such a way that similar products can be grouped together in an effort to start identifying opportunities for consolidation (a sound practice used data aggregation.)(Cecere *et al*, 2005:10)

Table 4.2 shows the catalogue that was created. A division between upstream and downstream operations was made in order to illustrate the complexity within the value chain. The classification was based on the rule that "*any product which has an oil/petrol base is considered downstream, with everything else, upstream*". These products can either be used in the direct supply or the indirect supply chain (see Figure 2.2). This is one possible classification for the products. Another classification can be made on where the product is used in the value chain or supply chain, but due to limited information regarding the end destination of the goods, this classification could not have been made.

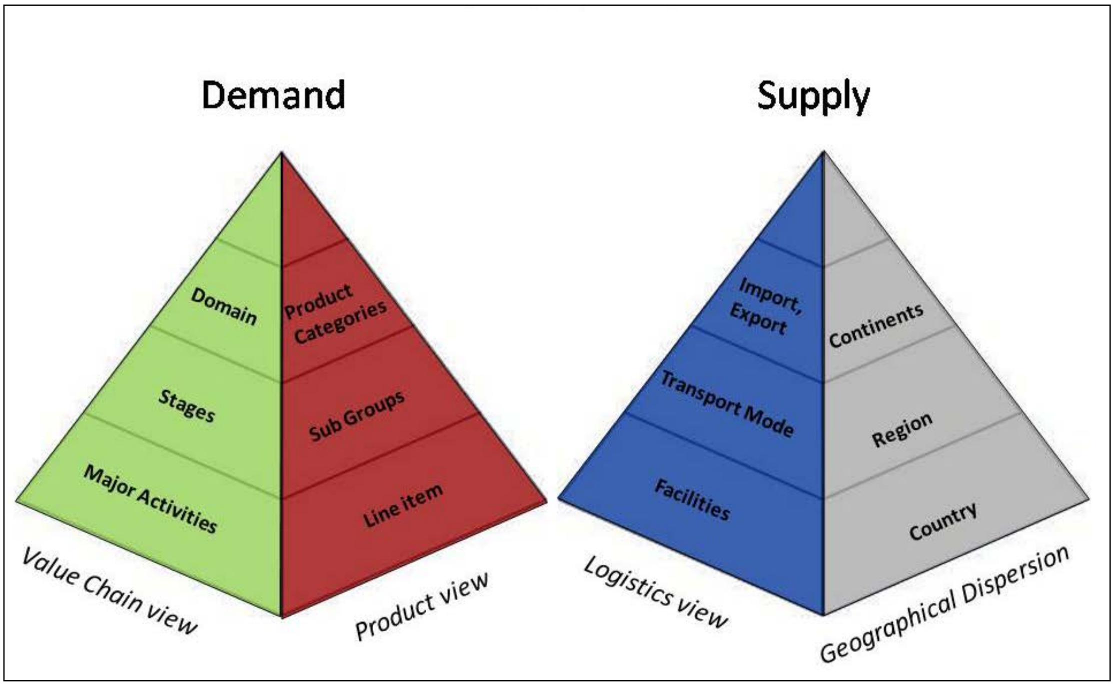

Figure 4.2: Demand, supply and product perspective – oil and gas industry

(Source: Adapted from Cecere et al, 2005:10)

In order to create a product catalogue for a supply chain, the data will need to be simplified. Furthermore, it will create a structure in the data set so if a specific question needs to be addressed, the level of information can vary depending on the level at which the question is being asked. For example, if a question was asked regarding the value chain view, regarding what products are needed in the production stage, the product catalogue together with the hierarchies that was created will indicate that numerous pipes and value products are needed within the stage.

The decision making process differs from strategic to operational level. Within each level the focus on the level of data changes. Detail information of products is needed on an operational level, while a more high level of information is needed on a strategic level. Various enabling technologies can benefit top level management in this process.

From the product catalogue (Table 4.2), there are various products that can be consolidated due to their nature and physical properties. Products that are non-disposable such as pipes and valves can be consolidated with ropes and cables for example. Consolidation can take place due to nature of the product, the packing of products, etc.

Table 4.2: Product catalogue – up and downstream

Upstream		Downstream	
Foodstuff	Foodstuffs	Petrol products	Petrol products
	Various food stuff	AGO	
Building material	Cement	Bulk products	Bulk products
	Paint products	Oil products	Lubricants
	Granite	Oil and lubricants	
	Blasting material	Turbine oil	
Oil well supplies	Oil well supplies	Lubricants	
Pipes &valves	Valves	Fuel	Fuel
	Steel products	Reformate	
	Pipes		
Safety products and clothing	Clothing		
	Safety products		
Welding products	Gas products		
	Welding products		
Various products	Various supplies		
	Various goods		
	Cigarettes		
	Various products		
	Containers		
	Miscellaneous		
	Cleaning materials		
	Paper products		
Ship spares	Ship spares		
Chemicals	Chemicals		
Ropes and cables	Mooring ropes		
	Ropes and cables		
Equipment	Electronics		
	Equipment		

Consolidation can also take place from different supply chain segments and multiple supply chain segments can be consolidated to reach economy of scale and scope. By looking for synergy between supply chains, service providers can optimize the movement of products from a variety of supply chains, both in the direct and indirect supply chain segments within the oil and gas industry.

4.3 DATAANALYSIS

The transactional data received from the service provider indicates that they were mainly responsible for arranging and providing transport services for the oil and gas industry. They formed the link between their clients and the client's suppliers. The data was firstly divided by whether it was either export or imports. A further classification were made between mode of transport, either sea or air freight. From the data, sea freight as mode of transport was the most favoured. The number of records for the classification is as follows:

- Exports
  - Sea - 1374
  - Air - 28
- Imports
  - Sea - 187
  - Air - 72

The classifications were made to illustrate the difference in preference regarding mode of transport, the products that were shipped by each mode of transport and the nature of the product. The nature of the product is linked to the movement, import/export and the relative size of the shipment.

Business intelligence (BI) software was used to highlight the extent of information that could be extracted from the data provided and enriched. ***Air imports were the only sub-Section that was not investigated due to the lack of data from the original dataset.***

4.3.1 Sea exports

Figure 4.3 indicates geographically the total number of shipments by sea freight from the port of Cape Town. It is evident that the larger portion of the product movement is along the West Coast of Africa, and especially to Angola. The large number of product movements indicates a major demand for the oil and gas industry in this region. The strategic question immediately arises whether the establishment of a hub in one of the countries could be feasible.

Movement to the rest of the world is small compared to the movement in Africa, which also indicates that the service provider has a strong emphasis on the continent. As stated earlier, the two critical elements identified for a hub to be feasible, is frequency and volume. Figure4.4 indicates the volume that was moved over the same time period. It is clear that the volume of product movement to the west coast of Africa corresponds to the number of transaction in the same area.

In order to get more intelligence from the data, questions can be asked such as where do these products fall within the value chain, and in what stage these products are needed. These questions can be answered with the use of BI systems. Figure 4.5 is an extract from the dataset with the focus on Angola.

From the data, it is clear that most of the products that were exported to Angola were located within the upstream domain (see Figure 4.5). Production and exploration is the main recipients of products. Furthermore, these products, although high in number moved, were not so large in size. This creates the opportunity for consolidation of products that need to be shipped.

