VAAL UNIVERSITY OF TECHNOLOGY

A MODEL FOR INFORMATION TECHNOLOGY OPTIMISATION IN SUPPLY CHAIN AND LOGISTICS OF LIBYA OIL AND GAS SECTOR: THE CASE OF ZUEITINA OIL COMPANY

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DECLARATION

I, Fathi A Tarom declare that the contents of this dissertation represent my own unaided work, and that the dissertation has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Vaal University of Technology.

Fathi 30/12/2020

Signature Date

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DEDICATION

I dedicate all my hard work and to the memory of my Mom and Dad who made me the person I am now. Of course, this dissertation would not have been possible without the love and support of my wife Tshepiso Mary-Priscilla Masithela, in so many ways you strengthened me to push harder. I know you understand how I feel when I say **thank you!**

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ABSTRACT

Crude oil is among the most in-demand and desirable commodities across the world today. The multiple uses of crude oil are widespread, ranging from the generation of energy to its use as fuel for the petrochemical and transportation sectors. Because of the high use of and demand for crude oil worldwide, the petroleum industry (also known as the oil and gas industry) is a significantly role player in the world economy.

Libya’s oil and gas industry is deemed the most essential and important sector in this country, as Libya is mainly dependent on proceeds from this sector. However, existing information technologies are not always optimally applied and utilised. This, together with the challenge that information technologies in the supply chain system and logistics processes of some of Libya’s oil and gas companies are not always sufficient, the productivity of the country’s oil and gas supply chain is compromised, and this results in revenue losses because of wasteful expenditure.

This research therefore aimed to determine what innovative information technologies should be considered by Zueitina Oil Company (as case study) in Libya to enhance its supply chain and logistics processes. Two primary research questions (PRQs) were formulated for this research, namely: (i) What is the current status of Libya’s oil and gas sector in terms of oil production and export? (ii) What innovative information technologies need to be considered by Zueitina Oil Company in Libya to contribute towards optimising its supply chain and logistics processes?

This study followed the qualitative research methodology, as the data collected were qualitative and the research design was inductive. A case study strategy was adopted, with Zueitina Oil Company in Libya as the case under study. The primary sources for the research were the management of the supply chain and logistics departments of Zueitina Oil Company. The qualitative data collection method selected was a survey conducted by means of telephone and focus group interviews. The data were analysed using thematic analysis. In total, five themes and six sub-themes emerged from the findings obtained from the analysis.

This research contributes to the scientific body of knowledge by proposing an Information Technology Optimisation Model for the Supply Chain of Zueitina Oil Company in Libya in order to achieve increased revenues, reduced costs, and improved customer services, among others.

Keywords: Zueitina Oil Company, supply chain, logistics, Information Technology, optimisation, Libya oil and gas

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GLOSSARY OF TERMS

Term	Definition
Information Technology (IT)	Information Technology is explained as studying or using systems, in particular computers and telecommunications, to access, store, retrieve, and send information (Lexico.com, 2020).
Information Technology Optimisation	IT optimisation involves much more than just techniques for programming, knowledge on hardware, and software domains. It is viewed as a strategy used by modern organisations that depend on using IT in their activities and operations in order to find optimal results (HEFLO BPM, 2018).
Inventory Control	Inventory control is defined as a technique applied to detect and categorise those inventories of materials or goods that could be used for manufacturing finished goods. It needs to be supported by a schedule that provides detailed information on opening inventory, acceptance of raw materials, issuing of goods, closing inventory, and scrap produced (Akrani, 2012).
Logistics Management	Logistics management refers to an element of supply chain management (SCM), utilised to meet the demands of a customer (or customers) through planning, managing, and implementing effective flow and storage of relevant information, services, and materials, from the source to the destination. Logistics management assists organisation with reducing expenses and enhancing customer service (Techopedia, 2020).
Manufacturing	Manufacturing is defined as the action or proses applied to convert components or materials into completed products that are ready to be sold in the marketplace (Levinson, 2018).
Optimisation	Optimisation entails attaining a substitute (or alternative) with the most obtainable and cost effective performance under specified limitations through maximising anticipated and preferred factors while minimising unwanted factors (WebFinance Inc., 2018a).
Point of Sale (POS) System	A POS system refers to the location where the customer pays for the service or goods on offer by an organisation (Erply Retail Software, 2018).
Procurement	Procurement is explained as a business management function which guarantees the management, detection, accessing and sourcing of the external resources that a company may require or need in order to achieve its strategic objectives (Kerzner, 2017).

Term	Definition
Retailer	A retailer refers to the organisation that purchases goods or services from a wholesaler or a manufacturer. The organisation then sells these products or services to customers, also known as end users. A retailer can therefore be viewed as a go-between or intermediary used by customers to obtain goods from the manufacturer (My Accounting Course, 2018).
Supplier	A supplier refers to the individual, company, or entity that offers goods or services that are needed by other individuals, companies, or entities. Both buyer(s) and supplier(s) are involved in business dealings. Suppliers offer or deliver goods or services, and buyers receive these goods or services (marketbusinessnews.com, 2018).
Supply Chain Management (SCM)	The industrial success of a company hinges on the exchanges between money flow, information, goods, labour force and capital equipment. The manner in which the mentioned five systems interconnect in order to strengthen and magnify each other and to instigate change and variation, forms the foundation for anticipating the influences of policies, investment choices, decisions, and organisational forms (Mentzer et al., 2001).
Transporter	A transporter is a means of transportation such as a large aircraft or vehicle used for carrying very large or heavy objects (collinsdictionary.com, 2019a).
Vendor	A vendor (or supplier) is a person or organisation selling materials or services to another person or company in the economic manufacturing chain (TechTarget, 2019b).
Voice over Internet Protocol (VOIP) Technology	VOIP is defined as digitally broadcasting or diffusing voice communications over a data network which is founded on Internet Protocol (IP) (NIJ, 2007).
Warehousing	A warehouse is large structure for storing goods or materials until they are used, sold, and directed to shops (Cambridge Dictionaries Online, 2018).

CHAPTER 1: INTRODUCTION

Figure 1.1: Graphical representation of Chapter 1

1.1 Introduction

Crude oil is among the most in-demand and desirable commodities in the world today. The multiple uses of crude oil are widespread, ranging from the generation of energy to its use as fuel for the petrochemical and transportation sectors (Sönnichsen, 2020). When crude oil has been converted into fuel, it is a crucial source of energy for inter alia aircrafts, automobiles, asphalt, heating and electricity. Petroleum use is also prevalent in chemicals, paint, tape, and plastic, among others (Investopedia, 2020). Because of the high use of and demand for crude oil worldwide, the petroleum industry (also known as the oil and gas industry) plays a significant role in today's world economy.

The most influential and authoritative players in the petroleum industry (also known as the oil and gas industry) are the countries having huge oil and gas reserves (NRGI, 2015). A total of five countries founded the Organisation of Petroleum Exporting Countries (OPEC) in 1960, forming a collaboration to obtain best prices for the oil they produce. OPEC expanded to include more countries, with a current total of 12 countries (EIA, 2020; OPEC, 2019b; NRGI, 2015). OPEC controls 80% of the proven oil reserves of the world as well 33% of the oil production (EIA, 2020).

Countries frequently close contracts or make agreements with companies involved in the oil and gas industry to extract/produce oil and take it to market. The most influential partakers in this market are called National oil companies (NOCs) – they are mainly or fully owned by their government (NRGI, 2015). A large number of these NOCs partake in trading commodities and regulating the gas and oil industry (NRGI, 2015).

Governments do not own international oil companies; these companies are owned by private shareholders and cover all facets of the oil and gas value chain – beginning with extraction and ending with distribution (EIA, 2020; NRGI, 2015).

> "The six largest *supermajor* companies are ExxonMobil, BP, Royal Dutch Shell, ConocoPhillips, Chevron/Texaco, and Total" (NRGI, 2015: 2).

1.2 Supply Chain Management (SCM) in the oil and gas industry

> “The oil and gas industry often refers to the concept of a value chain to describe the steps in the process to get the oil out of the ground and purchased on the commercial market” (NRGI, 2015: 2).

Tutorials Point (2016: 1) defines the concept of supply chain management (SCM) as the management of the flow of services/products, beginning “from the origin of products and ends with the product’s consumption at the end-user”. Chopra and Meindl fills in more detail, stating that a supply chain, “consists of all parties involved, directly or indirectly, in fulfilling a customer’s request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves” (Chopra & Meindl, 2004: 58).

Managing the supply chain of the petroleum industry, which is perceived as strict and uncompromising, together with the huge global demand for oil and the easiness of international trade today, has become increasingly complicated and difficult (Lisitsa, Levina & Lepekhin, 2019; Morton, 2003; Coia, 1999). Notwithstanding the significance of and the rise in complexity of supply chain management (SCM), the oil and gas industry is still in its infancy of efficiently managing their supply chains (Lisitsa, Levina & Lepekhin, 2019; Al-Husain, Assavapokee & Khumawala, 2016; Schwartz, 2000). There is much room for reducing costs and improvement in SCM in the oil and gas industry.

The classical supply chain cycle (Figure 1.2) starts from procuring raw materials to the manufactured/generated/produced items in the relevant factories. In the next step, the produced items (cargo) are shipped or transported to warehouses or storerooms for midway storage. Finally, the produced items are dispatched and delivered to retailers or customers (Scott, Lundgren & Thompson, 2011). To effect cost reduction and enhance service levels in a company, efficient supply chain strategy must be practised. The supply chain (or the chain of suppliers), also known the logistics system or network, comprises suppliers, warehouses, distribution/disseminating centres, manufacturing centres, retailers, finished products, and raw materials moving between the various facilities (Macbeth, 2000).

Figure 1.2 is a presentation of a classical supply chain.

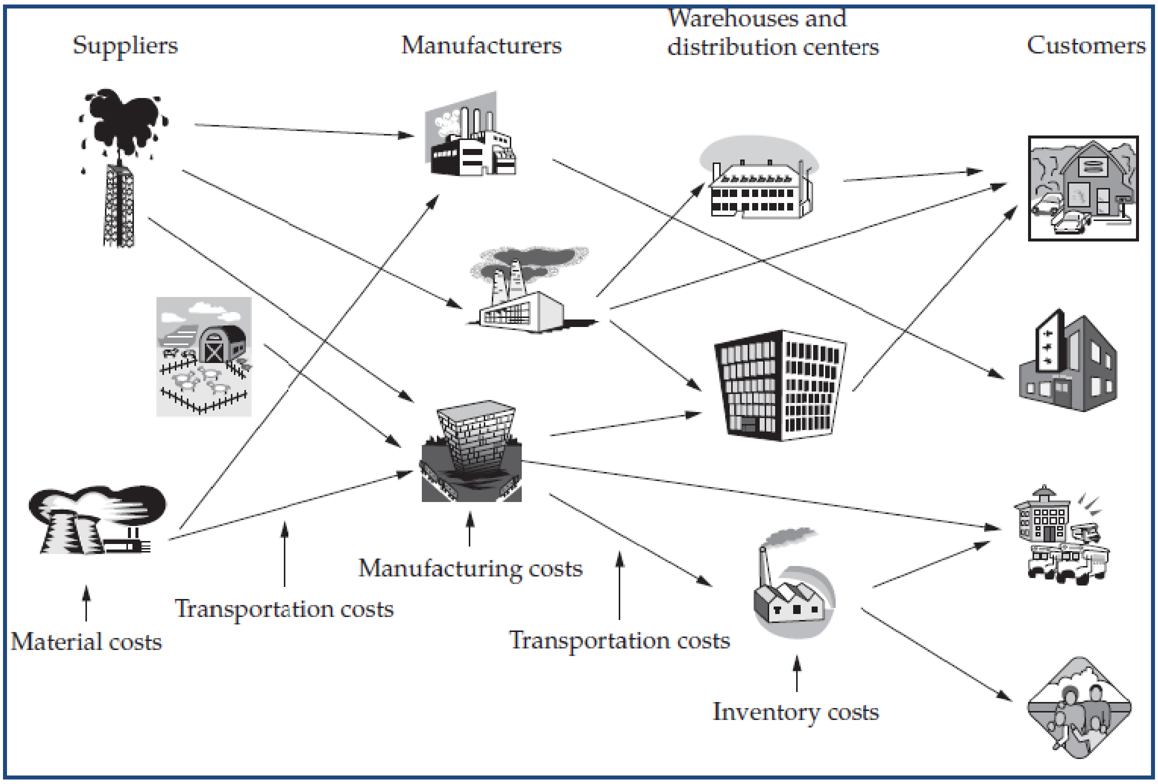


Figure 1.2: Classical supply chain
(Source: Slideplayer.com, 2014: 6)

Middle Eastern political undercurrents and unrests severely affected the sustainable supply of oil over the past decades, causing the sector to become extremely volatile (Barltrop, 2019; Hussain, Assavapokee & Khumawala, 2006). Petrochemical and oil companies had to begin maintaining higher volumes of safety stock and explore substitute supply sources (Hussain, Assavapokee & Khumawala, 2006), thereby placing increasingly more emphasis on SCM. Throughout the entire supply chain the primary limitation is inflexibility, which includes, but is not limited to, restricted transportation options, extended lead-times, and controlled manufacturing capacity, all of which are difficult to adjust (Lisitsa, Levina & Lepekhin, 2019; Hussain, Assavapokee & Khumawala, 2006).

Commodities such as petrochemicals, gas and oil, among others, need dedicated and specific transportation modes, which include railroads, pipelines, tankers or vessels (Van Heerden, 2020; Schwartz, 2000). The mentioned commodities are produced in limited, dedicated areas across the globe, but the demand is global, because numerous industries need them in the form of raw material and as crucial energy sources (Schwartz, 2000). In this sector, it is commonplace to have a lead-time of multiple weeks from the point of shipping to the endpoint (the destination of the customer).

To state an example: Sending oil from the Persian Gulf (shipping point) to America (customer destination) takes easily eight weeks; this includes shipping, processing and delivering (Schwartz, 2000).

The increasing growth and interest of organisations in various aspects of SCM (such as the transportation of oil and gas as well as maintaining higher levels of safety stock as indicated in the previous paragraphs), is attributed to intense competition among companies to attract and keep (or retain) customers. The intense cost-focused paradigm in SCM processes shifted completely to focus on enhancing the experience of the customer, as they, the customers, are the end-users of the service/product; customer satisfaction is the "ultimate goal" every company wants to achieve (Lisitsa, Levina & Lepekhin, 2019; Chima & Hills, 2011; Mentzer, 2004).

An organisation's SCM system is not restricted to a single company; it also comprises the suppliers and other external organisations that take part in the final delivery of the service or product. Thus, for an organisation's SCM system, which includes the relevant logistics processes, to be efficient, there is a continuous need to integrate the corresponding processes of the external suppliers and organisations (Rangarajan, Raghuram & Srinivasan, 2009). It is at this point that the role and value of information technology applications become important – to enhance the efficiency of the supply chain and logistics processes.

1.3 Information Technology (IT) in supply chain management

Information Technology (IT) is, and always has been, a vital component of supply chain and logistics operations, because without these processes, no facet of the supply chain is able to function on a high level (Varma & Khan, 2014). IT contributes towards enhancing the efficiency of supply chain and logistics processes, adding value to organisations, and enabling secure collaboration between supply chain members, anytime and anywhere (Varma & Khan, 2014). The authors furthermore posit that the advent and continuous improvement of new information and communications technologies (ICTs) has presented accurate and swift interchange of information.

For SCM, these new technologies have led to:

- Improved information provision to customers
- A decrease in inventory
- Augmented flexibility
- Reduced doubt and ambiguity surrounding the demand of a service or product

De Barros et al. (2015) as well as Auramo, Kauremaa and Tanskanen (2004) state the following advantages of using ICTs in SCM:

- Sharing of information between partners is easy
- The responses to both supplier and customer changes are effective, efficient and fast
- The cost of production is reduced
- In the supply chain, the profit margin increases and waste cost reduces
- Operational efficiency and the improvement of processed information
- Reliability, quality and accuracy
- Differentiation of services and products

The corporate world is becoming increasingly interested in the effect IT and ICTs have on SCM (Colin, Galindo & Hernández, 2016; Wu et al., 2005). Many American companies depend on the advantages of IT to enhance the effectiveness and agility in supply chain and logistics processes. The high investments in SCM software supports and confirms Wu et al.'s (2005) postulation; however, investing in IT does not guarantee exceptional SCM results, as productivity and consistency may also be found in business areas other than SCM. The advantages of IT are indirect and disseminated, which makes it challenging to measure. Susan Happek, the principal at UPS Supply Chain Solutions, stated the following in a White Paper:

> "As supply chains have moved from a cost focus to a customer focus and now currently to a strategic focus, the need to think strategically about the supply chain has never been more important. The success of a strategy is only as good as the company's ability to fully and properly execute it. A great supply chain strategy, linked with operational excellence, can provide success for not only the company in question but also its partners and customers" (Happek, 2005: 5).

1.4 Libya's oil and gas sector

The Libyan economy is empowered through this country's vast production of oil and gas (The World Factbook, 2019), which has been evolving and growing at a rapid pace since the 1960s when international oil and gas companies began operating in the desert and the coastal territories of Libya. The National Oil Corporation (NOC) of Libya was established in November 1970 as a state-owned entity established under Law No: 24/1970, thereby replacing the Libyan Petroleum Corporation to take up responsibility for Libya's oil and gas sector in terms of controlling oil and gas production and overseeing all petroleum activities of the country (NOC, 2019; Encyclopedia.com, 2019). Figure 1.3 is a map showing the ports, oil and gas fields, pipelines, and oil refineries in Libya.

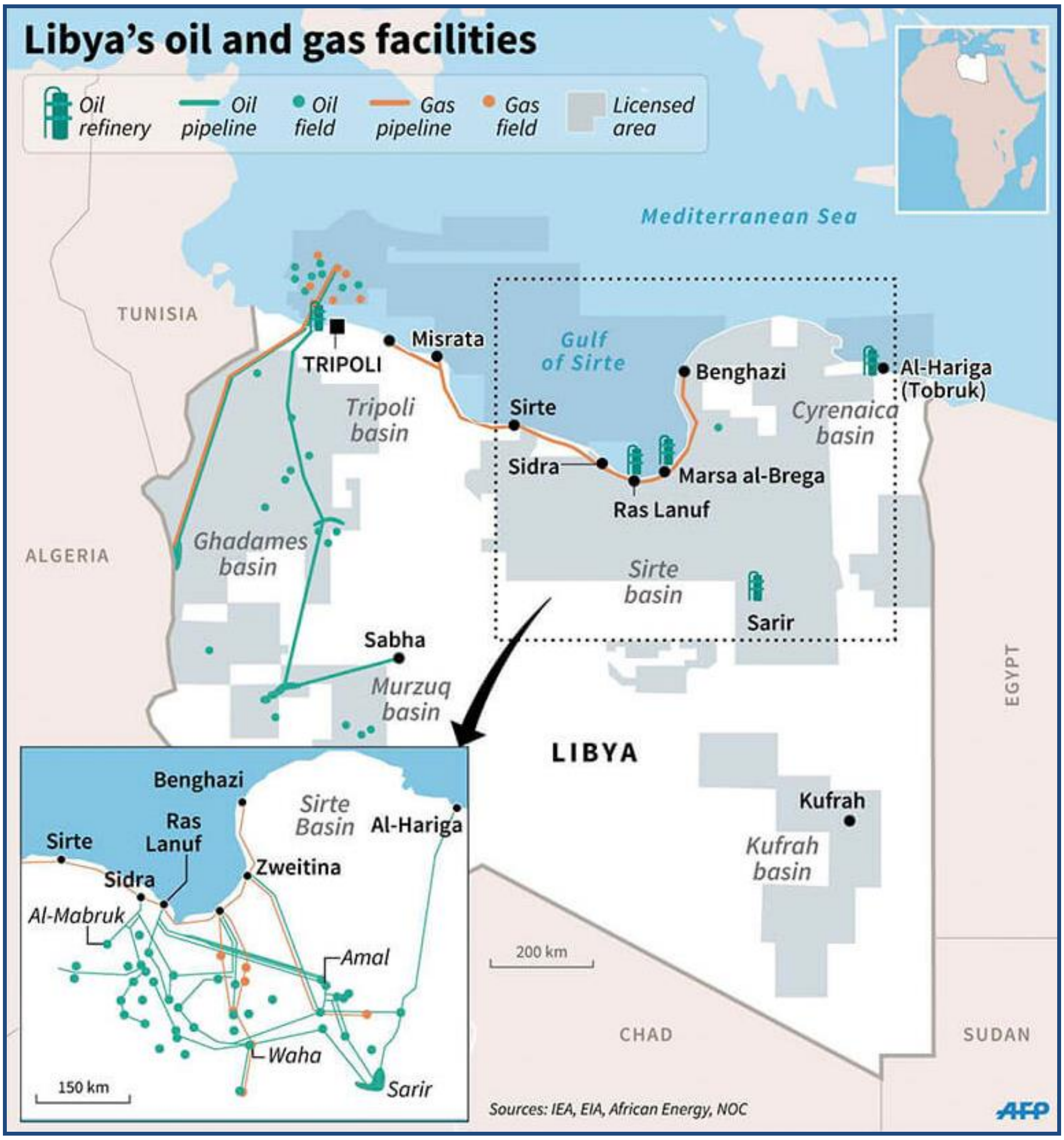


Figure 1.3: Map of Libya's ports, oil and gas fields, pipelines and oil refineries (Source: Atalayar, 2020:1)

The portfolio of the NOC comprises subsidiaries, eleven in total, and joint ventures (JVs), seven in total, stretching across the industry value chain (NOC, 2019). Prominent NOC subsidiaries include Ras Lanuf Oil and Gas Processing Company (RASCO), Brega Petroleum Marketing Company, and Arabian Gulf Oil Company (AGOCO) (NOC, 2019).

The NOC carries out oil and gas exploration, marketing and sales activities, and production processes through its subsidiary companies (NOC, 2019). One of these secondary Libyan companies is Zueitina (ZOC, 2020), which is the case study of this research. Zueitina Oil Company was established as a JV, Libyan owned, to manage the oil operations in the regions, also known as territories, granted under concession contracts the NOC made with both the *OMV Group* (an Austrian oil and gas company) and *Occidental* (an American company). The JV is known as Zueitina Oil Company (ZOC, 2020).

> "The mandate of Zueitina Oil Company is to efficiently produce Crude Oil, Natural Gas and Condensates at a minimum cost, with an optimum recovery, and with a great emphasis being placed on environmental and reservoir protection" (GulfTalent, 2016: 1).

In 2016, Zueitina Oil Company was managing up to 20% of the condensate and oil exports of Libya. The Company is perceived as competition for other oil companies locally and in Northern Africa, as it proudly has an infrastructure that is "fully developed, from drilling to terminal facilities, and employs a dedicated team of experienced and highly qualified engineers and technicians" (GulfTalent, 2016: 1). The crude oil produced by Zueitina Oil Company is considered the best in Libya. The Company confirms Gulftalent's (2016) statement that it handles up to 20% of Libya's crude oil via the Zueitina Terminal, and in addition to exporting crude oil internationally, it also provides liquefied gas to the local market (ZOC 2020). In 2018, the production capacity of the Company averaged 58,000 barrels of crude oil per day (ZOC, 2020).

Zueitina Oil Company faced (and still faces) many challenges, the main challenge being conflicts. Bosalum and Al-Warfalli (2015) report that the Zueitina Port, which is located in eastern Libya, had to be closed after activists insisted that jobs should be given to them. These protesters subsequently blocked a pipeline, which forced the management to close various eastern oil fields for quite some time. Mr Salah al-Merghani, one of the managers in Zueitina’s Supply Chain department, said during a televised news conference from the eastern city of Benghazi that, “there is some damage (at the port) due to the long closure” (Al-Merghani, 2014). This posed a huge challenge for a company that exported 70,000 barrels of oil per day through Zueitina Port in 2014.

Another huge challenge arose when, in 2020, a “blockade on oilfields and ports” by the National Army of Libya was imposed for months (The Arab Weekly, 2020: 1), which caused significant damage to the Zueitina Terminal. Libya's oil pumping fell from approximately 1.2 million barrels per day (bpd) to scarcely 100,000 pbd because of the blockade (Atalayar, 2020). In September 2020, The Arab Weekly (2020: 1) reported that Marshal Khalifa Haftar, a “guardian of the unrecognised government in eastern Libya and a strong man in the country”, announced that the blockade would be partially lifted. The lifting of the blockade led to reports that Libya’s oil production increased threefold since then (Atalayar, 2020). The blockade, together with the advent of the Covid-19 pandemic, had a detrimental effect on Libya’s economy. Peter Maurer, President of the International Committee of the Red Cross (ICRC), visited Libya in August 2020 and stated the following:

> “In Benghazi and Tripoli… neighbourhoods on the former frontlines in Tripoli are badly scarred and families have little if anything to return to. People are also at risk of being killed or injured by dangerous unexploded munitions. At the same time, infrastructure all over the country is falling apart. People have little electricity, drinking water, sanitation, or medical care in the middle of a growing pandemic” (OCHA, 2020: 1).

However, the force majeure at Zueitina Terminal was lifted by the NOC of Libya, which means production could proceed, albeit not optimally because of the damage caused by the lockdown (Reuters, 2020).

1.5 Problem statement and research aim

Libya’s oil and gas industry is deemed the most essential and important sector in the country, as Libya is mainly dependent on proceeds from this sector (EIA, 2020). The productivity of Libya's oil and gas supply chain is compromised due to: (i) current information technologies that are not always applied and utilised optimally, and/or (ii) insufficient information technologies in the supply chain and logistics processes of some of Libya's oil and gas companies. This leads to wasteful expenditure, which results in significant losses in revenue. To enhance functionality and efficiency in Libyan oil companies' supply chain and logistics processes, these companies need to consider adopting information technologies that are innovative, appropriate and cost efficient.

This research therefore aimed to: (i) explore the status of the oil and gas industry in Libya in terms of oil production and export; and (ii) determine what innovative information technologies should be considered by Zueitina Oil Company (as case study) in Libya to enhance its supply chain and logistics processes.

1.6 Research questions

1.6.1 Primary research questions

Two primary research questions (PRQs) were formulated for this research, with the first one focusing on the status of the oil and gas sector in Libya, and the second question focusing specifically on enhancing the IT and SCM processes in a selected oil and gas company in Libya. The two PRQs are:

PRQ1: What is the current status of Libya's oil and gas sector in terms of oil production and export?

PRQ2: What innovative information technologies need to be considered by Zueitina Oil Company in Libya to contribute towards optimising its supply chain and logistics processes?

1.6.2 Sub-research questions

Considering that Libya's oil and gas sector are influenced by the rest of the world's oil and gas production and exports, and that a number of countries in Africa are large exporters of oil, the following two sub-research questions (SRQs) were formulated to address **Primary Research Question 1:**

SRQ 1.1: What is the status of the world's oil and gas sector in terms of production and export?

SRQ 1.2: What is the status of Africa's oil and gas sector in terms of production and export, and specifically Libya's?

The following SRQs were formulated to answer **Primary Research Question 2:**

SRQ 2.1: What strategies/techniques are currently used to measure Zueitina Oil Company's supply chain performance?

SRQ 2.2: What metrics are currently used for Zueitina Oil Company's supply chain performance?

SRQ 2.3: What is the impact of information technology applications on Zueitina Oil Company's logistics, and specifically, on procurement, warehouse and inventory management?

SRQ 2.4: How is the logistics system at Zueitina Oil Company managed?

SRQ 2.5: What is the importance of optimised IT applications in Zueitina Oil Company's supply chain and logistics processes?

SRQ 2.6: What Information Technology Optimisation Model can be proposed to contribute towards enhancing the supply chain and logistics processes of Zueitina Oil Company in Libya?

1.7 Research objectives

Objective 1: To explore the status of the world oil's and gas sector in terms of production and export

Objective 2: To explore the recent status of Africa's oil and gas sector, and specifically Libya's, in terms of production and export

Objective 3: To identify what strategies/techniques are currently used to measure the supply chain performance of Zueitina Oil Company

Objective 4: To identify what metrics are currently used for Zueitina Oil Company's supply chain performance

Objective 5: To explore the impact of Zueitina's information technology applications on logistics, and specifically on procurement, warehouse, and inventory management

Objective 6: To explore how the logistics system at Zueitina Oil Company is managed

Objective 7: To determine the importance of optimised IT applications in Zueitina Oil Company's supply chain and logistics processes

Objective 8: To develop an Information Technology Optimisation Model to contribute towards enhancing the supply chain and logistics processes of Zueitina Oil Company in Libya

1.8 Research context

An underlying reason for organisations displaying increased growth and awareness towards enhancing their SCM, is the aggressive competition among these companies to win and retain customers. As mentioned in section 1.2, the supply chain and logistics sector underwent a complete paradigm shift towards enhancing and refining the experience of their customer. The customers are the end users of the product or service, and organisations strive to obtain the 'ultimate goal', which is user satisfaction. Moving closer towards reaching this ultimate goal, the IT applications within the supply chain and logistics processes of Libya's oil and gas sector need to be enhanced.

1.9 Research design

Connaway and Powell (2010) affirm that there are various methods available on conducting research; subsequently, there are also various definitions for research. Fowler (1998: 48) explains research as "the systematic investigation into and study of materials, sources, etc., in order to establish facts and research new conclusions". The Chambers 21st Century Dictionary (2018) defines research as a comprehensive and cautious examination of some fields or subjects of study, with the purpose of identifying and applying new evidence or information. Van Wyk outlines research design as follows:

> "Research design is the overall plan for connecting the conceptual research problems to the pertinent (and achievable) empirical research. In other words, the research design articulates what data is required, what methods are going to be used to collect and analyse this data, and how all of this is going to answer your research question" (Van Wyk, n.d.: 4).

A review of the literature has revealed a lack of extensive research conducted on the performance of information technology on the supply chain and logistics processes of Libya's oil and gas sector. Exploratory research using an inductive research approach and qualitative research methodology has been selected as the most appropriate research design, which will be elaborated on next.

1.9.1 Research approach

A research study can adopt either inductive or deductive reasoning. The inductive approach uses the research questions to refine the study's scope, and it focuses on developing new theory that emerges from the data. The deductive approach commences with a hypothesis and intends to test this theory (Gabriel, 2013).

Inductive reasoning usually aligns with qualitative research and concentrates on examining new phenomena or viewing phenomena that have been researched in previous studies from another perspective. Deductive reasoning is more commonly aligned with quantitative research and focuses mostly on causality (Gabriel, 2013). It is however important to know there are no fixed rules – qualitative research projects may take on a deductive stance (Gabriel, 2013).

This study has adopted an inductive research approach as it is guided by the research questions and aims to develop a model that may contribute towards enhancing the supply chain and logistics processes of Libya's oil and gas sector.

1.9.2 Research methodology

Two main research methodology approaches can be followed during a scientific study, namely a qualitative or quantitative approach, or both (known as mixed-methods). Quantitative research focuses on collecting people's opinions to generate hard facts. It is the manipulation and numerical representation of observations in order to describe and explain what those observations reflect. It is used in social and natural sciences (Kothari, 2009). In general, the use of questionnaires is the main data collection method for a quantitative research methodology.

A qualitative approach focuses on the assessment of attitudes, behaviour, and opinions. Non-quantitative results are inferred from the impressions and insights of the researcher(s). In general, in-depth interviews, projective techniques, and focus group interviews are the main data collection methods used for the qualitative research methodology.

This study has adopted the qualitative research methodology as the data collected were qualitative and the inductive research design was deemed appropriate.

1.9.3 Research strategy

For this research, a case study strategy was adopted to investigate the IT supply and logistics processes at Zueitina Oil Company in Libya. Thomas defines a case study as follows:

> "Case studies are analyses of persons, events, decisions, periods, projects, policies, institutions, or other systems that are studied holistically by one or more method. The case that is the subject of the inquiry will be an instance of a class of phenomena that provides an analytical frame—an object—within which the study is conducted and which the case illuminates and explicates" (Thomas, 2011: 511).

The case study selected is Zueitina Oil Company in Libya. The Company has a developed supply chain system and does invest in information technology applications within its SCM.

The second strategy identified for this research was a survey by means of interviews and focus groups to determine the role of IT applications in the supply chain and logistics processes of the Zueitina. The managers in the supply chain and logistics departments were the research participants. The researcher conducted telephonic and focus group interviews with 15 staff members (mostly executives) of Zueitina, and these interviewees were selected according to their involvement in the supply chain system. The focus groups were conducted with the managers who worked in accessible venues, and the telephonic interviews were conducted with participants working on ridges and other remote areas that were inaccessible to the researcher.

