DOCTOR OF PHILOSOPHY

A critical evaluation of operation cost drivers of oil and gas plays

a retrospective assessment of the economic viability of the Gulf of Guinea and the UK North Sea

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A critical evaluation of operation cost drivers of oil and gas plays: a retrospective assessment of the economic viability of the Gulf of Guinea and the UK North Sea

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This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Low Risk

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Declaration

I, Ibn Wahab Benin, hereby declare that this thesis is the product of my own effort and that no portion of it has been submitted for the application of another degree or qualification to another university or institute of learning. I can also confirm that where information from another source has been used in this research it is been duly acknowledged.

Content removed on data protection grounds

Dedication

This research thesis is dedicated to my parents (Benin Jabi and Marie Benin), my lovely daughter Hana Mmawisi Benin for their patience, support, prayers and inspiration to climb the academic ladder to PhD level.

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List of Abbreviation

ABC	Activity-Based-Costing
AIPN	Association of Petroleum Negotiators
BP	British Petroleum
CAPEX	Capital Expenditure
CIT	Corporate Income Tax
CSR	Corporate Social Responsibility
CEA	Chief Energy Attorney
E&P	Exploration and Production
EBITDA	Earnings before Interest Tax Depreciation and Amortization
EIA	Energy Information Administration
EOR	Enhanced Oil Recovery
ETF	Efficiency Task Force
EU	European Union
FCC	Full Cycle Cost
FCF	Free Cash Flows
FPSO	Floating Production Storage and Offloading
FID	Final Investment Decision
GAAP	General Accepted Accounting Principles
GNPC	Ghana National Petroleum Corporation
GPC	Ghana Petroleum Commission
GTL	Gas to Liquids
GPI	Government Participating Interest
ICT	Information Communication Technology
IAS	International Accounting Standards

IFRS	International Financial Reporting Standard
IPS	Integrated Project System
ITLOS	International Tribunal Law of Sea
JOA	Joint Operating Agreement
JVC	Joint Venture Corporation
KPIs	Key Performance Indicators
LNG	Liquefied Natural Gas
LCC	Life Cycle Costing
MIA	Mutual Interest Agreement
MENA	Middle East and North Africa
MER	Maximising Economic Recovery
NB	New Brunswick's
NC	Net Cash
NOC	National Oil Companies
NNPC	Nigeria National Petroleum Company
OFC	Oilfield Chemical
OLS	Ordinary Least Square
OPEX	Operating Expenditure
PCI	Participating and Carrying Interest
PSC	Production Sharing Contract
PWC	Price Waterhouse Coopers
RMMLF	Rocky Mountain Mineral Law Foundation
RMSE	Root Mean Square Error
ROI	Return on Investment
SPE	Society of Petroleum Engineers
SM	Senior Manager

SBDM	Senior Business Development Manager
SLO	Senior Legal Officer
SPE	Senior Production Engineer
SHRM	Senior Human Resource Manager
SME	Senior Maintenance Engineer
SN	Senior Negotiators
SCM	Senior Commercial Manager
SA	Senior Accountant
SDE	Senior Drilling Engineer
SE	Senior Engineer
SS	Senior Solicitor
SPCE	Senior Petroleum Chemical Engineer
SGFA	Senior Geopolitical and Financial Analyst
TEN	Tweneboa-Enyenra-Ntomme
UN	United Nations
U.K	United Kingdom
U.S.	United States
UKCS	UK Continental Shelf
UTC	Technical Operating Cost
VAR	Vector Autoregression
VAT	Value Added Tax
WSJ	Wall Street Journal
WC	Working Capital
WCR	Working Capital Requirement

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A critical evaluation of operation cost drivers of oil and gas plays: a retrospective assessment of the economic viability of the Gulf of Guinea and the UK North Sea

Abstract

Oil and gas industries are characterised as complex, highly capital intensive and high-level secrecy. Despite the global call for fossil fuel cut to reduce the global carbon emissions, the oil and gas industries account for about 58% of the global energy consumption. Previous studies on the oil and gas operations demonstrate the influence of operating cost on the operational performance, on a separate basis, within each of the regions of Gulf of Guinea and the UK North Sea. However, despite numerous studies in understanding the operational mechanics of this sector, there is limited academic literature on the operating cost dynamics vis-à-vis the operating cost drivers and also on how to foster effective comparison between the two important, but distinct regions namely: Gulf of Guinea and the UK North Sea. Comparison of the two regions is important because it helps towards understanding the universality or otherwise of the oil and gas operations. In response to the growing need to understand the dynamics in the industries, this study evaluates operating cost with a view to identifying and understanding activities that influence operating cost objects and their optimisation strategies in the oil and gas operations. The dynamics are crucial in identifying the economic viability of the projects undertaken within the two distinct regions in terms of regulatory framework and sources of labour. In this connection, three important research questions emerge. First, what operating cost drivers affect operating costs in the Gulf of Guinea and the UK North Sea upstream oil and gas operations? Secondly, what are the nature of the relationships that exist among operating cost objects in the Gulf of Guinea and the UK North Sea oil and gas operations? Finally, to what extent are the optimisation strategies implemented in the Gulf of Guinea and the UK North Sea help control operating cost to optimise oil and gas operations?

Based on the literature reviewed on oil and gas operations and cost evaluation techniques, this study employs semi-structure interviews and open-ended questionnaire and electronically distribute them to senior management in the oil and gas industry to solicit for information on oil and gas operating cost drivers and their optimisation strategies. Additionally, this study employs vector autoregressive (VAR) models to explore the operating cost dynamics and establish relationships that exist among the operating cost objects. The results from both qualitative and quantitative data demonstrate that maintenance and labour activities are the major drivers that influence operating cost in oil and gas operations in the two regions. However, a closer observation of the data from Gulf of Guinea indicates that maintenance cost is trigged by poor maintenance culture, while in the UK North Sea maintenance cost is trigged by the aged infrastructure, which generates complex maintenance activities that influence operating cost. The labour cost in Gulf of Guinea is influenced by labour unionism while in the UK North Sea region the labour cost is influenced by high wages to compensate for the nature of the operation. Furthermore, labour deficits in both regions appear to be one of the factors that influence the operating cost. Additionally, this study identifies the importance of health and safety and how it influences UK North Sea's operating cost, mainly due to strict regulation put in place in the provision of the health and safety. The study also documents evidence that security activities (e.g. from militancy, pipeline vandalization) often associated with weak regulatory system influence Gulf of Guinea operations, hence operators spend more resources to protect their assets. Furthermore, supplies and service cost in the Gulf of Guinea is influenced by the local content law where services are outsourced through the local company which often quotes outrageous prices of the service. However, in the UK North Sea, the supplies and service cost is influenced by oilfield chemicals for enhanced oil recovery processes. We conclude that, the operating costs in the two regions are affected differently given the peculiarities of the environments. These findings are particularly important to the investors when evaluating sensitivity of environmental factors to the operating costs. Based on the conclusion of this study, we recommend that there is a strong need for all stakeholder

engagement, collaboration, and commitment towards devising and employing an effective system to optimise labour, maintenance and health and safety activities in oil and gas operations.

Chapter One

Introduction

1.1 Background of the Study

The costs of investments and operations in the upstream oil and gas activities (ranging from discovery, development, to the actual production - lifting of crude oil from the reservoir) account for multi-million U.S. dollars (EIA 2016). In other words, a significant systematic proportion of the cost is generated from the production processes. Consequently, the extant literature on the oil and gas operations and costs establishes that a significant portion of the cost of production is influenced by the complexity in, uncertainties, risk, and harsh operational environment (Symms *et al.* 2018). Further studies indicate that, those factors mentioned above create various operational challenges which build uncertainty on the return on investment (Bob and Dudley 2019; Christer *et al.* 2019). Besides, the oil price volatility in the oil and gas markets (often attributed to sudden falls/rise in crude prices and competition from renewable energy) also significantly influences the upstream fiscal performance when markets face low oil regime, with unit cost of production remaining unchanged (Vernie 1976; Kutcherov 2013). From the fiscal viewpoint, these issues create a complex scenario in oil and gas operations for optimisation of the upstream operations (Kirsty 1998; Prabir *et al.* 2018; Kretzmann *et al.* 2019). Hence, it is in the best interest of the managers and investors to understand the operational mechanics of costs in order to optimise their firm's operations.