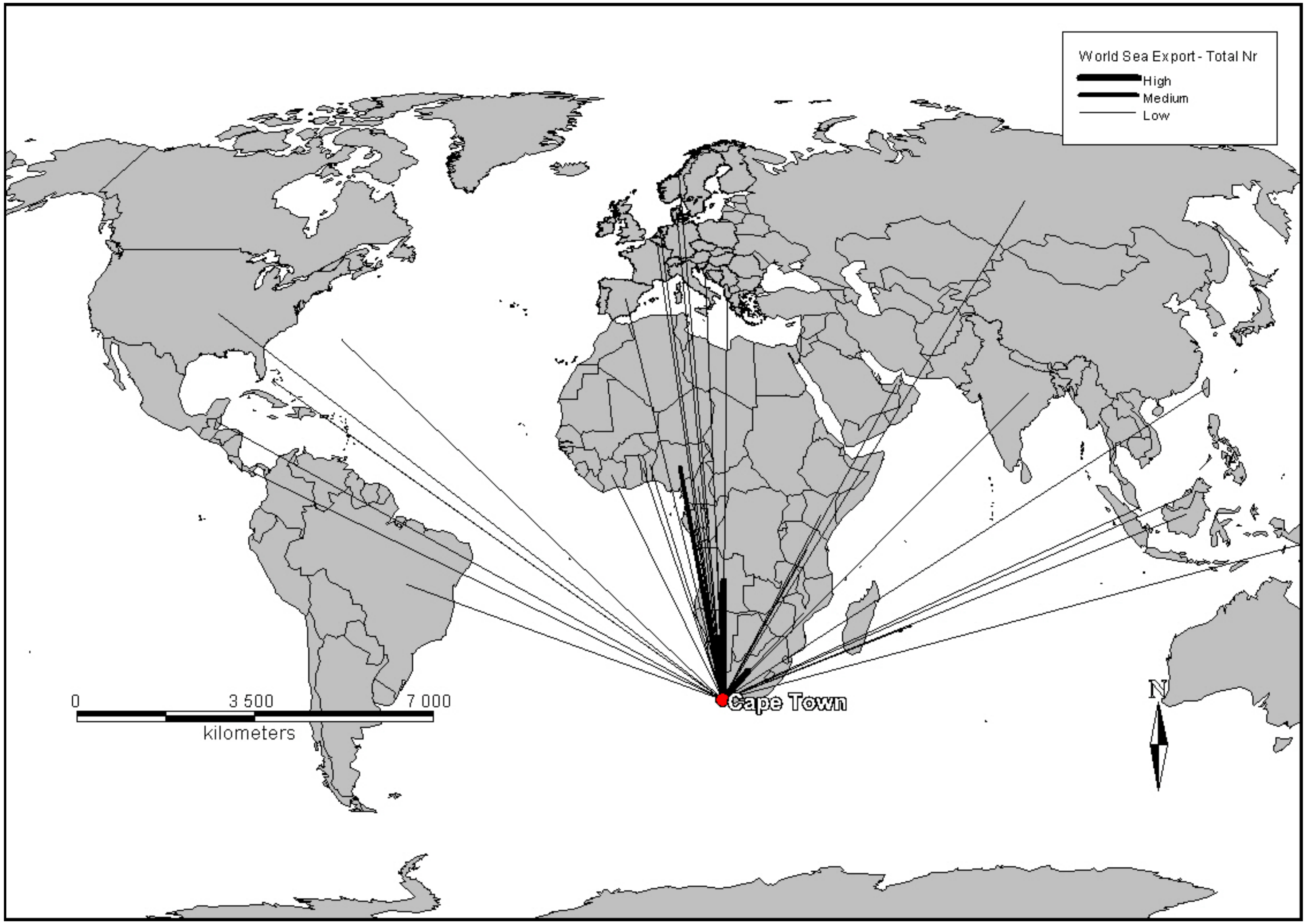

Figure 4.3: Sea exports – total number of transactions

Figure 4.4: Sea export – volume (chargeweight)

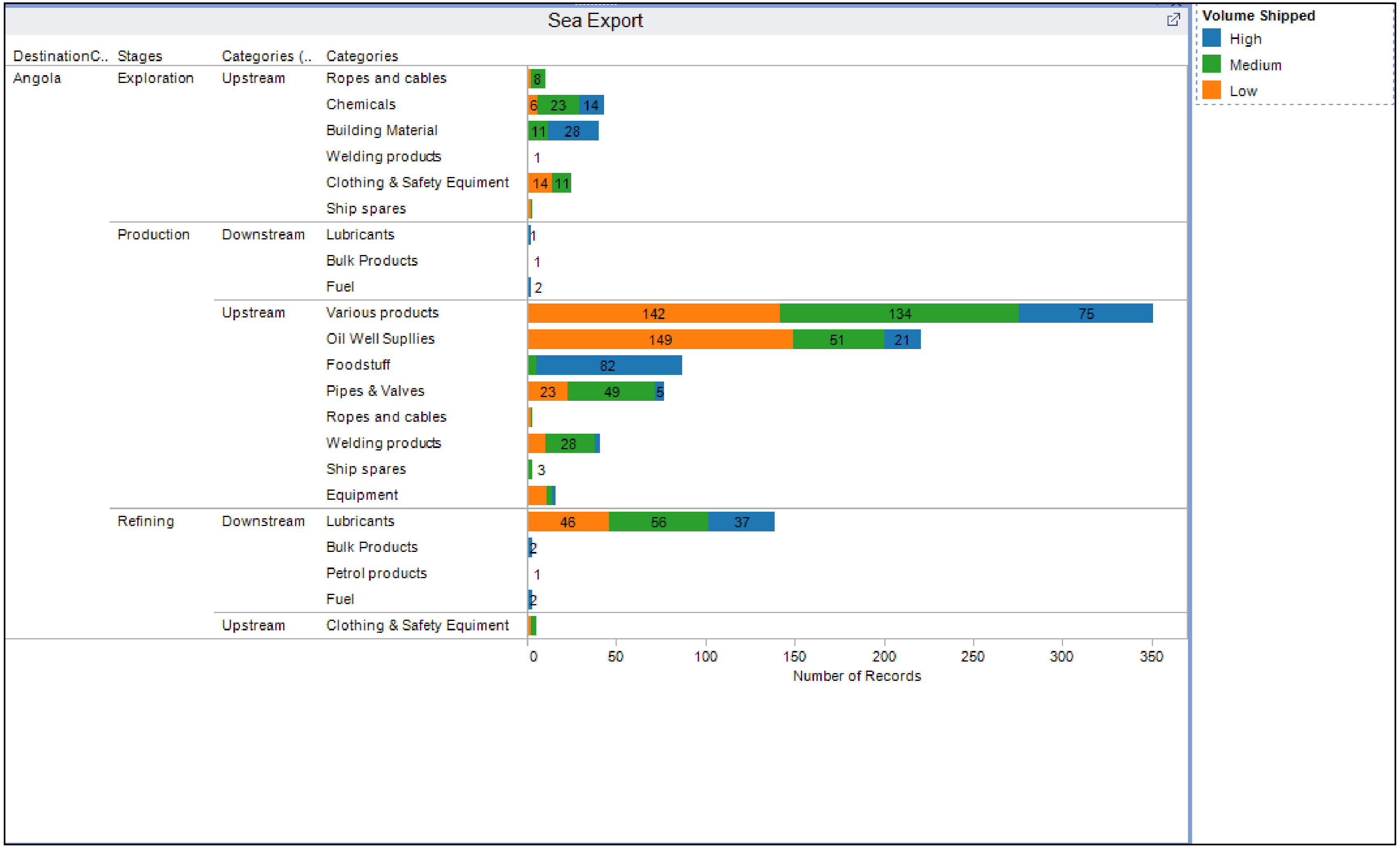

Figure 4.5: Sea export – Angola

4.3.2 Sea imports

As expected, the sea imports differ from the exports due to the origin of the products shipped. Firstly, most products were imported from Europe. This is a general trend for imports in Southern Africa. Furthermore, also shipments came in from the Middle East, which is also a general trend regarding the import of crude oil as seen in Figure 4.6.

One can assumes that the products that were imported require special skills to produce. This is in contrast to the products that were exported to Africa. However, the larger number of transactions that took place is not proportional to the volume that was shipped. Here, shipments from the Middle East were far larger in charge weight that the shipments from Europe. This difference can be seen in Figure 4.7.

This is evident from imports from countries such Saudi Arabia that are high in volume, but low in number. Products that were imported from Europe are products which require high intellectual property such as catalysts. These differences between sea import and sea export, indicate that highly specialised products are mostly imported, with low manufacture goods exported to the West Coast of Africa.

Figure 4.8 indicates the difference between products imported from Europe (Belgium and the Netherlands) and the products from the Middle East (Saudi Arabia and Kuwait). Most products from Europe are low to middle volume compare to the high volume from the other two countries. This reaffirms the notion of small shipments within the upstream domain, and large shipments of crude oil within the downstream domain. Furthermore, the natural resource, crude oil, is imported from countries such Saudi Arabia, and highly skilled manufactured goods, from countries such as Belgium.

Figure 4.8 also indicates the movement along the oil and gas value chain from upstream to downstream. With products moving along the value chain, different transport vehicles could be needed to transport the shipments. This information can help with planning shipments with the appropriate carrier mode.