1.9.4 Data collection

Hamilton (2004) Illustrates that research papers are usually filled with information gathered from primary and secondary sources, and the task of the researcher is to find suitable sources for both.

1.9.4.1 Primary sources

For this research, primary sources, which hold higher importance than secondary sources, have been consulted to find accurate and current information on the research topic. The primary sources for the research were the management of the supply chain and logistics departments of Zueitina Oil Company. The qualitative data collection methods chosen included surveys by means of telephone and focus group interviews. Collecting information from primary sources enabled the researcher to analyse accurate, detailed, first-hand information, which might only have be available internally to the Company.

1.9.4.2 Secondary sources

The focus of secondary sources is on published information. This type of information may not have be sufficient to deliver accurate data about Zueitina Oil Company; however, it was useful for referencing and benchmarking Zueitina’s activities. Chapter 2 provides an in-depth discussion of the relevant secondary sources consulted.

1.9.5 Data analysis

The researcher investigated the information technologies used with the supply chain and logistics processes of Zueitina Oil Company and evaluated the effectiveness thereof. Data were mostly collected in the Arabic language and then translated to and transcribed in English.

The data collected were analysed using a descriptive qualitative analysis method named thematic analysis. The phases of thematic analysis are:

i) Familiarisation with the data collected.
ii) Generating initial codes for interesting features found in the data, and collate data relevant to each code.
iii) Formulation themes by collating codes into potential themes.
iv) Review and verify the themes.
v) Define and name themes.
vi) Produce the research report (Braun & Clarke, 2006).

From the themes identified during the thematic analysis, the researcher developed a proposed Information Technology Optimisation Model to contribute towards enhancing the effectiveness of the supply chain and logistics processes of Zueitina Oil Company.

1.10 Delineation of research

The oil and gas sector of Libya is hampered by ineffective supply chain and logistics processes. For the purpose of this study, Zueitina Oil Company in Libya has been selected as the case subject because this company produces a large percentage of Libya's oil and gas for local use as well as international export. Zueitina Oil Company may therefore be representative of a percentage of the oil and gas sector in Libya, although further research that includes more oil and gas companies in Libya needs to be conducted to confirm representation.

The research participants for this study have been delineated to mostly executives (managers/directors/supervisors) in departments of the supply chain and logistics section of Zueitina Oil Company. Some of these executives worked in accessible locations, while others worked on ridges and other remote areas inaccessible to the researcher.

1.11 Research ethics

Firstly, human participants need to be protected, thus the research was conducted in a way that served the interests of individuals, groups and/or society as a whole. Anonymity of the participants was ensured. The researcher examined specific research activities and projects for their ethical soundness, having looked at issues such as the management of risk, protection of confidentiality, and the process of informed consent throughout the entire interview process.

1.12 Chapter overview

Chapter 1: Introduction

This chapter begins with a brief introduction of the purpose and scope of the research, and a short discussion on the company used in the case study. Following this, the primary and sub-research questions and objectives of the research are stated. The research design, used for data collection and analysis, is indicated. The chapter ends with a summary of the dissertation structure. See section 3.5..2.1 and section 3.10 for an in-depth discussion on the principles of research ethics.

Chapter 2: Literature Review

This chapter comprises a review of literature obtained on supply chain and logistics processes in the oil and gas sector of countries, and more specifically, in Libya. The impact of information technology on the supply chain and logistics processes of oil and gas sectors are investigated, and the benefits and limitations of information technology applications on the supply chain are explored. The research provides background information on the subject of the case study, namely Zueitina Oil Company.

Chapter 3: Research Methodology

This chapter presents the research philosophy, paradigm, methodology, approach, and strategy of the research case study. The data collection methods are discussed, and the primary and secondary sources are indicated. An in-depth explanation of the data analysis and descriptive qualitative analysis tools are elaborated on.

Chapter 4: Data Analysis, Findings and Discussion

In this chapter, the demographics of the interviewees, in this case the executives involved in the Supply Chain and Logistics section of Zueitina Oil Company are indicated. The interview questions (IQs) posed to collect data from the executives are discussed, categorised under each sub-research question that is addressed in this chapter. The findings drawn from the IQs are presented, and the themes and sub-themes that emerged from the findings, are indicated.

Chapter 5: Proposed Information Technology Optimisation Model for Zueitina's Supply Chain

An Information Technology Optimisation Model for Zueitina Oil Company's supply chain is proposed. The model considers the findings, themes and sub-themes that emerged from the analysed data.

Chapter 6: Conclusion and Recommendations

In the final chapter, each SRQ from the two primary research questions posed in section 1.6.1 is answered. SRQ 1.1 and SRQ 1.2 are discussed in Chapter 2; SRQ 2.1 to SRQ 2.5 are addressed in Chapter 4; while the proposed model in Chapter 5 presents the answer to SRQ 2.6. Limitations, recommendations and future research are discussed, and the thesis concludes with the researcher's reflection of a challenging journey due to the continuous conflicts in his home country.

CHAPTER 2: LITERATURE REVIEW

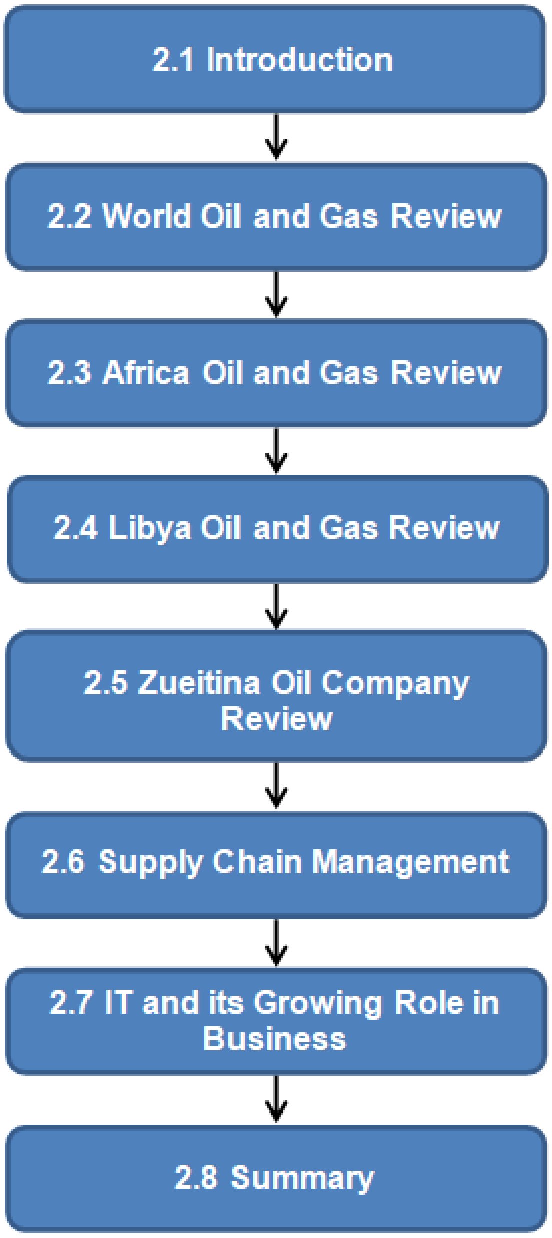


Figure 2.1: Graphical representation of Chapter 2

2.1 Introduction

This chapter focuses on a review of literature obtained from a wide variety of sources on information technologies (ITs) and supply chain and logistics processes, especially in the oil and gas industry worldwide and in Africa. It furthermore offers broad insight into the benefits and limitations of IT applications in the supply chain management of companies.

The chapter commences with a world oil and gas review, and strategically narrows the field of investigation down to an African world and gas review and then Libya's oil and gas review, where after it focuses specifically on Zueitina Oil Company in Libya, which is the case of this study. This is followed by an introduction of the supply chain and a discussion on IT and its applications within the supply chain.

In this chapter, the first primary research question **(PRQ1)** is addressed by answering both SRQ 1.1 and SRQ 1.2. **PRQ1** and the two corresponding SRQs are stated below.

PRQ1: What is the current status of Libya's oil and gas sector in terms of oil production and export?

SRQ 1.1: What is the status of the world's oil and gas sector in terms of production and export?

SRQ 1.2: What is the status of Africa's oil and gas sector in terms of production and export, and specifically Libya's?

Literature found in the available scientific body of knowledge on the world oil and gas sector was reviewed in-depth to answer the two sub-research questions.

2.2 World oil and gas review

The Petroleum Resource Library defines the word "petroleum" as follows:

> "Petroleum, or crude oil, is a fossil fuel and nonrenewable source of energy... Like coal and natural gas, petroleum was formed from the remains of ancient marine organisms, such as plants, algae, and bacteria. Over millions of years of intense heat and pressure, these organic remains (fossils) transformed into carbon-rich substances we rely on as raw materials for fuel and a wide variety of products" (National Geographic, 2020: 1).

Crude oil comprises hydrocarbons, primarily composed of hydrogen, approximately 13% in weight, and carbon, approximately 85% in weight (National Geographic, 2020). Other elements may be mixed in with the hydrocarbons.

These elements are sulphur (0.5%), nitrogen (about 0.5%), oxygen (1%), and metals such as nickel, copper (< 0.1%), and iron (National Geographic, 2020).

Generally, petroleum reservoirs are found thousands of feet below the surface (Rockefeller, 2012). These petroleum reservoirs can contain natural gas, oil, or both (Guo, Sun & Ghalambor, 2008).

> "Their important properties include pay zone thickness, lithology, rock porosity, rock total compressibility, and rock permeability. These properties affect fluid flow within the reservoir and thus well productivity" (Guo, Sun & Ghalambor, 2008: 45)

Oil and gas are uncovered through wells drilled down to these reservoirs (Rockefeller, 2012). When a well is drilled to delineate or discover a petroleum reservoir, it is called an exploratory well. A development well is drilled to produce a quota of oil and gas that were already found previously (Rockefeller, 2012). A large oil-producing reservoir may comprise quite a few producing development wells as well as one or a few producing exploratory wells. Oil and gas reserves are defined as approximate volumes of oil and gas in the reservoir, which are recoverable. Furthermore, reserves are categorised as possible, probable, or proved, based on the chance that the approximate volumes can be yielded cost-effectively. Various useable and valuable products can be produced from petroleum (Rockefeller, 2012).

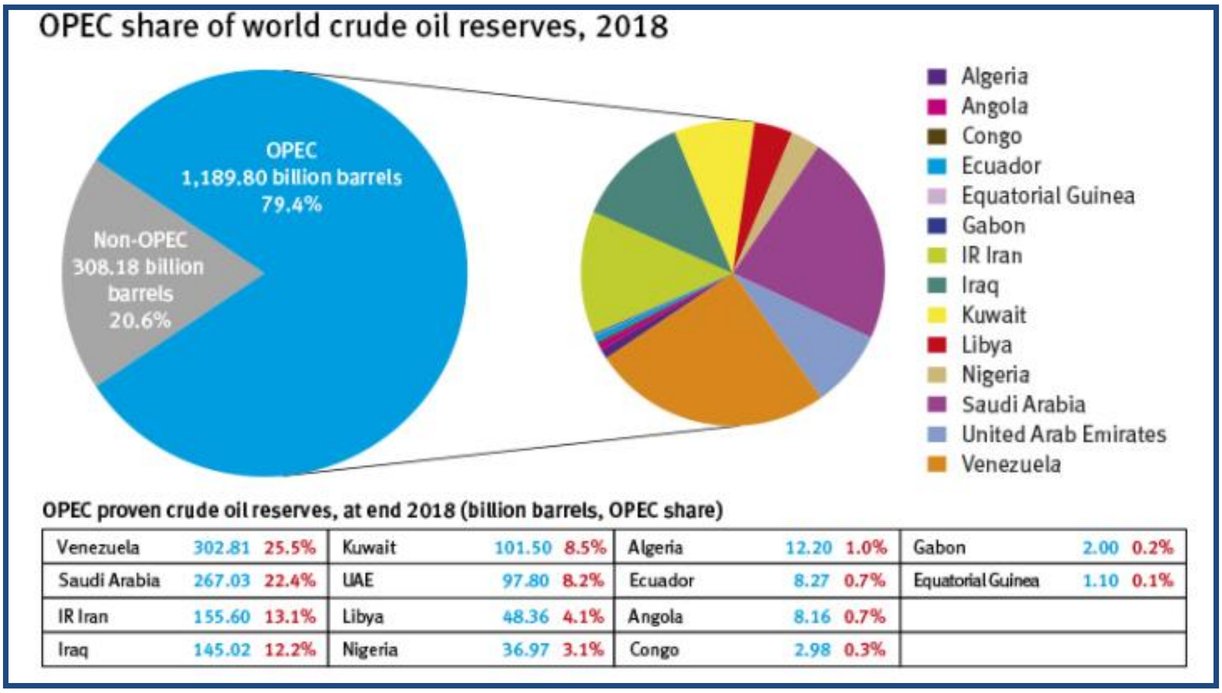
BP (2017) stated in their June 2017 report, *"BP Statistical Review of World Energy",* that global proved oil reserves dropped marginally in 2017 to 1,696.6 billion barrels—a decline of 0.5 billion barrels (-0.03%)—which were to meet a global production of 50.2 years at the 2017 levels. Venezuela's higher reserves, which increased by 1.4 billion barrels, were offset by Canada's weakening (-1.6 billion barrels) and minor declines in other non-OPEC countries. At the time, OPEC countries held 71.8% of confirmed global reserves.

The Organisation of the Petroleum Exporting Countries (OPEC) is an inter-governmental and permanent organisation, comprising developing nations that export oil. Its function is to coordinate and unify the petroleum policies of the countries involved, and ensuring stable oil prices in global oil markets. The OPEC countries are "Algeria, Angola, Congo, Ecuador, Equatorial Guinea, Gabon, IR

Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates and Venezuela" (JODI, 2020:1). Primary centers of non-OPEC companies include the North Sea, North America, and regions of the former Soviet Union (EIA, 2020). The non-OPEN countries currently produce 60% of the oil worldwide (EIA, 2020).

In BP's (2019) "*Statistical Review of World Energy for 2018*", the confirmed (or proved) world gas reserves increased by 0.7 Tcm (trillion cubic metres) to 196.9 Tcm from 2017. The current global R/P (reserves to production) ratio indicates that the 2018 gas reserves accounted for 50.9 years of current production, which is 2.4 years lower than in 2017.

Figure 2.2 below presents the 2018 world crude oil reserves, with the OPEC countries holding 79.4% and the non-OPEC countries the remainder of 20.6%.



Venezuela	302.81	25.5%	Kuwait	101.50	8.5%	Algeria	12.20	1.0%	Gabon	2.00	0.2%
Saudi Arabia	267.03	22.4%	UAE	97.80	8.2%	Ecuador	8.27	0.7%	Equatorial Guinea	1.10	0.1%
IR Iran	155.60	13.1%	Libya	48.36	4.1%	Angola	8.16	0.7%			
Iraq	145.02	12.2%	Nigeria	36.97	3.1%	Congo	2.98	0.3%			

Figure 2.2: 2018 World crude oil reserves (OPEC and non-OPEC)
(Source: OPEC, 2019: 1)

Figure 2.3 below depicts the 1998, 2008 and 2018 gas reserves in the world in trillion cubic metres (Tcm).

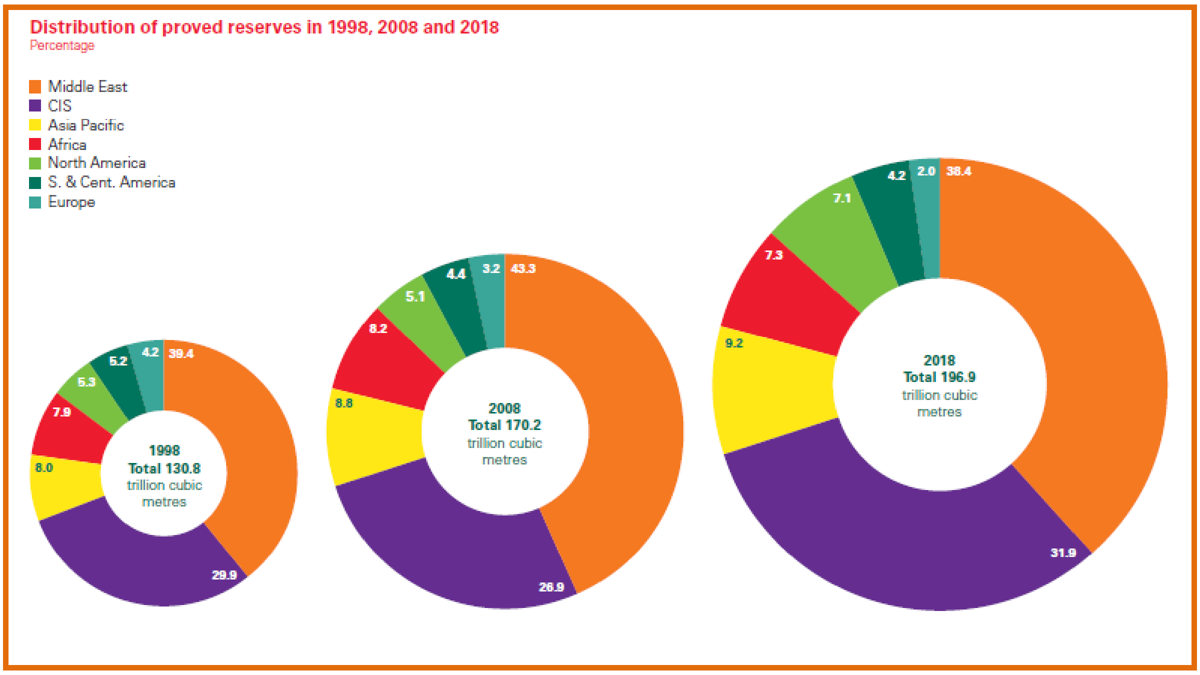


Figure 2.3: 2018 World gas reserves
(Source: BP, 2019: 31)

Figure 2.4 below depicts the OPEC, non-OPEC and total world crude oil supply, as well as the OPEC market share, for 2015-2019.

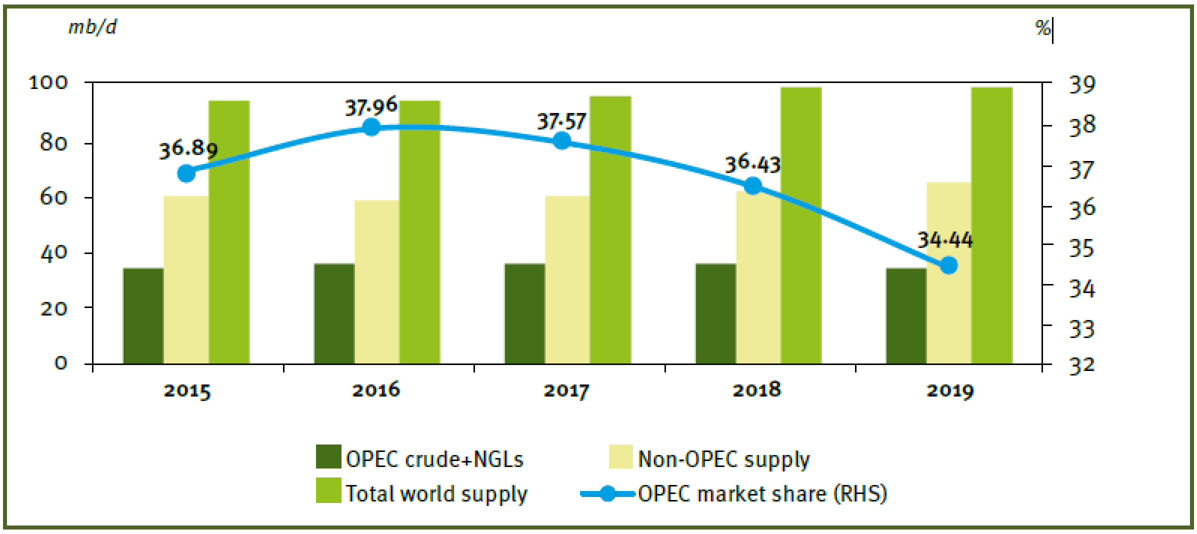


Figure 2.4: OPEC, non-OPEC and world crude oil supply and market share for 2015-2019
(Source: OPEC, 2019a: 26)

In Figure 2.4, NGLs "are premium by-products of crude and gas extraction used to produce liquefied petroleum gas, gasoline or naptha, a petrochemical feedstock" (Blas, 2010: 1).

To elucidate Figure 2.4, more precise figures (from 2016 to 2019) are presented in Table 2.1 below for the oil supply of non-OPEC countries, OPEC NGLs + NCOs (non-commissioned organisations), and OPEC countries.

Table 2.1: World oil demand and supply balance for 2016-2019
(Source: adapted from OPEC, 2019a: 25)

	2016	2017	2018	1Q19	2Q19	3Q19	4Q19	2019
World demand *(mb/d)*								
(a) Total world demand	95.7	97.4	98.8	98.8	98.6	100.5	100.8	99.7
World supply *(mb/d)*								
Total non-OPEC supply	59.2	60.0	63.0	64.4	64.3	64.8	66.4	65.0
OPEC NGLs + NCOs	4.6	4.6	4.8	4.8	4.8	4.7	4.8	4.8
OPEC crude oil production	31.7	31.5	31.3	30.0	29.5	28.9	29.1	29.3
Total supply *(mb/d)*	95.5	96.1	99.1	99.1	98.6	98.3	100.3	99.1
Balance (stock change and misc.)	−0.2	−1.3	0.2	0.4	0.0	−2.2	−0.5	−0.6

As can be seen in Table 2.1, the world oil supply and demand from 2016 to 2019 fluctuated slightly from under-supply to over-supply and back to under-supply.

2.2.1 COVID-19 impact on the oil and gas sector globally

> “The double blow of Coronavirus (COVID-19) and the oil price shock is hitting oil-exporting developing countries particularly hard at a time when the fossil fuel industry is facing a process of structural decline” (OECD, 2020: 1).

While some of the world’s oil producing countries might have wealth funds for times of crises, the majority of the world’s countries that produce and export oil are dependent on oil as primary resource (OECD, 2020). Many of the latter countries already faced high debt levels and various social and economic challenges before COVID-19 appeared on the scene with worldwide lockdowns in 2020. With the ‘hard lockdowns’ where borders of countries were closed due to the Coronavirus pandemic, or where exporting became a huge challenge due to extremely rigid restrictions, oil-producing countries started spiralling downwards into an unsustainable cycle of “increased reliance on short-term and expensive non-concessional private borrowing in recent years, a significant proportion of which is backed by oil collateral” (OECD, 2020). Subsequently, the Coronavirus pandemic catapulted the oil price to levels unseen since 2002 due to a worldwide collapse for crude oil (OECD, 2020, citing BBC News, 2020).

2.3 Africa oil and gas review

The Africa continent comprises 54 countries and the 2018 population estimation is 1.3 billion people (United Nations, 2019). Africa is rich in minerals, which include gas resources and fossil fuels (African Development Bank & the African Union, 2009). However, limited knowledge is available on how much of these resources exist, and therefore it remains a challenge to conduct feasible and reliable extended, country-based valuations. Furthermore, oil and gas resources are continuously discovered on the African continent, which presents distinctive economic opportunities. Notwithstanding these discoveries, the populations of Africa are yet to be advantaged by the evaluation and use of these valuable resources (African Development Bank & the African Union, 2009).

The oil and gas sector is essential to the African continent. Mbendi Information Services (2016) refers to the *2012 BP Statistical Energy Survey* when stating that by the close of 2011, Africa's substantiated oil reserves were counted to be 132.438 billion barrels, which was 8.01% of the world's reserves. In 2011, the crude oil bpd production averaged 10.44% of the world's, but, compared to 2010, showed a reduction of -12.7%. According to Mbendi Information Services (2016), the five countries that led the continent's production of oil during the first half of the past decade (2010 to 2015), from highest to lowest output, were Nigeria, Libya, Algeria, Egypt, and Angola, which together produced 85% of Africa's oil.

The top five oil producing companies in 2019, from highest to lowest output, were Nigeria, Angola, Algeria, Libya, and Egypt (Carpenter, 2020). The top five oil production countries in Africa are still the same, but their output ranking changed, for example, where Libya ranked second during the first half of the 2010-2020 decade, this country was ranked 4th by Carpenter in 2019.

A significant number of countries in Africa produce oil. According to the US Energy Information Administration (EIA, 2020) 16 of the 54 countries in Africa are exporters of oil since 2010. These countries are stated in Table 2.2.

Table 2.2: Africa's oil producing companies
(Source: adapted from KPMG, 2013)

Oil producing countries in Africa	
Algeria	Equatorial Guinea
Nigeria	Angola
Libya	Gabon
Sudan	Democratic Republic of Congo (DRC)
Egypt	Chad
South Sudan	Mauritania
Tunisia	Ivory Coast
Congo (Brazzaville)	Cameroon

KPMG (2015) indicates that Africa is a primary net exporter of oil in the world; to be more specific, only the net exports of the Middle East surpasses that of Africa. The continent accounted for over 11% of global oil production over the previous decade (2001-2010); however, due to low incomes, the consumption of oil in the majority of African countries still is low. As such, the oil consumption of Africa accounts for only 4% of the overall global oil use, which leaves the continent with a huge amount of oil for export (KPMG, 2015).

In 2013, the net oil exports of Africa dropped to 5.2 million barrels per day (bpd) – an average decline of approximately 6.3 million bpd over five years (2007-2011). This weakening in 2013 was mainly attributed to an intense drop in Libya’s output, although Algeria, Nigeria, and Sudan were also contributors to lower oil production (KPMG, 2015).

Over the years, political unrest on the African content affected oil exports. For example, in 2014, PWC reported that oil production levels dropped from 2012 to 2013 by approximately 35% due to political unrest in North Africa. After South Sudan became independent in 2011, Sudan and South Sudan began to recover in their oil production levels, but fighting and unrest continued threatening oil and gas installations in the South (PWC, 2014).

Another important oil exporting country on the continent with political unrest and civil war is Libya, which will be discussed later in the chapter.

Table 2.3 below depicts the total proved natural gas reserves in Africa from 1998 to 2018 (BP, 2019).

Table 2.3: Africa's proved natural gas reserves from 1998 to 2018
(Source: adopted from BP, 2019: 30)

	At end 1998	At end 2008	At end 2017	At end 2018			
	Trillion cubic metres	Trillion cubic metres	Trillion cubic metres	Trillion cubic metres	Trillion cubic feet	Share of total	R/P ratio
Algeria	3.9	4.3	4.3	**4.3**	**153.1**	2.2%	47.0
Egypt	1.0	2.1	2.1	**2.1**	**75.5**	1.1%	36.5
Libya	1.2	1.5	1.4	**1.4**	**50.5**	0.7%	145.9
Nigeria	3.3	5.0	5.3	**5.3**	**188.8**	2.7%	108.6
Other Africa	0.8	1.1	1.2	**1.2**	**41.7**	0.6%	44.3
Total Africa	10.3	14.0	14.4	**14.4**	**509.6**	7.3%	61.0

Figure 2.5 below shows the total proved oil reserves in Africa from 2010 to 2020 (in billion barrels). As can be seen in this figure, Africa's crude oil reserves in Africa amounted to 125.8 billion barrels of oil in 2020, after a decrease of 2.7 billion barrels from 2018 to 2019. From 2019 to 2020, there was a slight increase of 0.5 billion barrels of oil.

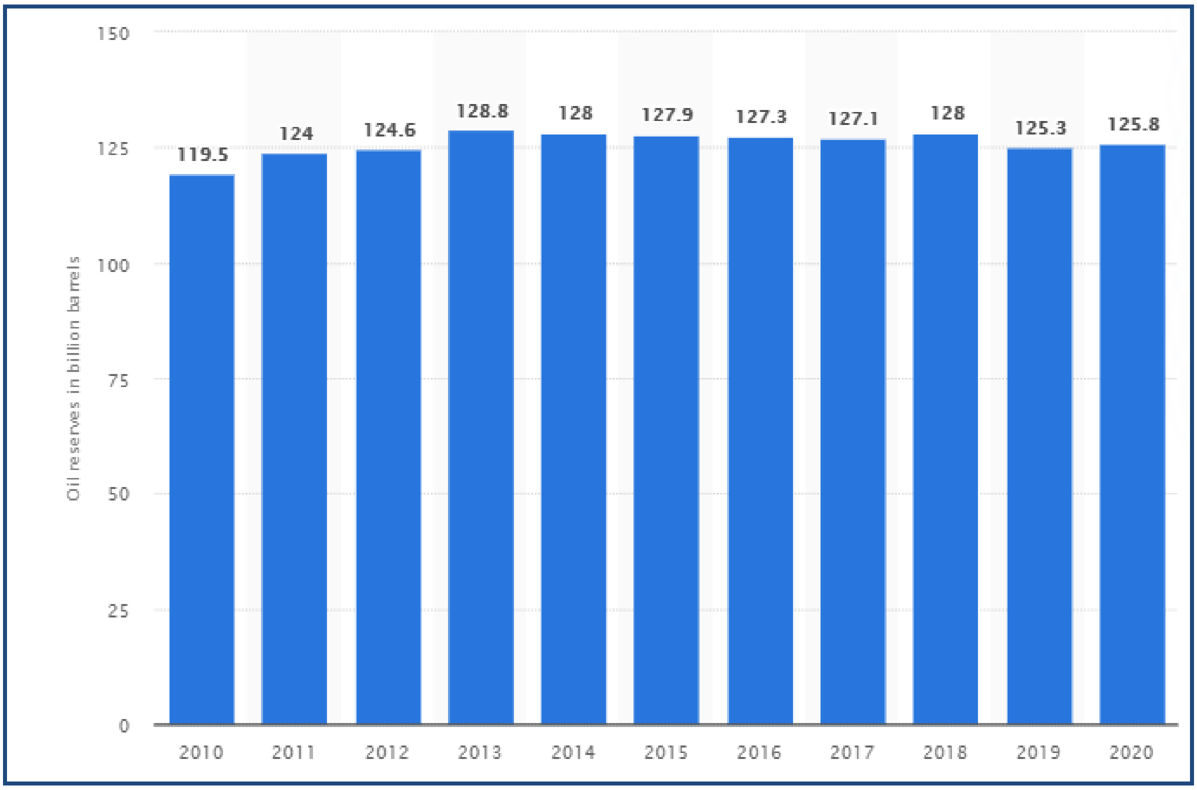


Figure 2.5: Africa's proved natural oil reserves from 2010 to 2020
(Source: Faria, 2020: 1)

Figure 2.6 below is a summary of the oil reserves, production, consumption, and exports of African countries from 2018 to 2020. This includes a brief description of the effect Covid-19 had (and still has) on the oil producing countries in Africa.