Despite the operational challenges, stakeholders advocating for green energy, including external bodies such as United Nations (UN), attempt to restrict the upstream activities because of the climate change issues and physical environmental pollution often associated with fossil fuels. All these factors add-up to the complexity and complications of the upstream operations, which ultimately affect the financial performance of oil and gas operators (Bellelli *et al.* 2013; Sandalow *et al.* 2014; Guo and Li 2018). Additionally, the upstream operations are also sensitive to other external factors such as civil wars and political instability. Hence, those issues lead to lawlessness in some oil producing nations which threaten the security of the operations and often lead to the destruction of oil and gas facilities and eventually increase the cost of operations in those regions (Bank of Ghana 2018; Budget Office 2018). Some examples of these issues include 1980 Iran-Iraq war, the political unrest in Libya, lawlessness and pipeline vandalisation in Nigeria and other oil rich nations. These issues affect the oil and gas operations and translate into additional cost of operations, as operators in those regions suffer the consequence (Paul 2003; Ashwarya 2017). Fundamentally, the above issues in oil and gas operations create a complex cost structure which makes it very difficult for managers to understand the cost behaviour and establish the best means to control it.

Furthermore, the expenditure in the oil and gas operation is classified into capital expenditure (CAPEX) and operating expenditure (OPEX). The CAPEX is generated from discovery and development activities, while the OPEX accrues from the expenses incurred on the operating activities (EIA 2016; KPMG 2019). An inquiry on the cost of operation in the upstream activities establish that discovery activities accrue $3million per square metre of 3D seismic survey and drilling well-cast (Guedes and Santos 2016). A documented statistical evidence indicates that the fiscal wealth of appraisal activities amounted to $15million and well testing of $20million (EIA 2016). Furthermore, literature indicates that assembling and installation of a production platform accrue $950milion (Aka 2016). From the cost categorisation, all these costs stated above are CAPEX which looks quite straightforward to understand and evaluate. Additionally, the costs are long term in nature, which are serviced on instalment basis for many years.

In contrast, OPEX is detailed and frequently recorded (on daily basis) given that it is generated from the operating activities (Kemp and Stephen 2014; Ritchie and Dowlatabadi 2017). A review of the financial reports, most particularly the statement of comprehensive income which is recognised by International Accounting Standard (IAS 1), establishes that labour, service, maintenance, health and safety and overheads are some of the key operating cost objects (major cost domains)/operating expense (Suslick and Schiozer 2004; Shapovalova and Stephen 2019). Fundamentally, the accumulation of those cost objects mentioned form the basis of the operating costs. A critical evaluation and adjustment of the operating cost objects, when compared against the operating revenue leads to realisation of the operating profit as operating items are treated in statement of comprehensive income to realise operating profit (MU and JI 2019). Notwithstanding the importance of the operating cost as a profit function, stakeholders in oil and gas operations fails to put structures in place to control operating cost to optimise their operations, which escalates and affects the operations as evidence in the succeeding paragraphs reveals.

A review of Financial Time (2015) report reveals that E&P operators frequently records fiscal operating deficits in their operations. This means that the operating cost (operating expenses) exceeds the operating revenue related to the operations. An evidence from PWC (2015) report illustrates that upstream operators lost 22 per cent investment due to uncontrollable operating cost which leads to operating losses in their operations. Besides that, Haynes and Boone (2016) produce empirical statistics which illustrate that 90 per cent of E&P companies are declared bankrupt due to the inability to service their debts obligations because they recorded a significant fiscal operating deficit. Other evidence from England (2015) and Mgbame *et al.* (2015) establish that the UK North Sea exploration and production (E&P) operators' return on investments (ROI) reduces from 50 per cent to 0.2 per cent due to high fiscal operating deficit. Additional evidence from the UK North Sea reveals that operators record high gearing ratio due to high fiscal operating deficit; this limits the operators from sourcing debt financial instruments to undertake their activities (Deirdre 2017; Deirdre and Michie 2019). Evidence from the Gulf of Guinea also establishes that the development of Tweneboa Enyenra Ntomme (TEN) is delayed due to fiscal operating deficit (Zaimi 2014; Deirdre Michie 2016; Zeng and Hu 2019). Another evidence from the Gulf of Guinea indicates that Tullow and HESS suspend the development of their prospects in Cape Three Point located in Ghana Shores due to fiscal operating deficit (Skaten and Monica 2018).

The above literature analysis and discussions demonstrate that there is a need for oil and gas companies to optimise their operating cost in order to eliminate fiscal operating deficits and generate operating gains in their oil and gas operations. Besides, the reviews are overwhelmed by reports which fail to adhere to a specific robust methodology to evaluate the cost. This creates a gap in the operating cost assessment in oil and gas industry. Hence, this study seeks to critically investigate the operating cost objects (major cost domains) with a view to identifying the activities that influence their behaviours via a mixed research method. Hence, data is gathered from both qualitative and quantitative sources to address the operating cost challenges in the Gulf of Guinea and the UK North Sea oil and gas operations.

1.2 Problem Statement of the Study

The evaluation of operating cost in the oil and gas industry is very critical for the effective optimisation of the oil and gas operations. Research evidence shows that operating cost affects the operations from many perspectives, hence it presents new challenges and opportunities for operators and researchers in the oil and gas industry to explore. However, very little is known about operating cost drivers' behaviour within the oil and gas operations because oil and gas industries are generally characterised as secretive (Murray *et al*. 2018). Furthermore, only small number of studies explores an in-depth data on factors affecting the operating cost objects in the industries and how they influence the operating cost within the industries (see Mari *et al.*

2014; Boriss *et al.* 2005). These factors are essential conditions for understanding oil and gas operations, vis-à-vis the cost elements.

Additionally, even where it is established that operating cost is important to E&P operators and the industry at large, the previous studies show that operators still record fiscal operating deficits, which can be largely associated with lack of understanding the operating cost dynamics in the industry (Mari *et al.* 2014). More specifically, the Gulf of Guinea and the UK North Sea are two important regions that produce oil and contribute significantly to global oil and gas market dynamics (Boriss *et al.* 2005). Despite their role in the international oil markets, there is yet limited literature on their operating cost drivers and behaviour, as well as the optimisation strategies. Moreover, previous literature on the topic within the context of these regions only focused on primary data (Awan *et al*.2005; Katharine 2012). Muhammad *et al.* (2018) and Peng *et al*. (2019) use a very limited secondary data to explore the issues, however, they conclude that their attempt was limited by the lack of operating cost data as a major limitation.

Consequently, there is a need for further investigation into operating cost drivers and their behaviour in oil and gas industries. Therefore, this study primarily focuses on addressing the problem by exploring the operating cost drivers in the upstream oil and gas operations of the Gulf of Guinea and the UK North Sea. In addition to this, there is a strong need to understand the dynamic relationship that exists among operating cost objects in both regions because of their important contribution in the oil and gas supply contributions and the economies that are dependent upon such supplies. Finally, there exists a need to investigate the optimisation strategies for regional operating cost drivers' and how they can impact on economic viability of oil and gas operations in the regions. To address lack of comprehensive research on this problem, this study employs a mixed methods methodology (where both qualitative and quantitative data was used) to identify operating cost drivers, and their optimisation strategies in the Gulf of Guinea and the UK North Sea.

1.3 The Rationale and Motivation of the Study

The optimisation of oil and gas operations is strongly linked to effective cost management (Pekney *et al.* 2019), and that can be achieved in oil and gas operations by employing a critical evaluation on the influence of operating cost drivers (the activities) on operating cost objects and their optimisation strategies. However, from the initial reviews Sections 1.1. and 1.2, a limited amount of literature has been reported on the operating cost drivers and their behaviour and how they are used as strategies to optimise operations in oil and gas operations.