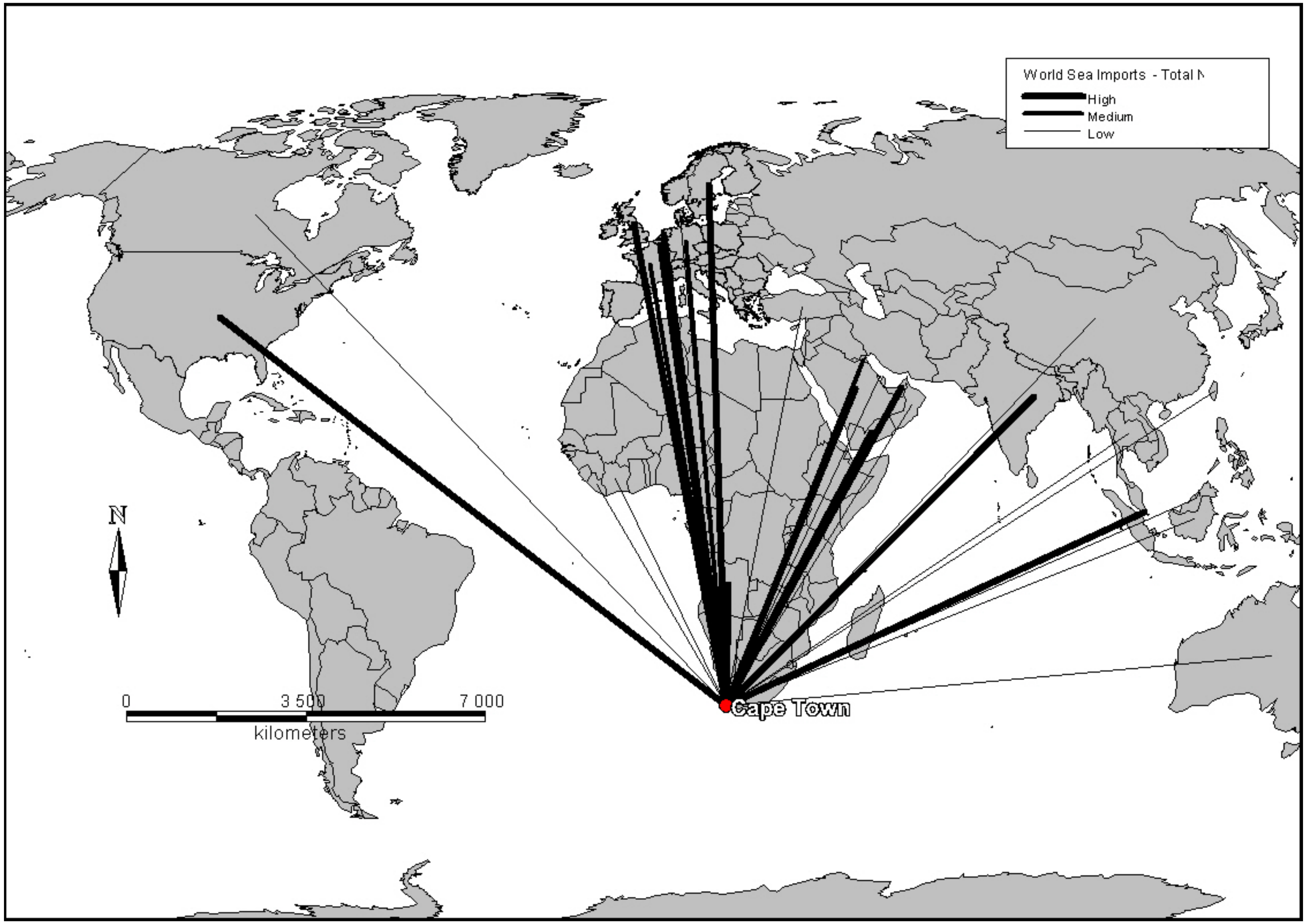

Figure 4.6: Sea import – total number of transactions

Figure 4.7: Sea import – volume (chargeweight)

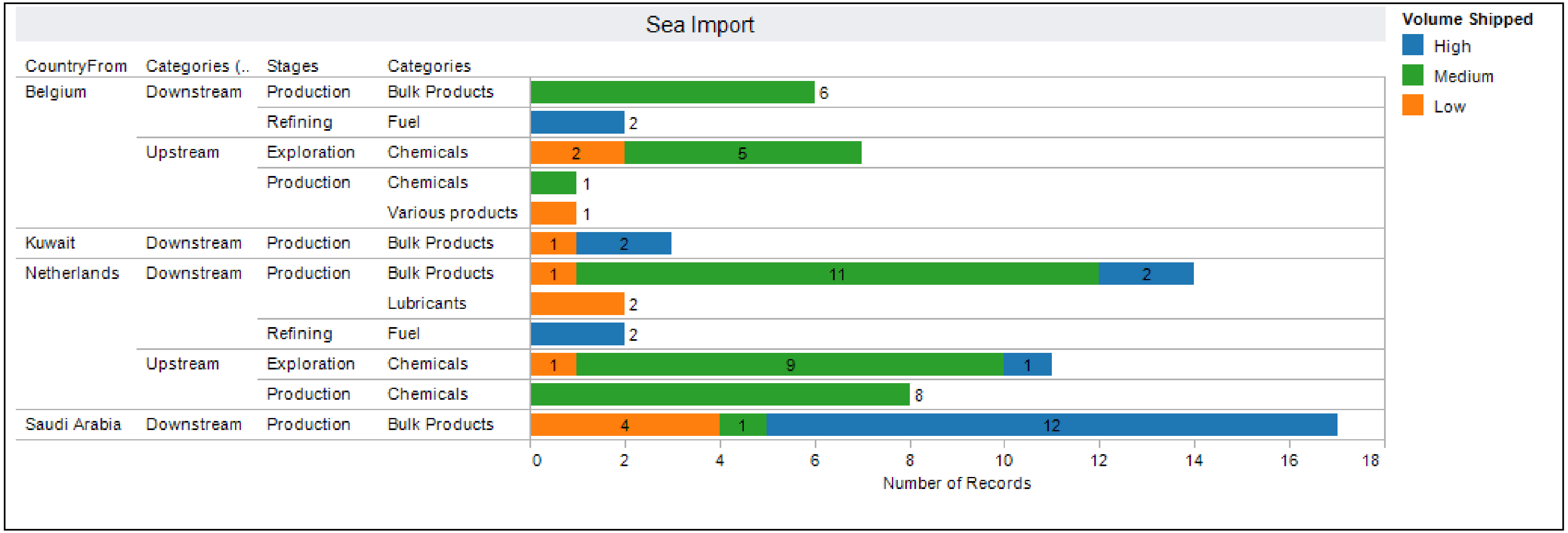

Figure 4.8: Sea import – Europe and the Middle East

4.3.3 Air exports

Air as a mode of transport was far less chosen compared to sea freight. This could be due to the high cost involved in the movement as well as the limitations on size that could be moved. However, air was used to move shipments that were crucially needed in a short period of time. This was the last resort for the movement of shipments. Figure 4.9 indicates the low number of shipments moved by air. Product shipments occur mostly to the West Coast of Africa and Europe.

Figure 4.10 indicates that products that were shipped to Africa were products that were needed to possibly repair equipment or the replenishment stock. Products shipped to Europe show no significant correlation, which means it was on an ad hoc basis or possible repairs that needed to be made due to faulty manufacturing.

The irregularity of movements, and the ad hoc nature of products being shipped, makes it difficult to establish patterns of movement and volume moved. Ad hoc movement, low frequency and low volume movement, makes consolidation of products difficult and thus the decision of establishing a hub even more difficult.

Due to the limitations associated with air transport, the shipments that were moved are also small compared to sea freight. However, within air freight, these shipments were classified as high volume. Figure 4.11 illustrates a high percentage of movements classified is high. With the high cost involved, shipments must be as loaded as possible in order to get economic value.

Figure 4.11is also an indication of what the BI system is capable of regarding a data set which lack information. From Figure 4.11, it is evident that there is no real repetition of movement of products to a specific country. This enforces the notion that the mode of transport is only used as a last resort to move shipment due to either time constraints or an unexpected need for a specific product.

Figure 4.9: Air export – total number of transactions

Figure 4.10 : Air export – volume (chargeweight)

Figure 4.11: Air export – global view

4.3.4 Frequency

Frequency was identified along with volume as a key indicator for the establishment of a strategic hub. During the study it was evident that the quality of data was of such a nature that a true reflection of the frequency of product movement would be difficult. However, as an indication of the value that can be gained from investigating the frequency of movement and the use of BI systems, the researcher used an extract of export and import to illustrate the advantage and necessity to look at frequency for a strategic study.

Two Gant-charts were generated by using an extract from both export and import as the two main divisions. A further division was made regarding mode of transport and then three categories were chosen to illustrate the difference in frequency for products. The time scale was set for the day the order was created. This was the only time scale that had sufficient information for establishing a baseline for frequency.

Frequency within this scenario indicates two important trends within the historical data (see Figure 4.12). Firstly, the demand for sea freight is significant more compare to the use of air freight. From the product categories that were chosen, “various products” are the most in demand. Foodstuff and pipe and valves have a consistent order cycle although less in demand than various products.