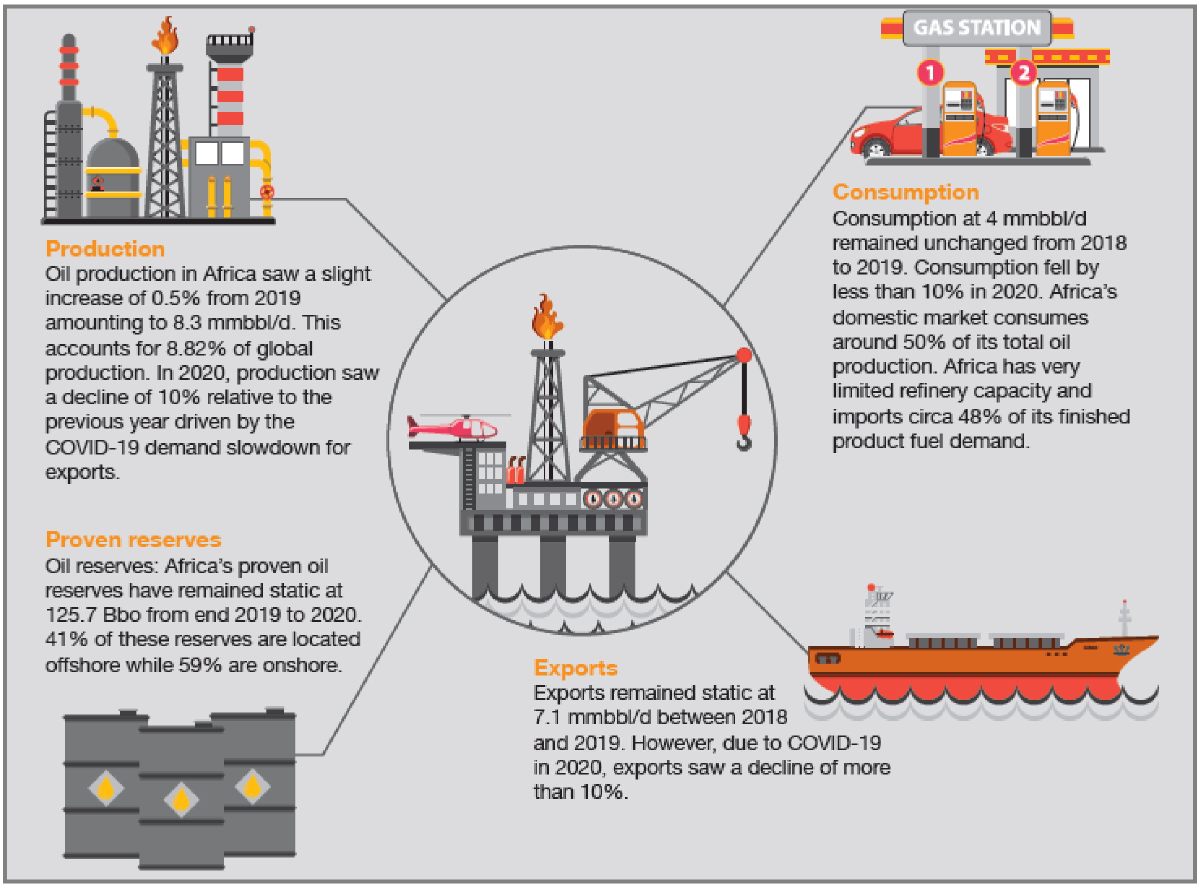


Figure 2.6: Africa's oil reserves, production, consumption, and exports from 2018 to 2020 (Source: PWC, 2020: 6)

As shown in Figure 2.6, oil production dropped with 10% in 2020 relative to 2019 due to the slowdown demand of a decline in exports in a worldwide attend to mitigate Covid-19 contamination. From 2018 to 2019, oil consumption in Africa remained unchanged, but declined with less than 10% in 2020. Africa's oil reserves remained static (Figure 2.4; Figure 2.5).

2.3.1 COVID-19 impact on the oil and gas sector in Africa

The oil and gas sector in Africa has been dealt a substantial blow by the onset of the Coronavirus, because the short-term positives and most recent advances and profits eroded fast (PWC, 2020). Due to the slowdown of exports in 2020, production cuts were substantial, and the projected downward figure for Africa's top five oil-producing countries is 19%. Added to this, fiscal pressure increased because budgets were diverted to the healthcare sector (PWC, 2020). The worldwide lockdowns has led to a huge breakdown in oil demands and related products, which disrupted the market in an unparalleled way. The reduction in oil demand during the global financial crisis in 2007 has been dwarfed by the COVID-

19 pandemic (PWC, 2020) (See Annexure C for COVID-19's influence on Africa's gas and oil producing countries).

2.4 Libya oil and gas review

Libya is a significant contributor to the worldwide supply of light sweet crude, and mostly exports to European markets (EIA, 2020). Apart from petroleum, the other natural resources are natural gas and gypsum. The World Bank (2020) classifies Libya as an 'Upper Middle Income Economy', along with only a few other African countries. Libya's small population, combined with its considerable revenues from the energy sector, gives the country one of the highest per capita GDPs on the African continent (The World Bank, 2020). Libya's current GDP per capita is calculated at US$19,673 (USA Today, 2020). Table 2.4 below depicts the main economic indicators of Libya from 2001-2016. Inflation below 5% is highlighted green.

Table 2.4: Libya's main economic indicators from 2001-2016 (Source: IMF, 2020: online)

Year	GDP (in Bil. US$ PPP)	GDP per capita (in US$ PPP)	GDP growth (real)	Inflation rate (in Percent)	Budget balance (in % of GDP)
2001	▲102.1	▼19,408	▼−1.8%	▼−8.8%	▲0.4%
2002	▲102.7	▼19,224	▼−0.9%	▼−9.9%	▲7.2%
2003	▲118.3	▲21,833	▲13.0%	▼−2.1%	▲6.4%
2004	▲127.0	▲23,051	▲4.5%	▲1.3%	▲11.7%
2005	▲146.7	▲26,236	▲11.9%	▲2.7%	▲31.4%
2006	▲161.0	▲28,294	▲6.5%	▲1.5%	▲31.8%
2007	▲175.8	▲30,411	▲6.4%	▲6.2%	▲28.6%
2008	▲184.0	▲31,293	▲2.7%	▲10.4%	▲32.5%
2009	▼179.9	▼30,178	▼−3.0%	▲2.4%	▼−6.5%
2010	▲187.8	▲31,094	▲3.2%	▲2.5%	▲12.5%
2011	▼63.9	▼10,792	▼−66.7%	▲15.9%	▼−17.2%
2012	▲146.3	▲23,282	▲124.7%	▲6.1%	▲28.6%
2013	▼93.9	▼14,987	▼−36.8%	▲2.6%	▼−5.1%
2014	▼44.9	▼7,175	▼−53.0%	▲2.4%	▼−73.8%
2015	▼39.5	▼6,246	▼−13.0%	▲9.8%	▼−131.0%
2016	▼37.0	▼5,801	▼−7.4%	▲25.9%	▼−113.3%

According to the calculations and figures of UK Trade & Investment (UKTI), Libya's economy is primarily dependent on their oil sector revenues, which comprise 65% of their GDP and 95% of their foreign export income (Allurentis, 2015). The largest proven oil reserves in Africa are in Libya – 48.4 billion barrels of proven oil reserves, which amounts to 2.9% of the world total (USA Today, 2020).

Libya holds the 5th largest amount of proved natural gas reserves in Africa (EIA, 2020). The country also holds the 8th largest proven oil reserves in the world, and the largest in Africa, as indicated previously (temehu.com, 2020). Despite this, Libya remains highly unexplored because current agreements with oil companies only cover 25% of Libya. Libya has more oil than its aging equipment can process, and after the recent lifting of the sanctions, the country has resumed purchasing parts and equipment to upgrade its refining and producing capacities (temehu.com, 2020).

Of the 15 countries that house the world's largest oil reserves, Libya is the only country that produces, on average, less than a million barrels of oil p/day (USA Today, 2020). Nevertheless, oil is crucial to the economy of Libya. In 2017, petroleum accounted for more than 95% of Libya's US$16.1 billion in exports (USA Today, 2020).

2.4.1 The oil and gas market in Libya

To fully comprehend how security and politics affect Libya's current oil and gas industry, it is necessary to reflect on how the country's politics have evolved since its independence in 1951 (Barltrop, 2019). Three distinctly contrasting periods of politics and power can be identified for Libya from 1951 to date. Libya's oil and gas industry was formed and shaped by political developments and policies during each of these time periods (Barltrop, 2019). The three periods are:

i) 1951-1969: The Kingdom of Libya until Colonel Muammar al-Qaddafi took over leadership in 1969.
ii) 1969-2011: The 42 years of al-Qaddafi's rule.
iii) 2011 to the present: The time period from February 2011 when al-Qaddafi was overthrown (also knows by Libyans as the "17th February revolution") to date (Barltrop, 2019).

2.4.1.1 1951-1969: The Kingdom of Libya

The new Kingdom of Libya was established on 24 December 1951, when the country became independent, which lasted for the next 18 years (Barltrop, 2019). After the Libyan Kingdom was founded, the United States and United Kingdom attained rights to set up military bases in Libya (OpenOil, 2015). The first oil exploration concessions were granted in 1956 to external (i.e. foreign) companies. The first successful drilling was reported in 1959 when ExxonMobil—one of the largest American oil companies—discovered Zletin oil field, which is one of the largest in Libya.

In 1961, upon successful completion of a pipeline 167 km in length that linked prominent oil fields in the interior to the Mediterranean Sea, Libya became an oil exporter, which ushered in an outstanding rise in oil production that would exceed 3 million bpd in 1969 (OpenOil, 2015). One year after Libya commenced with exporting oil, in 1962, the country joined the Organisation of the Petroleum Exporting Countries (OPEC) (EIA, 2020).

The discovery of substantial oil reserves in 1959 led to Libya moving rapidly from a country that relied on international aid as well as the rent from British and US air bases to an oil-rich empire. However, equity was absent in the country, and as oil exports increased, popular resentment increased, which set the stage for the *coup d'état* in 1969 by a young Colonel al-Qaddafi (OpenOil, 2015), when the Libyan Arabic Republic was established.

2.4.1.2 1969-2011: Libya during the 42 years of al-Qaddafi's rule

On 1 September 1969, the Kingdom of Libya came to and the Libyan Arabic Republic was formed when a "bloodless" *coup d'état* was actioned, led by Muammar al-Qaddafi and his group of military officers (BBC News, 1969). This event took place when King Idris underwent a medical procedure in Turkey. Only a few shots were fired because this revolution was widely supported by the people (BBC News, 1969).

In January 1970, Colonel al-Qaddafi assumed the title of Prime Minister (BBC News, 1969). At first, he practiced a "policy of Arab unity" by building relations with neighbouring countries, but diplomatic relations with the United Stated and the

United Kingdom broke down due to Libya's involvement terrorism – including the Lockerbie disaster – which lasted until 2003 (BBC News, 1969: 1).

> "Libyan leader Muammar al-Qaddafi initiated a major change in economic policy in mid-2003 when he called for the privatisation of the oil and gas industry, together with other sectors of the Libyan economy, signalling a move away from the socialist, command economy in place for almost three decades. Tentative steps to open the Libyan economy were taken in the second half of 2003" (St John, 2007: 1).

This policy, together with the decision of Libya in December 2003 to "renounce weapons of mass destruction and related delivery systems", has led to Libya being received back into the global community (St John, 2007: 1). With the USA's gradual lifting of sanctions after 2003, a number of economic initiatives were implemented by Libya, but the only economic sector that displayed substantial success was the country's the oil and gas industry (St John, 2007).

Oil and gas products have numerous applications and can be found in hospitals, textile, food, and fuel, among others. Approximately 92% of Libya's revenue in 2010 originated from the oil sector (People's Daily Online, 2011). According to the Central Bank of Libya, oil profits and proceeds in the country scaled to 40.5 billion Libyan dinars (approximately US$32.43 billion) in 2010 – a resounding 61% increase from 2009 when the oil sector proceeds were 25.1 billion dinars (approximately US$20 billion) (People's Daily Online, 2011). During this period, the largest proven oil reserves in Africa were found in Libya, and, with an estimated 2 million bpd, the country was the third largest oil producer on the continent of Africa after Nigeria and Angola (People's Daily Online, 2011). Libya set a target of reaching 3 million bpd in 2012, but conflict emerged in February 2011 in the country, which completely unsettled this goal (People's Daily Online, 2011).

2.4.1.3 2011-present: Libya after al-Qaddafi's rule

After Libya's growth and relative stability during the 2000s, an instable political arena and conflict in Libya—known as the 17th February Revolution (Barltrop, 2019)—emerged. The battle included aerial bombardment and large-scale ground-based conflict between organised armed forces across the country. The eight months conflict (People's Daily Online, 2011) ended in August in 2011 with the capture and defeat of long-time authoritarian Muammar al-Qaddafi.

In the aftermath of the conflict, in the months succeeding the overthrow of al-Qaddafi, the oil industry recovered rapidly, with companies restoring damaged infrastructure and oil production recommencing (Barltrop, 2019). Subsequently, in January 2012, after the major disruption (during which time oil production in Libya fell briefly to almost zero) the numbers increased to 1.1 million of barrels per day (mb/d). The same year, output averaged 1.5 mb/d (Baffes & Ćosić, 2013).

The post-conflict initial Libyan administration prepared for the election of a transitional government late in 2012, and, although foreign companies would take time and careful consideration before they were ready to resume investment plans, stabilisation of the country's oil and gas sector seemed promising (BP, 2018). There were talks of output returning to the pre-conflict 1.6-1.8 mb/d benchmark, and targets were even set to increasing output to 2 mb/d once more (BP, 2018).

Figure 2.7 depicts Libya's oil production from 2000 to 2018.

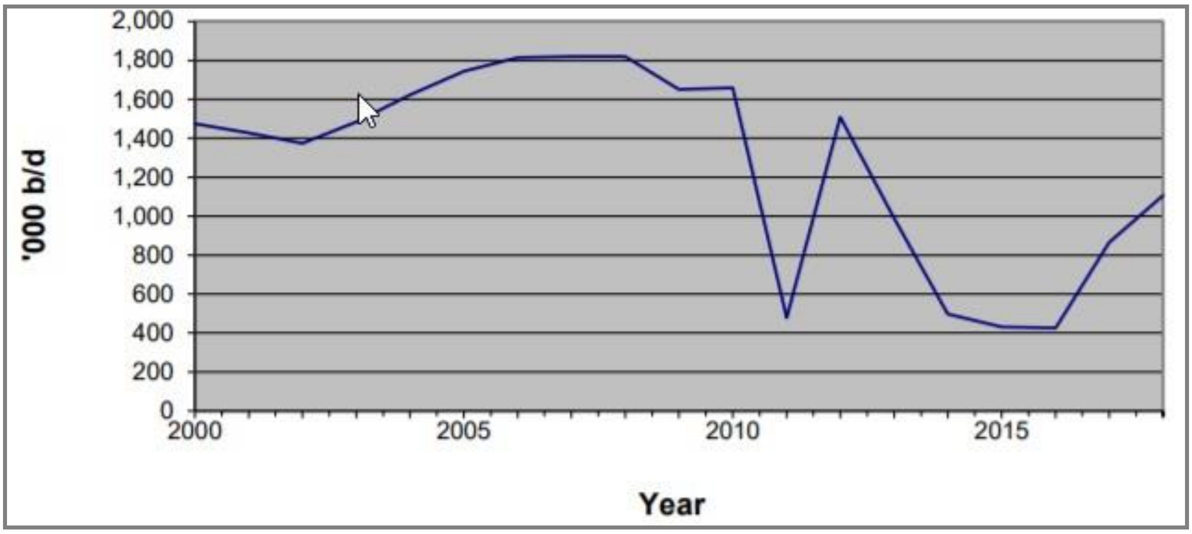


Figure 2.7: Libya's oil production 2000-2018
(Source: Barltrop, 2019: 14)

Table 2.5 below depicts a selected chronology of events from Libya's independence in 1951 up to March 2018.

Table 2.5: Selected chronology of events affecting Libya's oil and gas sector (Source: Barltrop, 2019: 12-13)

1951	Libya's independence
1959	First oil discovery in Libya
1961	First Libyan oil exports
1969	Colonel Muammar Qadhafi comes to power
1970	The NOC is established, replacing the Libyan Petroleum Company (Lipetco)
1973	Libya nationalizes 51% of foreign oil companies in the country
1977	General Congress (parliament) declares Libya a *jamahiriyya* ('state of the masses')
1982 and 1986	USA imposes economic sanctions on Libya
1991	USA and Britain indict Libya in connection with the 1988 Pan Am aircraft bombing over Lockerbie, Scotland
1999	UN Security Council suspends UN sanctions
2000	NOC puts 137 blocks out to tender
2003	UN Security Council lifts UN sanctions; Libya agrees Lockerbie compensation deal
2004	USA lifts its Libya sanctions, following Lockerbie compensation agreement
2004	West Libya Gas Project and Greenstream pipeline come on stream
2005	US companies secure 11 licences in new round of exploration and production licensing; Shell announces gas exploration agreement
May 2006	USA restores full diplomatic relations with Libya
Feb–Oct 2011	'17th February Revolution' leads to conflict and overthrow of Qadhafi
July 2012	First elections are held, and new transitional government takes office
May 2013	Parliament passes 'Political Isolation Law', barring the participation in government of people who held high office under Qadhafi
June 2014	Second elections are held; subsequent fighting and political crisis leads to emergence of rival governments in Tripoli and eastern Libya
Dec 2015	Libya Political Agreement is signed at Skhirat, Morocco
April 2016	Government of General National Accord (GNA) begins to establish itself in Tripoli
Jul 2017	Oil production exceeds 1 mb/d for first time since 2013
Mar 2018	Total buys out Marathon's share in the Waha oil concessions

2.4.2 Libya's oil sector infrastructure

The natural oil and gas infrastructure of Libya is presented in Figure 2.8.

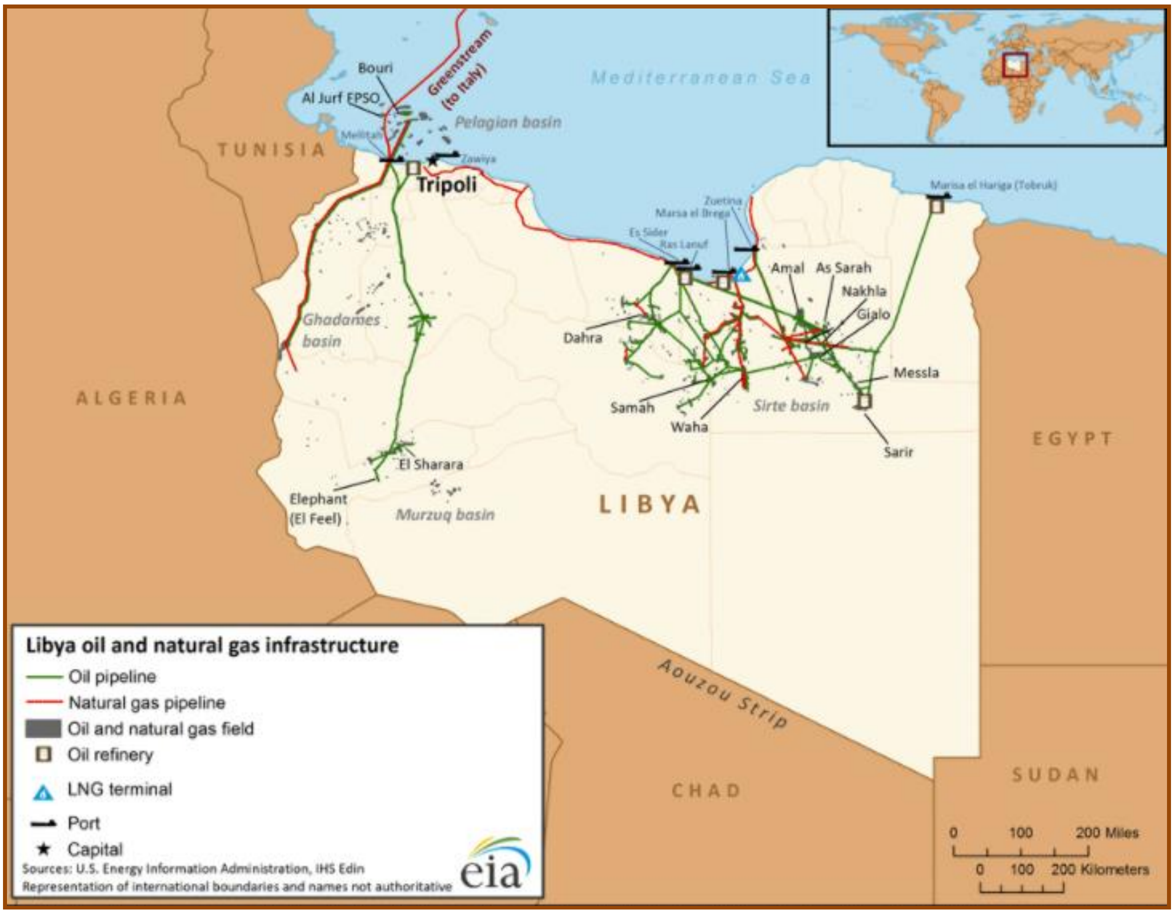


Figure 2.8: Libya oil and natural gas infrastructure (Source: EIA, 2015: 1)

The EIA (2015) states that six big sedimentary basins are found in Libya, namely: (i) Sirte; (ii) Ghadames; (iii) Murzuk; (iv) Kufra; (v) Cyrenaica; and (vi) the offshore basin. The Libyan government opines that theses basins have significant potential that is still to be uncovered. Of the recoverable reserves, approximately 80% are found in the Sirte basin, which is also this basin that "accounts for most of the country's oil production capacity" (EIA, 2015:2).

Allen and Allen (2013: 1) define sedimentary basins as "prolonged regions of prolonged subsidence of the earth's surface". Boggs (1987) explains that as these sediments are covered underground, pressure increases, leading to the formation of sedimentary rock due to lithification and compaction.

2.4.3 Crude exports by terminal

Mohareb (2020) reported on 31 October 2020 that Libya's daily crude output of Libya has reached 800,000 bpd, and citing the chairman of state-run National Oil Corp, Mustafa Sanalla, the target set by Libya for the start of 2021 is 1.3 mb/d. Libya exports various grades of light crude from six major terminals, of which five of these are located in the eastern part of the country.

In 2010/2011, a total of approximately 825,000 barrels per day of crude oil were exported over four months (October 2010 to January 2011) (International Energy Agency, 2011). Table 2.6 shows Libya's oil ports with corresponding production capacity in Libya for 2010/2011 over the same four months.

Table 2.6: Loading volumes of average barrels per day for 2010/2011 (Source: EIA, 2011)

Area	Terminal	Oct-10	Nov-10	Dec-10	Jan-11
East Libya	Es Sider Terminal	284,000	314,000	348,000	447,000
	Marsa el Brega	58,000	53,000	90,000	51,000
	Ras Lanuf	162,000	234,000	219,000	195,000
	Tobruk	63,000	20,000	51,000	51,000
	Zueitina Terminal	**117,000**	**161,000**	**175,000**	**214,000**
West Libya	Zawia Terminal	270,000	226,000	311,000	199,000
Unspecified	Other terminals	224,000	388,000	299,000	333,000
Total Libya		1,178,000	1,396,000	1,493,000	1,491,000

For comparison, Table 2.7 shows the production capacity for the same oil ports for January, October, November and December in 2020.

Table 2.7: Loading volumes of barrels per day for 2020 (Source: EIA, 2020)

Area	Terminal	Jan-20	Oct-20	Nov-20	Dec-20
East Libya	Es Sider Terminal	250,000	270,000	330,000	310,000
	Marsa el Brega	120,000	160,000	110,000	100,000
	Ras Lanuf	220,000	234,000	240,000	200,000
	Tobruk	130,000	80,000	80,000	80,000
	Zueitina Terminal	**90,000**	**160,000**	**190,000**	**220,000**
West Libya	Zawia Terminal	240,000	180,000	120,000	150,000
Unspecified	Other terminals	145,000	300,000	370,000	340,000
Total Libya		1,195,000	1,384,000	1,440,000	1,400,000

Due to sporadic unrests and conflicts, oil production and export fluctuated greatly in Libya over the past decade. Production was reported at 93,000 bpd in March 2020, which is very low. This records a decrease from the previous number of 147,000 bpd for February 2020. Libya's crude oil production data are updated monthly, averaging 1,393,000 bpd from January 2002 to March 2020, with 219 observations. The data reached an all-time high of 1,752,000 bpd in March 2008 and a record low of 7,000 bpd in Aug 2011 (CEIC Data, 2020).

Ghaddar (2020: 1) at Reuters reported that the relaxing of obstructions that were set up in January 2020 "by eastern forces" has led to an increase in the oil output of Libya (which is an OPEC member country), raising to 270,000 bpd as the country expanded it exports. The said obstructions caused the oil production of Libya to drastically fall from approximately 1.2 mb/d to only 100,000 bpd (Ghaddar, 2020). Mohareb (2020, citing Bloomberg, 2020) confirmed these numbers, stating that the energy industry in Libya resurged after September 2020, when the average bpd was a mere 100,000. This number is even more shocking when one considers that the share Libya has in OPEC is 1.7 million bpd (mb/d). The country aims to produce 1.6 mb/d by the end of 2021, but this depends on the Libyan government providing funding. Mohareb (2020: 1, citing Bloomberg, 2020) further elaborated that Libya's oil sector was "shut down in January when supporters of Khalifa Haftar, a Russian-backed commander trying to defeat the United Nations-recognised government of Prime Minister Fayez al-Sarraj, blockaded ports and fields". Figure 2.9 depicts Libya's crude oil production in thousand bpd from 2010 to 2019.

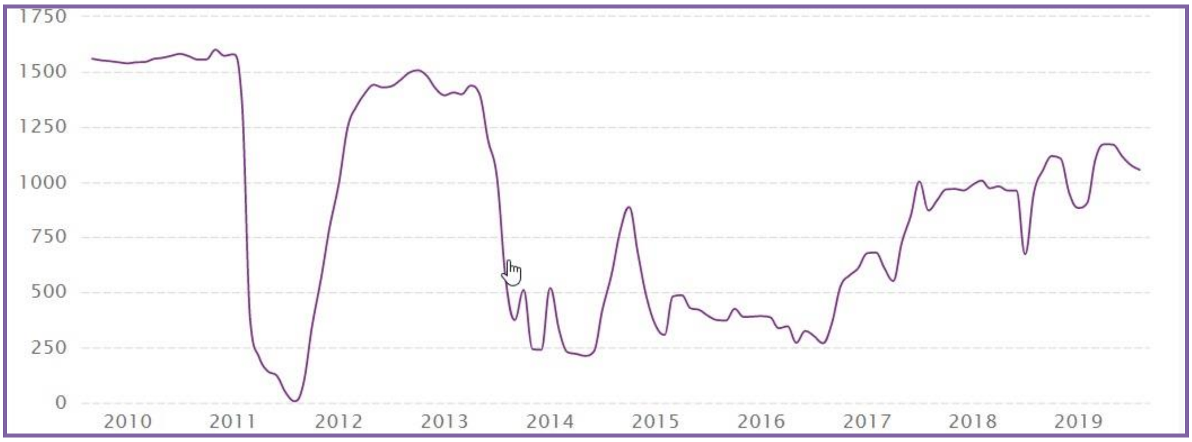


Figure 2.9: Libya Crude Oil production in thousand bpd (Source: OPEC, 2019b: 1)

2.4.4 Libyan oil and gas exports and companies

Figure 2.10 shows Libya's top daily crude oil export destinations (Ritholtz, 2015).

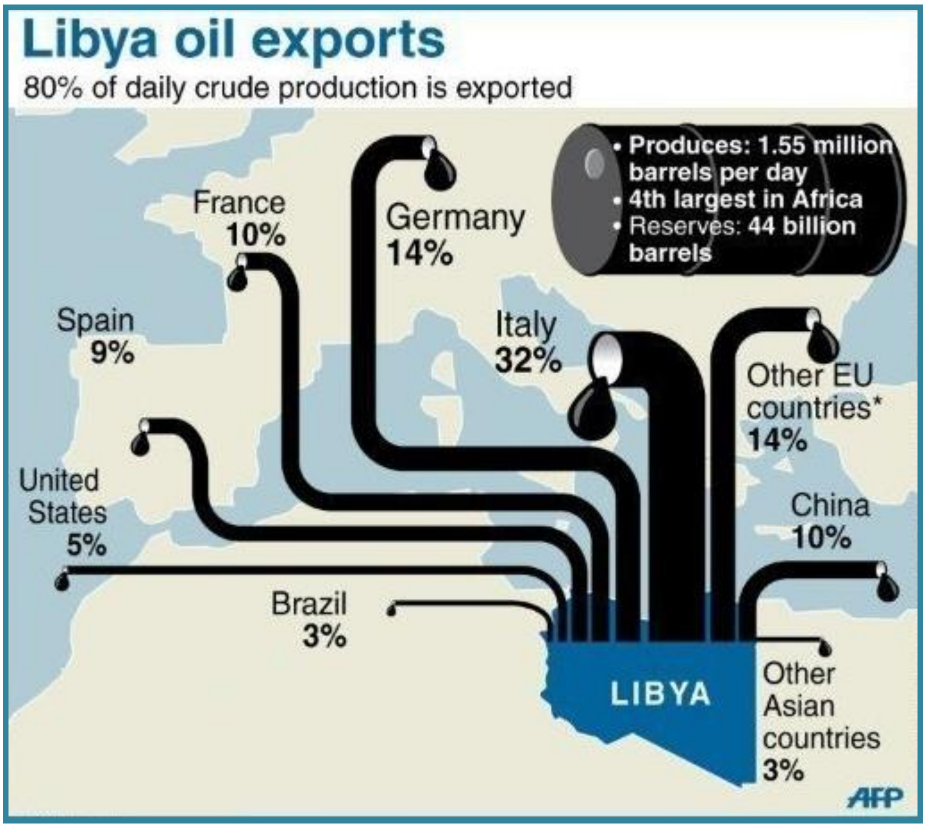


Figure 2.10: Map of Libyan oil exports
(Source: Ritholtz, 2015: 1)

As depicted in Figure 2.10, 80% of Libya's daily crude oil production is exported, primarily to Italy, Germany France, Spain, and other EU countries; 10% to China; 3% to other Asian countries; 5% to the US; and 3% to Brazil. Some of the oil and gas production companies in Libya are:

- Waha Oil Company
- Sirt Oil Company
- Arabian Gulf Oil Co.
- **Zueitina Oil Company**
- OXY-Libya Ltd
- Verenex Energy Inc.
- Woodside Energy (N.A) Ltd.
- ExxonMobil Libya Ltd.
- Chevron Intr'l Exploration & Production Co.

This case of the research study is Zueitina Oil Company, located in East Libya (Figure 2.11) (Al Jazeera, 2013). The remainder of Chapter 2 focuses primarily on Zueitina as the case under study.

Figure 2.11: Zueitina Oil Company location
(Source: Al Jazeera, 2013)

2.5 Zueitina Oil Company review

2.5.1 Zueitina background

Zueitina Oil Company (or Zueitina in short) is a joint venture in which the Libyan National Oil Corporation (NOC) and international oil companies *Occidental* and *OMV* are partners. In 2009, Zueitina employed 2,474 employees, of which 2,264 were local (ZOC, 2020). Various unrests and serious conflicts in Libya had a significant toll on the oil and gas sector of the country, especially with the sporadic closing of some of Libya's ports. This caused Zueitina's workforce to drop drastically to only 330 employees as of December 2020 (Zueitina LinkedIn).

Zueitina Oil Company is a Libyan state-owned company, with the main offices based in Tripoli. An array of oil operations is performed by Zueitina (ZOC, 2020). Statistics (Table 2.5; Table 2.6) indicate Zueitina's production numbers in a comparison between 2010/2011 and 2020. The oil terminal of Zueitina from which crude oil is exported, is situated 145 kilometres to the south of Benghazi (Libya's second largest city), at the eastern side of the Gulf of Sirte, which is in the Mediterranean Sea (OpenOil, 2013; VAOS, 2012). Zueitina Terminal is located about 850 kilometres from Libya's capital city, Tripoli (VAOS, 2012). In less volatile times, the Terminal’s export is calculated at approximately 20% of Libya’s total crude oil export (IncendiaConsulting, n.d.; OpenOil, 2013).

In 1986, Zueitina was nationalised as an incorporated company of Libya to carry out oil operations that were originally initiated in 1966 by Occidental International (ZOC, 2020). The Company’s directive is the efficient production of natural gas, crude oil, and condensates, with recovery that is optimum and cost that is minimum, while at the same time keeping into account the importance of environmental and reservoir production (ZOC, 2020; PETROLCOMET Services Co, 2009).

Zueitina maintains a competitive advantage with: (i) a team of highly qualified and experienced technicians and engineers; and (ii) infrastructure—from terminal to drilling facilities—that is developed fully (GulfTalent, 2016).

2.5.2 Sporadic unstable crude oil production of Zueitina

During the aerial bombardment and wide-spread conflict on the ground between organised armed forces across Libya, which ended with the capture and defeat of Muammar al-Qaddafi in August in 2011, oil production reduced drastically and almost ground to a halt (section 2.4.1.3), at a huge loss to the country. In 2012, Zueitina Oil Company restarted its crude production, pumping approximately 30,000 b/d, which was but 25% of its pre-war production of 1.6 million bpd (Faucon, 2011).

In 2015, the crude oil export terminal of Zueitina in the east of Libya was again closed for about six months due to unrest, but it reopened and proceeded to produce 70,000 bpd (EIU, 2015). Late in 2019, Zueitina crude oil port became once more under control of armed rebel groups, which led to the Terminal operating without environmental regulation and control (Environmental Justice Atlas, 2019).

2.5.3 Libya’s startling regeneration of oil and gas production

Provisional peace between rival groups (section 2.5.2) enabled the production of crude oil again in September 2020, and by the end November 2020, crude output has already skyrocketed to approximately 1.25 million bpd – which is almost 75%

as much as pre-war in 2011 with the battles during the fall of al-Qaddafi (El-Wardany, 2020).