Additionally, the literature also reports a significant fiscal operating deficit in several oil and gas operations. The situation leads many E&P companies out of business as there are no options to rely on to manage the operating cost and improve on their fiscal operational performance. Furthermore, the introductory literature reviews demonstrate that most of the studies on operating cost challenges are non-academic. Although the studies are very relevant to this research in particular and the oil and gas industry at large, they lack some basic academic structures such as a rigorous methodology followed to address the operating cost challenges in oil and gas operations.

1.4 Research Questions

In line with the background and research problem highlighted in Sections 1.1. and 1.2 (respectively), Section 1.4 presents the research questions to be answered in this study. The first research question is based on the need that exists amongst the managers, investors and other stakeholders to identify operating cost drivers (activities) that are associated to operating cost objects. In this regard, an important research question is; what operating cost drivers affect operating cost in the Gulf of Guinea and the UK North Sea upstream oil and gas operations? The second research question focuses on establishing a relationship that exists among operating cost objects. Hence the question, what are nature of the relationships that exist among operating cost objects in the Gulf of Guinea and the UK North Sea oil and gas operations? Finally, the third research question aim to identify strategies to implement and manage and control operating cost to optimise the operations. Hence the research question, to what extent are the optimisation strategies implemented in the Gulf of Guinea and the UK North Sea help control operating cost to optimise oil and gas operations? These set of the research questions are addressed in this study by conducting a mixed research which enables this study to collect both quantitative and qualitative data and analyse to understand the operating cost drivers and their optimisation strategies to address the significant fiscal operating deficit in oil and gas operation and to fill in the methodological gap identified in this study.

1. What are the key operating cost drivers and how they affect operating cost objects in the Gulf of Guinea and the UK North Sea upstream oil and gas operations?

2. What are nature of the relationships that exist among operating cost objects in the Gulf of Guinea and the UK North Sea oil and gas operations?

3. To what extent are the optimisation strategies implemented in the Gulf of Guinea and the UK North Sea help control operating cost to optimise oil and gas operations?

However, in an attempt to answer the research questions for this study, there is a need to have credible and reliable sources of data given that limited studies exist that detailed cost behaviours in the industries, and most particularly the two regions identified for this study. Hence, this study conducts a critical academic literature search to understand the kind of data and sources used previously, and also the needed data in order to address the operating cost issues in oil and gas operations. This study then explores an extant academic literature in oil and gas operations to know the kind of data and its sources previous studies used. Throughout the introductory reviews this study identifies that a substantial exploratory study is conducted on the petroleum fiscal regime (Al-Attar and Alomair 2005; Daniel *et al*. 2010; Samanhyia and Samanhyia 2016; Acquah *et al.* 2019). Other literature explores productivity issues in the oil and gas operation (Smith and Maitland 1998; Maniruzzaman 2009; Jahanet *al. 2011*; Hamdi and Sbia 2013; Mullins *et al.* 2016; Hamid *et al* 2017). These sets of literature also used quantitative data related to specific oil fields.

However, these studies use only the publicly available data and other policy documents related to oil and gas operations to understand the cost dynamics. It is established in the course of the literature review that, none of the previous studies uses primary data. Besides that, other studies are conducted on the oil and gas operations related to Corporate Social Responsibilities (CSR), yet mainly relying on the publicly available data (see Carter and Harris 2007; Kumhof and Muir 2012; Ablo 2015; George *et al.* 2016; Mohaddes *et al.* 2018). Some studies conducted on oil and gas risk and uncertainties (Yanting and Liyun 2011; Fallahned 2015; Sawah *et al.* 2016; Sachs 2017; Charles 2017). While other studies focus on geopolitics, politics, and violence (Schroeder and Love 2004; Lakhal *et al*. 2009; Brennan 2013; Lynn and Mike 2016; Falk *et al*. 2017; Martins *et al.* 2019; Bull and Love 2019). Both sets of studies used secondary qualitative data from publicly available sources and none explores the insights from the experienced workforce that deal with such day-to-day operational challenges related to the operating costs.

Reflecting on the above literature, no study is carried out on the operating cost dynamics in the oil and gas operations with respect to the two regions using multiple sources of evidence. In other words, none of the previous studies has used either primary data or a combination of both qualitative and quantitative data to address the operational challenges and the optimisation strategies. Based on these pieces of evidence, this study collects data from both primary and secondary sources to address the operating cost issues in oil and gas operations. This study uses a questionnaire and semi-structured interviews to solicit primary qualitative data from senior management staff with the decision making responsibilities in the oil and gas operations. Additionally, this study collects secondary qualitative data from government policy documents. Besides, this study collects quantitative data on operating cost from E&P operators at the Gulf of Guinea and the UK North Sea. Furthermore, this study also uses operators' financial reports and statements to support and augment the quantitative results.

1.5 The Aims of the Study

This study builds on the knowledge that vast majority of the introductory reviews on operating cost is unable to provide operating cost management strategies to E&P operators to eliminate the fiscal operating deficit. Hence, this study intends to explore how operating cost drivers influence the operating cost object and they can be controlled and managed to optimise oil and gas operations in the Gulf of Guinea and the UK North Sea.

1.6 Research Objectives

In the light of the research aim presented in Section 1.5, the following research objectives are formulated to be achieved based on the empirical evidence from the (mixed methods) combined philosophical stands from both interpretivist's and positivist's school of thought.

1. To critically explore the operating cost drivers in the upstream oil and gas operations of the Gulf of Guinea and the UK North Sea;

2. To critically evaluate the relationship that exists among operating cost objects in the Gulf of Guinea and the UK North Sea; and

3. To critically investigate the effect of optimisation strategies for operating cost drivers on economic viability of oil and gas operations in the Gulf of Guinea and UK North Sea.

1.7 Significance of the Study

It has been established based on the problem statement in Section 1.2 that, there is the need for this study to respond to the significant fiscal operating deficit in oil and gas operations and to close the gap in the literature and methodological lapses identified in operating cost studies in oil and gas operation. Hence, this study employs a mixed research to collects and processes data to provide answers to the research questions, which is a significant contribution of knowledge because readers of this study will understand operating cost behaviour in oil and gas operations from both qualitative and quantitative perspectives. Furthermore, the mixed methods methodology is adopted in this study, as previous studies in oil and gas industries to indicate the usefulness of this methodological approach. Despite that the above outcome, this study is also very significant to academic as it is the first of its kind to combine both qualitative and quantitative tools into understanding this important topic in the context of the two regions identified. Hence, it is a good reference point for other future studies in the oil and gas operating cost issues.

Another significance of this study is derived from its findings and recommendations. Considering the focus of this study to identify operating cost drivers and optimisation strategies in oil and gas operation, the findings and recommendations are useful, resourceful, relevant and important to E&P operators in managing and controlling their operating cost. This is primarily because, the findings expose operating cost drivers how they influence operating cost objects. These dynamics are important to the operators and the investors operating in the two regions. The study is significant because the recommendations are the strategies that can implemented to manage and minimise operating cost by the managers with a view to optimising their operations. Additionally, this study is significant and relevant for investment decision making purposes in the oil and gas operation, as it brings out regional peculiarities and the relevant operating cost drivers and their influence on the operating cost objects specifically at the Gulf of Guinea and the UK North Sea which will help to allocate resource in oil and gas operations. Additionally, the limitations and future research areas are identified in this study and policy implementation recommended will go a long way to help more research into evaluation of operating cost in the oil and gas operations.

1.8 Structure of the Study

This thesis is a traditional academic study which follows the conventional academic thesis structure and format and has been organised in six chapters. Chapter One the introduction, provides the background of cost structure. The chapter explores and establishes the problem statement and rationale of this study which highlights the relevant research gap. Furthermore, the aim of the study, research questions and objectives to achieve the purpose of the study are set in Chapter One. The chapter further shows the significance and how this study is structured. Chapter Two entails the literature review which provides a critical review of the empirical and theoretical studies of costs, most particularly operation costs as they relate to oil and gas operations. The chapter further provide the conceptual framework of this study which demonstrates the systematic structure of the literature and how data is organised to answer the research questions. Chapter Three, which is on the methodology, presents positivist and interpretivist research philosophies and further shows the implementation of triangulation sequential mixed methodological approaches for data collection and analysis. Furthermore, the chapter describes the Delphi method and content analysis and demonstrates their implementation for qualitative data collection and analysis. The chapter also discusses Vector Autoregression (VAR) and Ordinary Least Square (OLS) models that this study adopted for quantitative analysis. Chapter Four and Five presents the results, analysis, and discussions, where Chapter Four presents qualitative results and discussion of the questionnaire and the semi-structured interviews, whereas Chapter Five presents the quantitative results and discussions from the historical operating cost data obtained from operators. Finally, Chapter Six the conclusion draws conclusions on the novelty of this study findings, policy implementation, limitations, and replicability of study.