The import Gant-chart indicates (Figure 4.13) a more sporadic order cycle throughout the product categories. Bulk products are large in volume and possible the frequency for import is far less than the other products. However, with South Africa being a net importer of oil, the frequency is much higher than the other product categories. Sea freight again is the most popular choice of transport. A distinctive order can be seen at pipes and valves which can indicate high need for the product and the use of air freight that it was needed due to some sort of emergency.

By highlighting a few of the trends within the frequency of movement for either export or import, it is clear that by using descriptive decision support systems, valuable information can be extracted in order to help within the strategic decision making sphere.

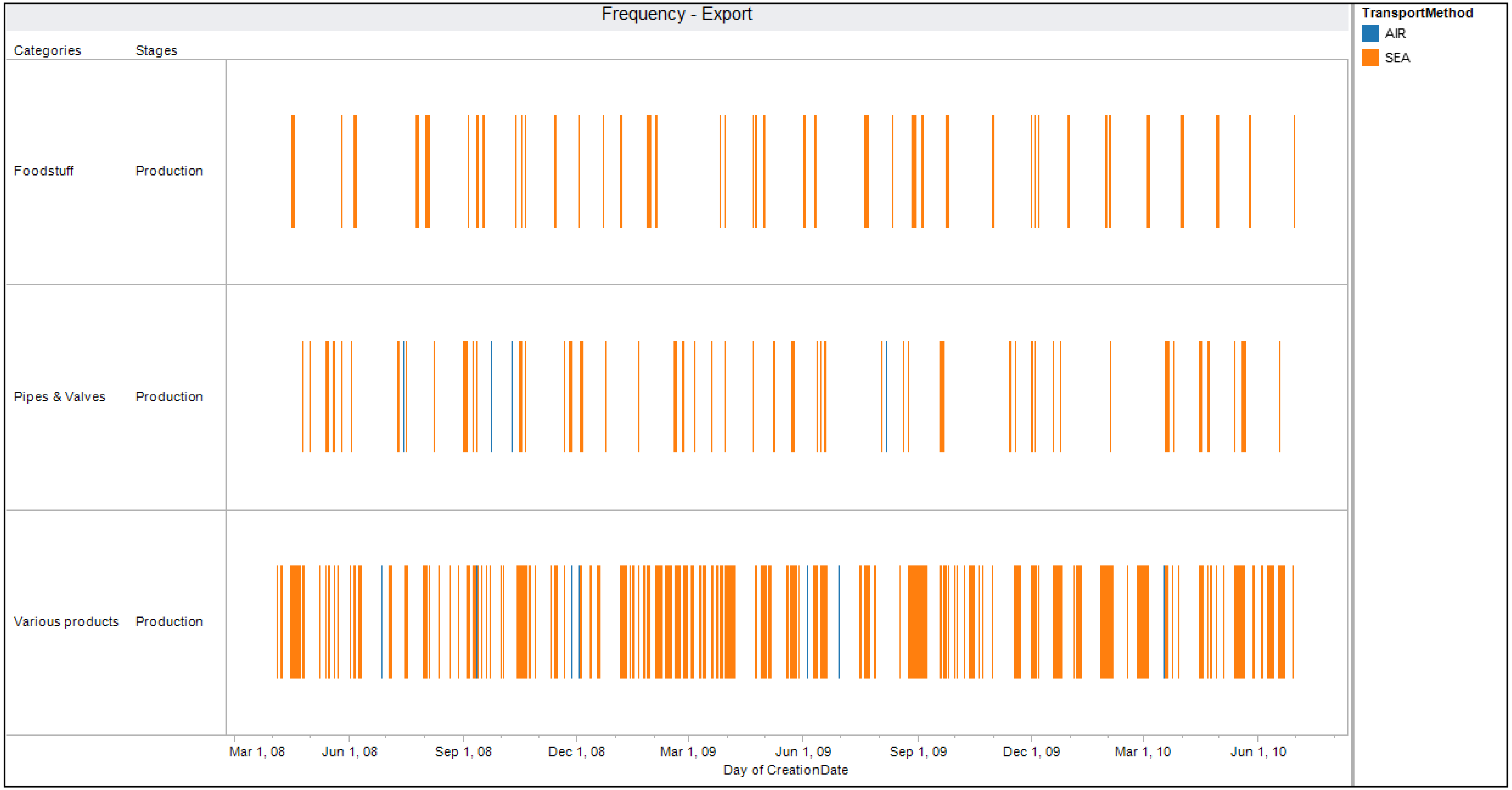

Figure 4.12: Frequency - export

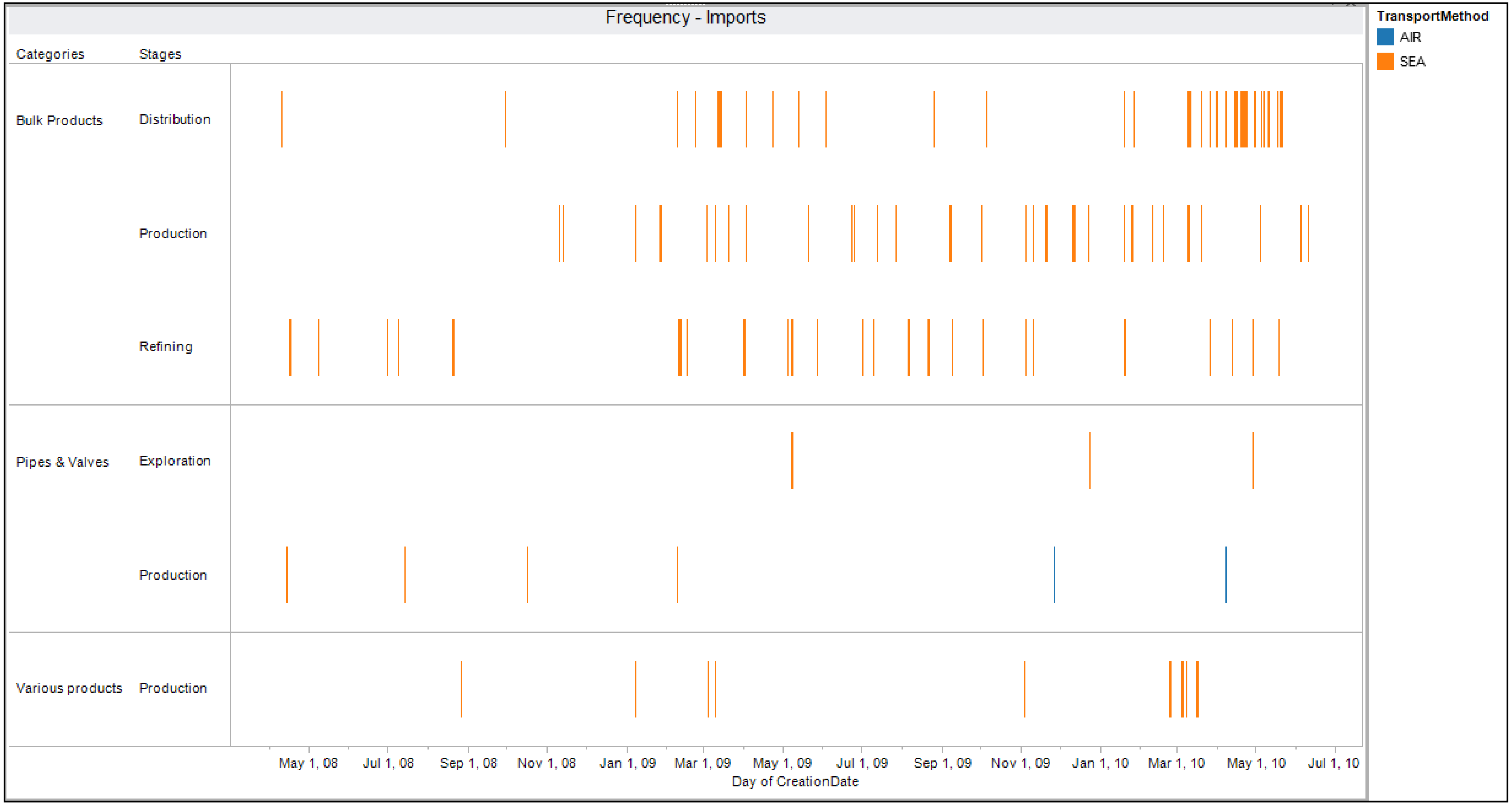

Figure 4.13: Frequency – import

4.4 RESULTS DISCUSSION

The data analysis shows the advantage of using descriptive decision support systems within an organization to look at the movement of products, especially from a geographical capacity perspective.

These systems provide valuable information regarding the following:

- The destination/origin;
- The nature of the product;
- The domain of the product on the value chain;
- The stage within the domain;
- The volume that was shipped; and
- The number of transactions to/from a specific destination/origin.