> "The speed of the recovery took oil markets by surprise. It's also causing anxiety for the Organization of Petroleum Exporting Countries and allies such as Russia as they restrict global output to prop up crude prices. Libya is exempt from the cuts and currently supplies more oil than several of its OPEC peers. The so-called OPEC+ alliance is sure to weigh the impact of Libyan oil when it meets next week to assess its strategy as the coronavirus ravages fuel demand in much of the world" (El-Wardany, 2020: 1).

The question on everyone's lips in Libya however is whether the country will be able to sustain, or even surpass the pre-conflict levels of 2011, as huge amounts of money are needed to restore/upgrade the energy infrastructure needed to do so. "That in turn will require a lasting peace and political settlement" (El-Wardany, 2020: 1). With regard to Zueitina, the NOC requested the Company in September 2020 to recommence with its oil production and export via Zueitina Oil Terminal (Lee, 2020). It is important to note that the main supplier of LPG in Libya is Zueitina. Furthermore, the Company is perceived as a primary source for Libya's coastline system, as it allows the other operators to provide gas to the Zueitina and North Benghazi power plants. This, in turn, eases the distress of citizens in Benghazi city and surrounding areas, as it supplies natural, clean gas (Lee, 2020). Zueitina's port, together with the Brega and Hariga ports are therefore classified as "safe ports" (Lee, 2020: 1).

Figure 2.12: Zueitina's Port in Eastern Libya
(Source: Lee, 2020: 1)

2.6 Supply chain management

2.6.1 Overview of supply chain management

Hayes defines SCM as:

> "The management of the flow of goods and services and includes all processes that transform raw materials into final products. It involves the active streamlining of a business's supply-side activities to maximize customer value and gain a competitive advantage in the marketplace" (Hayes, 2020: 1).

Hayes (2020) continues by explaining that the supply chain manager's task is to coordinate the logistics (i.e. controlling and planning the flow of materials and goods through the manufacturing process of an organisation) of all aspects of the supply chain. Kenton (2019) views a supply chain as the system (or network) between a business and its suppliers, with the objective to disseminate and distribute a product to the end-user (buyer). This network or system encapsulates a variety of events or activities, objects/entities, individuals, information, and resources. Sotiris Zigiaris provides the following clear and concise definition of SCM:

> "Supply chain refers to a wide range of functional areas. These include supply chain management related activities such as inbound and outbound transportation, warehousing, and inventory control" (Sotiris, 2000: 35).

Rainer, Turban and Potter (2006) define the supply chain as the flow of services, money, information, and materials coming from suppliers through manufactures and warehouses to the final consumers. According to Croxton et al. (2001), managing the supply chain is all about integrating essential business processes, from the original suppliers all the way to the end user. Handfield (2020) posits that SCM is actively managing the supply chain functions, with the aim of maximising value for the customer, and achieving and maintaining a competitive advantage that is sustainable. It signifies conscious efforts by companies developing and managing supply chains competently and efficiently (Handfield, 2020).

Strong competition in the petroleum global market is a reality. The expectations of customers are extremely high, and new products with shorter life cycles are continuously introduced into the market; businesses are therefore compelled (if they want to be sustainable) to increasingly invest in their supply chains (Lu, 2011). Furthermore, enhanced ICTs—such as overnight/same-day deliveries, mobile technology and the Internet—in the transportation sector motivate businesses to continuously improve their supply chain and develop/obtain novel management techniques (Lysons & Farrington, 2006).

A typical (or generic) supply chain cycle (Figure 1.2; section 1.2) commences with (i) procuring raw materials, (ii) producing items from the materials in factories, (iii) shipping the products to intermediary warehouses, and finally (iv) transporting the products to retailers or customers (Scott, Lundgren & Thompson, 2011). Efficient supply chain strategies need to be considered frequently in order to continuously reduce costs and enhance service levels.

The logistics network in the chain comprises: (i) raw materials; (ii) depots (or warehouses); (iii) suppliers; (iv) centres for distribution and manufacturing; (iv) retailers; and (v) finished products moving between the various facilities (Macbeth, 2000).

In SCM, all facilities influencing the product costs or services affect customer satisfaction and need therefore careful consideration, from manufacturing and supplier facilities through to distribution centres, depots, stores and users (retailers) (Lambert & Cooper, 2000). In fact, given their influence on the performance of the supply chain, the customers' customers and the suppliers' suppliers are extremely important and need to be taken into account (Fisher, Vaidyanathan & Gu, 2009).

The primary aim of SCM is cost efficiency throughout the entire system, from commencement to the finished product. Therefore, the focus is not merely on reducing inventories or minimising transportation costs, but rather on applying a **systems management approach** for the entire supply chain. The business's functions and activities at various levels (operational, tactical and strategic) form part of the supply chain (Dedrick, Kraemer & Linden, 2011).

2.6.2 Supply chain management effects and implications

A core element to operational efficacy is managing the supply chain, as successful running of the supply chain contributes greatly to a company's success and to its customer satisfaction, also inside social settings such as medical missions that include different kinds of emergencies and disaster relief operations (Schecterle & Senxian, 2008, citing Aberdeen Group, 2008). Employers seek employees who are skilled and knowledgeable on SCM because of the important role it plays inside their organisations. SCM is crucial to a company's success and business operations for many different reasons (Van Hoek, 1999).

According to Sundarakani et al. (2010), SCM is globally important; in fact, the whole world is portrayed as a huge supply chain where major issues are touched on through SCM; for example, strategic partnership and the fast growth of multinational companies, sourcing and global expansion, fluctuating oil and gas prices, and other environmental affairs. For societies, SCM is essential to their infrastructure and foundation. SCM inside a well-functioning society may decrease pollution and create more job opportunities. Also, the standard of living may increase while the use of energy may decrease (Vachon, 2007).

Besides all of this, Armstrong (2010) alludes to the importance of the effect SCM has on business and mentions two ways in which it may influence business: firstly, through enhancing customer service, which can be done by making sure the right product or service is delivered to the customer on time with the desired quality; and secondly, SCM has a massive impact on the finances and profit of organisations. Companies value managers of the supply chain because of their ability to reduce large fixed assets usage, for instance, transportation vehicles, depots (or warehouses), and plants (or factories) in the supply chain. Faster product delivery increases the cash flow of a company. SCM furthermore offers different tools and techniques to assist with streamlining the risk of product non-availability and diagnosing various problems associated with this risk.

2.6.3 Supply chain management and business competitiveness

SCM is considered an important strategy for achieving competitiveness, since there are theoretical and practical limits to improving the internal processes of an organisation (Lambert & Cooper, 2000). Without improving the whole supply chain, which includes distributors and suppliers, the resources and efforts of the organisation will decrease, which will lead to competitiveness. Usually, the outbound and inbound logistic units are not perceived as partners but as service providers. There is always mistrust when they are treated and tied to the organisation with arms-length contracts (i.e. parties do not try to influence each other), and loyalty does not exist. Also, the supplier can be abandoned by the customer at any time, and vice versa (Talib, Rahman & Qureshi, 2011).

Major or significant changes in the business environment and customers demanding a variety of products compel companies to enhance their supply chains. Companies succeeding with faster time-to-market hold a competitive edge over their opponents – this competition is between their supply chains (Dedrick, Kraemer & Linden, 2011).

To increase competitiveness, companies may consider adopting lean manufacturing technologies such as the paperless (PO-less) continuous replenishment (CRP) of customers for their supply chain (IntelliChief, 2016; Yuliang & Martin, 2008; Asprova Corporation, 2008). Continuously ordering and delivering to their customers is a reversed role for suppliers. By reengineering the supply chain through adopting ICTs, the delivery of customer orders can be done while keeping low inventories and reducing system costs. The supply chain becomes thus less vulnerable to inaccurate forecasts and uncertainties (Yuliang & Martin, 2008).

In the banking sector, both managing the supply chain and adopting SCM thinking are important, as competition is increasing rapidly between the supply chains of banks. To state an example, the supply chain for credit cards comprises different players, and all of them need to perform efficiently and seamlessly so as to satisfy the ultimate cardholders or end-users at the end of chain (Keating et al., 2008).

Supply chain performance comprises various dimensions, which include information, flexibility, resources, innovativeness and productivity, to keep (often demanding) customers happy and satisfied (Bratić, 2011). Thus, continuously enhancing the performance of the supply chain has turned into one of the most important factors for companies to gain and then hold a competitive advantage (Bratić, 2011). In addition, Cai et al. (2009) clarify that the supply chain is a tool for dynamic management, and unceasing improvement of performance is essential for suppliers to be perceived as fierce competitors.

2.6.4 Supply chain management in the oil and gas industry

“Exploration → Production → Refining → Marketing → Consumer”

The chain above depicts the most important links in the supply chain of the oil and gas sector. The links portray the connection or intersection between materials and businesses/companies flowing through the supply chain. Each of the five stages comprises several functions/operations (Dabade & Kulkarni, 2019; Chima 2007).

> “**Exploration** includes seismic, geophysical and geological operations, while **production** operations include drilling, reservoir, production, and facilities engineering. **Refining** is a complex operation and its output is the input to marketing. **Marketing** includes the retail sale of gasoline, engine oil and other refined products” (Dabade & Kulkarni, 2019: 2).

Each section in the link may consist of a single business, but it may also represent the division of an integrated business. The shared focus throughout the entire chain of links in the oil and gas sector is financial, balancing advantages/profits and expenses/costs (Chima, 2007). Figure 2.8 visually depicts the supply chain in the oil and gas industry (Jasuja, 2009).

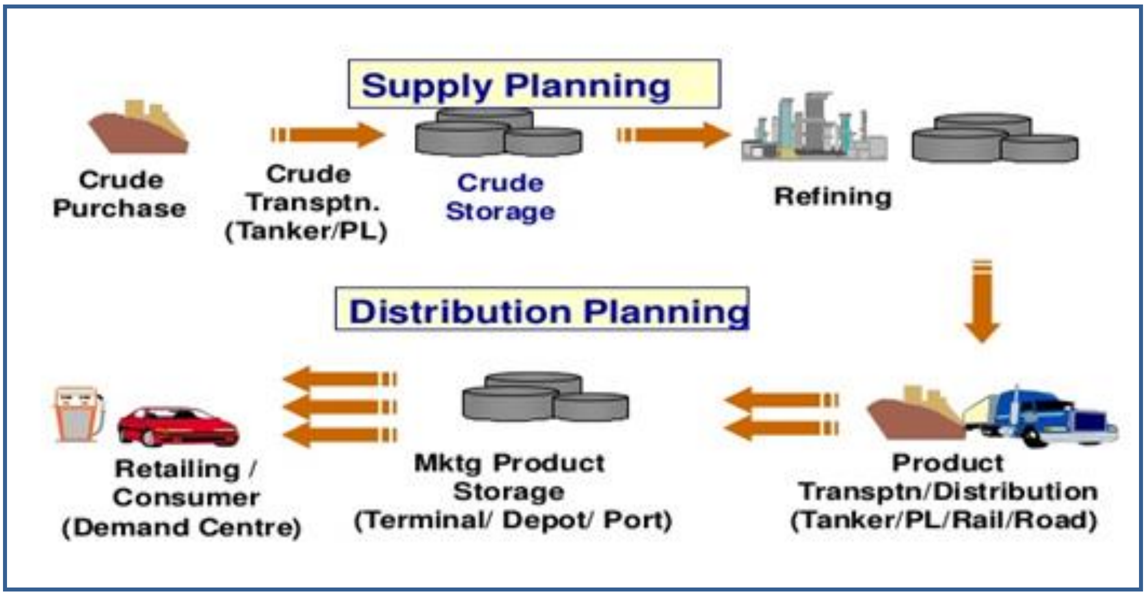


Figure 2.13: Supply chain in the petroleum industry
(Source: Jasuja, 2009: 1)

2.6.5 Impact of the supply chain in the oil and gas industry

According to Jasuja (2009), the following points explain the impact of the supply chain on the oil and gas sector:

- This sector has proven to be tremendously asset intensive
- Similar to other chemical businesses, the oil and gas sector's supply chain may account to 70% of a company's overall cost
- Supply chain optimisation at a strategic and operational level is a value creating opportunity for chemical companies and a potential source of competitive advantage
- A streamlined or optimised supply chain may bring in numerous benefits for a company, including:
    - Increased profits
    - reduced costs
    - High quality products
    - Faster processing along the chain
    - Faster product-to-market

2.6.6 Typical supply chain model for Libya's oil and gas sector

Figure 2.14 depicts the current status of the supply chain of Libya's oil and gas sector from the perspective of the researcher.

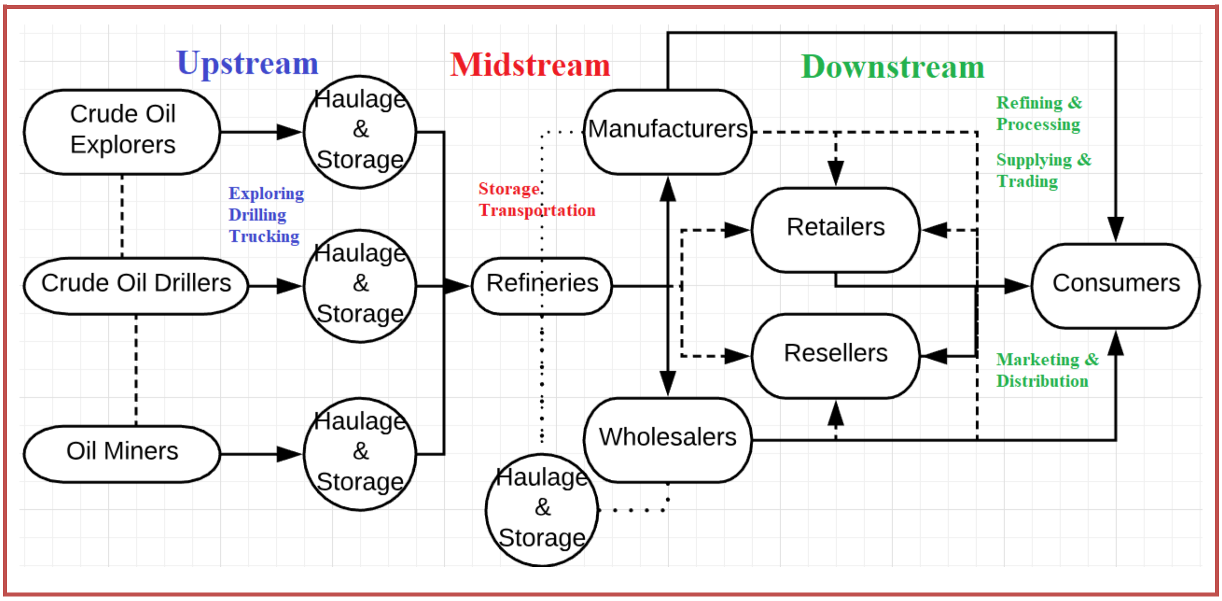


Figure 2.14: Typical supply chain model for the oil and gas sector in Libya (Source: Researcher)

The main activities of supply chain are: “purchasing, outsourcing, manufacturing, inventory control, distribution and customer services” (Shkoukani, Alnagi & Abulail, 2013: 1). When explaining **where** in the oil and gas supply chain a company is primarily positioned, three generic business terms are considered: “Upstream”, “Midstream”, and “Downstream”. A company that is more focused on servicing the end user will incline towards the downstream function, whereas a company that produces crude oil, inclines towards the upstream function. A company in the oil and gas sector may focus its efforts on “procurement and inbound logistics” (Shkoukani, Alnagi & Abulail, 2013: 2), which is upstream-centred, or on “distributors and customers” (Shkoukani, Alnagi & Abulail, 2013: 2), the selling-side, which is downstream-centred. A large number of companies in the oil and gas sector are referred to as “integrated”, because they amalgamate their upstream operations with their mid- and downstream activities, thereby covering the full supply chain (Chen, 2020a).

Each of the three industry sectors is discussed next, as visually depicted in Figure 2.14.

2.6.6.1 Upstream

> “Upstream is a term for the operations stages in the oil and gas industry that involve exploration and production” (Chen, 2020a: 1).

E&P (exploration and production) companies inclined towards the upstream sector are involved in processes and operations related to: (i) underground/ underwater exploration, which requires advanced, sophisticated technology and techniques, to find crude oil and/or fields of natural gas; (ii) test drilling of identified exploratory wells to determine an estimate of the potential resource; and if successful, (iii) operational wells are constructed to extract the natural, raw gas and/or the crude oil (Chen, 2020a; Lisitsa, Levina & Lepekhin, 2019; Shkoukani, Alnagi & Abulail, 2013). It is important to note that these wells are also operated by the upstream-inclined companies (Chen, 2020a).

In summary, the upstream sector of the oil and gas industry comprises all the functions/activities taking place in the field, namely, the *drilling* and *operating* of wells, mining oil sands, and trucking supplies. Furthermore, activities related to various environmental research studies and analysis may also be included.

2.6.6.2 Midstream

Midstream activities include the processing, storing, transporting and marketing of oil, natural gas, and natural gas liquids (Chen, 2020b: 1), but the two main midstream functions are *storage* and *transportation* (Lisitsa, Levina & Lepekhin, 2019). Means of transportation may differ from huge cargo ships that cross oceans, to trucking fleets, rail cars and small connector pipelines. For natural gas to be transported, it has to be compressed or liquefied, whereas with oil, it may be transported in its current state. Midstream companies may include those that concentrate primarily on operating and managing pipelines, tanker ships, or storage facilities (Chen, 2020b).

2.6.6.3 Downstream

> "The downstream sector refers to the refining of crude oil, and the selling and distribution of natural gas and products that are derived from crude oil" (Huslig, 2014: 1).

Downstream processes comprise the *conversion* of gas and oil into usable, consumable, sellable (i.e. finished) products (Chen. 2020c; Lisitsa, Levina & Lepekhin, 2019), i.e. outbound logistics. The oil and gas downstream sector participants primarily are: (i) petrochemical plants; (ii) refineries for oil; (iii) outlets (retail; petroleum distribution); and (iv) companies that distribute natural gas (Huslig, 2014). Retail marketing activities assist with moving (*transporting*) the final goods (products) from companies in the oil and gas supply chain to end users or retailers.

2.7 IT and its growing role in business

> "Information technology (or IT) is defined as the application of computers and Internet to store, retrieve, transmit, and manipulate data, or information… From small businesses run by a single person to huge multi-national corporations, the importance of information technology in any business setting is evident. Computer technology is used across the business world in every department and has become vital to business operations in the modern world" (South College, 2020: 1).

Over the past few decades, significant changes spread across the business sector on a world-wide scale, which spectacularly influenced the way business is conducted, especially with the advent of the digital age (Ristovska & Ristovska, 2014). Globalisation has forced organisations to seriously consider, apart from their cost, aspects such as the satisfaction of customers, product differentiation, adopting ICTs, thinking more innovatively, and optimising supply chains (Ristovska & Ristovska, 2014; Turban & Potter, 2006).

Advancements in IT have blown a trail for new ways of thinking and conducting business. The concept of “information digitisation” has led to businesses increasingly tapping into the advantages being offer by the application of numerous digital business tools (Hirt & Willmott, 2014). Business plans are reliant on IT, from small businesses to multibillion organisations. A company’s digital capabilities progressively shape its ability to create value (Hirt & Willmott, 2014). Not all information technologies might be new, but they are all used in a new way to optimise a company’s benefits (Hirt & Willmott, 2014; Melville, Kraemer & Gurbaxani, 2004).

Email was initially one of the most important services provided by the Internet as means of communication between a company’s staff, suppliers, and customers due to being inexpensive and relatively simply to use (Liang, Steinbach & Girod, 2001). As technology advanced, other Internet communication tools evolved in business communications, including live chat, Voice over Internet Protocol (VOIP) technology, video conferencing systems, and online meeting tools. All these services provided by the Internet assisted companies with saving money on communication and reducing the time needed to communicate with other businesses (Liang, Steinbach & Girod, 2001).

Already at the beginning of the millennium, companies were aware that in order to meet demand, they had to maintain sufficient inventory without spending more than what was required (Gérard & Fischer, 2000). IT systems were deployed to manage inventory, monitor the quantity of each item, and plan the ordering of additional stock to maintain sufficient inventory (Gérard & Fischer, 2000). In the late 2000s, Syntetos, Boylan and Disney (2009) emphasised the benefits of connecting a point-of-sale (POS) system to an inventory management system, as the POS system automatically updated the inventory count when the Sales

Department sold an item; thus, information flow between departments were established.

Today, companies are able store and share huge amount of data economically, and data can be accessed easy from anywhere in the world. The use of information technology has become a core element in numerous and different types of businesses.

2.7.1 IT applications in supply chain management

The supply chain has become the most changeable area of business operations in the last two decades. For companies to compete effectively, it is no longer enough to streamline their internal operations. Companies transform their supply chains into value chains in order to become successful. To achieve this value chain transformation, companies need to use their information technology systems effectively (Lancioni, Smith & Schau, 2003).

The following are some of the benefits using IT applications in the supply chain, as stated by Auramo, Kauremaa and Tanskanen (2005):

i) **Integration:** This refers to the extent of the connection between the activities of the organisation and its partners. Through IT, companies can simplify their decision making, thereby maintaining a greater exchange of information between supply chain partners and facilitating the integration of planning and production control activities.

ii) **Cost of storage and handling:** The total logistics costs can be divided into inventory and storage costs, transport and handling, and facilities (Stringfellow, 2020). The use of IT can reduce costs of storage and handling of the chain by better planning of these activities and the reduction of administrative roles, leading to a consequent reduction in staff and stock.

iii) **Competitiveness:** The use of IT enables initiatives that result in gains in competitive advantage for the chain, such as agility, speed of response to new market demands, increased flexibility, personalised service, greater customer satisfaction, and performance in different markets.

iv) **Speed:** IT provides the speed of information processing and the disposal of redundant activities, thereby increasing the speed of the process chain.

v) **Inter-organisational coordination:** This is the planning of actions between organisations, such as forming alliances between the chain components. Through IT, companies can achieve a higher level of coordination among members of the chain, thereby facilitating the exchange of information and collaborative planning.

The supply chain has been the most changeable area of business operations over the past two decades. For companies to compete with their rivals, their supply chain must be transformed into value chains rather than only streamlining their internal operations. Thus, the use of information technology applications becomes important.

2.7.1.1 Implications in logistics

Haley and Krishnan (1995) identified the Logistics business area as the most benefitting from the automation and cost reduction as enabled through the effective use of information technologies. IT is an invaluable resource for the success of initiatives in logistics and SCM. Thus, the use of IT in SCM is a prominent issue that has drawn much attention in the corporate world (Wu et al., 2005).

A growing number of companies invest in IT to increase the agility and efficiency of their supply chains. Approximately 5.5 billion US dollars were spent on information technology for SCM in 2003 (Gunasekaran & Ngai, 2004), and the trend is that these investments will increase even more. According to Vella (2012), the John Deere Company's use of SmartOps logistics management software has helped the equipment supplier to increase its on-time shipments to dealers from 63% to 92%, while reducing its inventory by nearly 1 billion US dollars.

According to Auramo, Inkiläinen et al. (2005), the use of IT is considered a prerequisite for the effective control of today's complex SCM. There are several IT applications available in logistics. However, the existence of gaps in terms of substantial experience and knowledge among professionals and those responsible for logistics processes is noticeable. Often, logistics professionals are unaware of the best system to adopt the characteristics of the second chain (Gunasekaran & Ngai, 2004). If not addressed, these gaps will prevent the realisation of the promises brought by combining SCM and IT.

In terms of information technology, there are several solutions available in logistics (Patterson, Grimm & Corsi, 2003). The main technologies that are used the area of logistics include: legacy systems; bar codes; smart labels; Computer-Aided Design (CAD); information systems based on the Internet or Web-based Information Systems (WISs); Business Intelligence (BI); Electronic Data Interchange (EDI); fleet tracking; the Automation system of Quality Control (AQC); Transportation Management System (TMS); Warehouse Management System (WMS); Customer Relationship Management (CRM); Product Development Management (PDM) system; Manufacturing Execution System (MES); Radio Frequency Identification (RFID); Supply Chain Planning (SCP) system; Demand Forecasting System (DFS); and Enterprise Resource Management (ERP).

IT implementation in logistics has significant benefits to companies; it provides faster information access and response, improves efficiency, and reduces logistics processes. The only perceived barrier to the adoption of IT applications is the high implementation cost.

2.7.1.2 Implications in warehousing and optimising inventory

A warehouse can be defined as a place used for the storage or accumulation of goods. The storage function can be carried out successfully with the help of warehouses used to store the goods. Warehousing can also be defined as assuming responsibility for the storage of goods. By storing the goods throughout the year and releasing them as and when needed, warehousing creates time utility (Chand, 2014). Warehousing and inventory management plays an important role in the supply chain process, and IT is the crucial drive for successful warehouse operations.

IT applications enable companies to manage the inbound flow of goods, the outbound order fulfilment, and the inventory storage successfully, and to ensure that the material flow is enhanced in order to meet customer demand within a reasonable cost. The IT applications allow cost professionals to track, capture, measure, and analyse all costs associated with managing inventory items when it moves through the supply chain (Chiang, Lin & Chen, 2011).

In traditional ERP systems, managers and operators are required to navigate to different areas of the application depending on the tasks they are performing. The users not only have to look for what needs to be done, they also need to access different areas of the system to perform their work (Ruiz et al., 2011).

Shiau and Lee (2010) state that by using new IT applications for managing inventory, the pending work can be brought to the forefront, thereby guiding operators and managers through the system based on their responsibilities and roles as well as the outstanding workload. Furthermore, by using modern IT applications for warehouse management, the managers can be provided with native embedded analytics and key performance indicators that allow them to set and measure operational goals as well as to track and resolve possible problems in the warehouse (Shiau & Lee, 2010).

A single and common view of outbound shipping and picking, and inbound receiving can be provided when using IT applications. Warehouse managers can identify problem areas quickly and delve deeper into the details to solve issues. Managers will also have the ability to compare metrics from the current period with a prior period to identify existing problems. Key performance indicators (KPIs) can enable warehouse managers to stay up-to-date with important issues (Tan, 2008).

Deciding on inventory quantities and managing inventory policies have become extremely difficult due to an increase in demand uncertainty, competition, outsourcing, and other challenging economic conditions. Organisations take into account the lead-time variability, supply and demand of their entire supply chain. According to Scavarda et al. (2012), the use of IT applications in companies has led to improved customer service levels, more balanced revenues, and easier manageable inventory budgets. Furthermore, the use of IT applications for optimising inventory assists companies in determining the best optimal solution through leveraging risk-pooling techniques, it enables managers to make better and faster decisions, and it leads to cutting-edge stochastic improvement.

Liu, Wen and Qian (2012) illustrate that firms have to account for all variability in their supply chain in order to optimise their inventory investment. Demand variability is caused by the introduction of new products, by promotions, by forecast errors, and by various seasonal factors. Unreliable delivery by suppliers, product quality, other supplier performance issues, and uncertainties in lead time all lead to supply variability.

The capturing of demand and supply variability enables companies to avoid limitations brought on by deterministic optimisation techniques and to obtain accurate decisions on the required inventory investment needed to meet the objectives of the company's customer service, all within reasonable cost (Connolly, 2008).

A company usually has different customer service targets and must therefore have the right information to focus on inventory investment in terms of their most profitable customers or products. Companies make use of IT applications to determine their most profitable targets and clarify the different service levels as needed for each product and customer (Li et al., 2011).

The time element is one of the problems companies need to take into consideration when developing an inventory policy. According to Shapiro and Wagner (2009), inventory stores should not be constant all the time because of seasonal impacts, variations in product quality, and changes in product life cycles, all of which require that inventory be hedged differently over time. IT applications can assist executives in analysing the planning of information because these applications have the ability to facilitate the integration of the various supply chain sections.

The following are some results from well-known companies that used IT applications in their warehouses (Shapiro & Wagner, 2009):

i) **Agilent,** the best measurement company in the world with net revenue of US$6.6 billion and 20,000 employees has improved their inventory accuracy to nearly 99% after using warehouse software solutions.

ii) **Metalsa,** a truck and bus body manufacturer has reduced their inventory write-offs by 10% after using inventory management software.

iii) **Changan Automobile**, the Chinese automobile giant with 15 vehicle and engine factories and around 50,000 employees saved US$3.4 million on their shipping and inventory by using a warehousing application.

iv) **Royal Appliance** manufacturing company, founded in 1905 and well known for its vacuum cleaners products, has managed to improve the accuracy of inventory location from 50% to 98% by using IT applications in their warehouses.

v) **Polpharma,** the international pharmaceutical company, trusted by their patients for more than 75 years, managed to reduce their staff needs by 50% because of the use of IT application in their warehouses.

IT applications play vital role in warehousing and inventory optimisation. Because of the importance of warehousing to a business, many companies invest in IT applications related to warehouse management and inventory optimisation.

2.7.1.3 Implications in procurement

Organisational spending on suppliers is increasing annually; therefore, Procurement departments are working hard on saving working capital and increasing profitability (Humphreys et al., 1998). However, each success makes the following year more challenging, as Procurement departments should continue saving even more while meeting targets using less resources. Purchasing departments should take advantage of every sourcing opportunity that arises through reducing manual processing in order to deliver repeatable savings and adding the best possible value (Humphreys et al., 1998).

Traditional purchasing processes are often manual and inefficient, requiring paper catalogues, phone calls, e-mails and faxes to obtain the right products from approved suppliers. In best practice, organisations build relationships with their best suppliers in the safest supply markets and avoid accepting arbitrary boundaries of trading communities.

In 1996, the University of Pennsylvania started to use Oracle applications to transform the Procurement Department into a value added department, and this helped the University to save around 74 million USD on products and services purchases (Min & Galle, 2003). The University used an integrated financial and procurement system in 2002, which led to a 40% reduction in invoice processing time and a reduction of nearly 98% in the cost of invoice processing. The University marketplace and requisitioning system is being used by up to 1,700 people, and this has reduced the prices of procurement by nearly 35% (Min & Galle, 2003).

The electric motors and electronic instruments factory AMETEK Inc. implemented one of the IT applications to streamline and standardise their procurement processes (Min & Galle, 2003). Their employees use the application to manage spending, which is nearly 80 million USD. They have managed to achieve a reduction of approximately 14%. In addition, by using the system, AMETEK Inc. expects to reduce spending in repairs, maintenance and operations by approximately 10% (Min & Galle, 2003).

Sandia National Laboratories, an engineering and nuclear research facility, has an approximate purchasing spending of 600 million USD annually (Min & Galle, 2003). They link their buyers directly with suppliers using an IT application to make their Procurement Department more efficient. The IT application also provides their employees with self-service ordering, which has assisted them in achieving an 83% increase in buyer productivity, while the time of obtaining the supplies has become shorter. This causes the employees to focus more on the job aspects in terms of science and engineering (Min & Galle, 2003).

Another good example is Ingersol Rand, one of the leading companies that provide solutions and innovations for different manufacturing markets (Sanders, 2005). To reduce the efforts of their buyers, the Company implemented an IT application for their Procurement Department. The Company's interaction with their suppliers has become faster and more accurate and the administration burden has been reduced. There was also a 75% decrease in calls for supplier support reported. The Company's planner-buyer productivity has improved by approximately 50%, while their order cycle time has decreased by nearly half of what it originally was (Sanders, 2005).

2.8 Summary

The literature obtained from various sources on the oil and gas sector globally and in Africa was reviewed, discussed and interpreted in this chapter. The chapter started with a world oil and gas review, and then the field of investigation was strategically narrowed down to a world and gas review of Africa, the status of Libya's oil and gas industry, where after the focus shifted to Zueitina Oil Company in Libya, the case of this study. A model of the oil and gas sector supply chain in Libya, designed by the researcher, was presented and discussed. SCM and its importance in the current era were elaborated on, and the importance of information technology and the impact it has on business when used effectively, was indicated.

Chapter 3 provides a detailed discussion on the research design, data collection, and data analysis of the Zueitina case study.

CHAPTER 3: RESEARCH METHODOLOGY

Figure 3.1: Graphical representation of Chapter 3

3.1 Introduction

This chapter provides an in-depth discussion of the research methodology, philosophy, approach, and strategy that form the underlying basis for the choice of research design adopted to conduct this study. The concepts and techniques associated with a qualitative study are elaborated on within the specified scope of the study. The chapter further deliberates on the sampling techniques applied to select the participants, and the methods used to analyse the data and present the findings.