Chapter Two

Literature Review

2.1 Introduction

This chapter critical explores the empirical and theoretical enquiries on oil and gas operations and cost drivers, with particular focus on the operating costs. It systematically evaluates the extant literature on the topic by identifying similarities and differences with a view to establishing the research gap for this study to address. More specifically, the chapter critically explores oil and gas operations, cost evaluation techniques and operating cost objects and their optimisation strategies to identify what has been previously carried out, when and how it was carried out. This review is important towards identifying the gap which this study seeks to address. Therefore, the chapter begins by providing a critical overview on oil and gas operations, followed by a review of oil and gas cost behaviours and evaluation of the operating cost techniques in the oil and gas operations before eventually carrying out the evaluation of the oil and gas operating cost drivers. The chapter further evaluates cost optimisation strategies, evaluates the of relevance of Petroleum Fiscal Regime to operating cost in the context of Gulf of Guinea and the UK North Sea oil and gas operations. The chapter concludes with the conceptual framework which demonstrates the systematic processes and stages involved in the entire argumentation and direction of the study and the summary of the chapter.

2.2 An Overview of Oil and Gas Cost of Operations

Oil and gas operations processes are very integrated complex and capital extensive. An evaluation of literature indicates that an upstream project investment accrues a cost of $2.1billion of US dollars that accumulated from various phases of the operations (Ken *et al* 2017). According to Carlos and Moreno (2009), the exploration, development, production, and decommissioning are the key technical operational phases that generate cost. Further literature demonstrates that the fiscal system and regulation framework governing the operating activities also generates a systemic costs in the operations via the obligations such as local content law, labour obligations (Garcia *et al.* 's 2014; Suda *et al.* 2015; António and Mukhisa 2017). Though the above studies analysis acknowledged the factors influencing oil and gas operating however, the sources of data for their analysis are limited to regions not on a global perspective. For instance, the $2.1 billion costs are a project in the Gulf of Guinea. On the contrary, projects in North Sea, Gulf of Mexico, and Caspian Sea will surely accrue different figures. Besides, the regulatory framework discusses is very valid in general, perspective, however, the source of the data for the review is selected fiscal systems in Africa only. Hence, the literature disregards other countries in Europe, Asia, and America Australia. Another flaw identifies in those literatures is the authors reviews policy documents such as local content law which very credible sources of data but failed to contact the operators to understand the impact of these on the operations.

Regardless of those flaws in the data sources of regulatory, Boykett *et al.* (2012); John *et al.* (2013) further establish that cost recovery in the fiscal system is another cost element in the oil and gas operations. The cost limit is valid from the Production Sharing Agreement (PSA) standpoint but invalid with respect to a traditional Royalty Tax Agreement, as the total cost is recovered under Royalty Tax regime. Further critical reviews show that service contracts, which is, practice most in the Middle East also contradicts the cost recovery limit. Further extant literature evidence demonstrates that local content law obligations vary from region to region and even from nation to nation and cannot be applied to the entire oil and gas operation. An excellent example of these issues can ascertain in the Middle East where local content law and cost recovery limit are very less and utterly different from other regions. Notwithstanding the differences in the countries regulatory and operational structures in oil and gas industry, Matthew (2015) advocates the impact of regulation on operating cost, but does not justify enough evidence in the study, as the study involves a review of local content law, petroleum revenue act. Hence, the study fails to address the impact of these elements on investment from the operational standpoint. Thus, data used in Matthew's (2015) study fails to cover E&P operations to measure the magnitude and effect of these regulations on the operations and costs.

The above arguments on regulatory framework and fiscal system demonstrate that they affect the operations. However, the arguments fail to identify and establish a specific affect these regulations and fiscal regimes pose on operations and cost. A follow up critical review of Ghanaian first Petroleum Fiscal System reveals a relinquishment clause which require revoking 25 per cent, 50 per cent and 75 per cent of the license field in the event that operators are unable to meet the agreed timeline in the work plan for exploration, appraisal and development respectively (GNPC 2018). This piece of evidence identified is a potential financial hazard, as the relinquished portion cost of the oil filed would not be recognise as capital cost, rather written off to comprehensive income statement as an expense, which increases operating cost. Despite the above discussions in relation to regulatory clauses, there are different clauses such as ring fencing in UK petroleum fiscal system, operators' costs that are restricted to a particular fields and disallowance transfer of non-production field cost to the productive one for Taxes purposes (Malone *et al*. 1993; Kastning 2014). Additional studies on regulatory by Elijah *et* *al.* (2016), establish that these elements affect the operations. Further argument from Kellou and Maya (2017) on the reviews of Tax and Royalties produce similar remarks to Elijah *et al.* (2016)**'s** findings. However, an analysis of Aka (2016) and Sanjib's (2016) suggests that uplift and the other investment incentives such as tax credit set as incentives to motivate operators. However, they have a less and short-term impact on cost reduction. Collectively, a review of the analysis and discussions of the above studies are very relevant in understanding operational regulations and their cost implication in oil and gas operations. However, they are basically secondary studies, and the originality of the studies are bit flawed as primary data was not collected from the operators and the workers as notified in the various sources of data collection and processing into information.

Furthermore, Andy *et al.* (2017); Stephen and Ronan (2017) indicate that all the costs discussed above are indirect operational cost factors and are not directly related to the technical physical activities such as exploration, appraisal, development and production. Hence, they conclude that cost generated from the technical activities are considered economic costs, as the cost incurred brings out the economic values of the oil and gas resources. Thus, the above evidence suggests those phases costs deemed prudent and critical in the oil and gas operations, as their outputs provide economic justifications of the oil and gas operation. They studies analysis and discussion are reliable as they use data primarily sources and the analysis very important to the oil and gas operations. The background discussion and the problem statement in Sections 1.1 and 1.2 respectively, demonstrate that those phases cost as discussed by Andy *et al.* (2017); Stephen and Ronan (2017) accrues a substantial cost.

Many intersected exploratory pieces of evidence directed to the production activities and its cost implications in the oil and gas operations in providing understanding of production activities. Frank *et al.* (2016) indicate that the production phase is engross with integrated and interlinked activities, which generates cost from the activities. Further evidence from EIA (2018) report, a credible source of data in oil and gas establishes that the production phase has a continuous operating cycle of interlinked and integrated activities and systems, processes to performed in lifting the crude oil from the reservoir, hence all activities generates cost. Furthermore, Skaten (2018) extends the discussions of the production activities to cost behaviour. Additionally, Tore (2014)'s assessment of the production activities and systems reveals that the wellhead (the actual metal on top that are fixed and connected onto the production pipelines into production reservoir via producing well to pump crude oil out of the reservoir) generates various kinds of costs which include energy, consumables, repairs and maintenance costs and labour cost. Furthermore, Babusiaux *et al.* (2011) extend the assessments to manifold and gathering system, which they describe as an integrated individual production wells connected onto the main production facility over a network of pipeline that produce similar costs as part of the production activities. Notwithstanding these, Aguilera (2014**)** further indicates that separation systems are designed and installed to separate the crude oil from gas and impurities and further remove water, which also generate cost. Metering, storage and export systems monitor and control the quantities of crude oil produced and then transportation of these activities that often generate cost. Devold (2013) and Frank *et al.* (2016) reveal that those activities and processes are very integrated and continuously performed throughout the economic lifespan of the operations, and cost incurred is very variable as variable cost is influenced by activities level. Additionally, José *et al.* (2016); Paul and Horak (2016) analysis establish that the costs generates from those activities are very variable and on daily basis. Furthermore, findings from Kolios and Martinez's (2016) are consistent to fixed and variable behaviour of the costs. Kumaraswamy (2016) establishes that oil and gas operations and activities behaviour correlates to costs but not directly correlates to number of the quantity of barrels production like the other industries. Kolios *et al.* (2016) reinforce that in oil and gas operational activities, identifying determinants of the cost behaviours are more important than the focus on the quantity of productions.