With the focus on the strategic location of hubs, a high level view of the supply chain was needed. By looking at the attributes indicated above, it is evident that the technologies that were used did provide sufficient information in order to do an analysis of this nature.

By looking at the data from a demand, supply and product perspective and applying it to a geographical capacity perspective, the results gave a clear picture of the various movements.

4.4.1 Demand perspective

The oil and gas industry consist of various major activities which takes place in various stages within the value chain (see Figure 4.1). These stages can further be classified in the domain which they occur, either upstream or downstream (see figure 4.2). Firstly, these hierarchies eased the analytical component of the study. By moving up and down these hierarchies, various questions could be answered on each level.

The demand side of the data analysis involved the various needs from the customer side. Thus, the customer had a need for products to be shipped from Cape Town to various destinations or to Cape Town from various origins. These products range from products in the upstream domain (mostly exports) to large consignments of crude oil in the downstream domain (mostly imports). Each of these exports/imports has a defined geographical location.

Together with the demand of the customer and the defined geographical location, these shipments have a specified volume/weight. Thus, the combination of the data perspective, which is applied to the geographical capacity perspective, the movement pattern was established for the up and downstream.

4.4.2 Supply perspective

The supply perspective considers what mode of transport is available for the customers to move their products to the respective destinations (see Figure 4.14). The service provider has to provide the most appropriate mode of transport but also at the correct time. As discussed in the literature, the mode of transport is either sea freight of air freight. With the mode of transport relatively fixed, the main issue would be if the movement of products would be economical or not.

Here the concept of consolidation of products comes to the forefront. Shipments will not always be a full container and will not always fill an entire ship. Thus, for the service provider, it is essential to know the volume/weight of the shipment and the destination in order to arrange the most cost effective mode of transport in the specified time.

The supply side of the data analysis involved the differentiation between modes of transport, with the focus on the geographical dispersion. The differentiation between air and sea freight gave the researcher an indication of the preferences of the clients as well as the volume/weight that were transported by each mode of transport.

4.4.3 Product perspective

The product perspective was used in conjunction with the demand and supply perspective in order to make sense of the movement. Here, the classification between up and downstream was crucial in the analysis. The rule of "*any product which has an oil/petrol base is considered downstream, with everything else is upstream*" helped in creating the product catalogue (see Table 4.2). This product catalogue is a first attempt at a classification system for the service provider. As with the other perspective, hierarchies were created in order to help with the analysis.

Similar products were grouped together according to their physical characteristics. This was done with the possibility of consolidating products. As stated, the customer has specific needs regarding to movement of products. In the product perspective, a distinct difference came to the forefront regarding the type of product. Firstly, by mode of transport and secondly, in which domain the product was needed and lastly the geographical region to which it must go or where it is arriving from.

The product side of the data analysis involved the classification of the products. This was done on the nature of the product and the rule of where it would be found in the value chain and the volume/weight of the reclassified products according to the product catalogue (see Figure 4.14).

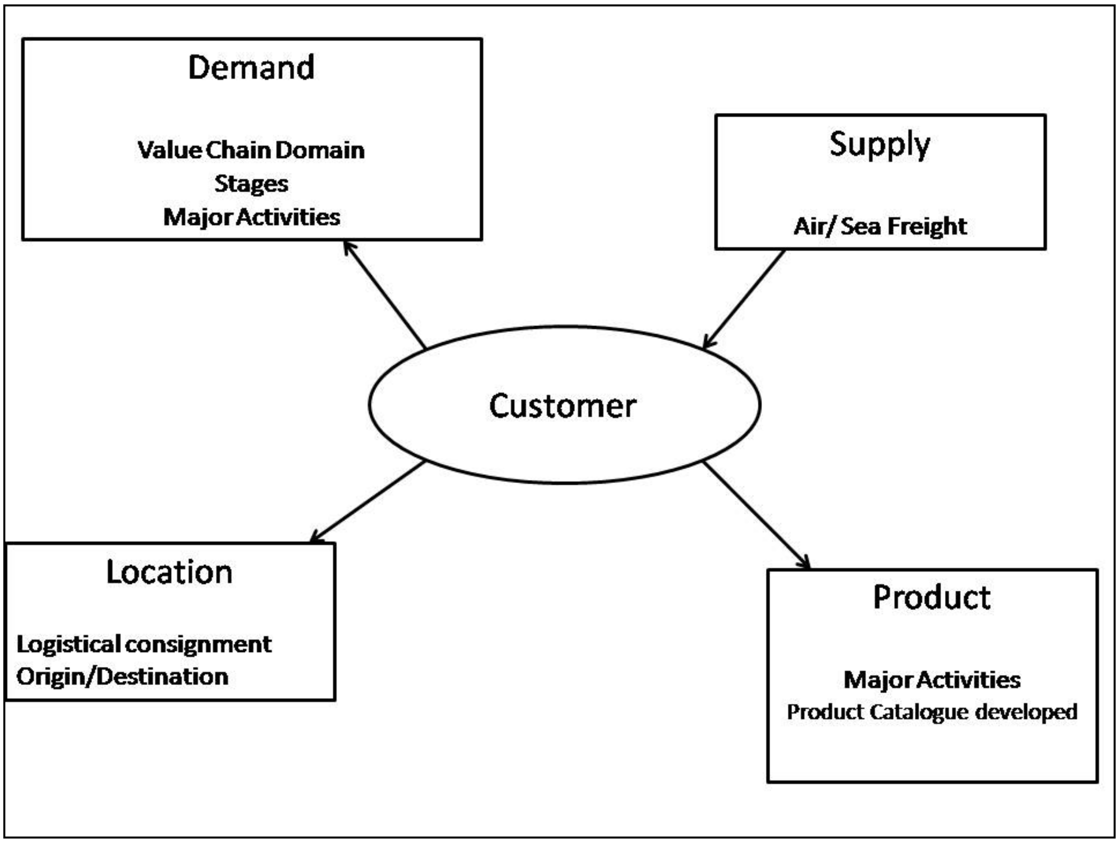

Figure 4.14: Demand, supply and product perspective – service provider

4.4.4 Findings on information from interviews

The interviews that were conducted regarding the operational process, some problems also came to the forefront. These problems include:

- Still a very manual process;
- External factors a major issue – customs;
- Paperwork;
- Over commitment – lead times a problem;
- Visibility not good;
- Duplications in operating system a problem;
- Tracking of product- could be investigated further;
- Information sharing – No standard process; and
- National & international level.

These problems were reinforced by the researcher's personal observation regarding the process. Personal observation included:

- Highly influenced by clients preferences regarding mode of transport;
- Manual operational process ;

- Double operating systems can lead to problems – National policy for all operations centres needed; and
- Data management a concern.

These problems associated with the operational process are a clear indication of how historical development influences the process today. Thus, the need for constant revision of business processes, organisation processes and information processes, is highlighted.

4.4.5 Major deductions

The data indicates that most of the movement occurs along the West Coast of Africa, with Angola the main destination/origin country. Products that were exported were mainly located in the upstream domain, with products imported mainly in the downstream domain. As stated in Section4.2, consolidation opportunities exist within the upstream domain. This can be done by consolidating various supply chain segments, with similar product characteristics, packing needs, etc. in a single shipment. This opportunity within the upstream domain exist and by consolidating multiple supply chains segments across various supply chains, the ground work is laid for the creation of a strategic hub. From the data available, the results indicate that Angola could be the best location for a strategic hub for the oil and gas industry. Angola fulfils both of the crucial criteria: volume and frequency.

The deduction was made on a single point of operation (Cape Town). This is just a proof of concept answer. By only investigating a single point of operation, the lack of data may lead to a miss-interpretation and lead to an incorrect assessment of the supply chain. This can have major implications down the line for the service provider. Thus, in order to answer the question in totality, the organization needs to look at all the operation points and the contribution to the oil and gas industry. Other aspects should be taking into account such as market penetration, total volume being shipped to the destination as well as future growth prospects. Once these aspects are taken into account, a clear decision can be made regarding investment in a strategic hub.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

Throughout the study, various key concepts and elements regarding consolidation and specifically strategic hubs came to the fore. These include synergy between products, frequency, data management, volume of goods, origin and destination points, product differentiation. These concepts and elements showed that in order for a hub to be established, a lot of thought, planning and supply chain analyses must be done.

The following Sections will link the four components of the study, namely the research problem (and related questions); the literature review, methodology and the case study (see Figure 5.1). By linking the four components, a conclusion is made regarding the consolidation of multiple segments of various supply chains, the feasibility of strategic hub within the oil and gas industry. Furthermore, recommendations are made regarding various aspects from an industry point of view as well as from a company perspective.