3.2 Definition of research

"The word 'research' originated from the old French word *recerchier* meaning to search and search again" (Kabir, 2016: 1). There are different definitions of research because researchers conduct different types of research (Connaway & Powell, 2010). The Merriam-Webster Online Dictionary (2019) describes research as a cautious and meticulous investigation, thoughtful and reflective inquiry, gathering of data regarding a specific subject, and as:

> "…an investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws" (Merriam-Webster Online Dictionary, 2019: 1).

Research is also described as a methodical and innovative study that is performed, with the focus on humans, culture, and/or society, to contribute new outcomes/applications/insight to the scientific body of knowledge (OECD, 2015). Naidoo posits that,

> "In science, research is the diligent systematic enquiry into nature and society to validate and refine existing knowledge and to generate new knowledge" (Naidoo, 2011: 47).

Creswell (2002: 23) posits that research "is a process of steps used to collect and analyse information to increase our understanding of a topic or issue". Three steps are identified, namely: (i) posing a question; (ii) data collection in order to address the question; and (iii) presenting an answer to the question (Creswell, 2002).

3.3 Research attributes

Research is the process of gathering, analysing, and then transforming data into information, i.e. into answers to the research questions posed (Kumar & Kumar, 2014). The authors identify a number of attributes or characteristics vital to this process for it to be described as research:

i) **The process needs to be regulated:** Many factors exist that may affect the outcome or solution of a process/event in real life. A certain occurrence is seldom seen as being a one-on-one relationship and the intricacy of relationships varies greatly. The majority of outcomes are a balance of communication between various factors and interactions. It is therefore critical to connect the causes and effects found in a research study. In reality, this is not easy to accomplish, which is especially true for the Social Sciences discipline (Kumar & Kumar, 2014).

ii) **The process needs to be rigorous:** It is vital that the researcher is dependable, principled, and honest to make sure that the processes followed to develop solutions to research questions are appropriate, valid, and reasonable (Kumar & Kumar, 2014).

iii) **The process must be valid and verifiable:** This indicates that the findings and conclusions derived by the researcher are accurate and can be verified or replicated by other researchers (Kumar & Kumar, 2014).

iv) **The process needs to be methodical:** The steps/processes performed during a research study should follow a rational, sound, coherent and specific sequence (Kumar & Kumar, 2014).

v) **The process must be analytical:** Vigilant, cautious, exact, and measured judgement needs to be maintained at all times (Kumar & Kumar, 2014).

vi) **The process should be experimental:** The evidence collected from actual experiences using solid, rigorous, and valid data collection techniques will result in a valid conclusion (Kumar & Kumar, 2014).

3.4 Research design

> “Research design is defined as a framework of methods and techniques chosen by a researcher to combine various components of research in a reasonably logical manner so that the research problem is efficiently handled. It provides insights about ‘how’ to conduct research using a particular methodology” (Bhat, 2019: 1).

Research design can be described as the methodical planning of research processes in order to derive sound, scientific conclusions (Reis & Judd, 2000). Grove, Burns and Gray (2012: 214) define research design as “a blueprint for conducting a study with maximum control over factors that may interfere with the validity of the findings”. According to Polit, Beck and Hungler (2001), research design is perceived as an all-inclusive plan on gathering and analysing data, and this plan contains requirements on both the external as well as the internal validity of the research. Design points to the choices made by the investigator or researcher when preparing or getting ready for the study (Schurink, Fouché & De Vos, 2011). Through research design, the researcher is able to foresee appropriate decisions that will lead to sound results. It is a set of instructions or guidelines on how to reach a specified goal.

Saunders, Lewis and Thornhill (2009: 98) use the “research onion” design model to clarify and portray the research process (Figure 3.2). ‘Newer’ research onion designs have been introduced by the authors in consecutive books, but the fundamentals are the same. According to the authors, a social sciences research study commences with the outer layer, and then each layer is addressed consecutively until the inner layer is reached. The layers from the outer to the inner part of the research onion are as follows: research philosophy, approach, strategy and choices, as well as time horizons and techniques and procedures that include data collection and analysis methods (Saunders, Lewis & Thornhill, 2009).

This study adopted the 2009 research onion design of Saunders, Lewis and Thornhill as portrayed in Figure 3.2.

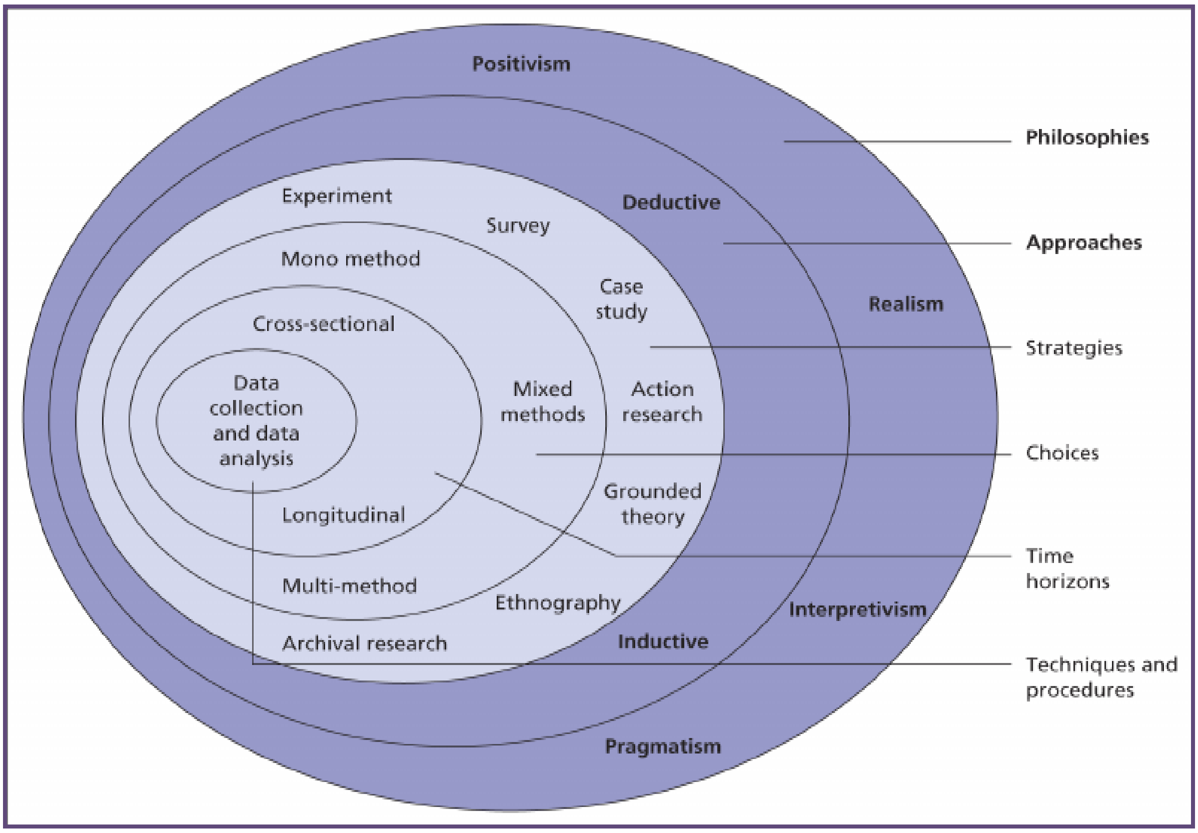


Figure 3.2: Research onion design model
(Source: Saunders, Lewis & Thornhill, 2009: 108)

Each layer in Figure 3.2 relevant to this study is discussed next.

3.4.1 Research philosophy

The thought processes of the researcher on a specific study can be captured to form the scientific philosophy of the research (Zukauskas, Vveinhardt & Andriukaitienė, 2018). Bandaranayake (2012) posits that research philosophy is the overarching term for creating or developing new knowledge and the characteristics of this knowledge. It supports the researcher in terms of evaluating different methods or methodologies and then choosing the method that is most suitable to their particular field (or area) of research. In addition, a research philosophy enhances the researcher's self-assurance to uncover an appropriate method/way to do the research (Bandaranayake, 2012).

Research philosophy can take on an ontological and epistemological stance. Ontology concentrates on research questions such as, "What is reality?", and "How do we recognise what is real?" (Bashir, Syed & Qureshi, 2017). This stance stems from the Greek word *ontos*, meaning 'being' or 'that which is', and the word *logos,* meaning ‘the study of’. It therefore points to research performed on reality, being, or existence, and it results in queries/questions regarding the premises and assumptions made by the researcher regarding the way the world functions.

Epistemology points to the investigation into the methods the researcher adopts and applies to derive meaningful and sound information. It answers the question, “How do we know?” (Landauer & Rowlands, 2001). It captures the character of beliefs, the forming or formulating of beliefs, the reliability of the senses, and rational thinking, as well as sentiments, emotions, recollections, ideas, and comprehension. Epistemology furthermore concentrates on the way our cognition relates to real-life, and the soundness of these relations (Landauer & Rowlands, 2001). Stahl (2013) highlights the significance of comprehending the concept of research as well as the aim and objectives of research before adopting a suitable epistemological stance.

In total, four main research philosophies are recognised by Saunders, Lewis and Thornhill (2009), namely, positivism, realism, interpretivism, and pragmatism, which are discussed next.

3.4.1.1 Positivism

Positivism is a philosophical theory taking on the premises that specified positive information is founded on natural phenomena, and on the associations and characteristics of these phenomena. Thus, knowledge acquired from sensory experiences, interpreted and constructed through reasoning and logic, is the sole source of this information (Macionis & Gerber, 2010). Positivism holds that civilisation (i.e. our physical world), behaves in alignment with general rules (Sala & Maldonado, 2010), and tends to include objective, deductive, and quantitative research. Characteristics associated with positivism include “experience, the system of facts, objective, human, and natural phenomena” (Pawlikowski, Rico & Van Sell, 2018: 1).

3.4.1.2 Realism

Realism is founded on the premise that reality is not dependent on the cognitive processed of our human mind, and that in order to grow one’s knowledge, a scientific approach needs to be followed. Realism is categorised into direct and critical realism (research-methodology.net, 2019a).

Direct realism is summarised as, “What you see is what you get” (Saunders, Lewis & Thornhill, 2012), meaning it depicts our world through personal human sensory experiences. Contrary to this, critical realism contends that humans experience the impressions (or sensations) and images (or pictures, metaphors) of the real world, and that these impressions and pictures can be misleading as they usually do not represent the real world (Novikov & Novikov, 2013).

Thus, phenomena that can be observed, deliver reliable and trustworthy facts and data. When this data are insufficient, our sensations are inaccurate, thus pointing to direct realism. On the other hand, phenomena generate sensations, and these impressions are open to misinterpretation, thus pointing to critical realism (Gómez & Mouselli, 2018).

3.4.1.3 Interpretivism

Interpretivism is perceived as the opposite of positivism. It incorporates human interest into a research project, because the researcher interprets the components, elements, or concepts of the study (research-methodology.net, 2019b). Myers (2008) posits that access to the real world can only be obtained through social constructs, and therefore interpretivism is encapsulated in social phenomena and subjective connotations. The focus is on the intricacies (or details) of a condition or situation and the reality behind these intricacies, and leans towards subjective, inductive, qualitative research. Interpretivism has its foundation on the naturalistic approach of data gathering, which includes methods such as observations and interviews, while secondary data research is also prevalent. With interpretivism, meanings arise or materialise generally when the research process draws towards an end (research-methodology.net, 2019b).

3.4.1.4 Pragmatism

The Collins Dictionary defines pragmatism as “thinking of or dealing with problems in a practical way, rather than by using theory or abstract principles” (collinsdictionary.com, 2019b). According to Kaushik and Walsh (2019), pragmatism incorporates a multiplicity of methods. It is regularly associated with mixed-methods or multiple-methods; however, this philosophy emphasises effects of research and focuses on the research questions instead of on the methods (Kaushik & Walsh, 2019).

> "Pragmatism as a research paradigm refuses to get involved in the contentious metaphysical concepts such as truth and reality. Instead, it accepts that there can be single or multiple realities that are open to empirical inquiry" (Creswell & Clark, 2011, cited by Kaushik & Walsh, 2019).

Depending on the research question, phenomena that can be observed and/or meanings that are subjective can offer acceptable, adequate knowledge. The focus of pragmatism is on applied research, where various perspectives are combined or integrated to assist the researcher with interpreting the data (Gómez & Mouselli, 2018: 19).

3.4.1.5 Philosophy selected for this research

This study adopted interpretivism as research philosophy, because the study commenced with research questions. Next, data were collected by means of interviews and focus groups, where after findings were derived and interpreted, and themes and sub-themes emerged, which assisted with the development of the Information Technology Optimisation Model.

With interpretivism, it is imperative that the researcher, as a social actor, values, welcomes and understands dissimilarities between people. Moreover, interpretivist studies may utilise multiple methods to reveal and portray various aspects of a matter (research-methodology.net, 2019b).

3.4.2 Research approach

According to Williams (2018), there are primarily two research approach categories, namely deductive reasoning and inductive reasoning. It is essential to comprehend these two approaches in order to enhance the efficiency and correctness of a research study. The inductive and deductive approaches differ from each other, as indicated in Figure 3.3.

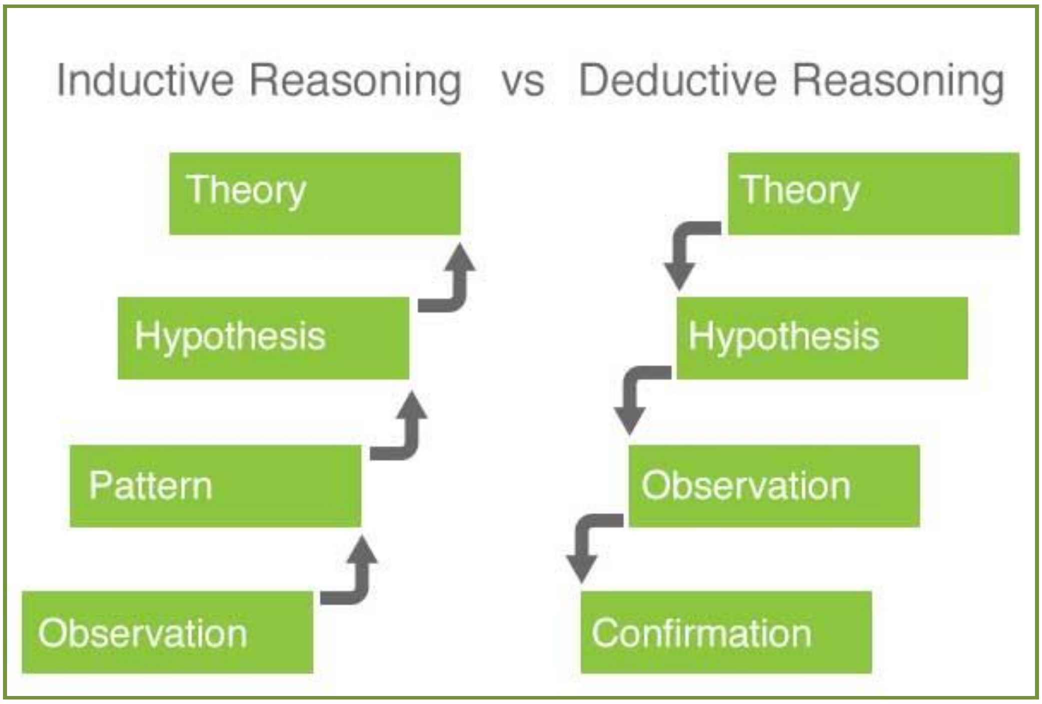


Figure 3.3: Inductive reasoning vs. deductive reasoning
(Source: Elmansy, 2016: 2)

Deductive reasoning is aligned to positivism, and inductive reasoning is aligned to interpretivism. To substantiate the selection of a suitable research approach, the researcher must be able to understand and differentiate clearly between these two approaches (Williams, 2018). Gabriel (2013) maintains that the primary difference between the two approaches lies in the notion that deductive reasoning tests a theory, while inductive reasoning develops or generates a new theory which emerges from the data and related findings. Unlike the deductive approach,

> "Inductive reasoning is not logically rigorous. Imperfection can exist and inaccurate conclusions can occur, however rare; in deductive reasoning the conclusions are mathematically certain" (TechTarget, 2019a: 1).

Inductive reasoning applies to possibility (or probability) rather than certainty so as to make a point. For example, the following is an inductive argument:

i) Ninety percent (90%) of the time Faruk goes to the shop, he buys milk and bread.
ii) Faruk is going to the shop today.
iii) Thus, Faruk is probably going to buy milk and bread.

There is a chance that the conclusion will turn out to be not true, even though both of the premises may be factual. However, it is likely that Faruk will indeed buy milk and bread. This is in complete contrast to deductive reasoning, which leads to a certain conclusion, assuming that all premises are true and that the logic is valid.

This study employed the inductive research approach, because inductive reasoning is a logical process that assimilates multiple assumptions, all trusted to be true or found true most of the time, in order to reach a specific conclusion.

3.4.3 Research strategy

Saunders, Lewis and Thornhill (2009: 600) define research strategy as “the general plan of how the researcher will go about answering the research questions”. The research strategy specifies the inclusive direction and progression of the study (Remenyi et al., 2003). An appropriate and applicable research strategy has to be adopted, founded on the (i) research questions and corresponding objectives, (ii) philosophical stance of the researcher, (iii) extent and degree of the existing knowledge available on the topic of the study, and (iv) the time and resources available (Saunders, Lewis and Thornhill, 2009).

The research onion design model (Figure 3.2) depicts the following strategies that can be adopted for collecting data: experiment, survey, case study, action research, grounded theory, and archival research. This study has adopted both the survey and case study as strategies, which will be discussed next.

3.4.3.1 Survey

Check and Schutt (2012: 160) define survey research as “the collection of information from a sample of individuals through their responses to questions” Survey research may employ quantitative strategies such as questionnaires containing numerically ranked questions, qualitative research strategies such as open-ended questionnaires, or both strategies, known as mixed-methods (Ponto, 2015). The most common data collection methods are questionnaires, interviews, and focus groups.

i) Questionnaires

Typically, a questionnaire is an instrument (list of questions) that is administered to a research study's participants (Ponto, 2015). Questionnaires can be given to the respondent to complete (i.e. self-administered) or administered by the researcher/ professional who poses the questions to the participant and then records the answers on paper (and with a voice recorder is permission is granted) (Ponto, 2015). Questionnaires may be administered individually or in a group, and typically contain a sequence of items reflecting the research aims. Questionnaires may also include demographic questions (Ponto, 2015). Questionnaires can be compiled on paper and then mailed to participants via snail mail, or sent in electronic format using email or an Internet-based program such as SurveyMonkey (Ponto, 2015).

ii) Interviews

When comparing interviews to questionnaires, the perception is that interviews are more personal, investigative and inquisitive. Unlike interviews, questionnaires do not offer sufficient freedom in terms of posing follow-up questions to further explore the answers of the respondents.

Interviews may be performed telephonically, using the computer, or in person, with the advantage that the researcher is able to detect and classify the non-verbal responses of the respondent visually, thereby clarifying the intended question. An interviewer can use probing comments to gather further information on a topic, or ask for clarification and a motivation when the interviewee's answer is to vague (Singleton & Straits, 2009). A disadvantage of interviews is that it can be costly and time intensive, which makes it less feasible of practical when the samples are large (Ponto, 2015). According to Mann and Stewart (2000), conducting telephone interviews has advantages as well as disadvantages, which are indicated next.

Benefits:

- Information gathering via a telephone interview is fast
- There is some form personal contact between the interviewer and respondent, similar personal interviews
- People all over the world can be interviewed

- Telephone interviews grant the researcher access to respondents at dangerous sites such as war zones or places where diseases are prevalent and common (Mann & Stewart, 2000)

Shortcomings:

- The interviewer cannot observe the respondent's body language
- In might be that some respondents do not have (access to) telephones (Mann & Stewart, 2000)

This research adopted **surveys** as qualitative research strategy in the form of focus groups and telephone interviews.

Furthermore, the researcher adopted qualitative research to collect information from executives working at Zueitina Oil Company in departments that form part of the Company's supply chain. This was done through telephone interviews using a set of prepared questions as guideline during these interviews. The researcher selected the telephone interview approach rather than questionnaires, as the staff members who are knowledgeable on IT applications in supply chain management are usually the managers. Furthermore, interviews via telephone provided the researcher the opportunity to access data fast and easily, and it offered the researcher a more insightful perspective on the topic that was studied. A further reason for selecting qualitative research is that the samples are investigated in their natural setting, making the interview an important technique in collecting primary data (Sutton & Austin, 2015).

In addition to telephone interviews, focus group discussions were conducted with Zueitina executives, who were all managers of departments involved in the supply chain of the Company during the study. The interview guide (Annexure A) containing a set of 15 prepared questions was used during the data collection phase.

3.4.3.2 Case study

> "Case studies are based on an in-depth investigation of a single individual, group, or event to explore the causes of underlying principles [and] can be single or multiple case studies" (PressAcademia, 2019: 1).

The researcher adopted a qualitative case study approach, with Zueitina Oil Company as the case. Selecting Zueitina as the case was based on the knowledge that the Company has a developed supply chain and continuously invests in IT applications for its supply chain. Furthermore, Zueitina is the second largest company in the oil and gas sector in Libya; the Al-Waha Oil Company is the largest. It is important to note that the results/outcomes of a case study can usually not be generalised; thus, in this case, the proposed IT Optimisation Model cannot be applied to other oil and gas companies.

Initially, the researcher made contact via telephone with the Company and presented the theme of the project, the research objectives, and the way in which the organisation could participate. The Company submitted the contact details of officials to be interviewed telephonically to the researcher, with the requirement that the interviewees work in SCM and actively use information technologies. Each telephone interview lasted approximately an hour. The researcher personally administered and recorded the questions in Arabic. The responses were translated into English, where it was transcribed.

3.5 Research methodology

Scholars present two main research methodologies for conducting research: quantitative (statistical) and qualitative (narrative) research. When both these methodologies are followed in a single research project, it is known as mixed-methods research.

3.5.1 Quantitative research methodology

In quantitative research, data can be measured and calculated, and the focus is on objectivity (Queirós, Faria & Almeida, 2017). Generally, samples tend to be large and are believed to be representative of the population; the statistical results are therefore accepted “as if they constituted a general and sufficiently comprehensive view of the entire population” (Queirós, Faria & Almeida, 2017: 370, citing Martin & Bridgmon, 2012). Statistics and Mathematics are typical disciplines making use of quantitative research, and the analysis and generalisation of the outcomes/results is of fundamental importance to quantitative researchers.

3.5.2 Qualitative research methodology

The qualitative research methodology focuses on assessing opinions, attitudes and behaviour (Kothari, 2009). The insights and impressions of the research forms the core, and non-quantitative results are generated.

> "Qualitative researchers have to use key principles of research design, such as, linking the research questions to the methodological approaches, considering issues of analysis and data collection as integrated, and being clear about the purposes of the research" (Haradhan, 2018: 7, citing Mason, 1996).

In general, focus group interviews and in-depth one-on-one interviews are the archetypes of qualitative research. The concentration is on collecting data on the perceptions and opinions of individuals or group(s) to produce factual outcomes. Qualitative research is furthermore manipulating and representing data obtained from observations to explain and describe what these observations portray. It is used in the social and natural sciences (Kothari, 2009). The findings of a research study are influenced by the quality of the research methodology (Pappa et al., 2002).

Patton (1990) describes and explains the characteristics of qualitative research in data collection as well as design strategies as follows:

In design strategies:

- **The investigation is naturalistic** (true-to-life), meaning the researcher explores real life situations without restrictions or limitations on the derived findings
- **The flexibility of developing design is important,** therefore the researcher follows new findings as they emerge, thus preventing becoming restrained by rigid designs that reduce responsiveness
- **Sampling should be focused,** thus individuals/groups, events, companies, and cultures are considered and chosen for case studies because of the in-depth and wide-ranging knowledge they possess and the useful indices of the phenomenon of interest they offer (Patton, 1990)

In data collection strategies:

- **The data should be qualitative in nature,** thus, explorations need to be done in depth, observations should provide detailed descriptions, interviews need to collect the personal experiences and perceptions of individuals, and documents should be reviewed (Patton, 1990)

For this research, the qualitative research methodology was employed, as the samples were investigated in their natural setting and the interview played an important role in gathering the primary data (Denzin & Lincoln, 2002). Information on the experiences of executives (managers) was collected through telephone interviews.

3.5.2.1 Qualitative research: Benefits and shortcomings

Bird, Nicholls and White (1995) identify the following benefits and shortcomings of qualitative research:

Benefits:

- The experiences of an individual can be explored even when it is complicated
- Not many assumptions and limitations are placed on the data to be gathered, and when restrictions are required, it can be set out clearly. For example, when a quantitative study aims to measure depression by using an interview guide of ten (10) questions based on a 1-5 scale, data can only be gathered using the ten predetermined questions
- Respondents provide data in their own individual way using their own words
- Qualitative studies enable the researcher to conduct more in-depth data collections on respondents
- Topics that cannot be quantified easily, for example individual experiences, can be explored by means of qualitative research (Bird, Nicholls & White, 1995)

Shortcomings:

- It remains a challenge to determine the dependability, consistency, trustworthiness and validity of linguistic data

- It remains difficult to determine the scope of influence that the researcher exercises over the findings and outcomes of the study
- The recording and transcription of interviews are generally time-consuming and expensive
- Open questions may lead to ‘data overload’, which takes time to analyse (Bird, Nicholls & White, 1995)

3.5.2.2 Qualitative research process evaluation

To maintain the quality and ethics of a research process or study, various principles have been put in place that should be followed. The main principles are as follows:

i) **Credibility**: When the responses of the interviewees are clear and true, the research is viewed as credible. For the Zueitina study, the researcher translated interview questions from English to Arabic for the best possible understanding (Collis & Hussey, 2013). For the transcriptions, the researcher translated the answers back to English.

ii) **Transferability**: When the findings can be applied to other situations similar to those in the study, the research is viewed as transferable (Collis & Hussey, 2013). To capture the responses/situations correctly, transferability requires smooth/easy explanation, interpretation, and decryption, as well as an in-depth analysis of the data to deliver comprehensive results (Schwandt, Lincoln & Guba, 2007).

iii) **Dependability**: Research is viewed as dependable when a clearly documented and systematic process has been followed (Collis & Hussey, 2013).

iv) **Conformability**: Conformability is achieved when the research is unbiased and the responses of the interviewees are in alignment with the findings (Schwandt, Lincoln & Guba, 2007).

3.5.3 Differences between qualitative and quantitative research

Table 3.1 depicts the differences between qualitative and quantitative research.

	Qualitative	Quantitative
Purpose	To describe a situation.	To measure magnitude.
Format	No pre-determined response categories.	Pre-determined response categories
Data	In-depth explanatory data from a small sample.	Wide breadth of data from large statistically representative sample.
Analysis	Draws out patterns from concepts and insights.	Tests hypotheses, uses data to support conclusion.
Result	Illustrative, explanatory & individual responses.	Numerical aggregation in summaries, responses are clustered.
Sampling	Theoretical	Statistical

Table 3.1: Qualitative vs. quantitative research
(Source: Sunday, n.d.: 5)

Queirós, Faria and Almeida (2017) approach the difference between qualitative and quantitative research from a different perspective, stating the dimension in relation to the methodology, as indicated in Table 3.2:

Dimension	Quantitative research	Qualitative research
Focus on understanding the context of the problem	Smaller	Bigger
Dimension of group studies	Smaller	Bigger
Proximity of the researcher to the problem being studied	Smaller	Bigger
Scope of the study in time	Immediate	Longer range
Researcher's point of view	External	Internal
Theoretical framework and hypotheses	Well structured	Less structured
Flexibility and exploratory analysis	Lower	Higher

Table 3.2: Qualitative vs. quantitative research according to dimension
(Source: Queirós, Faria & Almeida, 2017: 371)

3.6 Research sources

Research papers and reports such as dissertations and theses usually contain information collected from primary and secondary sources, and the researcher’s task is to find relevant and applicable information from both types of sources (Hamilton, 2004).

In this research, the primary sources were of a higher priority than the secondary sources, as accurate and current information was needed to develop the Information Technology Optimisation Model. Generally, the focus of secondary sources is on published data, which would not have provided this study with sufficient accurate data on Zueitina; however, it has been useful for referencing and benchmarking against Zueitina's activities. The primary sources of the Zueitina case study have been identified as individuals from the Zueitina Oil Company's management who were interviewed telephonically, with the researcher using an interview guide (Annexure A) to collect accurate data.

After inspection of the data collected from the primary resources, the data were found to be reasonable. Smith, Todd and Waldman (2009) view the benefits and shortcomings of primary data collection as follows:

Benefits:

- The researcher can exert more control over the primary data collection process, as s/he is able to determine the time required for collecting the data as well as the method to be applied, and this enables the researcher to focus more on specific aspects of the research
- The researcher can select the most appropriate method of data collection
- The researcher is presented with original data that are generally unbiased because of direct interaction between the researcher and the information source (Smith, Todd & Waldman, 2009)

Shortcomings:

- Data collection may be time-consuming. The researcher therefore needs to prepare for the data collection process so as to manage time and handle the various demands of the process competently and effectively
- Conducting the study may be costly (Smith, Todd & Waldman, 2009)

3.7 Data collection

According to Biggam (2015), choosing an applicable sample is equally important to determining whether the research approach should be qualitative or quantitative. Time and budget constraints are always present, and in most instances, it is extremely challenging to gather data from the full population; thus, it is more feasible to take only a selected group as a sample (Saunders, Lewis & Thornhill, 2009).

Target population sampling can be divided into two categories: probability and non-probability sampling (Figure 4.2). Probability sampling is appropriate when respondents are selected randomly, meaning each individual in the available pool has an equal chance to be chosen. With non-probability sampling, the researcher has a specific reason for selecting certain individuals, for example, it might be convenient for the researcher to select his own group of students as it will be easier and more cost-effective to collect data from them (Saunders, Lewis & Thornhill, 2009). Figure below 4.2 shows the various sampling options.

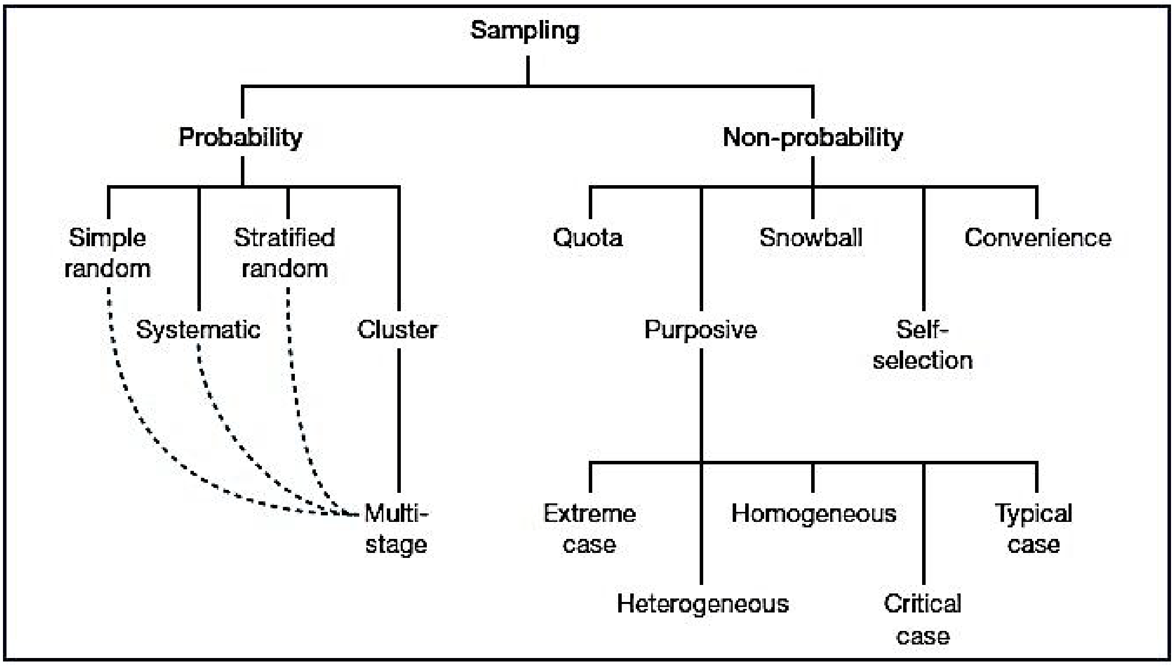


Figure 3.4: Sampling technique types
(Source: Saunders, Lewis & Thornhill, 2009: 207)

3.7.1 Sample frame

Sample framing allows for generalising samples from a wider population, and it ensures that the primary data is correct and sound (Saunders, Lewis & Thornhill, 2009). The sample frame for this research was outlined to select (mostly) managers employed at Zueitina Oil Company who are knowledgeable on, and engage with IT applications in the Company's supply, in order to gather relevant and significant data for this study (Churchill, 1979).