2.3 A Review of Oil and Gas Cost Behaviours

The cost behaviours in oil and gas operations are very complex, dynamic, and associated with operational activities. Generally, cost behaviours are influenced by number of units of products and magnitude of services and can be categorised as fixed cost and variable cost (OxCarre and Naumoc 2016). In the oil and gas operations, cost behaviour is not just associated with activities but also associated with the process and system of operations which are more of variable than fixed (Curott 2016; Macdonell 2017). The theorise of cost described cost behaviour as the movement of the various expenditure in relation to ordinary operations in a business (Mark 2017). This theoretical explanation of cost behaviour suggests that, cost behaviour relates to number of units of production of goods and services in other industries against the level of activities and process in the oil and gas industry. Ernst and Young (2016) establishes that cost behaviour is the analysis of production cost which illustrates the state of cost as fixed or variable and to exploration of the factors that are responsible for the variable and fixed behaviour of cost. Ebert (2015) analysis indicates those units of product and the level of activities and process influence cost behaviours in oil and gas operations.

A review of the extant literature reveals that fixed behaviour of cost from theoretical standpoint is constant cost figure incurred on a cost item/object in producing goods and service for a period regardless of the quality, quantity and magnitude of service produced (Abubakar *et al.* 2016). For instance, insurances, mortgage or loan payment, depreciations, rent of office have fixed behaviour. Ahmad *et al*. (2015) add that labour cost has a fixed behaviour, which contradicts Macdonell (2017) analysis that views labour cost as more variable, as a result of replacement for lost injury time, maternity leave, permanent work annual leave. Hence, oil and gas cost behaviours are complex and very difficult to completely describe or identify as fixed behaviour of cost in the operations.

From the analysis of cost behaviour, cost correlates with production units, which is assumed to be influenced by raw materials. Increase in raw materials leads to increase in production units when other production factors are kept constant. Hence, in the typical manufacturing industry, raw materials influence operating cost behaviour. In the oil and gas operation, the activities, and processes in the actual operations influence cost behaviour, which suggests that all inputs costs in the oil and gas operating influence the cost behaviour. Not far from that Berend and Scheffers (2016) indicate that variable cost is a cost that rapidly changes in behaviour with change in unit of production due to raw materials consumed and other factors. This description of the variable cost relates to other industries such manufacturing, and not very relate to oil and gas industry. In the oil and gas industry, the variability of activities and processes of the operations rapidly changes the costs incurred on them. Which can be described as variable cost such as labour cost, maintenance cost, service and supplies and health and safety cost. All these cost objects are associated and influenced by the level of activities. Hence, this study describes these operating cost objects collectively as operating cost because they are directly related to the actual operations in the oil and gas industry.

In an attempt to assess the behaviour of operating cost in oil and gas industry, Nouara (2015) indicates that it is very difficult to do so as compared to manufacturing where the operating cost is viewed as direct costs, which include direct labour costs, material and manufacturing overheads as against in the oil and gas operation where all the variable costs have direct impact on operations not just limited to the direct labour, direct material like in the manufacturing industry. However, some operating costs that directly impact the activities in manufacturing industry such as administrative overheads, though similar cost items in the oil and gas operations have indirect impact but very crucial and sensitive to the operations. For example, legal service cost, transportations cost, signature bonus (Amunwa 2012). Furthermore, the variable behaviour of the cost objects are activities sensitive such health and safe cost, labour cost, daily consumables cost, maintenance cost in oil and gas operations as compare to manufacturing variable cost behaviour which is sensitive to raw material cost (Frazier *et al.* 2013). This study views the above discussions and connects them to the direct and indirect cost of operations.

Theoretical explanation of direct cost relates to cost incurred on direct activities, processes, materials and labour associated to product or a service (Haahr 2015). Without those elements no oil and gas operations can be carried out. Zohar (2010) establishes that direct cost is the cost of direct inputs into the business operations. Reflecting on the various explanations of direct cost, this study views direct cost from oil and gas operational standpoint as direct fiscal value of actual labour cost, maintenance cost, service and supplies, health and safety associated with lifting crude oil from the reservoir up to the wellhead. Extending the cost discussions to indirect impact of cost on the operations is describes as the cost of the indirect activities of an operation, which can be ignore in some business operation, such receptionist wage, without receptionist business can still operate. However, in the oil and gas operations indirect cost such as legal service cost, granting instruments cost, transportation cost and decommissioning are some of the sensitive indirect cost (Deutch 2010). These indirect costs effect in oil and gas operation is very significant and cannot be override.

Further to cost discussions, cost can be view as short-run and long-run in behaviour, where short-run relates to variable cost which frequently changes, and long-run cost relates to fixed cost unchanged for long period of time. Other forms of cost in business operation that can change cost behaviour is marginal cost, which is a measure of an additional cost incurred in producing an additional unit or service. Reflecting on the discussions on the cost's behaviour and its impact on business operations, this study identified that activities level and processes dictate cost behaviours in oil and gas cost operation while unit of products produce and raw materials, influence manufacturing cost behaviour. Furthermore, this study views cost as financial resources spent or invested in operations to undertake technical operational activities. Hence, this study extends the discussion into next section and critically explore for operating cost objects in the oil and gas operations.

2.4 The Empirical Evaluation of Oil and Gas Operating Cost Objects.

As described within the ABC framework, cost objects are basically a cost accumulated from several similar activities connected to an operational unit and sometime described as cost centre with respect to traditional costing (Raine *et al.* 2014). Reflecting on the preliminary discussions of this study and the operational unit in the oil and gas operation, the operating cost objects identified include labour cost, service and supply cost, maintenance cost, security health and safety, and overheads cost (Holt *et al.* 2015; George *et al.* 2016; Andy *et al.* 2017). Furthermore, most of the financial statements and reports reviews in the oil and gas also reported those operating cost objects. Additionally, a critical review of oil and gas operational regulations which include local content law also highlighted some of these operating cost objects, especially labour obligations and outsources of other services (Yevna *et al.* 2015). These operating cost objects are considered the main cost elements that influence the entire operations based on the substantial literature in oil and gas operation. Additionally, these operating cost objects are the main operations cost elements in the oil and gas income statement though there are other operating cost objects however under these. Hence, this study conducted a critical review on these five main identified operating cost objects in oil and gas to establish their effect on the operation and cost as discussion below.

2.4.1 Empirical Evaluation of Labour Cost Object of Oil and Gas Operations

Labour is a significant determinant of productivity and operational performance in an economy. Furthermore, an extant literature demonstrates that labour cost is very important and prudent in business operations and directly linked to personnel (Chen *et al.* 2010). Hence, any effect of labour would directly influence the business operations. This suggests that data on labour cost is key to organisations operations. Further critical literature analysis on labour suggests that labour cost is one of the most crucial operating cost objects in business operations because of the legal obligation guiding the labour issues in oil and gas operations (Crabtree *et al.* 2007; Giacchetta *et al.* 2015).

A critical review and analysis of labour statistics illustrate that 2.1 per cent increase in unit labour cost in 2019 as compared to 1.8 per cent in 2018 in the oil and gas production sector (James *et al.* 2019). These statistics suggest that labour cost increase by 0.3 per cent within a one-year window, which is a significant cost because workers' salaries, allowance and other entitlements increase by 0.3 per cent margin. In other word oil and gas operators cost increase by 0.3 per cent from 2018 to 2019. A literature survey into oil and gas service sector establishes that 1.9 per cent increase in labour cost, further literature analysis indicates that maintenance sector in oil and gas operation labour increase by 3.2 per cent in the same period (Patrick 2019). These three sets of statistics reported by UK National statistics suggest that maintenance works drive labour cost in oil and gas operating, and then followed by service activities. Collectively the analysis suggests 5.4 per cent increase in labour cost in oil and gas operations. Though the sources of statistics are credible and dependable, the report failed to highlight the driving factors of the increase in unit labour cost in oil and gas operations. Furthermore, the literature analysis from the statistics on labour failed to suggest measure that can be initiated and implanted to control the rising unit labour cost in oil and gas operations.