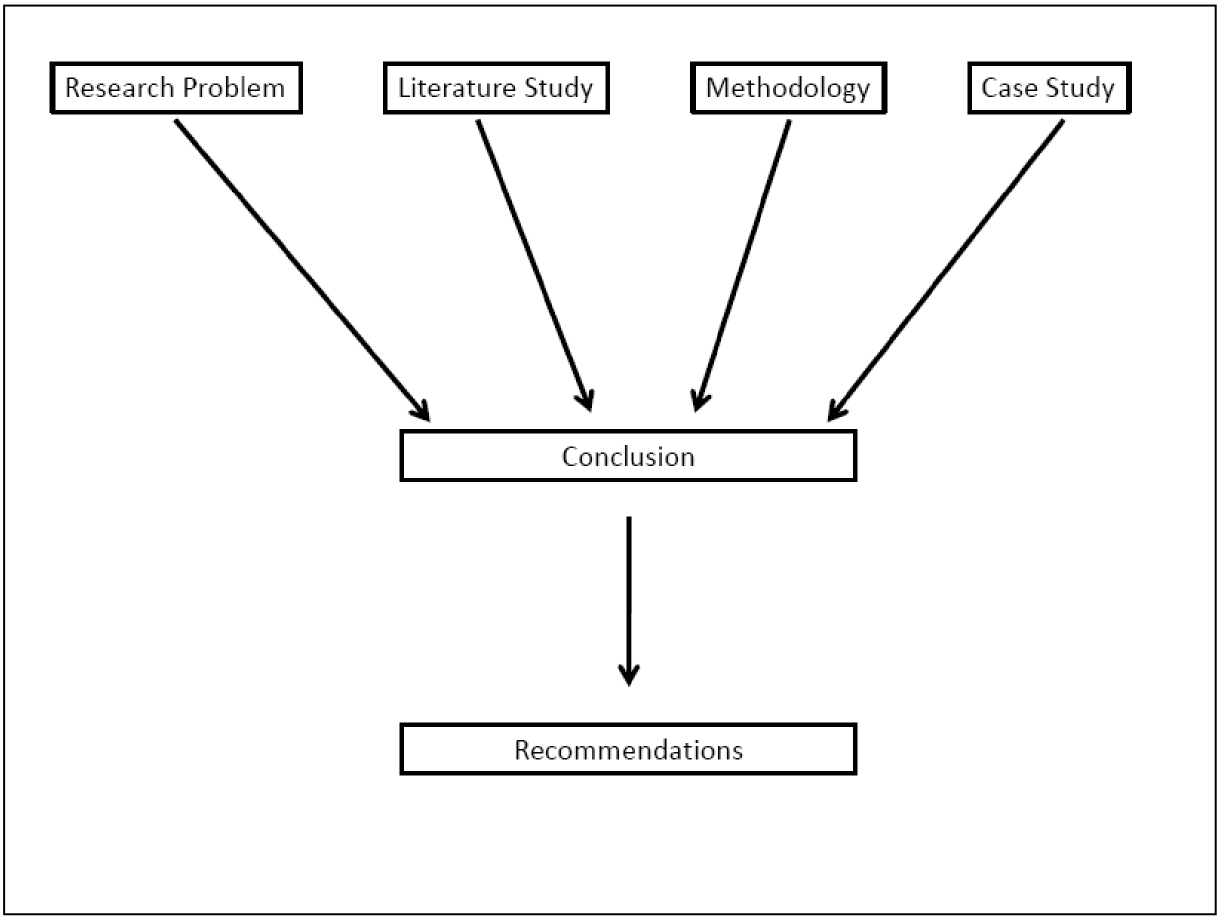

Figure 5.1: Conclusion and recommendations chapter structure

5.1.1 The Research Problem - answers

From the onset of the study, it was clear that the domain in which the research was set was a difficult environment. The oil and gas industry as a whole is an industry that protects information due to the competitiveness between companies such as ExxonMobil, BP and Shell. They compete for a scarce resource which is becoming scarcer, with the cost set to rise by 57 % by 2025 (African Development Bank, 2009:72). This competitiveness increases the difficulty of the study due to the lack of information regarding hubs within the industry. Furthermore, the complexity of providing the necessary supporting logistics infrastructure for 3PLs, make such as study more complex and difficult to demarcate.

However, the research problem is one of future possibilities, and due to the lack of information, this specific research field can develop further. It became clear that a strategic hub as a network configuration option would greatly benefit the industry. For companies which focus primarily on this industry, numerous advantages could be identified regarding the serving of the industry if they consolidate their operations within a defined geographical area.

Furthermore, the use of descriptive decision support systems, especially modern analytical technologies, could greatly benefit management regarding the decision making process. Strategic decisions could become a company's greatest challenge if the process that was followed did not take the correct variables into account. Investment is such developments amounts to large sums of money, and thus, by using analytical technologies on a regular basis, management can be provided with the correct information over time. The regular use of such technologies should ease to process, not complicate it further.

An important aspect that came to the fore during the study was the aspect of data cleaning, aggregation and preparation. Although, one of the crucial findings during the study, it was decided to discuss it under the research problem. Data cleaning, aggregation and preparation are of such great importance in the modern business world, that in order to make informed decisions, data must be looked at in pro-active way. Most of the problems associated with a study of such a nature, can be found with the quality of the data that was received. By having a data management system, that suit the need of the company, various problems can be eliminated in advance. With an accurate information system, the correct operating system and correct data, management can make strategic decision in a much shorter space of time. The research question on *"How do logistics service providers (3PLs) configure their supply chain capabilities strategically to service the oil and gas industry?"*

This question was answered by linking the literature and methodology with the data from the case study. Key findings were identified and will be discussed subsequently.

5.1.2 Key findings - methodology

The methodologies that were used during the study, both quantitative and qualitative, were enhanced by the application of it historical data from a service provider within the oil and gas industry. The first analysis of the data and the process that was used to do so was basic but an effective methodology. The process included (see Section 3.5):

- Data gathering;
- Data cleaning, aggregation and preparation;
- Data visualisation by the use of descriptive decision support systems - GIS and BI; and
- Data interpretation.

By using this simple process, the researcher indicated the global movement pattern of products that were shipped during a specific time period. By looking at two key indicators, volume and frequency, a strategic overview was given regarding this movement. However, in the competitive environment of today, an overview of historical data is not enough. By further the application of the data obtained, along the various levels of data for management (Section 2.6.3), a conclusion regarding can be made of a possible strategic supply chain design which was applied to a known supply chain configuration which is discussed later in the chapter.

As stated in Section 4.4.5, this is a proof of concept answer. In order to gain a complete view of the company and establish a true reflection of the role the service provider play within the oil and gas industry, all relevant data must be analysed. An example of such a study was done by Procter & Gamble (Camm, Chorman, Dill, Evans, Sweeney & Wegryn. 1997:132) during the early 90's. By using descriptive decision support systems (DDS), which in the study was a GIS application, they reviewed a number of their supply chains and made significant changes to their North American supply chains. During the study, some form of simulation was done in order to establish the impact these changes will have on the company.

In order for a logistics service provider to be pro-active in their design for an industry with such unpredictability as the oil and gas, simulation will be needed. Within this realm, lies the opportunity to reach an effective, efficient and cost effective supply chain design which can be adaptable to various changes in the current oil and gas environment. Thus by furthering the initial process as described in Section 3.5, a possible process that includes simulation can be as follows:

Step 1: *Identify the supply chains within organization*

Identification of the supply chain will establish the current situation and generate a starting point.

Step 2*: Determine the quality of data of the various supply chains*

The data that will be used is important, and thus by establishing the quality, a feel can be gained of what is capable from the information.

Step 3*: Identify key attributes which needs to be analysed*

By identifying key attributes, the questions that need to be addressed begin to formulate. This helps in narrowing down the scope of the study.

Step 4: *Choice most appropriate decision support system for the study*

Every decision support technology has strengths and weaknesses. By choosing the most appropriate technology for the study, possible problems with compatibility will be minimised.

Step 5*: Analysis*

During the data analysis stage, the various parameters are set in order to conduct the study. By looking at the parameters, and the various attributes associated with these parameters, the data analysis will indicate whether the research objectives can be reached. (Initial process within the study, Section 3.5)

Step 6*: Determine best configuration and design (Hicks, 1999:29)*

After the first analysis was done, decide on the most appropriate configuration and design, alternatively to the current situation

Step 7*: Simulate possible changes to network (Hicks, 1999:29)*

With some modern technologies, simulation is possible. By simulating possible changes to network, possible bottleneck and problems can be foreseen.