The researcher opted for non-probability sampling, as only executives in Zueitina Oil Company were selected for the collection of current and reliable data. These executives were managers of the Procurement, Logistics, and Warehousing departments, all related to Zueitina's supply chain. These managers were perceived as having the most 'inside' knowledge and experience of the specific topic under investigation.

3.7.2 Sample size

Larger sample sizes offer a better chance to collect valid and reliable data (Saunders, Lewis & Thornhill, 2009). During the time of the study, more than 2500 employees worked for Zueitina Oil Company. After the researcher made initial contact with the Company, he was provided with the contact details of 15 executives. The sample size was therefore 15 (Table 4.1), sufficient for qualitative data collection and analysis.

3.7.3 Sampling method

According to Gunasekaran and Ngai (2003), little research has been conducted to date on the impact of Information Technology investments in SCM, and, in general, the performance measures adopted are based only on economic aspects, including Return on Investment (ROI), Return on Assets (ROA), and Return on Sales (ROS). This way of researching IT investments has been criticized widely, as other aspects relevant to organisations are ignored (Bergeron, Raymond & Rivard, 2001). The criticism had led to a growing awareness to include executives in studies when analysing the impact and value of IT (Torkzadeh & Doll, 1999).

As already stated in section 3.7.2, the sample size selected was 15, with all respondents being Zueitina executives. The sampling method decided on was non-probability sampling (section 3.7.1). The research questions (Annexure A) were sent to the 15 participants in advance so that they could prepare for the interviews. The data were collected through recording and transcribing each interview, and then translating it from Arabic to English in order to simplify the analysis (section 3.4.3.2). In accordance with Seidman (2006), one advantage of sampling is that the time required to identify appropriate units (or people) can be reduced, which was useful for this study as the researcher only intended to interview managers involved in SCM at Zueitina Oil Company.

3.7.4 Unit of analysis

The unit of analysis can be described as the primary entity that is studied during the research (Web Centre for Social Research Methods, 2006). Some examples of a unit of analysis include artefacts (journals, books, newspapers, photos), social interactions between individuals, and geographical units (province, town, census tract, state) (Web Centre for Social Research Methods, 2006). The unit of analysis for this study has been identified as the information technologies and IT applications driving the supply chain and logistics processes of the Zueitina Oil Company in Libya.

3.7.5 Unit of observation

While the unit of analysis is primarily determined by the study's research question, the unit of observation is largely identified by the data collection method used to answer the research question. The unit of observation is observed or measured by the researcher in an attempt to learn more about the unit of analysis (De Carlo, 2018). The unit of observation for this study has been identified as the 15 executives of the departments involved in SCM at Zueitina.

3.8 Data analysis

Data analysis is defined as the process of examining, scrutinising, cleaning, refining, transforming, and modelling the collected data, with the aim of uncovering valuable information to inform conclusions and support decision-making (Xia & Gong, 2015). The data analysis process involves multiple features, components, approaches, and techniques under a variety of names, and it is performed across various business, science, and social science domains. In the business word today, the data analysis process performs an important role in enhancing scientific decision making and assisting businesses with functioning and operating more efficient (Xia & Gong, 2015).

Judd and McCleland (1989) define data analysis as the process of collecting raw data from selected respondents and transforming this data into information that is valuable and useful for users to make sound decisions. Data are gathered and analysed to answer research questions, test hypotheses, or invalidate theories (Judd & McCleland, 1989).

Data analysis can adopt one of two approaches, namely exploratory or confirmatory approach, usually decided on before data collection commences (Adèr, 2008). With the exploratory approach, a clear hypothesis does not exist, and the collected data are examined for models or patterns that describe the data well. Exploratory research aligns well with inductive reasoning and qualitative research. With confirmatory analysis, clear hypotheses about the data are tested. Confirmatory research aligns well with deductive reasoning and quantitative research (Adèr, 2008).

Various types of qualitative analyses can be applied during this phase. The main types are: content analysis, narrative analysis, discourse analysis, framework analysis and grounded theory (Sunday, n.d.).

> "Content analysis is the procedure for the categorisation of verbal and behavioural data for the purpose of classification, summarisation, and tabulation. Content analysis can be done on two levels: Descriptive: What is the data? Interpretive: What is meant by the data?" (Colorado State University, 2019: 1; Sunday, n.d.: 26).

Another popular qualitative analysis method not mentioned in Sunday's definition, is thematic analysis. Content analysis and thematic analysis are referred to interchangeably; however, there is a definite difference between the two (Bloor & Wood, 2006). While both can be classified as descriptive qualitative approaches to data analysis, the intention of content analysis is to describe the attributes or qualities of the data content by investigating who says what, to whom, and with what effect (Bloor & Wood, 2006). Content analysis is thus a research tool used to determine the presence of certain words or concepts within texts or sets of texts (Colorado State University, 2019). Thematic analysis, on the other hand, is viewed as a method to detect, recognise, analyse, and report patterns (themes) found within data (Braun & Clarke, 2006).

The aim of this Zueitina case study was to investigate the influence of IT on the supply chain and logistics processes of this oil and gas company, and to evaluate the effectiveness thereof. This exploratory study adopted thematic analysis as qualitative data analysis method. Thematic analysis is one of the most common forms of analysis within qualitative research. Thematic analysis is a robust, descriptive qualitative method of analysis that is uncomplicated to use for beginner qualitative researchers, as well as for more experienced researchers working in interdisciplinary teams and/or looking to produce research for public consumption (Braun, Clarke & Weate, 2016). It is viewed as a method to detect, recognise, analyse, and report patterns (themes) found within data (Braun & Clarke, 2016).

Table 3.1 indicates the steps or phases of thematic analysis that the researcher followed to analyse the collected qualitative data.

Table 3.3: Phases of thematic analysis
(Source: Braun & Clarke, 2006: 35)

Phase	Description of the process
1. Familiarise oneself with the data	Transcribe data (if necessary), read and reread the data, noting initial ideas
2. Generate initial codes	Code interesting features of the data systematically across the full data set; collate data relevant to each code
3. Search for themes	Collate codes into potential themes; gather all data relevant to each potential theme
4. Review themes	Verify if the themes work in relation to the coded extracts (Level 1) and the full data set (Level 2); generate a thematic 'map' of the analysis
5. Define and name themes	On-going analysis to refine the specifics of each theme, and the overall story the analysis tells; generate clear definitions and names for each theme
6. Produce the report	The final opportunity for analysis; select vivid, compelling example extracts; final analysis of selected extracts; relate the analysis back to the research questions and literature; deliver a scholarly report of the analysis

3.9 Research limitations

The main limitation of this study was that it focused on a single case study within the oil and gas sector of Libya, instead of incorporating multiple case studies, which would have offered a more in-depth understanding of the topic being investigated. However, the reason for selecting a single case study can be attributed to the time and cost restrictions in order to complete this study within the allocated timeframe.

3.10 Research ethics

The researcher might be excited and passionate about his research project, and enthusiastic to commence with gathering detailed, high quality data from the respondents who are the closest and most involved in the topic under investigation. However, this may pose a risk to the research process. The researcher needs to be acutely aware of unethical research practices, including attempts towards gaining or holding back some of the gathered data.

For this research study, consent was obtained from the company where the case study was performed, i.e. Zueitina Oil Company in Libya. Resnik (2015) mentions various reasons of the significance of adhering to ethical culture and norms, as adherence to the truth and avoiding mistakes contributes positively to the research objectives. Ethical principles include inter alia trustworthiness, mutual respect among colleagues, integrity, honesty, sincerity, openness, impartiality, non-discrimination, being careful, confidentiality, valuing intellectual property, accountable publishing of results, responsible mentoring, social responsibility, proficiency, legality, and protecting human subjects (Resnik, 2015).

Section 3.5.2.2 elaborated on ethical principles for qualitative research. Other principles that need to be upheld include the following:

- **Autonomy: "**Autonomy (or respect for people) demands that the ability of competent subjects to make their own decisions be recognised and respected, while also protecting the autonomy of the vulnerable by preventing the imposition of unwanted decisions" (Owonikoko, 2013: 242). This fundamental autonomy principle brought into existence the informed consent practice, whereby a knowledgeable and capable prospective respondent or approved representative is permitted to make an educated decision of whether to participate in a study or not (Owonikoko, 2013).

- **Beneficence and non-malfeasance:** The principle of beneficence together with the twin concept of non-malfeasance requires that respondents are not harmed in any way throughout the study. Risk mitigation should form part of the research design and address the intensity and probability of potential harm to the research participants (Owonikoko, 2013).

- **Justice:** The principle of justice requires that all participants be handled justly and fairly (Owonikoko, 2013). This implies equal sharing of risk and advantages across subjects. Furthermore, the load or responsibility placed on the participants should be proportionate to the prospect of profiting or benefiting from the research outcome(s) within the possible boundaries.

3.11 Summary

In this chapter, the research design of the study was discussed. This included the research philosophy, approach, strategy, methodology, data collection, and data analysis. This study adopted interpretivism as research philosophy, as well as an inductive research approach, both the survey and case study as strategies, and the qualitative research methodology.

Data were collected by means of a survey in the form of telephone and focus group interviews using and interview guide with 15 questions. The sampling method decided on was non-probability sampling. The unit of analysis has been identified as the information technologies and IT applications driving the supply chain and logistics processes of the Zueitina Oil Company in Libya, and the unit of observation was identified as the 15 executives of the departments involved in SCM at Zueitina. Thematic analysis was adopted as qualitative data analysis method for this exploratory study.

Finally, the primary limitation of the research was elucidated and the research ethics principles that need to be upheld for scientific research were stated.

Chapter 4 provides a detailed discussion on the data analysis and on the findings derived.

CHAPTER 4: DATA ANALYSIS, FINDINGS AND DISCUSSION

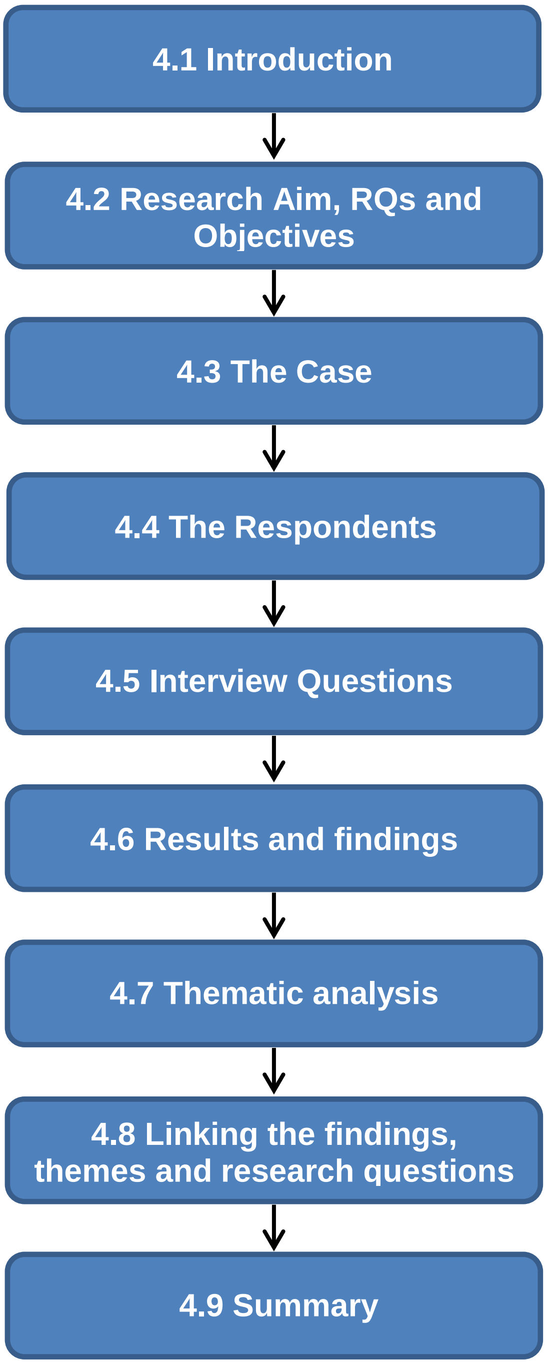


Figure 4.1: Graphical representation of Chapter 4

4.1 Introduction

In this chapter, the data analysis is discussed and findings are drawn. First, the research aim and objectives are re-stated, where after the case of the study is summarised, a brief profile of each respondent is provided, and the interview questions (IQs) (Annexure A) are introduced. Each IQ is then individually stated and the collected data are analysed. Thematic analysis is applied to derive themes and sub-themes from the findings. The chapter closes with a summary.

4.2 Research aim, research questions and research objectives

For the convenience of the reader, the research aim and five of the sub-research questions (SRQs) linked to **Primary Research Question 2** (PRQ2), which are relevant to the data analysis, are re-stated below.

4.2.1 Research aim

The aim of this research was to: (i) explore the status of the oil and gas industry in Libya in terms of oil production and export; and (ii) determine what innovative information technologies should be considered by Zueitina Oil Company (as case study) in Libya to enhance its supply chain and logistics processes (section 1.3).

4.2.2 Research questions

PRQ2: What innovative information technologies need to be considered by Zueitina Oil Company in Libya to contribute towards optimising its supply chain and logistics processes?

SRQ 2.1: What strategies/techniques are currently used to measure Zueitina Oil Company's supply chain performance?

SRQ 2.2: What metrics are currently used for Zueitina Oil Company's supply chain performance?

SRQ 2.3: What is the impact of information technology applications on Zueitina Oil Company's logistics, and specifically, on procurement, warehouse and inventory management?

SRQ 2.4: How is the logistics system at Zueitina Oil Company managed?

SRQ 2.5: What is the importance of optimised IT applications in Zueitina Oil Company's supply chain and logistics processes?

4.2.3 Research objectives

The five research objectives aligned to section 4.2.2 and formulated in section 1.7 are re-stated below:

Objective 3: To identify what strategies/techniques are currently used to measure the supply chain performance of Zueitina Oil Company

Objective 4: To identify what metrics are currently used for Zueitina Oil Company's supply chain performance

Objective 5: To explore the impact of Zueitina's information technology applications on logistics, and specifically on procurement, warehouse, and inventory management

Objective 6: To explore how the logistics system at Zueitina Oil Company is managed

Objective 7: To determine the importance of optimised IT applications in Zueitina Oil Company's supply chain and logistics processes

4.3 The case

Zueitina Oil Company was the case under study. This choice was based on the Company having a developed supply chain, being consistent, and invested significantly in information technology applications for their SCM. Zueitina is considered one of the top oil companies in Libya, together with Waha Oil Company, Sirte Oil Company, Agoco, and Mellitah Oil & Gas B.V. (not including the international oil companies in Libya) (Marcopolis, 2013).

For this study, Zueitina submitted the contact details of officials to be interviewed over the phone. The respondents were chosen because of their knowledge on supply chain processes and information technology applications in the Company, and because they worked in different departments relevant to SCM. The telephonic interviews, which lasted on an average one hour each, were recorded and afterwards transcribed by the researcher.

4.4 The respondents

In total, 15 respondents took part in this qualitative study. To adhere to the research ethics, each participant is referred to only by generic number, from P1 to P15. Table 4.1 provides a summary of each participant's work profile.

Table 4.1: Summary of respondents

Participant	Job title	Short summary of participant
P1	Supply Chain Manager Director	Ultimately responsible for the Company's performance
P2	Supply Chain Manager	Overseeing and managing the Company's overall supply chain and logistics strategy and operations to maximise process efficiency and productivity
P3	Supply Chain Manager	Overseeing and managing the Company's overall supply chain and logistics strategy and operations to maximise process efficiency and productivity
P4	Logistics Managing Director	Organising and monitoring the storage and distribution of goods; managing the full order cycle to enhance business development and ensure sustainability and customer satisfaction
P5	Logistics Manager	Overseeing the warehouse, inventory control, material handling, customer service, transportation and planning staff
P6	Warehouse Manager	Maintaining the receiving, warehousing and distribution operations through initiating, coordinating and enforcing programme, operational and personnel policies and procedures
P7	Information Technology Manager	Accomplishing IT staff results; planning, monitoring and appraising job results; coaching, counselling and disciplining employees; initiating, coordinating, and enforcing systems, policies and procedures
P8	Warehouse Supervisor	Maintaining and overseeing inventory and supplies through receiving, storing and delivering items; securing warehouse; supervising staff
P9	Procurement Manager	Directing the purchasing agents and buyers throughout the process of evaluating suppliers, conducting interviews with vendors, negotiating supplier agreements, and managing supplier and vendor contracts

Participant	Job title	Short summary of participant
P10	Information Technology Supervisor	Overseeing the operations of the Information Technology Department; managing staff that upgrade and maintain the Company’s computer systems, including databases, mainframe systems, data communication networks, and software programs
P11	Procurement Managing Director	Developing strategic approach to corporate procurement and material management process for the purchase of direct and indirect goods and services; developing and implementing procurement related training programmes for the procurement team and the organisation
P12	Materials Manager	Overseeing the planning and coordination of the Company’s Inventory and Purchasing departments; tasked with researching the best prices, monitoring inventory levels, distributing supplies and negotiating contracts
P13	Purchasing Specialist	Handling all the purchasing needs; responsible for ensuring that the business is able to acquire needed supplies, materials and other relevant items, following a strict budget and keeping records of all the transactions
P14	Purchase Assistant	Placing orders for the products and raw materials needed by a business; working under the supervision of a buyer or purchasing manager; conducting administrative and support tasks to keep the Purchasing Department running effectively
P15	Procurement Manager	Responsible at some level for buying/approving the acquisition of goods and services needed by the Company; seeking reliable vendors or suppliers to provide quality goods at reasonable prices; negotiating prices and contracts

4.5 Interview questions (IQs)

To achieve the five objectives set out in section 4.2.3, thereby answering the SRQs stated in section 4.2.2, a total of 15 interview questions (IQs) (Annexure A), categorised per research objective, were posed to the participants to collect data for the study.

Table 4.2 summarises the interview questions per sub-research question.

Table 4.2: IQs aligned to the relevant SRQs

Sub-Research Question	Interview Question
SRQ 2.1: What strategies/ techniques are currently used to measure Zueitina Oil Company's supply chain performance?	**IQ1:** How is Zueitina Oil Company's supply chain performance measured?
SRQ 2.2: What metrics are currently used for Zueitina Oil Company's supply chain performance?	**IQ2:** What metrics are important to Zueitina for tracking / measuring their supply chain performance?
SRQ 2.3: What is the impact of information technology applications on Zueitina Oil Company's logistics, and specifically, on procurement, warehouse and inventory management?	**IQ3:** What is the impact of using Information Technology applications on the metrics employed? **IQ6:** How does the use of IT applications help Zueitina in optimising warehouse resources? **IQ7:** How do IT applications help in fulfilling large orders? **IQ8:** How do IT applications help Zueitina reduce inventory levels without lowering its customer service standards?
SRQ 2.4: How is the logistics system at Zueitina Oil Company managed?	**IQ4:** How important is a logistics system to Zueitina? **IQ5:** How effective is the use of IT applications in logistics?
SRQ 2.5: What is the importance of optimised IT applications in Zueitina Oil Company's supply chain and logistics processes?	**IQ9:** How do IT applications help Zueitina reduce its spending on products and services? **IQ10:** How do IT applications help Zueitina with sourcing activities? **IQ11:** How do IT applications contribute towards effecting contract pricing to the terms and conditions agreed upon? **IQ12:** How do IT applications help simplify Zueitina's procurement processes? **IQ13:** How do IT applications help staff control and automate purchasing? **IQ14:** How do IT applications help reduce information lag time with processing errors, manual efforts, and supplier enablement? **IQ15:** How do IT applications help manage Zueitina's supplier performance?

4.6 Interview question (IQ) research results

Zueitina Oil Company is well aware of the importance of implementing information technologies for more flexibility in the business. Aiming towards the optimisation of their processes and improving their relationship with customers, Zueitina has invested significantly in IT infrastructure and telecommunications. The participants for this study were primarily managers responsible for the Company's SCM, having sound knowledge on information technologies.

In the next five sub-sections (4.6.1 – 4.6.5), the outcomes of the data analysis are presented per SRQ, where all interview questions (IQs) relevant to the stated SRQs are discussed. (See Annexure B for a summary of the alignment of the IQs with the SRQs and corresponding research objectives.)

4.6.1 Sub-Research Question 2.1

SRQ 2.1: What strategies/techniques are currently used to measure Zueitina Oil Company's supply chain performance?

4.6.1.1 Research results for Interview Question 1

IQ1: How is Zueitina Oil Company's supply chain performance measured?

An executive interviewed answered the question by saying that,

> *"Zueitina's main strategy is the improvement of the quality of their products, services and value they provide to their customers"* (P1).

To ensure this improvement, the Company has adopted the ISO 9000[1] quality standard. It was furthermore uncovered that they make use of management techniques such as the Balanced Scorecard[2], benchmarking, continuous improvement[3], project management and Total Quality Management (TQM)[4].

The performance of Zueitina's supply chain is measured because of the importance of the supply chain to the Company.

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[1] "The ISO 9000 family is the world's best-known quality management standard for companies and organizations of any size" (https://www.iso.org/iso-9001-quality-management.html).

[2] "A Balanced Scorecard monitors the performance of all or part of an organisation, towards strategic or operational goals" (2GC, 2014: 1).

[3] Continuous improvement is "the ongoing improvement of products, services or processes through incremental and breakthrough improvements. These efforts can seek 'incremental' improvement over time or 'breakthrough' improvement all at once" (ASQ, 2020: 1).

[4] TQM "describes a management approach to long-term success through customer satisfaction. In a TQM effort, all members of an organization participate in improving processes, products, services, and the culture in which they work" (https://asq.org/quality-resources/total-quality-management).

The researcher found that tools such as “lean manufacturing”, “just-in-time manufacturing” (or JIT in short), and “activity based costing” (or ABC) are not used in Zueitina. Although *lean manufacturing* and *JIT manufacturing* are often used interchangeably, according to Thompson (2019: 1), the two concepts are not the same. JIT manufacturing’s emphasis is on efficiency, and “can be practiced on its own, or as one step in your lean manufacturing process”. Thus, JIT manufacturing focuses on improving manufacturing/production as well as the supply chain processes (RFgen, 2020). Lean manufacturing focuses on using/applying efficiency in order to add value to customers (Thompson, 2019); thus, highlighting the desires of customers (RFgen, 2020).

Activity based costing (ABC) is defined as driver performance measures (Thyssen, Israelsen & Jørgensen, 2006) for scorecards, “providing rates for customer profitability analytics, helping devise human resource plans, modeling sustainability, and supporting budget development and planning” (Turney, n.d.: 1). By assessing the efficiency of the supply chain processes using ABC, root cause problems can be detected and processes can subsequently be enhanced, thereby adding value to the supply chain.

The following findings were derived from the research results presented in section 4.6.1:

i) Zueitina’s cares about brining value to their customers through improving the quality of their products.
ii) Zueitina preferred to adopt the ISO 9000 model and other management techniques such as the Balanced Scorecard, benchmarking, continuous improvement, project management and Total Quality Management (TQM) to measure supply chain performance.
iii) Tools such as “lean manufacturing”, “just-in-time manufacturing” (or JIT in short), and “activity based costing” (or ABC) are not used in Zueitina.

4.6.2 Sub-Research Question 2.2

SRQ 2.2: What metrics are currently used for Zueitina Oil Company’s supply chain performance?

4.6.2.1 Research results for Interview Question 2

IQ2: What metrics are important to Zueitina for tracking/measuring their supply chain performance?

According to an executive who were interviewed, Zueitina's staff considered and adopted a number of essential supply chain metrics, including:

> "*Logistics costs; inventory costs; handling costs; overall spend/costs; delivery speed; coordination and planning; customer satisfaction; commitment and trust in customer relationships; competitiveness; distribution network integration*" (P2).

Metrics that were not specifically mentioned include: quality; on-time delivery; order fulfilment lead time; capacity; and total delivered price. These metrics, or at least some of them, might well be present in Zueitina's performance measures, but they were not uncovered during the research.

The following findings were derived from the research results presented in section 4.6.2:

i) The important metrics identified for Zueitina's supply chain performance include: logistics, inventory, handling and overall spend/ costs; delivery speed; coordination and planning; competitiveness; customer satisfaction; commitment and trust in customer relationships; and distribution network integration.
ii) Metrics that were not specifically mentioned, include: quality; on-time delivery; order fulfilment lead time; capacity; and total delivered price. These metrics may be present in Zueitina's performance measures, but they were not uncovered during the research.

4.6.3 Sub-Research Question 2.3

SRQ 2.3: What is the impact of information technology applications on Zueitina Oil Company's logistics, and specifically, on procurement, warehouse and inventory management?

A total of four (4) IQs are categorised under **SRQ 2.3.** Each of the four IQs is discussed next.

4.6.3.1 Research results for Interview Question 3

IQ3: What is the impact of using information technology applications on the metrics employed?

Considering the variables selected for the study, an executive (P7) interviewed alluded to the following impacts of using of IT applications for Zueitina's SCM:

- IT applications allow for enhanced management and planning of the supply chain, thus leading to a decline in logistics cost management, lowered inventory levels and, consequently, a decrease in **storage costs**
- Technologies such as Transport Management Systems (TMSs) assisted in optimising the Company's fleet and freight management, leading to reduced **handling costs**
- A reduction in the delivery time of products and increased delivery accuracy has led to an increase in the **speed** of the delivery process
- The coordinated implementation of IT systems has enabled the **coordination and planning** of logistics activities in combination with supply chain partners. This, in turn, has increased **commitment and trust in customer relationships**, as it improved Zueitina's practice of vendor managed inventory (VMI)
- The use of IT applications has made it possible to set apart the Company's products over competitors, especially with products coming from outside the country, mainly because it is a *commodity*, which has led to increased **competitiveness**
- A strong emphasis emerged on **integration –** through IT applications, the Company now has the ability to upholder increased communication levels among and between supply chain partners, thus building an integrated nationwide distribution network
- The overall spend has decreased since Zueitina implemented IT applications. The sales team managed to reduce/cut uncontrolled and

unnecessary spending and obtain more attractive prices from suppliers, thereby contributing to a reduced inventory.

Thus, it can be noted that the IT applications implemented by Zueitina have given the Company a competitive advantage in terms of cost reductions, enhanced communication, faster and more accurate product delivery, and increased customer trust, which resulted in increased supply chain performance.

4.6.3.2 Research results for Interview Question 6

IQ6: How does the use of IT applications help Zueitina in optimising warehouse resources?

The participants indicated that since Zueitina's implementation of IT applications, their resources such as equipment, workforce, and space have all been enhanced. One executive supported this by saying:

> *"Classification rules provided by the application helped us to reduce fragmentation and reduce obsolescence, whereas, we can classify items regarding materials, volume and different parameters*" (P6).

Another executive in the Warehousing Department said the following:

> *"The travel time is lessened when collecting stock for outbound orders because of using the 'nearest location' feature of the IT app, and also, the oldness is minimised by the FIFO [first-in-first-out] principle"* (P8).

Thus, the two factors that were emphasis by the participants with answering this question are time saved, and lowered obsolescence, although it needs to be mentioned that the stock with a risk of becoming old is not critical and there is no high spend on it.

4.6.3.3 Research results for Interview Question 7

IQ7: How do IT applications help in fulfilling large orders?

Information technology made it possible for the Zueitina warehouse staff to structure the entire execution process, which made completing large orders very fast and planning much easier.

However, one of the executives interviewed said the following:

> *“We usually receive the same [types of] orders and we do not have many different products. Also, we always have high demand for our products in the Libyan market or the foreign market”* (P13).

From this, it can be safely deduced that IT applications do not seem to impact highly on fulfilling large orders.

4.6.3.4 Research results for Interview Question 8

IQ8: How do IT applications help Zueitina reduce inventory levels without lowering its customer service standards?

The executive of the Warehousing Department said the following:

> *“There is not a particularly high impact of information technology apps on reducing the inventory levels because the demand for Zueitina’s Company products is very high, but, spare parts that are very critical are reduced by a small percentage without any influence on the operations”* (P6).

In summary, for SRQ 2.3, the IT applications implemented by Zueitina have led to cost and time savings, faster and more accurate processes, increased and better communication, more trust from customers, and lowered obsolescence (although the impact here is low), all of which have enhanced supply chain performance.

The following findings were derived from the research results presented in section 4.6.3:

i) It can be safely inferred that the IT applications employed at Zueitina reduce overall costs, as it reduces inventory levels and storage/ logistic costs, hence leading to enhanced planning and management.
ii) Handling costs are reduced by implementing TMS technology, which helps Zueitina consolidate its freight and fleet optimisation.
iii) IT applications implemented by Zueitina have given the Company a competitive advantage in terms of faster and more accurate product processing and delivery, resulting in increased supply chain performance.

iv) The IT applications improved Zueitina’s Vendor Managed Inventory (VMI) processes, thereby increasing trust in customer relationships.
v) Information technology helps Zueitina to keep track of competition and differentiate the Company’s products from the competitors.
vi) Higher levels of communication between supply chain partners and Zueitina is maintained, thus building an integrated distribution network.
vii) The overall spend has decreased since Zueitina implemented IT applications; uncontrolled spending is reduced and better prices are obtained from suppliers, thereby contributing to a reduced inventory.
viii) IT systems save time, and subsequently, also costs; it contributes towards optimising resources such as labour, equipment and overall use of space, and it helps reduce the risk of stock being outdated.
ix) Although IT applications enable Zueitina to fulfill large orders fast and simplify tasks planning, it does not seem to have a significant impact, as product demand is already high.
x) The impact of the IT applications on the reduction of inventory levels is not huge, because the demand for Zueitina products is already high.
xi) IT software deployed in the Procurement Department significantly contributes towards decreasing the spending on goods and services, and reducing the purchasing cycle time.

4.6.4 Sub-Research Question 2.4

SRQ 2.4: How is the logistics system at Zueitina Oil Company managed?

A total of two IQs are categorised under **SRQ 2.4**, which are discussed below.

4.6.4.1 Research results for Interview Question 4

IQ4: How important is a logistics system to Zueitina?

According to the Logistics Manager, improvements in Zueitina’ logistics system can be very beneficial to the Company. He said the following:

> *“Costs form a high percentage of the total cost of the item [product]; so, improving the logistics system can cause considerable increases in the revenues of Zueitina”* (P5).

Another executive said that because logistics are so important,

> "*Zueitina usually invests in tools to help improve the supply chain and logistics processes. The Company offers a central after-sales service and distribution network that covers the whole territory nationally*" (P4).

Two types of customers are accommodated through the distribution process, namely: (i) *for automatic fill*; and (ii) *on request*.

The 'on request' customers are being supplied based on how frequently they submit their orders. Zueitina has a Customer Service Centre for their customers, where they are able submit orders using the cloud-based application called *WebEDI*. The executive further said the following:

> *"Customers are supplied directly by Zueitina because our Company manages the entire process. There really is no need to worry about the gas tank levels, because the tanks will be replaced when the level falls to a specific point. Reason be, the system tanks are remotely monitored [Remote Monitoring System Tank]"* (P4).

Analysis of the data has revealed that Zueitina Oil Company integrates their supply chain by using a management system that employs the following technologies: (i) Bar coding; (ii) Enterprise Resource Planning (ERP); (iii) Computer-Aided Design (CAD); (iv) Customer Relationship Management (CRM); (v) Supply Chain Planning (SCP); (vi) Manufacturing Enterprise System (MES); (vii) Warehouse Management System (WMS); and (viii) Business Intelligent (BI) Systems.

> *"In addition to having our own fleet, we also make use of Fleet Tracking Geo-coded and TMS [Transport Management Systems]"* (P10).

The researcher furthermore found that the following systems are not employed at Zueitina: (i) Active Quality Control (AQC); (ii) Product Data Management (PDM); (iii) WIS; and (iv) RF. However, the Company does have plans to adopt these information technologies.

Another participant informed the researcher that Zueitina opted for a specific telecommunications technology and then migrated its infrastructure network based on this IP protocol.

> *"Zueitina originally aimed to save approximately 175,000 USD for this project, which would enable more secure and faster access to information… We hope to achieve greater efficiency in the use of various IT applications, such as relationship management [CRM]. With the corporate IP network, the Company will increase the reception of applications, issuance of notes and accounts receive light [sic] more efficiently suppliers and customers"* (P7).