Furthermore, Lilian (1993) and Gamble *et al.* (2010) reveal that the offshore labour issues are strongly linked to core technical activities which influence the labour cost due to experience and skill labour deficit in oil and gas operation. An analysis of the extant literature indicates that 2 per cent declined in labour in 2019 due to high retirement rate, which poses larger number of the core technical positions at risk in 2019. This compels operators to resort to contract staffing and that course a significant increase in labour cost due to shortage and the contract staffing (Nick *et al*. 2019). Additionally, Samanhyia (2019) conducts a survey on oil and gas managers and the analysis establishes that 24.4 per cent of the labour cost is associated to upstream activities.

Furthermore, Ahmadun *et al.* (2009) establish the relationship between labour cost and oil price with reflecting on the fact that the fallen of oil and gas prices in 2014, which leads to a decline of 18 per cent of jobs in oil and gas. However, the evidence of the 18 per cent declined in labour effect on labour is not discussed in the literature. Wang *et al.* (2010) also conducted a survey by interviewing oil and gas experts' and operators reveal their findings via textual analysis that educating, institutions training, training of local people as a requirement of the local content law drives labour cost in oil and gas. Further studies suggest that labour unions, labour laws also strongly advocate for local people development with no experience very less experience in oil and gas operations. Additionally, policies implementation relates to human capital development also influences labour cost object as resources are spend on developing the people.

Furthermore, Salsabiela and Menhat (2019) conduct a survey on 28,000 participants across 28 disciplines within 178 countries in order to under the labour issue in oil and gas operations. The results reveal that 56 per cent representation of the survey population demonstrates that labour cost cause the industry economic instability and 22 per cent believed that labour shortage is a growing concern in the oil and gas operations. Critically, these statistics can be bias considering 28,000 participants in entire oil and gas industry against millions of workers around the globe. Furthermore, there are more than thousand oil and gas producing countries and the survey only covers 178. However, the data are from primary sources, but sample size of the study can produce potential biased result because it is not representative of the population and at the same time insignificant, considering the total number of oil and gas producing countries. Notwithstanding, labour cost is very important in oil and gas operation.

2.4.2 Empirical Evaluation of Service & Supplies Cost Object in Oil and Gas Operations

Service and supply activities are essential in oil and gas operations. They involve providing oilfield chemical and their application in the upstream activities, which include drilling, exploration, development, production and even decommissioning activities. Furthermore, supply and service activities includes supply of pipelines and other consumables to carry out activities in oil and gas operations (Vanessa *et al.* 2016). The supply and service activities most time are provided by the third-party providers (Concawe 2008). Service and supply in oil and gas operations is very crucial because of the substantial importance they play in the total value chain activities from exploration down to the finished product in the market for the final consumers. This study conducts an empirical enquiry to measure the magnitude of the activities and other factors impacting on the service and supply cost in oil and gas operation.

In an attempt to investigate the service and supply activities to understand the activities that drives cost in the oil and gas operation, this study carries out evaluation from academic literature, documents on operational activities and other policy reports in the oil and gas operation. An evaluation of corporate report analysis from Claudio and Descalzi (2016) via trend analysis conducted from 120 E&P operators reveals that 12 per cent of the operating cost accounted for service and supply activities. This result suggests that service and supply cost represent a substantial portion of operation cost and this is worrying, because it is third-part cost. A critique of the above study is on the sample size which is 120 as indicated above. This is very insignificant considering the entire population of E&P operators in oil and gas industry. Hence, the study results might be bias based on the sample. Furthermore, this study will argue that the study conducted trend analysis which only demonstrate the percentage effect of the service and supply impact on the operating cost and failed to mention or address the driven factors of the 12 per cent. Though the study opinion on service and supply is valid but not critical enough in addressing the operating cost issues in oil and gas operation.

Not far from the trend analysis, Daniela and Prosper (2011) evaluate service and supply activities by conducting financial evaluation in operational and income statements reports of 50 E&P operators at the UK North Sea. The aim of their study is to measure the magnitude of the service and supply activities and their cost impact in oil and gas operating cost. The study statistics establish 3.1 per cent of service and supply cost is associated with catering and facility management activities. Furthermore, 17.2 per cent of the service and supply cost is associated to sea and air transportation and 3.6 per cent of service and suppliers cost is associated to warehousing and logistic activities. Again, this study's critique of the above study is on sample size, as there are more than 200 E&P operators in UK North Sea, hence the study sample size failed to cover even three-quarters of E&P operator. Hence result from a small sample size can be bias and might be misleading. Haahr (2015) links service and supply cost to activities at the upstream sector and highlighted that the upstream activities increase service and supply which reflect on cost. Pettit (2017) establishes the activities most influenced by new projects which lead to high demand for those services. Calvert (2013) establishes the service activities cost is influenced by the local service providers which add significant profit margins to the prices of the services provided, which is, the local content law protects the local service providers with less control of the pricing of the service.

Other studies establish that oilfield chemical generates a substantial cost of service and supply activities as they are applied in all operational phases in the upstream sector. Kan *et al.* (2016) survey analysis shows that crude oil lifted from the reservoir is a mixture of impurities, water and gas and other associated substances which are separated using oilfield chemical and this happens on daily basis. Additionally, the impurity and the waste water produced through the separations process are treated by applying oilfield chemical before disposal (Kelland 2014). Furthermore, oilfield chemicals are injected into the reservoir during drilling and exploration. Beside these, the oilfield chemicals and other substances from the crude oil cause corrosion and other forms of damage to the equipment. Hence, oilfield chemicals are applied in all these processes (Al Aftab *et al.* 2012; Tao *et al.* 2016). Furthermore, they oilfield chemical are apply to enhance the quality of the crude oil as a tradable commodity (Peter and Hughes 2001; Concawe 2008), and the price pay for the oilfield chemicals and service is a substantial amount and are relate to service and supply cost object.

Furthermore, a review of the literature on oilfield chemicals reveals that they are more applied in the core production processes than any other phase in the oil and gas operations. A review of upstream operational report literature indicates that these oilfield chemical are used in cementing, production wells completion, stimulation, and even in Enhanced Oil Recovery chemicals (EOR) (Beltramini and Lu 2000). A critical analysis from a survey conducted result suggests that producing well stimulation activities consumed a significant amount of the different oilfield chemicals which reflects on the cost of service and supply cost (Levine *et al.* 2014). Further literature enquiries highlight that workover activities in the producing reservoirs within mature oil fields are also associated with high consumption of oilfield chemicals. Based on the above literature synthesis that oilfield chemicals are significant component of the service and supply which affect operating cost. Additional evidence from Karl (2012) extends literature argues that the rapid growth of unconventional oil and gas activities influence the use of oilfield chemicals, which have a significant influence in the North America shale gas and Bitumen operating cost. Furthermore, other studies suggest that the oilfield chemicals cost is influenced by frequent use of the oilfield chemical to improve on reservoir pressure, and the viscosity of the crude oil. Hence, service and supply activities and cost play an important part in oil and gas operational activities and cost.

2.4.3 Empirical Evaluation of Maintenance Cost Object of Oil and Gas Operations

Maintenance activities involve conditioning operational equipment in assuring their safety and effective functioning. An investigation into the literature establishes that maintenance activities ultimate main is to increase or to maintain the optimal performance level of operational equipment in oil and gas operations (Hasrulnizzam *et al.* 2011). An extended literature synthesis suggests that maintenance activities enhance operability of the operational equipment and further enable them to function up to require capacity (Ikwunze and Nwosu 2016). Adding to those above two arguments of the purpose of the maintenance activities in oil and gas operation, Jarrell and Bond (2001) suggest that maintenance activities ensure equipment effective functioning and safety operations which enhance productivity and can also reduce equipment downtime. A empirical enquiries from (Dey *et al.* 2004) state that maintenance activities include periodic examination and inspection of equipment on to detect malfunctioning on equipment in order to rectify faults. The above discussion of the literature on maintenance activities suggests that maintenance activities are very crucial in oil and gas operation.