Step 8*: Review*

Reviewing the process and results, possible changes to the study can be made if the focus could have shifted over the time period.

The process as described above is more developed as the initial process that was used during the study. This process was not applied within the context of the study, as too many unknowns within the service provider need attention.

5.1.3 Key finding - literature

The literature was looked at from various perspectives. These perspectives were used in order to gain a better understanding of the concepts surrounding network design, consolidation and the hub and spoke concept. The following Section indicates the insight gain from the literature.

5.1.3.1 Global view

Historical development of trade routes and the dominance of the northern hemisphere in the global trade, have led to the formation of trade hubs within this hemisphere. As Wang and Wang (2011:60) noted, five regions account for the majority of global trade. These regions in a sense control the global trade movement. Thus, the global trade movement have a distinct movement pattern. Movement is predominantly between these regions, but also to what is called feeder regions. These regions are located in the developing countries in Africa and South America.

Global trade is set to change from the developed nations to the developing nations (Selfin & Hope, 2011:6). Thus, the assumption can be made that the historical movement pattern of global trade will also change. Feeder regions such as Africa and South America can become more prominent in the future.

O'Connor (2010: 358) established a correlation between what he called global city regions and logistics activities. He found that in the most prominent global cities, logistics activities play a significant role. Also, the most prominent global cities correlate with the trade hubs located around the world. This indicates that to be a prominent role player in global trade, logistics activities should be an important attribute with a city.

On a global level, capacity and geographical location does not influence the location of a hub, as there is no single hub for the world (Wang & Wang, 2011:59), but rather smaller, regional hubs that service a specific geographical area.

5.1.3.2 Regional view

Wang and Wang (2011:59) illustrated the existence of a hub system within the regional shipping systems around the world (see Figure 2.8). These smaller hubs service a geographical region. They link other trade hubs with themselves. The case study indicates that the service provider have a strong focus on Africa. According to Wang and Wang

(2011:62), the African continent has three hubs, namely Durban, Lagos and Dakar (Figure 2.8). The data from the service provider from their Cape Town operations indicate that Angola is the major destination. This movement pattern is evident from economic growth in the region and the importance of Angola in the oil and gas industry (African Development Bank, 2009:70).

Africa is a region that is earmarked for increased global trade; thus infrastructure would be needed to cope with this increase in volume. South Africa is the largest economy in Africa, and export substantially to the rest of Africa. This economic dominance and the future growth expectations regarding global trade, will lead to more trade taking place to regions such as Central Africa and West Africa. Infrastructure will be needed to cope with this increase. Thus, from an infrastructure perspective, the attributes highlighted by Botha (2008:63) that constitutes a good hub, would be essential.

Capacity within the region of Africa is set to increase in the future. Thus, the supply chain configuration should take this into account. With the movement of the global shipping industry to a hub system, the configuration of supply chains should be able to accommodate this development. Consolidation of products to a defined geographical region would allow logistics service providers to obtain better economies of scale and scope. The movement towards hub system for shipping liners create an ideal situation for the establishment of regional hubs.

The mode of transport within a global and regional context is fixed, in that sea and air transport are the only choices. This can be seen by the preference by the service provider to use sea transport, with the exception of emergencies where air transport is used. It must be stated that although cost plays an important role in the selection of mode transport, it should not be the only consideration.

As Wang and Wang (2011:59) illustrated by the Figure 2.8, the regional hub shipping systems, that modern analytical technologies could give a global or regional view. This information is invaluable to any top level management in order to understand the business context.

5.1.3.3 Industry view

The oil and gas industry is difficult to predict. This unpredictability creates problems, from exploration to the final distribution. The volatility of the markets combined with the scarce resources that they need, influence the supply chains that serve the industry. Thus, logistics service providers need a supply network that is adaptable and responsive to changes.

The movement pattern of products in the upstream and downstream domain, differ a great deal. Firstly, the upstream product movement is mainly towards the exploration and production facilities. The downstream product movement is from these facilities to the refining facilities. This can be seen in the data from the service provider. Also, the production and refining facilities are located in different countries, which create other complexities within the supply chain.

As stated in the literature review, Africa is the only continent where significant oil and gas reserves have been found in the past years (African Development Bank, 2009:70). Thus, the assumption can be made that due to this increase in reserves, and the increase in demand for petroleum products, the African continent could become a more important destination for the industry. More facilities located along the value chain means an increased demand for supporting products. In order to keep up with this increase in demand and the general trend towards hubs for shipping liners creates an ideal situation to create an industry specific hub. This could attract interests from around the world, focused on the oil and gas industry.

Due to the lack of information about supply chain configuration within the oil and gas industry, the configuration should allow the integration of other supply chain configuration from various role players within the industry. This will help with an industry specific hub, within a regional context.

Again, the mode of transport within the industry is fixed. This is due to the large volume of crude oil that needs to be transported. The supporting products for the upstream domain can further be consolidated to achieve better economy of scale. Thus, by creating an industry specific, regional hub, focused on the consolidation of the upstream segment, the industry can achieve further economy of scale and scope.

5.1.3.4 Company view

A correlation between hubs and global city regions can be seen from the studies of O'Connor (2010:358) and Wang and Wang (2011:57). These studies indicate that various global city regions influence global trade (see Section 2.6.3). Thus, the assumption can be made that for a hub to be effective, the geographical location should have some sort of significance (hook). A hook can be described as a specific characteristic for a geographical area in which the company may have interest and has an active role. This can be on regional level, such as a major port for import/export purposes, or it can be the capital of the country which has a concentration of direct or indirect service providers which serve the industry or it can be a geographical area where various role-players setup their base of operations as it is close to their respective natural resources. Without such a characteristic, no competitive advantage may occur.

From company point of view, if the need is there to create a hub for its own purpose, a geographical location with a hook would be the best option. However, from the data and the analysis, the option for a service provider that serve the oil and gas industry, *a company owned hub would not be feasible*.

Although the movement pattern of products is not the main concern, it is the volume and frequency (capacity) of which these products are moved. The data indicates that the service provider have regular movement towards countries such as Angola. With the classification of products that are exported (upstream) and products that are imported (downstream) the volume and frequency would not justify a hub on company level. The cost involved in creating a hub would not be justified by the current volume and frequency.

The infrastructure that is needed to be able to move the various products, as defined by Botha (2008:63-66) is normally subjected to the development by the government of the country. Thus, infrastructure development is not a function of the company itself. With the reliance on development from outside the company, infrastructure development costs are also high in areas where there is a lack of services.

As stated earlier, capacity within the oil and gas industry is set to increase; the role of the logistics service would also increase in serving the industry. Thus, the assumption can be made that within an increase in demand, the role of the service provider would also increase.

For the service provider to be able to meet this demand, their supply chain configuration should be able to meet this possible increase in demand. The various supply chain configurations that were discussed in Section 2.4 (also see Figure 2.4) are examples which can be a starting point for a company. However, configuration can be adapted to the specifications of the company itself.

Consolidation is a method used in order to create a configuration within the supply chain where there are numerous suppliers and destination points. As stated in the previous Section, by consolidation various segments of the various supply chains, in this case the upstream domain, economy of scale and scope can be achieved. From the product catalogue that was created during the study, it is evident that the product diversity is a problem. Thus, focusing on the upstream domain and the advantages of consolidating various product groups within the domain would make transport easier.

With the mode of transport fixed from a global level to a company level, the emphasis should be on providing the most reliable service and value adding service. For example, instead of consolidating the food, the food could be a source locally (if possible) or flown to the destination rather than shipped. This could increase cost, but the value that could be gained from fresh produce may be more.

5.1.4 Key findings – data analysis

The data analysis showed that by analysing data from a chosen perspective, and by creating hierarchies within the dataset, an in-depth analysis of the data is possible. ***Further with the help of descriptive decision support systems such as GIS and BI systems, this insight in data can greatly support management in their decision making process.***

From the data analysis it was clear that the majority of movement occurred along the West Coast of Africa. Angola was the most prominent recipient of upstream goods and materials. Downstream products were imported from countries such Saudi Arabia, which indicates that the movement of products coincide with the general trend regarding import/exports for RSA. This general trend in the movement of products and the movement of products within the oil and gas industry provide a backbone configuration for establishing a strategic hub.

As stated in Section 5.1.3.1, the movement of global shipping towards a hub system, created an ideal opportunity to create an industry specific regional hub. With the opportunity that lies within the upstream domain to consolidate products, across multiple supply chains, **"*an industry specific regional hub would be the only feasible option, as it would service a defined geographical region (West Africa) and various role players could be based within the hub.“***

The mode of transport within the global context is dominated by the use of sea freight. This preference is also true within the oil and gas industry. Air freight plays a significant role within the industry, but as the data showed, on a much smaller scale. However, it must be stated that in order for a strategic hub to be effective, air transport must be taken into account as an alternative mode of transport, especially in the case of emergencies. Thus, for the hub to be effective, both modes of transport should be present.