It was further found that the Vendor Managed Inventory (VMI) systems are perceived as being of 'little use' to the Company. However, the implementation of (VMIs) may lead to increased efficiency in managing Zueitina's supply needs, a more accurate control of the logistics processes, and a reduction in the supply chain costs. Nevertheless, Zueitina does work on increasing their productivity and competitiveness to provide an enhanced product to their customers.

In summary, it is evident that the Company regards logistics as extremely important, and that they do invest in information technologies to continuously enhance and strive towards optimising their logistics processes.

4.6.4.2 Research results for Interview Question 5

IQ5: How effective is the use of IT applications in logistics?

For the Logistics Manager, the most important systems in SCM are: CRM, ERP, CAD, AQC, SCP, WMS, and MES (see also section 4.6.3.1). It is important to note that AQC has not yet been adopted by Zueitina (as mentioned in section 4.6.3.1), but the Logistics Manager does believe it is one of the most important systems for SCM. One participant said the following of the systems that have been employed:

> *"The IT systems that Zueitina adopted have a high degree of sharing with our partners in the supply chain, both suppliers and customers, but the System Bar Codes and Fleet Tracking Systems are only shared with our customers"* (P5).

Participant 5 continued to say ICTs do influence the functioning and performance of Zueitina's supply chain significantly, especially for the transportation processes, product distribution, managing the inventory, and purchasing. For P5, IT system deployment is a strenuous and lengthy process, because structures within the organisation have to be redesigned to accommodate complexity and growth. However, all of this is to the absolute benefit of the Company, because IT applications lead to services and products of high value and quality.

In summary, important benefits of adopting ICTs include production planning, cost reduction, optimised routing of product distribution, and the most useful balance between production and demand. Thus, Zueitina Oil Company found that their investment in IT applications resulted in driving costs down and increasing customer satisfaction.

The following findings were derived from the research results presented in section 4.6.4:

i) An enhanced/optimised logistics system leads to increased revenues
ii) Customer service is a priority to Zueitina; the Company employed a Customer Service Centre where customers can submit orders using the cloud-based application WebEDI
iii) Multiple technologies have been deployed to manage Zueitina's supply chain, including CAD, SCP, WMS, ERP, CRM, BI Systems, TMS Systems and Fleet Tracking; however, the following systems are not employed: PDM, AQC, RFID and WIS. The Company does have plans to adopt these systems
iv) Zueitina is eager to continue saving on costs and improving its supply chain and logistics processes by implementing additional information technologies

4.6.5 Sub-Research Question 2.5

SRQ 2.5: What is the importance of optimised IT applications in Zueitina Oil Company's supply chain and logistics processes?

A total of seven (7) IQs are categorised under **SRQ 2.5.** Each of the seven IQs is discussed next.

4.6.5.1 Research results for Interview Question 9

IQ9: How do IT applications help Zueitina reduce its spending on products and services?

According to the Procurement Department executive, employing IT applications in the Procurement Department,

> *"Helped a lot to reduce the spending on goods and services. The purchasing cycle time decreased a lot compared to the time when Zueitina buyers did not rely on IT applications"* (P10).

The IT application employed has a 'spend analysis tool' that helps the procurement staff at the Company to collect the information of all the spending processes from lines of business and to organise it, among others, in accordance with the following categories: (i) time; (ii) organisation; (iii) commodity; (iv) type of contract; (v) supplier; (vi) purchaser.

With IT applications, it is easier than before to monitor price trends and the workload of buyers. Furthermore, monitoring and tracking the contract commodity's performance assists Procurement with benefitting in terms of making use of opportunities to save and in taking full advantage of agreements that are in place. In addition, monitoring and tracking the spending assists buyers with being less dependent on prediction analysis. Finally, because of the consolidation of various sources of data, increased transparency helps with saving more on services and products. An executive said following:

> "*By implementation these ICTs, the Department saw a reduction in spending of between 1.3% and 5.1%, and we still want more significant savings*" (P1).

4.6.5.2 Research results for Interview Question 10

IQ10: How do IT applications help Zueitina with sourcing activities?

Before the deployment of IT applications in Zueitina's Purchasing Department, traditional sourcing took up much time and the process was difficult and intricate, causing the Company to lose large amounts of money because of non-sourced spending.

Furthermore, there was always a supply risk for various critical items. After the implementation of SAP IT applications, procurement professionals discovered various saving opportunities and gained more value from each transaction.

The sourcing actions done manually were reduced and the sourced spend percentage increased significantly. The built-in templates in the software supports online negotiation and collaboration to run requests for information (RFIs), requests for quotations (RFQs), requests for proposals (RFPs) and bid processes in a short time. It also became easier for buyers to use renegotiation tools for cloning expiring agreements into updated sourcing events.

Using analytics to compare bids became much easier and faster, as did the rules and decisions for awarding bids. Furthermore, the conditions and terms of any negotiated agreement can now be included in the procurement contracts and employee self-service portal.

Zueitina realised within a short time period just how significant their savings were by using IT applications for sourcing. Furthermore, the Company does not face a supply risk anymore.

4.6.5.3 Research results for Interview Question 11

IQ11: How do IT applications contribute towards effecting contract pricing to the terms and conditions agreed upon?

Deploying IT applications contributed greatly to Zueitina's Procurement Department effecting and implementing purchasing agreements faster, easier and more effective than before. Furthermore, the 'spend' is sent directly to preferred suppliers, the transaction purchasing process is actioned automatically, and the monitoring and tracking of internal and external compliance for supplier contracts is streamlined and simplified. In addition: (i) negotiated agreements are easy to execute for all Procurement's products; (ii) the contract deliverables can be monitored easily; (iii) and contract compliance is transparent and delivered timeously to responsible parties.

4.6.5.4 Research results for Interview Question 12

IQ12: How do IT applications help simplify Zueitina's procurement processes**?**

According to an executive that was interviewed,

> "Costs of *transactions have been slashed by a decrease in purchasing processes because of the use of information technology applications. The routine transactions when buying is touched [sic] less and this led to more productivity by buyers and freed purchaser staff to pay more attention to strategic activities*" (P9).

Regular tasks such as generating manual orders, responding to suppliers and attending to inquiries are reduced, which means staff can focus more on other activities, including the negotiation of contracts, sourcing, analysing, and spending. Thus, the total lead time is hugely reduced, which, in turn has a positive effect on the core functions of the Company.

4.6.5.5 Research results for Interview Question 13

IQ13: How do IT applications help staff control and automate purchasing?

According to one of the executive that was interviewed, various approaches have been introduced with the deployment of IT applications in the Procurement Department.

> "*By ordering the Web Shop Tool provided by the SAP procurement application, we can now use any web browser to place and track orders without bothering with 'professional' buyers. The Purchasing Department controls all the requested services and products. Also, if there is any order then it will be destined to preferred suppliers*" (P11).

With IT software, staff are able to request changes online and monitor shipments though using the self-service tracking application, which reduces inept requests to the Procurement Department. Furthermore, the 'returns and receiving' functions are also self-service, and this seems to save the procurement Department significant time and money.

4.6.5.6 Research results for Interview Question 14

IQ14: How do IT applications help reduce information lag time with processing errors, manual efforts, and supplier enablement?

An executive said the following:

> "*This is very important; since using the information technology applications in the Procurement Department, the overall efficiency saw a dramatic increase*" (P3).

According to the respondent, Zueitina's enablement strategies now offer openness and flexibility. In addition, the exchange of purchasing orders (POs), making payments, and delivering information are much easier than ever before, which has led to an increase in the accuracy and efficiency of transactions with high volumes of suppliers. Time and money is saved because of electronic integration.

4.6.5.7 Research results for Interview Question 15

IQ15: How do IT applications help manage Zueitina's supplier performance?

According to the procurement executive manager, Zueitina benefited from using information technology applications in managing their supplier performance.

> "*Before using the information technology applications in the [Procurement] Department, the Company was blind to problems, which had negative impacts to [sic] the company bottom line, due to traditional management of supplier performance which has been spotty at best. After implementing the IT application, many advantages were gained"* (P1).

With the support of the IT applications that were deployed, the following advantages have been uncovered: (i) real-time performance management ensures transparency and accountability; (ii) relevant staff are made aware of potential challenges/problems through automatic alerts; (iii) contract deliverables can be assigned to both internal and external owners; (iv) all deliverables can be monitored and tracked using the IT software, purchase orders can be viewed, and buyers can drill down to related additional documents; (v) buyer staff are able to access all information on contract communications and purchasing documentation; (vi) decision makers are able to review current spend and real-time key performance indicators (KPIs); and (vii) in the case of a performance alert, purchasers and suppliers can reach an agreement for corrective actions and find key deliverables needed in order to get back on track.

These advantages help Zueitina with knowing in real-time how all users and suppliers perform by measuring them against their signed agreements; this, in turn, enhances supplier development.

In summary, the outcomes of the data analysis show that the executives/ managers of Zueitina's who were interviewed are in agreement that the implementation of IT applications has a high impact on the Company's supply chain performance, especially in carrying out activities related to order processing, inventory management, procurement, and transportation and distribution. However, IT deployment offers little support for activities such as packaging, storage, and the handling of materials. But, the application of IT assists staff greatly with managing the supply chain, which leads to a competitive advantage for the Company, as the overall supply chain performance has increased and can be measured continuously.

The following findings were derived from the research results presented in section 4.6.5:

i) Zueitina realised within a short time period just how significant their savings were through using IT applications for sourcing (RFIs, RFQs, and RFPs). Furthermore, the Company does not face a supply risk anymore
ii) Changing the entire system in Zueitina was costly, but it paid off in terms of reduced costs, increased profits, increased efficiency, high quality products, enhanced supply chain performance, enhanced customer service, and trust

4.7 Themes and sub-themes derived from the research findings

In this section, the findings derived from the IQ discussions (section 4.6) are stated and the themes derived from these findings are categorised and presented. In total, 22 findings were derived. From the findings, five (5) themes and six (6) sub-themes were identified – four (4) sub-themes under Theme 3 and two (2) sub-themes under Theme 4 (Table 4.3). The findings are presented below according to each theme and sub-theme.

4.7.1 Theme 1: Supply chain performance strategies/techniques

Theme 1 was derived from the following three (3) findings, focusing on the value Zueitina Oil Company offers to their clients, and on the various IT strategies used by the Company to measure supply chain performance as discussed in IQ1 (section 4.6.1.1):

Finding 1: Zueitina's cares about bringing value to their customers through improving the quality of their products

Finding 2: Zueitina preferred to adopt the ISO 9000 model and other management techniques such as the Balanced Scorecard, benchmarking, continuous improvement, project management and Total Quality Management (TQM) to measure supply chain performance

Finding 3: Tools such as "lean manufacturing", "just-in-time manufacturing" (or JIT in short), and "activity based costing" (or ABC) are not used in Zueitina

4.7.2 Theme 2: Supply chain performance metrics

The focus of Theme 2, derived from the two (2) findings below, is the metrics identified for supply chain performance as discussed in IQ2 (section 4.6.1.2).

Finding 4a: The important metrics identified for Zueitina's supply chain performance include: logistics, inventory, handling and overall spend/ costs; delivery speed; coordination and planning; competitiveness; customer satisfaction; commitment and trust in customer relationships; and distribution network integration

Finding 4b: Metrics that were not specifically mentioned include: quality; on-time delivery; order fulfilment lead time; capacity; and total delivered price. These metrics may be present in Zueitina's performance measures, but they were not uncovered during the research

4.7.3 Theme 3: Optimisation of procurement, warehouse resources and inventory management through IT implementation

Theme 3 was derived from 11 findings, as discussed in IQ3, IQ6, IQ7 and IQ8 (sections 4.6.3.1 – 4.6.3.4). These findings are categorised into four (4) sub-themes, which are discussed next.

4.7.3.1 Sub-theme 3.1: Accuracy and speed

The following two findings focus on increased accuracy and speed, which include fast order processing and simplified planning through their IT processes:

Finding 7: IT applications implemented by Zueitina have given the Company a competitive advantage in terms of faster and more accurate product processing and delivery, resulting in increased supply chain performance

Finding 19: Although IT applications enable Zueitina to fulfill large orders fast and simplify tasks planning, it does not seem to have a significant impact, as product demand is already high

4.7.3.2 Sub-theme 3.2: Costs and time

In total, five of the 22 findings focus on decreasing costs and saving time through the use of IT processes in Zueitina's supply chain.

Finding 5: It can be safely inferred that the IT applications employed at Zueitina reduce overall costs, as it reduces inventory levels and storage/ logistic costs, hence leading to enhanced planning and management

Finding 6: Handling costs are reduced by implementing TMS technology, which helps Zueitina consolidate its freight and fleet optimisation

Finding 11: The overall spend has decreased since Zueitina implemented IT applications; uncontrolled spending is reduced and better prices are obtained from suppliers, thereby contributing to a reduced inventory

Finding 18: IT systems save time, and subsequently, also costs; it contributes towards optimising resources such as labour, equipment and overall use of space, and it helps reduce the risk of stock being outdated

Finding 21: IT software deployed in the Procurement Department significantly contributes towards decreasing the spending on goods and services, and reducing the purchasing cycle time

4.7.3.3 Sub-theme 3.3: Trust and communication

Two (2) findings derived from the data analysis focus on the communication and trust between Zueitina and their customers.

Finding 8: The IT applications improved Zueitina's Vendor Managed Inventory (VMI) processes, thereby increasing trust in customer relationships

Finding 10: Higher levels of communication between supply chain partners and Zueitina is maintained, thus building an integrated distribution network

4.7.3.4 Sub-theme 3.4: Inventory levels and competition

Two (2) findings derived from the analysed data emphasise the importance of Zueitina maintaining a sense of healthy competitiveness, which is linked to maintaining and balancing the inventory levels through its IT systems.

Finding 9: Information technology helps Zueitina to keep track of competition and differentiate the Company's products from the competitors

Finding 20: The impact of the IT applications on the reduction of inventory levels is not huge, because the demand for Zueitina products is already high

To summarise, the deployment of IT applications have increased the overall performance of Zueitina Oil Company's supply chain.

4.7.4 Theme 4: Value of optimised logistics system

Theme 4 was derived from four (4) findings, categorised under two (2) sub-themes as discussed in IQ4 and IQ5 (sections 4.6.4.1 and 4.6.4.2). Each sub-theme is discussed next.

4.7.4.1 Sub-theme 4.1: Increased revenues and customer service

Sub-theme 4.1 was derived from the following two (2) findings:

Finding 12: An enhanced/optimised logistics system leads to increased revenues

Finding 13: Customer service is a priority to Zueitina; the Company therefore employed a Customer Service Centre where customers can submit orders using the cloud-based application *WebEDI*

4.7.4.2 Sub-theme 4.2: Multiple information technologies

Sub-theme 4.2 was derived from the following two (2) findings:

Finding 14: Multiple technologies have been deployed to manage Zueitina's supply chain, including CAD, SCP, WMS, ERP, CRM, BI Systems, TMS Systems and Fleet Tracking; however, the following systems are not employed: PDM, AQC, RFID and WIS. The Company does have plans to adopt these systems

Finding 15: Zueitina is eager to continue saving on costs and improving its supply chain and logistics processes by implementing additional information technologies

4.7.5 Theme 5: Importance of IT applications in the supply chain

Theme 5 was derived from the following two (2) findings:

Finding 16: Zueitina realised within a short time period just how significant their savings were through using IT applications for sourcing (RFIs, RFQs, and RFPs). Furthermore, the Company does not face a supply risk anymore

Finding 17: Changing the entire system in Zueitina was costly, but it paid off in terms of reduced costs, increased profits, increased efficiency, high quality products, enhanced supply chain performance, enhanced customer service, and trust

4.8 Summary of categorised research questions, objectives, themes and findings

The primary data collected were analysed using thematic analysis (section 3.8; Table 3.1). The themes and sub-themes identified from the data analysis, together with the corresponding IQs, are presented in table 4.3.

Table 4.3: Themes and sub-themes linked to the interview questions

Themes and sub-themes	IQ #
Theme 1: Supply chain performance strategies/techniques	IQ1
Theme 2: Supply chain performance metrics	IQ2
Theme 3: Optimisation of procurement, warehouse resources and inventory management through IT implementation **Sub-theme 3.1:** Accuracy and speed **Sub-theme 3.2:** Time and Costs **Sub-theme 3.3:** Trust and Communication **Sub-theme-3.4:** Inventory levels and competition	IQ3, IQ6, IQ7, IQ8
Theme 4: Value of optimised logistics system **Sub-theme 4.1:** Increased revenues and customer service **Sub-theme 4.2:** Multiple information technologies	IO4, IQ5
Theme 5: Importance of IT applications in the supply chain	IQ9, IQ10, IQ11, IQ12, IQ13, IQ14, IQ15

Table 4.4 depicts the relationship between each interview question and the corresponding theme derived from the findings, which, in turn, is aligned to a specific SRQ and research objective.

Table 4.4: Sub-research questions, objectives, themes and findings

SRQ	Objectives	Themes	Findings
SRQ 2.1: What strategies/ techniques are currently used to measure Zueitina Oil Company's supply chain performance?	**Objective 3:** To identify what strategies/techniques are currently used to measure the supply chain performance of Zueitina Oil Company	**Theme 1:** Supply chain performance strategies/ techniques	**Finding 1:** Zueitina's cares about brining value to their customers through improving the quality of their products **Finding 2:** Zueitina preferred to adopt the ISO 9000 model and other management techniques such as the Balanced Scorecard, benchmarking, continuous improvement, project management and Total Quality Management (TQM) to measure supply chain performance **Finding 3:** Tools such as "lean manufacturing", "just-in-time manufacturing" (or JIT in short), and "activity based costing" (or ABC) are not used in Zueitina
SRQ 2.2: What metrics are currently used for Zueitina Oil Company's supply chain performance?	**Objective 4:**To identify what metrics are currently used for Zueitina Oil Company's supply chain performance	**Theme 2:** Supply chain performance metrics	**Finding 4a:** The important metrics identified for Zueitina's supply chain performance include: logistics, inventory, handling and overall spend/ costs; delivery speed; coordination and planning; competitiveness; customer satisfaction; commitment and trust in customer relationships; and distribution network integration **Finding 4b:** Metrics that were not specifically mentioned, include: quality; on-time delivery; order fulfilment lead time; capacity; and total delivered price. These metrics may be present in Zueitina's performance measures, but they were not uncovered during the research
SRQ 2.3: What is the impact of information technology applications on Zueitina Oil Company's logistics, and specifically, on procurement, warehouse and inventory management?	**Objective 5:** To explore the impact of Zueitina's information technology applications on logistics, and specifically on procurement, warehouse, and inventory management	**Theme 3:** Optimisation of procurement, warehouse resources and inventory management through IT implementation **Sub-theme 3.1:** Accuracy and speed **Sub-theme 3.2:** Time and Costs **Sub-theme 3.3:** Trust and Communication **Sub-theme-3.4:** Inventory levels and competition	**Finding 5:** It can be safely inferred that the IT applications employed at Zueitina reduce overall costs, as it reduces inventory levels and storage/ logistic costs, hence leading to enhanced planning and management **Finding 6:** Handling costs are reduced by implementing TMS technology, which helps Zueitina consolidate its freight and fleet optimisation **Finding 7:** IT applications implemented by Zueitina have given the Company a competitive advantage in terms of faster and more accurate product processing and delivery, resulting in increased supply chain performance **Finding 8:** The IT applications improved Zueitina's Vendor Managed Inventory (VMI) processes, thereby increasing trust in customer relationships **Finding 9:** Information technology helps Zueitina to keep track of competition and differentiate the Company's products from the competitors **Finding 10:** Higher levels of communication between supply chain partners and Zueitina is maintained, thus building an integrated distribution network

SRQ	Objectives	Themes	Findings
			Finding 11: The overall spend has decreased since Zueitina implemented IT applications; uncontrolled spending is reduced and better prices are obtained from suppliers, thereby contributing to a reduced inventory **Finding 18:** IT systems save time, and subsequently, also costs; it contributes towards optimising resources such as labour, equipment and overall use of space, and it helps reduce the risk of stock being outdated **Finding 19:** Although IT applications enable Zueitina to fulfill large orders fast and simplify tasks planning, it does not seem to have a significant impact, as product demand is already high **Finding 20:** The impact of the IT applications on the reduction of inventory levels is not huge, because the demand for Zueitina products is already high **Finding 21:** IT software deployed in the Procurement Department significantly contributes towards decreasing the spending on goods and services, and reducing the purchasing cycle time
SRQ 2.4: How is the logistics system at Zueitina Oil Company managed?	**Objective 6:** To explore how the logistics system at Zueitina Oil Company is managed	**Theme 4:** Value of optimised logistics system **Sub-theme 4.1:** Increased revenues and customer service **Sub-theme 4.2:** Multiple information technologies	**Finding 12:** An enhanced/optimised logistics system leads to increased revenues **Finding 13:** Customer service is a priority to Zueitina; the Company employed a Customer Service Centre where customers can submit orders using the cloud-based application *WebEDI* **Finding 14:** Multiple technologies have been deployed to manage Zueitina's supply chain, including CAD, SCP, WMS, ERP, CRM, BI Systems, TMS Systems and Fleet Tracking; however, the following systems are not employed: PDM, AQC, RFID and WIS. The Company does have plans to adopt these systems **Finding 15:** Zueitina is eager to continue saving on costs and improving its supply chain and logistics processes by implementing additional information technologies
SRQ 2.5: What is the importance of optimised IT applications in Zueitina Oil Company's supply chain and logistics processes?	**Objective 7:** To determine the importance of optimised IT applications in Zueitina Oil Company's supply chain and logistics processes	**Theme 5:** Importance of IT applications in the supply chain	**Finding 16:** Zueitina realised within a short time period just how significant their savings were through using IT applications for sourcing (RFIs, RFQs, and RFPs). Furthermore, the Company does not face a supply risk anymore **Finding 17:** Changing the entire system in Zueitina was costly, but it paid off in terms of reduced costs, increased profits, increased efficiency, high quality products, enhanced supply chain performance, enhanced customer service, and trust

4.9 Summary

This chapter answered SRQ 2.1 to SRQ 2.5 to achieve the corresponding objectives set in accordance with the SRQs. The data collected from the Zueitina executives were analysed, findings were derived from the discussion of each interview question, and then themes and sub-themes were formulated from the findings, presenting the effectiveness of employing information technology applications for Zueitina's supply chain.

Chapter 5 presents the proposed model for optimising Zueitina's supply chain.

CHAPTER 5: PROPOSED INFORMATION TECHNOLOGY OPTIMISATION MODEL FOR ZUEITINA'S SUPPLY CHAIN

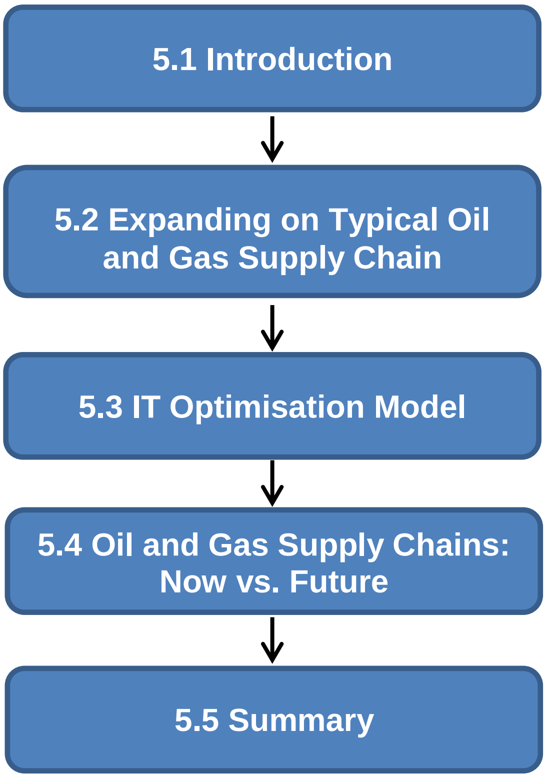

Figure 5.1: Graphical representation of Chapter 5

5.1 Introduction

In this chapter, the proposed Information Technology Optimisation Model for Supply Chain Management at Zueitina Oil Company, taking into consideration the findings, the themes and sub-themes identified in section 4.7 and summarised in Table 4.4, is presented. With this, the final sub-research question (section 1.6.2), is then addressed.

SRQ 2.6: What Information Technology Optimisation Model can be proposed to contribute towards enhancing the supply chain and logistics processes of Zueitina Oil Company in Libya?

5.2 Expanding on the typical supply chain model for Libya

The typical supply chain model for Libya's oil and gas sector is depicted in Figure 2.14 and discussed in section 2.6.6. The upstream, midstream and downstream sectors are explained, and, according to the literature, oil and gas companies in

Libya apply this model in their business. This research uncovered a gap in the model, specifically for Zueitina, which, if addressed, may contribute towards supply chain optimisation in terms of increased revenues, reduced costs, and improved customer services, among others. Because this research is a case study, the outcomes may not be generalised to apply to other oil and gas companies. However, with more research and by adopting a multiple case study approach, it may be found that the IT supply chain optimisation model proposed in the next section, may be used, with minor adjustments, for similar oil and gas companies in developing countries.

5.3 Proposed Information Technology Optimisation Model

Over the past years, many oil companies adopted practices such as lean manufacturing and total quality management (TQM). As result, they were able to achieve improved process TQM while filtering out much of the excess cost from their supply chain systems (Elhuni & Ahmad, 2012). Although there is still room for improvement for many companies, the major gains that have been realised are as follows:

- Increased revenues (section 2.6.5; section 4.7.4.1; section 4.7.3.2)
- Increased productivity (section 2.6.3)
- Increased trust and communication (section 4.7.3.3)
- Competitive advantage (section 4.7.3.4)
- Reduced costs (section 2.6.5; section 4.7.3.2)
- Enhanced customer service (section 2.7.1.1)
- Reduced defects, waste and inventory (section 1.3)
- Improved supply chain design (section 4.6.4.2)
- Adapted to changing markets and regulatory environments (section 2.7.1)

Finding 15 (section 4.7.4.2) states the following*: Zueitina is eager to continue saving on costs and improving its supply chain and logistics processes by implementing additional information technologies.* Thus, Zueitina recognises that further optimisation of its supply chain is possible and needed.

Taking into considering the themes and sub-themes that emerged from the findings (Table 4.4), this research proposes an Information Technology

Optimisation Model for Zueitina's Supply Chain. Figure 5.2 graphically depicts the model proposed by the researcher.

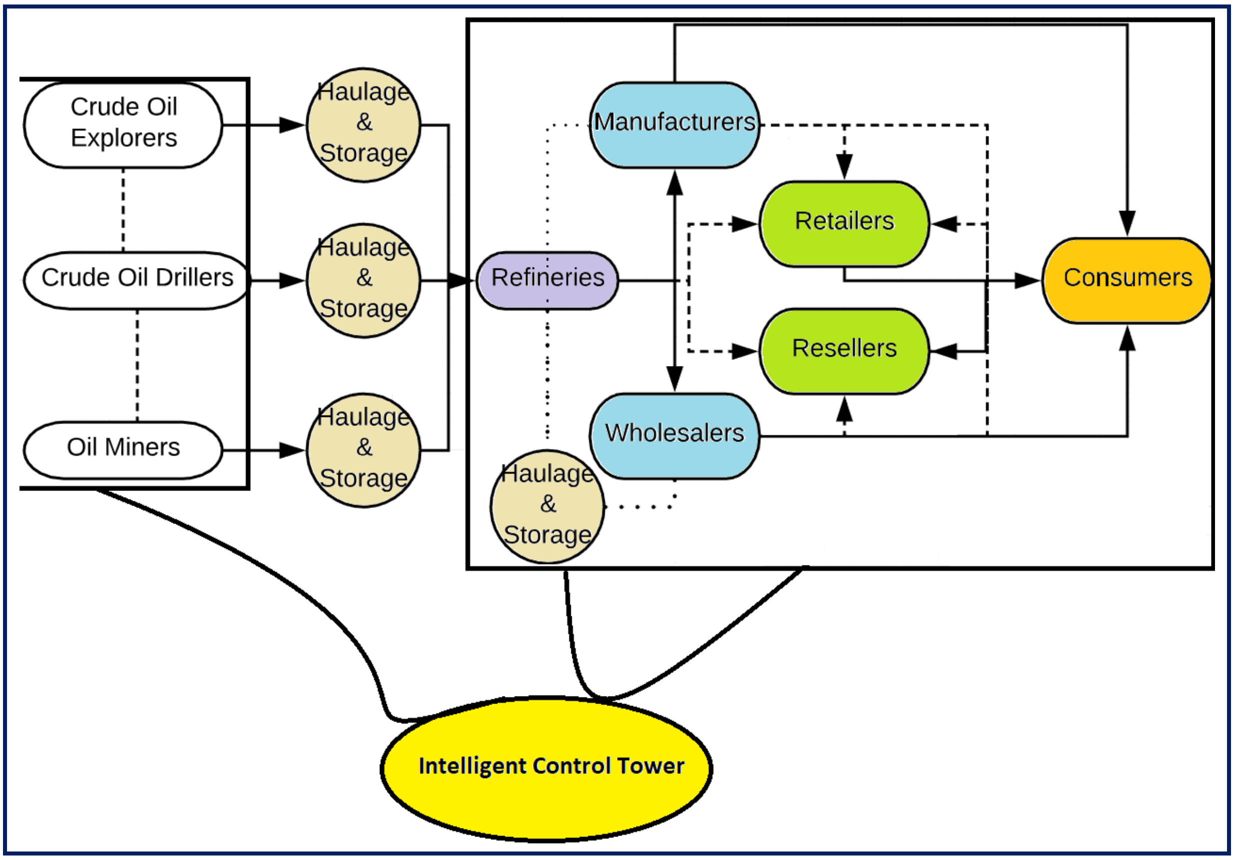

Figure 5.2: Proposed Information Technology Optimisation Model for Zueitina's Supply Chain (Source: Researcher)

The opportunity to optimise Zueitina's supply chain resides primarily with Procurement, Distribution, and Logistics. As indicated in Figure 5.2, the researcher proposes the inclusion of an **Intelligent Control Tower** for decision making, monitoring and managing the execution of processes across all departments/ units/functions in the Company's supply chain to optimise/enhance the entire oil and gas supply chain network. This solution may prove to be more cost effective, efficient and responsive. it is important to note that this **Intelligent Control Tower** is not a physical tower or object, but a centralised hub that contains all the needed technologies, organisational tools, and processes to acquire (capture) data across all stages of the supply chain.

Figure 5.3 drills down into the **Intelligent Control Tower** concept to depict the four primary levels (or dimensions) (Duckworth, 2018; One Network Enterprises, 2020) of this Centralised Digital Hub which serves as interface between, and offers a new perspective on the upstream, midstream and downstream sectors of the supply chain in terms advanced information technologies.