A critical enquires of maintenance activities from Schlumberger, Halliburton, and Baker Huges reports which this study assumed these oilfield servicing companies have a significant and diverse experiences in the oil and gas maintenance activities because they are in the centre of the oil and gas servicing activities. A critical literature analysis from those oilfield companies reports establish that there are different kinds of maintenance activities. The reports further highlight that preventative and corrective maintenances activities are the common kinds of maintenance activities in oil and gas operations. However, the literature from the report only addresses how the activities are performed with less depth on cost generate from them (Olaniran *et al.* 2015). A subsequent investigation results reveal that these kinds of maintenance activities are conducted to increase the reliability of the operational equipment (Claude 2001; Jojarth 2008). Further reviews of BP's (2018) maintenance report indicate that preventive maintenance activities are conducted based on predictions or routine of the equipment to ensure improvement in the capacity and integrity of the equipment. While corrective maintenance activities are conducted to rectify faults, damage and malfunctioning associated with operational equipment (Mussatti *et al.* 2002).

An analysis of the literature reveals that some of the oilfield chemicals applied in operational processes causes technical damage to technical equipment and this increase corrective maintenance activities (Groote 1995; Finbak *et al.* 2012). Other studies argue that failure to conduct preventive maintenance can increase in corrective maintenance and this translate to cost. Additionally, some studies also conclude that poor implementation of maintenance system and program in oil and gas operation leads to significant damage of operational equipment and pasts of equipment which increase maintenance cost.

Consistently, Steinhäusler *et al.* (2008) carry out survey on activities and the results establish that the exploration and production activities record frequent maintenance of equipment. They argued that oil and gas operations entail applying tonic chemical which have the potential of causing damage to the operating equipment and frequent breakdown. However, Wang and Liu (2015) argue that production facilities entail connected and interlinked process and activities which respond to frequent maintenance schedule to keep the operations alive and this leads to increase maintenance cost. Alkhaldi *et al*. (2017) analysis highlight that some of maintenance activities at productions facilities often lead to shutdown of the operational system which cost the operators more resources because no production and payment would be made. Additionally, Lazzarini *et al.* (2013) reveal that mature oil and gas fields with old production facilities result in acute safety and maintenance issues because, most of the equipment lost their integrity. Furthermore, mature oil and gas fields are associated with frequent reservoir workover, which increase the maintenance activities.

In this connection, an extant literature analysis further identifies that poor maintenance culture is one of the main factors that increase maintenance activities and costs in the oil and gas operations. Confirming this argument, a survey study conducted in the UK North Sea oil and gas maintenance activities by interviewing 130 managers. Result from the survey emphases on operators are very relax on good housekeeping and very adamant on routine maintenance schedule but rather interest in increase productivity (Jantunen *et al.* 2011). Furthermore, evidence from Moghaddam (2013); Anatol *et al*. (2015) criticise postponing of maintenance reviews as operators view them as non-essential shutdowns and turnarounds that lead to unaddressed maintenance backlogs, which increase the future maintenance activities and cost. Furthermore, literature establish that poor maintenance culture increases unreliability on operations and poses safety risk to both workers and equipment (Alan 2011). Xiao *et al.* (2015) reveal that 80 per cent of the operating cost is associated with repairs and maintenance activities, which is influenced by long-lead maintenance activities in upstream operations.

2.4.4 Empirical Evaluation of Health and Safety Cost Object of Oil and Gas Operations

Health and safety initiatives and practices are obligatory systems and are measures put in place to protect the physical and mental health of workers. Their practices also ensure the welfare of workers and efficient operability in oil and gas operations in preventing ill health arising from the activities. They further enable identifying and controlling risk at workplace. Health and safety activities continuous to ensure the fitness of workers and proper functioning of equipment to perform a job safety (Mick and Borwell 2017). The above synthesis of health and safety discussions suggests that they are very crucial in oil and gas operations as the discussion are connected to health, safety, and wellbeing of workers/human being responsible for the operations within oil and gas industries. Thus, the stakeholders in the oil and gas industry need to understand the importance of the health and safety in the operations enacted laws and regulations governing the provision of the health and safety service in the oil and gas industry. Hence, provision of the health and safety in oil and gas operations is not a matter of choice but a mandatory requirement. And failed of operators to comply to the regulations of health and safety provision can tannish their reputations (David *et al.* 2016). Hence, the laws mandate operators to be responsible for the health and safety of the workers on site and also to provide safety operational environment and equipment (Roberta and Bigliani 2013), failure to comply shall lead to sanctions.

The legal framework, (including Acts, regulations) governing health and safety systems can not eliminate safety issues entirely in oil and gas operation. Regardless of strong legal framework, the operations still encounter health and safety challenges which lead to serious incidence cases and operators to pay price upon the occurrence of accidences. An extant literature synthesis of oil and gas operation on the health and safety activities identified upstream sectors operational activities being predominately generate acute health and safety issues (Rusinga 2010). A study on the upstream activities reveals that the acute health and safety challenges in the upstream operational activities are link to the complex nature of upstream activities (Mick and Borwell 2017).

Further literature evidence reveals that, the activities are very integrated with systems and processes, and applying many different oilfield chemical cause acute health and safety in oil and gas operations (Michalis and Myrto 2012). An enquiry into the extant literature indicates that the upstream sectors activities involve complex facilities and equipment which been used continuously (Bigliani 2013). A finding from a survey indicates that most of the acute safety challenges which lead to accidents are associated to upstream activities (Rachel and Konne 2014). Empirical evidence identified the two most historical accidents of Piper Alpha and Macondo Blowout in the history of oil and gas operation. Though health and safety systems were implemented to facilities the operability in the oil and gas operations these accidents still occurred. This piece of literature on accidence on oil and gas operations suggest that, the failure of safety measures in oil and gas operation cause damage to the operations. Reflecting on the impact of the two historic accidence includes human lives, environmental pollution, and economic and affect the operators financial and technical operations.

Various studies investigate the impact of the health and safety activities on the cost and the operation in oil and gas industry. A survey conducted in the upstream operational environment in the oil and gas operations establishes that failure to provide a comprehensive training for workers to acquire knowledge and understand health and safety practice leads poor and weak safety practices which can lead to accidence (Haahr 2015). Further literature analysis demonstrates that the failure to effectively implement and monitor health and safety systems create unsafe operational environment which trigger accidents and losses (Zafar and Ali 2014). Further literature analysis emerged from Mick and Borwell (2017) on safety and safety, indicates that poor safety culture drives health and safety activities in oil and gas operations. The outcome of the poor safety culture result hazards and incidents which can lead to accidence in oil and gas operations. Assessing the effect of poor culture in oil and gas operation, this study reference Piper Alpha accident, where the investigations reports on the Piper Alpha findings indicate that a worker failed to read and follow work in process report before starting a shift (David *et al.* 2016).

A review of safety and health reports provide and overwhelmed analysis which demonstrates the negative impact of effect of safety and health practices in the oil and gas operation. An empirical statistic from UK National Safety Council Statistics (2015) establishes that 274 accidents were recorded in oil and gas operations. According to the same statistics, the accident resulted 14,000 loss of lives and 2 million injuries. A critical analysis from a report reveal that weak and poor safety management in the oil and gas operations triggers the above statistics (Harald *et al*. 2016). A review of the existing literature reveals that poor safety practice leads to safety issues which cost operator £1.85 billion and £1.5 billion on medical bills and lost injuries hours (UK Health Safety Executive reports 2016).