Data and data management came to the fore during the study as a crucial aspect in conducting the study. As discussed in Section 5.1.2, the research problem, the importance of an effective data management strategy cannot be highlighted enough. This strategy should be communicated throughout the organization, from the bottom to the top level management.

By having clear visibility regarding the strategy, the importance of correct data capturing and data management will become more evident.

5.2 CONCLUSION AND CONCLUDING REMARKS

As shown by Figure 5.1, combining the four components of the study, the following conclusion can be made. Firstly, the limited information within the oil and gas industry regarding network configurations creates problems for both potential researchers and management alike. The limited information that is available paints a picture that the industry is highly dependent on location of facilities and the subsequent network configuration. Further, the inflexibility of current supply chain configurations creates problems. Hussain (2006:90) noted that "the petroleum industry is still in the development stage of efficiently managing their supply chains".

The movement of the global trade, and especially the shipping trade, to a hub system creates a situation that if the oil and gas industry would too invest in a hub, it will work to their advantage. As stated in Section 5.1.5, ***the only feasible option would be an industry specific regional hub as it could fulfil a need within the oil and gas industry.*** By linking in with the global movement in network configuration, various problems that are experienced with current configurations can be eased or even eliminated.

Every study has its own set of parameters and constraints. The process that was developed was an attempt in providing management with an alternative to heuristic methods in placing facilities. In conjunction, these two methods can elevate to thinking process of management regarding strategic decisions.

Service providers play an increasingly more important role within the supply chain of companies. Much of literature can be found of the advantages of using service providers; however, what are the implications for them regarding serving a supply network on a global nature. Service providers influence strategic decision making of their clients, as co-operation between the two parties influence each other's business model. Application of historical data is an important aspect within strategic study, but the real challenge will be to predict future demand in a global economy that is ever changing and the development of supply chain networks accordingly.

As stated, the primary objective of the study was to provide an alternative to pure mathematical and normative approaches followed in placing of facilities studies. ***These approaches which are more established should co-exist with descriptive methods. This combination of analysis methods could provide not only the oil and gas industry***

with a new way thinking, but also the service providers with their placement of facilities in order to service a specific industry.

The oil and gas industry is an industry that is characterised by inflexibility of supply chains, volatility in the market and protection of information, which creates various problems for management along the supply chain. With the industry still developing their management of their supply chains, an alternative way of thinking could help the development of these supply chains and create more effective and integrated supply chains.

5.3 RECOMMENDATIONS

During the study, various key elements came to the foreground. One of these aspects is the question surrounding data. Data plays a key role in any study and data quality is crucial to conducting a study. Master data and the creation of a master database can help eliminate small problems within the database. These small problems in the long run compound to large scale data cleaning and preparation that take a large percentage of the time of a study.

By standardising the data and the use of one operating system, connectivity between operations points can occur more effective and efficient. Without some sort of standardisation of data and the nature of the data, strategic studies will continue to be a major problem.

5.4 FUTURE STUDIES

This study focused on the process developed and followed to address the research questions related to supply chain configuration and possible consolidation opportunities from a service provider perspective. The use of descriptive decision support techniques and technologies were also explored and indicate the contribution it could make. Future studies can include the optimisation of networks within the oil and gas industry and the policy in placing facilities. Also, the data flow between service providers and their clients to better the current network configurations and design and the visibility of data between them.

Finally, data management is a crucial aspect in any organisation, a study on how the creation of a master data set within a service provider will benefit the organisation could provide valuable insight the bottlenecks that occur between client and themselves.

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ADDENDA

ADDENDUM A – ORIGINAL DATA FROM SERVICE PROVIDER

GoodsDescrip	GrossWeight	Volume	ChargeWeight	PortTo	DestinationPortName
1 X BOX STC LOCTITE AND SIKAFLEX ITEMS	16	0.065	0.07	AOLAD	LUANDA
1 X BOX STC LOCTITE AND SIKAFLEX ITEMS	16	0.065	0.07	AOLAD	LUANDA
JOINT,WASHERS, BOLTS	379	1.279	1.28	AOLAD	LUANDA
JOINT,WASHERS, BOLTS	379	1.279	1.28	AOLAD	LUANDA
BLASTING GRIT	240000	240	240	AOMAL	Malongo
1 X BOX STC LOCTITE AND SIKAFLEX ITEMS	16	0.065	0.07	AOLAD	LUANDA
1 x PLYWOOD BOX STC 5 X 5L DRUMS TECTYL 506	35	0.09	0.09	AOLAD	LUANDA
PAPER	5	1	1	AOMAL	Malongo
CAPACITORS	100	1	1	AOMAL	Malongo
AFROX ACETYLENE PODS	309.6	1	1	AOMAL	Malongo
various supplies	3308	15.3	15.3	AOMAL	Malongo
various supplies	19712	36.73	36.73	AOMAL	Malongo
TITRATING SOLUTION, VULCANIZING SOLUTION , ANTI FREEZE & CARBOLINE THINNERS	3809	8.3	8.3	AOMAL	Malongo
TITRATING SOLUTION, VULCANIZING SOLUTION , ANTI FREEZE & CARBOLINE THINNERS	3809	8.3	8.3	AOMAL	Malongo
various supplies	5109	1.559	5.11	AOMAL	Malongo
PAPER TOWEL DISPENSER	300	2.38	2.38	AOMAL	Malongo
carboline thinners	3856	8.5	8.5	AOMAL	Malongo
OLYMPIAD MULTI GYM	221	0.89	0.89	AOMAL	Malongo
BLASTING GRIT	150000	150	150	AOMAL	Malongo
BLASTING GRIT	150000	150	150	AOMAL	Malongo
OFFSHORE BUSKETS	25400	68.034	68.03	AOMAL	Malongo
OFFSHORE BUSKETS	25400	68.034	68.03	AOMAL	Malongo
STEEL PLATES, PIPE, ANGLE IRON	4800	4.84	4.84	AOMAL	Malongo
STEEL PLATES, PIPE, ANGLE IRON	4800	4.84	4.84	AOMAL	Malongo
STEEL PLATES, PIPES, ANGLE IRON	7700	6.15	7.7	AOMAL	Malongo
STEEL PLATES, PIPES, ANGLE IRON	7700	6.15	7.7	AOMAL	Malongo

ADDENDUM B – EXTRACT FROM REVISED DATA AFTER DATA MANAGEMENT TOOK PLACE

New sub-section within hierarchy

GoodsDescrip	Categories	Stages	GrossWeight	Volume	ChargeWeight	Weight Level
various safety products	Clothing & Safety Equiment	Refining	420.00	0	-	Low
Assorted Supplies and Consumables	Various products	Production	107.00	0.853	0.85	Low
Various Oils and Lubricants	Lubricants	Production	480.00	0.96	0.96	Low
SHOES	Clothing & Safety Equiment	Refining	900.00	1	1.00	Low
Cigarettes	Various products	Production	47.30	1	1.00	Low
CIGARETTES	Various products	Production	302.00	1	1.00	Low
Cigarettes	Various products	Production	188.80	1	1.00	Low
cigarettes	Various products	Production	188.80	1	1.00	Low
Outboard motor	Various products	Production	328.00	1.208	1.21	Low
insect spray	Chemicals	Exploration	373.00	1.44	1.44	Medium
20 x cartons Cigarettes	Various products	Production	177.12	2	2.00	Medium
FOOTWARE	Clothing & Safety Equiment	Refining	600.00	2	2.00	Medium
COVERALLS	Clothing & Safety Equiment	Refining	3,769.98	3.769	3.77	Medium
COVERALLS	Clothing & Safety Equiment	Refining	3,900.00	3.9	3.90	Medium
life rafts and spares	Ship spares	Production	790.00	4.256	4.26	Medium
Cigarettes	Various products	Production	188.20	5	5.00	Medium
freon gas	Welding products	Exploration	1,481.00	5.309	5.31	Medium
CIGARETTES	Various products	Production	283.18	10	10.00	Medium
various supplies	Various products	Production	10,500.00	20	20.00	Medium
Thinners	Chemicals	Exploration	16,000.00	20	20.00	Medium
various supplies	Various products	Production	18,000.00	20	20.00	Medium
Assorted cleaning materials	Various products	Production	8,000.00	20	20.00	Medium
Battery acid, insect spray,boric acid power & Oil finding paste	Chemicals	Exploration	12,000.00	20	20.00	Medium
Various supplies	Various products	Production	18,000.00	20	20.00	Medium