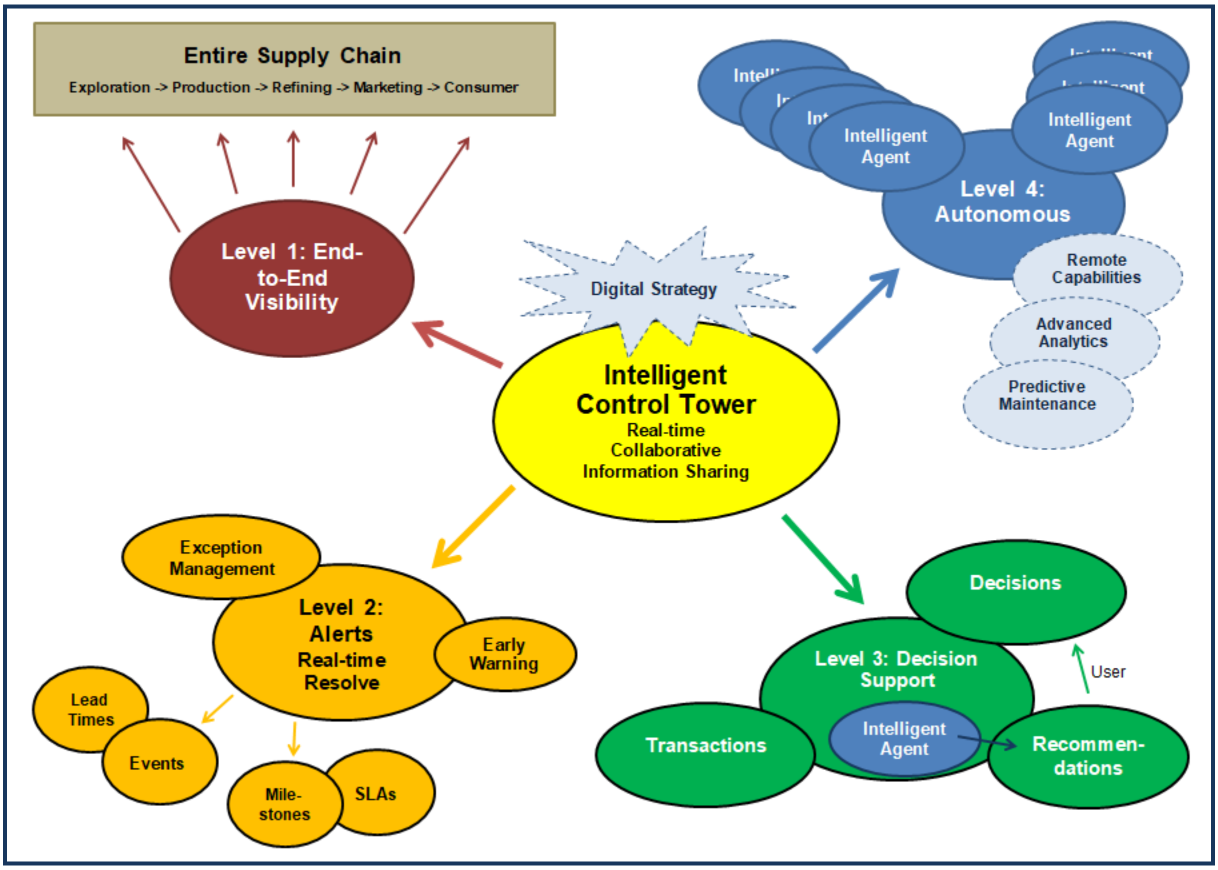

Figure 5.3: Intelligent Control Tower (Centralised Digital Hub)
(Source: adapted from Duckworth, 2018)

Control towers for the oil and gas sector supply chain offer considerable benefits and capabilities across four layers or levels: (i) Visibility; (ii) Alerts; (iii) Decision Support; and (iv) Autonomous Automation. The key capabilities to look for in a control tower solution, as depicted in Figure 5.3 and adopted from Duckworth (2018) and One Network Enterprises (2020), are as follows:

- **Collaborative information sharing** – share information and collaborate in real-time
- **End-to-end visibility** – visibility across the entire supply chain, which includes all supply chain partners such as the suppliers, contract manufacturers, transportation carriers, and third-party logistics.

- **Early warning alerts and exception management** – resolve supply chain disruptions before the business is disrupted. Alerts come in based on SLAs and lead times, which are tagged to events and milestones
- **Prescriptive and predictive decision support** – intelligent agents conduct predictive and prescriptive analytics and make recommendations to the user, who then make decisions based on these recommendations
- **Autonomous decision making and control** – In level 4, intelligent agents are embedded in what is called "the execution layer"; these agents the manage or run the supply network without the intervention of humans

A **digital strategy** (Figure 5.3) is proposed to be built upon the application of various technologies for developing the capabilities to implement autonomous and remote operations. In the (near) future (if not already existing), robots will have the built-in capability to run/manage multiple operations autonomously, thereby and, primarily replace field workers and decrease costs across the entire value chain. Augmented automation will furthermore advance precision and efficiency, and increase safety, while at the same time upholding and sustaining production levels at a very small percentage of the present costs.

Still with Figure 5.3, the researcher furthermore propose the following functionalities to be considered in Layer 4:

i) **Remote abilities,** system-wide, through computer networks, to increase access control and robustness (which could be a topic for further research).

ii) **Advanced analytics:** The phenomenal increase in software flexibility and computing power means more automated and faster analytics models for the oil and gas supply chain, leading to Big and more diverse data being analysed faster with more precise outcomes. Oil companies can therefore identify profitable opportunities easier and faster, while at the same time apply real-time knowledge and insight to avoid risks.

iii) **Predictive maintenance:** By pre-empting alarms for equipment servicing through harnessing analytical software and devices connected to the Internet of Things, a supply chain's operational efficiency can be enhanced and costs can be reduced significantly (Velmurugan, 2019).

5.4 Oil and gas supply chains: Now vs. future

Where SCM was initially established to reduce costs, companies now realise it can offer so much more when advanced information technologies are incorporated. SCM has the ability to mitigate risks and drive advancement, but this shift in focus requires a total digital transformation of SCM (IMG, 2020).

Table 5.1 depicts the characteristics of supply chains today vs. the supply chain of the future (IMG, 2020). Manual actions and processes will be replaced with automated processes and simulations.

Table 5.1: Supply chain: Today and tomorrow (Source: IMG, 2020: 1)

Now	Future
Collecting data manually across roles and/or systems	Connections/links in real time
Collaborations happening manually	Collaborations taking place digitally
“If” or “what” is created	Simulation, automated
Planning and the making of decisions are “cadence-based”	Planning and the making of decisions are event-driven and continuous

5.5 Summary

In this Chapter, an Information Technology Optimisation Model was proposed to contribute towards enhancing Zueitina Oil Company’s supply chain through employing additional advanced information technologies. The foundation of the proposed model is based on Figure 2.14 (a visual depiction of Libya’s supply chain from the perspective of the researcher). Added to this foundation, the researcher proposes the inclusion of an Intelligent Control Tower in Figure 5.2. This control tower is not a physical tower or object, but a centralised hub that contains all the technology, organisational tools, and processes needed to capture data from all stages of the supply chain, from the manufacturer to the consumer. Figure 5.3 drills down into concepts and technologies contained in the Intelligent Control Tower.

The next and final chapter answers the RQs and SRQs in summative form, recommendations are made, and the limitations encountered during the study are discussed.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

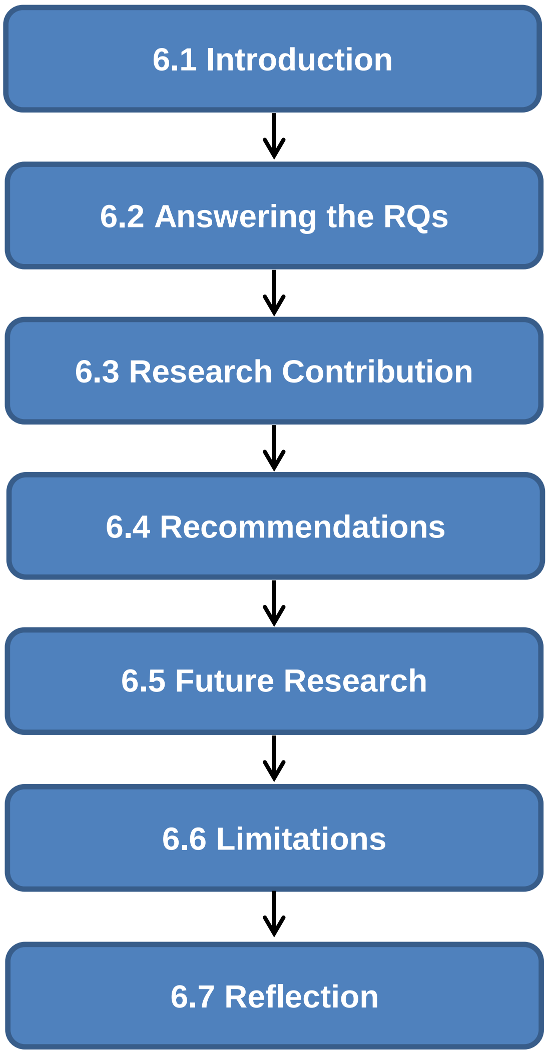

Figure 6.1: Graphical representation of Chapter 6

6.1 Introduction

Libya’s economy is primarily dependent on the production and export of its oil and gas industry (EIA, 2020). However, existing information technologies are not fully utilised by oil and gas companies in the country, and specifically in their supply chain and logistics processes. This causes the productivity of Libya’s oil and gas supply chain to be compromised, leading to significant losses in revenue and wasteful expenditure. This study therefore aimed to: i) explore the status of the oil and gas industry in Libya in terms of oil production and export; and ii) determine what innovative information technologies should be considered by Zueitina Oil Company (as case study) in Libya to enhance its supply chain and logistics processes.

This final chapter summarises how each of the research questions was addressed during the study. Recommendations are made for Zueitina Oil Company, which was the case of the study. The limitations are pointed out, future research is suggested, and the chapter ends with the researcher reflecting on his research journey, which was filled with challenges in his home country.

6.2 Answering the research questions

Each of the SRQs for PRQ1 and PRQ2 is answered next, based on the reviewed literature and the findings and themes that emerged from the data analysis. By answering all of the SRQs, the primary research questions are addressed, the aim has been achieved and the study is therefore completed.

6.2.1 Primary Research Question 1

PRQ1: What is the status of Libya's oil and gas sector in terms of oil production and export?

6.2.1.1 Sub-Research Question 1.1

SRQ 1.1: What is the status of the world's oil and gas sector in terms of production and export?

- In 2017, the global proved oil reserves dropped marginally to 1,696.6 billion barrels, which showed a decline of 0.5 billion barrels (-0.03%) from the previous year (BP, 2017). At the time, the OPEC countries held 71.8% of confirmed global reserves and the non-OPEC countries held 28.2% (section 2.2).

- For the 2018 world crude oil reserves, the OPEC countries held 79.4% and the non-OPEC countries the remainder of 20.6% (OPEC, 2019a) (section 2.2).

- From 2016 to 2018, the total world oil supply increased slightly (95.5 mb/d, 96.1 mb/d and 99.1 mb/d respectively). However, the total world oil demand was higher than the supply in 2016 and 2017 (95.7 mb/d and 97.4 mb/d respectively). In 2018, the supply (99.1 mb/d) could meet the demand of

98.8 mb/d, with a small surplus. In 2019, the demand was 99.7 mb/d, but the supply was less, at 99.1 mb/d (section 2.2; Figure 2.4; Table 2.1).

- In 2020, the advent of COVID-19 changed the oil and gas sector world outlook drastically. Due to 'hard lockdowns' and extremely firm import and export restrictions, oil-producing countries depended on oil as their primary resource fell into an unsustainable cycle of non-concessional private and short-term borrowing, "backed by oil collateral" (OECD, 2020: 1) (section 2.2.1).

- The coronavirus pandemic catapulted the oil price to levels unseen since 2002 due to a worldwide collapse for crude oil (OECD, 2020, citing BBC News, 2020) (section 2.2.1).

6.2.1.2 Sub-Research Question 1.2

SRQ 1.2: What is the status of Africa's oil and gas sector terms of production and export, and specifically Libya's?

- The oil and gas sector is absolutely crucial to the African continent. A total of 16 out of 54 African countries produce and export oil since 2010 (EIA, 2020) (section 2.3).

- In 2019, the top five oil producing companies in Africa were identified as: (i) Nigeria, (ii) Angola, (iii) Algeria, (iv) Libya, and (v) Egypt, ranked from the highest to the lowest output (Carpenter, 2020) (section 2.3).

- From 2001 to 2010, Africa accounted for over 11% of global oil production over the previous decade (2001-2010); however, because of low incomes in the majority of the African countries, oil consumption is still low on the continent. Therefore, Africa's oil consumption is stated as only 4% of the overall global oil use, meaning the continent has a tremendous amount of oil that can be exported (KPMG, 2015) (section 2.3).

- Political unrest on the African content has had a negative impact on oil exports over the past decade. In 2013, the net oil exports of Africa showed an average decline of approximately 6.3 million bpd over five years (2007-2011). An intense drop in Libya's output was the main reason for the weakening, followed by lower oil production in Algeria, Nigeria, and Sudan (KPMG, 2015). PWC (2014) reported that oil production levels dropped from 2012 to 2013 by approximately 35% due to political unrest in North Africa (section 2.3).

- Africa's proved natural oil reserves showed an increase from 2010 to 2014, with 119.5 billion barrels in 2010, 124 billion in 2011, 124.6 billion in 2013 and 128.8 billion in 2014. From 2015 to 2017 the reserves were relatively stable with slightly higher than 127 billion barrels (Faria, 2020). In 2018 the number increased to 128 billion, but then the decrease was significant, with 125.3 billion barrels in 2019 (thus a decrease of 2.7 billion), and 125.8 billion in 2020. These fluctuations are mostly attributed to unrest on the continent (Faria, 2020) (Figure 2.5; section 2.3).

- Recent profits and loans have been eroded fast in Africa's oil and gas sector since the Coronavirus spread all over the continent (PWC, 2020). The COVID-19 lockdowns and slowdowns led to significant oil production cuts, with a projected decline of 19% in the top five oil producing countries in Africa. Countries' budgets were redirected to the healthcare sector, which added to the fiscal strain (PWC, 2020) (section 2.3.1).

- According to the calculations and figures of UK Trade & Investment (UKTI), Libya's economy is primarily dependent on their oil sector revenues, which comprise 65% of their GDP and 95% of their foreign export income (Allurentis, 2015). The largest proven oil reserves in Africa are in Libya – 48.4 billion barrels of proven oil reserves, which amounts to 2.9% of the world total (USA Today, 2020) (section 2.4).

- Libya is a significant contributor to the worldwide supply of light, sweet crude oil, and the country mostly exports to European markets (EIA, 2020). Despite Libya's small population, the country is classified as an "Upper Middle Income Economy". Libya's considerable revenues from the energy sector gives the country one of the highest per capita GDPs on the African continent (The World Bank, 2020), currently calculated at US$19,673 (USA Today, 2020) (section 2.4).

- Libya holds the 5th largest amount of proved natural gas reserves in Africa (EIA, 2020) and the 8th largest proven oil reserves in the world (and the largest in Africa) (temehu.com, 2020). Notwithstanding, Libya remains highly unexplored because current agreements with oil companies only cover 25% of Libya (section 2.4).

- Continuous conflict and unrest among rival groups seeking control of Libyan territories made it extremely challenging for the researcher to collect data at Zueitina Oil Terminal, which is located about 850 kilometres from Libya's capital city, Tripoli (VAOS, 2012) (section 2.4.3; section 2.5.2; Table 2.5; Table 2.6; Table 2.7)

6.2.2 Primary Research Question 2

PRQ2: What innovative information technologies need to be considered by Zueitina Oil Company in Libya to contribute towards optimising its supply chain and logistics processes?

6.2.2.1 Sub-Research Question 2.1

SRQ 2.1: What strategies/techniques are currently used to measure Zueitina Oil Company's supply chain performance?

- From the data collected and analysed at Zueitina Oil Company, it became evident that as main strategy, managers do work on improving the quality of their services, and on the value and products they offer to their customers. The organisation has adopted ISO 9000 as a model, and management techniques such as the Balanced Scorecard, benchmarking, continuous improvement, project management and Total Quality Management (TQM) are applied (section 4.6.1.1).

- The research found that tools such as "lean manufacturing", "just-in-time manufacturing" (or JIT in short), and "activity based costing" (or ABC) are not used in Zueitina (section 4.6.1.1).

6.2.2.2 Sub-Research Question 2.2

SRQ 2.2: What metrics are currently used for Zueitina Oil Company's supply chain performance?

- The important metrics identified for Zueitina's supply chain performance include: logistics, inventory, handling and overall spend/costs; delivery speed; coordination and planning; competitiveness; customer satisfaction; commitment and trust in customer relationships; and distribution network integration (section 4.6.2.1)

- Metrics that were not specifically mentioned, include: quality; on-time delivery; order fulfilment lead time; capacity; and total delivered price. These metrics may be present in Zueitina's performance measures, but they were not uncovered during the research (section 4.6.2.1)

6.2.2.3 Sub-Research Question 2.3

SRQ 2.3: What is the impact of information technology applications on Zueitina Oil Company's logistics, and specifically, on procurement, warehouse and inventory management?

- It can be safely inferred that IT applications are an **overall cost saver**, as it allows Zueitina to reduce storage/logistic costs and inventory levels, hence leading to better planning and management (section 4.7.3.2)

- IT applications implemented by Zueitina have given the Company a **competitive advantage** in terms of faster and more accurate product processing and delivery, resulting in increased supply chain performance (section 4.7.3.1)

- The IT applications improved Zueitina's Vendor Managed Inventory (VMI) processes, thereby increasing trust in **customer relationships** (section 4.7.3.3)

- Higher levels of **communication** between supply chain partners and Zueitina is maintained, thereby building an integrated distribution network (section 4.7.3.3)

- IT systems save **time**, and, subsequently, also **costs**; it contributes towards optimising resources such as labour, equipment and overall use of space, and it helps reduce the risk of stock being outdated (section 4.7.3.2)

- Although IT applications enable Zueitina to fulfill large orders fast and simplify task planning, it does not seem to have a significant impact, as product demand is already high (section 4.7.3.1)

- The impact of the IT applications on the reduction of inventory levels is not huge, because the demand for Zueitina products is already high (section 4.7.3.4)

6.2.2.4 Sub-Research Question 2.4

SRQ 2.4: How is the logistics system at Zueitina Oil Company managed?

- Customer service is a priority to Zueitina; the Company therefore employed a Customer Service Centre where customers can submit orders using the cloud-based application called *WebEDI* (section 4.7.4.1)

- Multiple technologies have been deployed to manage Zueitina's supply chain, including CAD, SCP, WMS, ERP, CRM, BI Systems, TMS Systems and Fleet Tracking; however, PDM, AQC, RFID and WIS are not employed. The Company does have plans to adopt these systems (section 4.7.4.2)

6.2.2.5 Sub-Research Question 2.5

SRQ 2.5: What is the importance of optimised IT applications in Zueitina Oil Company's supply chain and logistics processes?

- Zueitina realised within a short time period just how significant their savings were by using IT applications for sourcing (RFIs, RFQs, RFPs), and how these technologies reduced the Company's supply risk (section 4.7.5)

- Changing the entire system in Zueitina was costly, but it paid off in terms of reduced costs, increased profits, increased efficiency, high quality products, enhanced supply chain performance, enhanced customer service, and trust (section 4.7.5)

- As indicated in section 6.2.2.1, “lean manufacturing”, “just-in-time manufacturing (JIT)” and “activity based costing (ABC)” are not used in Zueitina. Practicing the JIT principle will promote the reduction of lead-time in the supply chain, thereby improving the service levels and reducing inventories. By assessing the efficiency of the supply chain processes through ABC, root cause problems can be detected and processes can subsequently be enhanced, thereby adding value to the supply chain (section 4.6.1.1)

In summary, Zueitina is aware of the importance of logistics to differentiate their services, gain market share, and reduce costs. The products offered in the oil and gas sector are perceived as commodities, so the logistics services play a key role in product differentiation.

6.2.2.6 Sub-Research Question 2.6

SRQ 2.6: What Information Technology Optimisation Model can be proposed to contribute towards enhancing the supply chain and logistics processes of Zueitina Oil Company in Libya?

Building on the typical supply chain model of Libya’s oil and gas sector (Figure 2.14, designed by the researcher), an Information Technology Optimisation Model for Zueitina’s supply chain is proposed in Chapter 5 (Figure 5.2, designed by the researcher) to contribute towards gaining further benefits from deploying advanced information technologies. The researcher proposes the inclusion of an **Intelligent Control Tower**. This control tower is not a physical tower or object, but a centralised hub that contains all the needed technologies, organisational tools, and processes to acquire (capture) data across all stages of the supply chain, which are depicted as “Exploration → Production → Refining → Marketing → Consumer” (Dabade & Kulkarni, 2019: 2).

Figure 5.3 drills down into the Intelligent Control Tower (depicted in Figure 5.2), which is the main contribution of this case study research on Zueitina Oil Company’s supply chain.

6.3 Contribution of the research

This research contributed to the scientific body of knowledge in the oil and gas field by proposing an Information Technology Optimisation Model for the supply chain of Zueitina Oil Company in Libya in order to increase revenues, reduce costs, and improve customer services, among others.

Because this research was a case study, the model may not be generalised to apply to other oil and gas companies. However, with more research (and considering a multiple case study approach), it may be found that the Information Technology Optimisation Model proposed in Chapter 5 may be applied, with minor adjustments, to similar oil and gas companies in developing countries.

6.4 Recommendations

The following recommendations may be considered by Zueitina Oil Company to optimise its supply chain:

- Zueitina Oil Company should continue investing in new information technologies that will enable the Company to keep up with the rapid growth of ICTs in the digital age, albeit at a limited investment cost, to continue working towards optimising its supply chain and logistics processes

- Zueitina Oil Company should develop the skills of employees to help increase employee capacity, optimise inventory in order to meet demand, and develop strategic relationships with financial institutions to assist with financing emergencies and capital investments needed to invest in technology, train professionals, and develop strategies to help reduce disruptions in the supply chain

- Zueitina Oil Company may consider formally introducing the following metrics to enhance its supply chain performance: i) Quality; ii) On-time delivery; iii) Order fulfilment lead time; iv) Capacity; and v) Total delivered price

6.5 Future research

The research methodology adopted for this study was deemed an effective tool to explore and analyse the data collected from the case under study. This methodology may be considered feasible for other case studies in the oil and gas sector in developing countries. For developed countries, however, the methodology might not deliver outstanding results/outcomes, as more intensive analyses and statistics could be needed to bring meaningful understanding to the study.

Research may also be conducted on the feasibility of introducing e-procurement into Libya’s oil and gas sector, given the rapid and exponential advancement of information technologies in this digital age. Apart from e-procurement, other manual processes in the oil and gas supply chain of companies in Libya might also be explored to be converted to full (or significant partial) automation.

Finally, research may be conducted to further develop/expand on the proposed Information Technology Optimisation Model for the supply chain processes and logistics of other oil and gas companies in Libya, or even other developing countries across the world.

6.6 Limitations

The main limitation of this study was the focus on a single case (Zueitina Oil Company) of the oil and gas sector in Libya rather than multiple cases, which would have provided a wider scope and a more in-depth understanding of the topic that was investigated. The researcher would have collected more data, but the time limit as well as conflicts across Libya made this not feasible at the time.

A minority of the respondents found it challenging to understand the interview questions, although the researcher telephonically translated the questions into Arabic to make it easier for them. This language barrier, i.e. limited knowledge of the English language, could have affected the accuracy of the data when the researcher translated the transcriptions back to English, although care was taken to provide accurate data.

6.7 Reflection

I would like to take this time to reflect on my journey from my humble beginnings, filled with anxiousness and excitement. I embarked on a path to explore a field I had never thought I would take—logistics warehouse management—just when I thought this was out of my comfort zone, I was thrown a curve ball. As I was ready to start my journey as a Master's student in the field of *Logistics Warehouse Management*, my University informed me that I would I have to study *Warehouse Management in IT* as my BTech was in Computer Systems. Nonetheless, I prepared myself and accepted the topic.

With uncertainty, I commenced with my studies and slowly became comfortable with the topic. Unfortunately, my supervisor at the time left the University, and due to an intricate flow and intermingling of consequences beyond my control, I had to start my studies from the beginning.

With a heavy heart I started over, but Thank God for a very passionate Professor, my newly appointed supervisor, who had success on her mind. I was not sure if I wanted to carry on as my country broke out into civil war, not to even mention the fact that I was working full time and providing for a big family. The constant battles between the rebels made living an absolute fight for survival. This, accompanied with the constant power outages in my country, meant no access to the Internet for long periods of time. We were under siege for days on end, and without running water on other days.

This continuous conflict among rival groups seeking control of Libyan territories made it extremely challenging for the researcher to collect data at Zueitina Oil Terminal, which is located about 850 kilometres from Libya's capital city, Tripoli (VAOS, 2012). But, with all that was happening around me, I continued to press on with my thesis as my Professor was my greatest cheerleader and forever encouraged and told me that I'll be fine. So, I would organise remote interviews with Managers of Zueitina Oil Company. We would use phone calls, we Skyped, and we texted each other. At one point I had to evacuate my family out of the country; we went to South Africa and shortly thereafter we went to Egypt due to work. I really was not sure if I was going to make it through this workload, both my work and my studies, while at the same proving for and taking care of my family.

But we pushed on through it all, my Professor and me. Piece by piece we worked on my thesis and I refused to give up, as we had come so far. I am now at the end of my journey and I could not be more grateful, even if I wanted to.

REFERENCE LIST

ASQ *see* American Society for Quality.

EIA *see* US Energy Information Administration.

IMF *see* International Monetary Fund.

IMG *see* International Management Group.

NIJ *see* National Institute of Justice.

NOC *see* National Oil Corporation.

NRGI *see* Natural Resource Governance Institute.

OPEC *see* Organisation of Petroleum Exporting Countries.

PWC *see* PricewaterhouseCoopers.

VAOS *see* Value Added Oilfield Services.

ZOC *See* Zueitina Oil Company.

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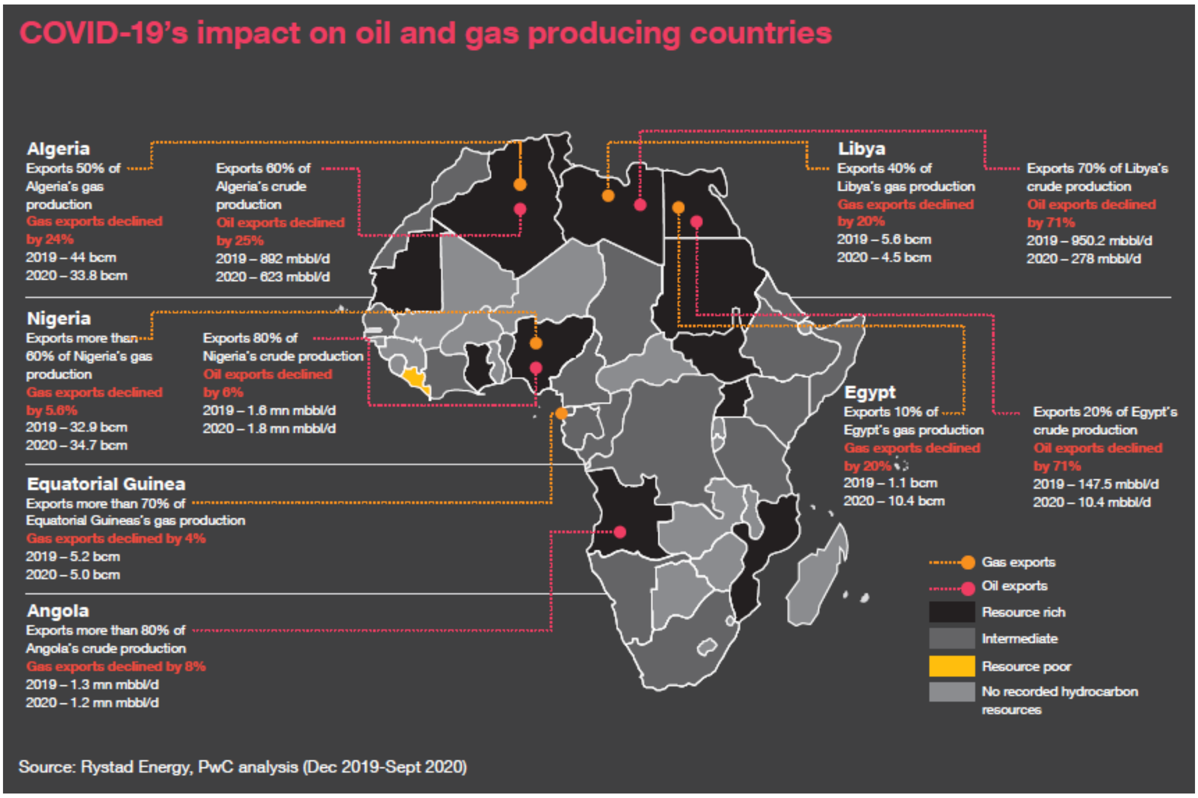
ANNEXURE A: INTERVIEW GUIDE

IQ#	Interview Question
IQ1	How is Zueitina Oil Company's supply chain performance measured?
IQ2	What metrics are important to Zueitina for tracking/measuring their supply chain performance?
IQ3	What is the impact of using Information Technology applications on the metrics employed?
IQ4	How important is logistics system to Zueitina?
IQ5	How effective is the use of IT applications in logistics?
IQ6	How does the use of IT applications help Zueitina in optimising warehouse resources?
IQ7	How do IT applications help in fulfilling large orders?
IQ8	How do IT applications help Zueitina reduce inventory levels without lowering its customer service standards?
IQ9	How do IT applications help Zueitina reduce its spending on products and services?
IQ10	How do IT applications help Zueitina with sourcing activities?
IQ11	How do IT applications contribute towards effecting contract pricing to the terms and conditions agreed upon?
IQ12	How do IT applications help simplify Zueitina's procurement processes?
IQ13	How do IT applications help staff control and automate purchasing?
IQ14	How do IT applications help reduce information lag time with processing errors, manual efforts, and supplier enablement?
IQ15	How do IT applications help manage Zueitina's supplier performance?

ANNEXURE B: INTERVIEW QUESTIONS PER RESEARCH QUESTION AND RESEARCH OBJECTIVE

Sub-Research Question	Objective	Interview Question
SRQ 2.1: What strategies/techniques are currently used to measure Zueitina Oil Company's supply chain performance?	**Objective 3:** To identify what strategies/ techniques are currently used to measure the supply chain performance of Zueitina Oil Company	**IQ1:** How is Zueitina Oil Company's supply chain performance measured?
SRQ 2.2: What metrics are currently used for Zueitina Oil Company's supply chain performance?	**Objective 4:** To identify what metrics are currently used for Zueitina Oil Company's supply chain performance	**IQ2:** What metrics are important to Zueitina for tracking/ measuring their supply chain performance?
SRQ 2.3: What is the impact of information technology applications on Zueitina Oil Company's logistics, and specifically, on procurement, warehouse and inventory management?	**Objective 5:** To explore the impact of Zueitina's information technology applications on logistics, and specifically on procurement, warehouse, and inventory management	**IQ3:** What is the impact of using Information Technology applications on the metrics employed? **IQ6:** How does the use of IT applications help Zueitina in optimising warehouse resources? **IQ7:** How do IT applications help in fulfilling large orders? **IQ8:** How do IT applications help Zueitina reduce inventory levels without lowering its customer service standards?
SRQ 2.4: How is the logistics system at Zueitina Oil Company managed?	**Objective 6:** To explore how the logistics system at Zueitina Oil Company is managed	**IQ4:** How important is a logistics system to Zueitina? **IQ5:** How effective is the use of IT applications in logistics?
SRQ 2.5: What is the importance of optimised IT applications in Zueitina Oil Company's supply chain and logistics processes?	**Objective 7:** To determine the importance of optimised IT applications in Zueitina Oil Company's supply chain and logistics processes	**IQ9:** How do IT applications help Zueitina reduce its spending on products and services? **IQ10:** How do IT applications help Zueitina with sourcing activities? **IQ11:** How do IT applications contribute towards effecting contract pricing to the terms and conditions agreed upon? **IQ12:** How do IT applications help simplify Zueitina's procurement processes? **IQ13:** How do IT applications help staff control and automate purchasing? **IQ14:** How do IT applications help reduce information lag time with processing errors, manual efforts, and supplier enablement? **IQ15:** How do IT applications help manage Zueitina's supplier performance?

ANNEXURE C: COVID-19 INFLUENCE ON AFRICA'S OIL AND GAS



(Source: PricewaterhouseCoopers, 2020: 9)

ANNEXURE D: PROOFREADING CERTIFICATE

29 December 2020

FATHI A TAROM
Faculty of Applied and Computer Sciences
ICT Department
Vaal University of Technology

RE: CERTIFICATE - TECHNICAL EDITING AND PROOFREADING OF MASTER'S THESIS

I, the undersigned, herewith certify that the technical editing and proofreading of the Master's thesis of Fathi Tarom, *"A MODEL FOR INFORMATION TECHNOLOGY OPTIMISATION IN SUPPLY CHAIN AND LOGISTICS OF LIBYA OIL AND GAS SECTOR: THE CASE OF ZUEITINA OIL COMPANY"*, has been conducted and concluded.

Sincerely

AJordaan

Professor Annelie Jordaan
DTech: Information Technology
Ph: 065 990 3713

Member: SATI 1003347

South African Translators' Institute (SATI)

ANNEXURE E: TURNITIN REPORT

Number of words were set to 3

All sources are < 1 (16% accepted by VUT if all sources are < 1)

A MODEL FOR INFORMATION TECHNOLOGY OPTIMISATION IN SUPPLY CHAIN AND LOGISTICS OF LIBYA OIL AND GAS SECTOR: THE CASE OF ZUEITINA OIL COMPANY

ORIGINALITY REPORT

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