Other literature sources have identified security as a challenge in oil and gas operations which threatens health and safety of the workers. For example, the evidence reveals that kidnapping of workers and destructions of operational facilities are the outcome of weak security systems in the oil and gas operations (Soekardan 2016). Nigeria, Libya, Iraq, Iran, and Venezuela are some of the oil and gas producing countries that encounter such type of security challenges (Hough 2017). A review of the literature identifies that geopolitics and political instability cause wars and civil instabilities which generate the security challenges in the oil and gas operations (Paki *et al*. 2011). Additional literature evidence reveals that political instability creates lawlessness in the system and leads to formation of unregistered pressure groups that cause security threats. These are established affect the safety of the workers and the operational equipment in oil and gas operations (Smith *et al.* 2016). Studies (such as Paterson 2012) identify some of unregistered pressure groups in Nigeria as Niger Delta militants that often engage in kidnapping of oil and gas workers for ransom, blockage of roads leading the production facilities and vandalisation of operational facilities. Additional evidence of the unregistered pressure groups in Libya is Islamic militants who can also stage an attack on Sarir oil field and vandalise production facilities worth millions of dollars (Lambrechts *et al.* 2016). Health and safety issue in the oil and gas operations are very important and affect the entire operation. Hence, this study is seeking knowledge on how to management and control health and safety activities to optimise operation in the oil and gas industry at the discussion section.

2.4.5 Empirical Evaluation of Overheads Cost Objects of Oil and Gas Operations

The overheads costs in oil and gas operations are relatively different from overheads costs in other industries by functions, and this informs the classification of oil and gas as a specialised accounting that makes the industry to deserve a unique accounting standard. However, the

General Accepted Accounting Principles (GAAP) and International Accounting Standards (IAS) recognises overheads cost and their treatment in the comprehensive income statement by nature not by function. For instant, GAAP recognises transaction relating to office rental, bills, depreciation and other administrative supportive activities as overheads, which standard absorption costing also recognises those forms of transactions as overheads (Huang *et al.* 2015). An analysis of the extant literature demonstrates that overheads costs are indirect cost in operations and most firms report them in the financial statements as operation expenses, which are adjusted with other operating cost items to realise the operating profit. However, the overheads costs vary significantly from industries to industries, and are significantly influenced by the intensity of activities in the operation (Doyle *et al.* 2007; Rakesh 2013). Hence, oil and gas operations by nature and by operations are very complex and have integrated activities which attract more and frequent supportive activities in the operations that generate a significant overheads (Bea and Chiang 2013).

A review of the oil and gas operations and financial reports reveal that, oil and gas operation have a unique supportive activities transaction as compare to other industries (Salem *et al.* 2014). For example, legal service costs. These legal prices include treaties fees, which are best described as signature bonus, and other operational legal activities. The important or the function of the legal fee is direct against the indirect concept of the overheads as recognises by IAS and GAAP. The legal services are very sensitive in oil and gas operations as their consequence have a direct effect on the entire operations. Yousif *et al.* (2011) stress that the signature bonus, which is one off payment for the license, when licenses are revoke, the entire operations are affected. However, the treatment of license cost is expense and can be described as overheads (Chen and Huibin 2005). This is a unique overhead cost by function because, other industries such as manufacturing and other industries do not have signature bonus as a transaction (Roychowdhury *et al.* 2006). Thus, legal cost is central to all E&P operations but often recognised as overhead.

Additional evidence reveals that insurance also generates systematic cost in oil and gas operations in providing indemnity to protect unexpected damage in the operations. A literature enquiry establish that insurance contributes a significant cost challenges in oil and gas operations. In an event of accidents, the insurance premium would be increase (Beaulieu *et al.* 2002). For example, the occurrence of Mancondo blowout accidents has created an issuance argument between BP and Lloyd's insurance company for payment of the insurance and increase in insurance premium (Silvaa *et al.* 2016).

Furthermore, a review of the financial reports in the oil and gas operation reveals that consultancy and other accountancy services fee also affect the overheads cost. Oil and gas operational activities are aggressive, subject to changes, and full of uncertainties. Additionally, the oil and gas industry is considered the most volatile industry and the operations are very sensitive to economic and political shocks. Hence, the operators often resort to consultancy services where they seek for professional advice in order to survive. Additional literature discloses that accountancy service fees are relative higher in oil and gas operations due to the complex nature of operations. Most importantly, there is no specific accounting standard designed for the treatment of oil and gas expenditure, rather depend on GAAP, which is does not fit in for oil and gas operations as compare to other industry. Hence, it is difficulties and time consuming for auditors to audit the financial statement in oil and gas operations (Novák *et al.*'s 2017).

Other reviews of various oil and gas financial statements, technical and operations, report that travelling for meeting and workshops generates an overheads from flight tickets, travelling insurance, allowances, honorarium, enumerations, refreshment which influence the operating cost in oil and gas operations (Ryu *et al.* 2014; Huang *et al.* 2015; Jean *et al.* 2016). Furthermore, other reviews related to other industries indicates that overheads costs are influence by weak internal control system and improper administrative procedures administrative cost associated bureaucratic administrative procedures (Banker *et al.* 1995; Fay *et al.* 2001). Hence, it can be concluded that overheads cost in the oil and gas operations is the different from the other operations by function and very importance to the operations.

2.5 An Evaluation of Operating Cost Techniques in the Oil and Gas Operations

The cost evaluation empirically demonstrates quantitative and qualitative methodology guide in cost assessment via collecting and analysing cost data to measure the magnitude of fascial resource required to invest in executing a project or an activity (Bea and Chiang 2013). Some literature findings establish that cost evaluation techniques enable identification and classification of cost into cost objects. They also enable identification of the cost drivers/activities in predicting cost behaviour in business operations (Davis 2017). A literature review on this indicates that cost evaluation techniques enable companies organisations and firms to establish a relationship between various cost objects and predict cost objects behaviour with respect to the cost drivers (Akenbor and Agwor 2015). A cost evaluation techniques further engaged evaluating the impact of the costs objects and cost drivers on the operation and fiscal performance of operations (Stephen *et al.* 2015).

A fundamental literature of cost evaluation techniques classified and described them in groups of conventional and non-conventional techniques as the two main kinds of operating cost evaluation techniques (Kolios *et al.* 2016**)**. Existing evidence shows that, the conventional costing techniques differ from the traditional cost evaluation because they apply absorption costing and marginal costing techniques to allocate cost in oil and gas operations. These two kinds of conventional concepts are adopted to evaluate contribution and profit associated to a product or a unit of service produced (Mark and Bills 2015). Additional literature analysis indicates that these two kinds of conventional costing techniques are implemented to measure the variables and the fixed costs in the operations (Kolios *et al.* 2016). The marginal cost concept even ignores overheads and fixed in measuring a unit contribution of a product, however it is matched to direct gross revenue and contribution (Sarah *et al.* 2011). Though the absorption cost concept measures profit in the operating, the apportionment of overheads is based on total labour hours or total machine hours (Pettit 2017). Collectively, both kinds of conventional costing techniques fail to evaluate cost objects to identify the drivers/activities which are the pivot of this study. Though these costing techniques are acceptable costing techniques and relevant to this study but failed to meet the requirements of this study hence this study eliminated conventional costing techniques and concepts in further discussions of the costing techniques in this study.

On the other side, there exists non-conventional costing techniques, in relation to which the extant literature indicates that they are implemented to evaluate operating cost in the complex operation like oil and gas industry. A previous literature indicates that techniques such as full cycle costing (FCC), life cycle costing (LFC), unit technical costing (UTC) and activity based costing (ABC), are most commonly used non-conventional costing techniques in the evaluation of oil and gas operating cost (Weyant 2017). These types of cost evaluation techniques are adopted to estimate cost with different aims. Comparatively, some of the non-conventional costing concepts are designed to identify cost objects and their respectively driven activities, while others are designed to describe the cost built up in oil and gas operations by demonstrating the most cost sensitive operational activities (Tehran 2017). Besides, some of the non-conventional costing techniques are designed to predict cost behaviours in business operations (Hawkins 2018). Based on these substantially suggested functions of non-conventional costing techniques which align with the aim and objectives of this study (as stated in the introduction chapter), this study reviews a critical literature on the four kinds of the non-conventional costing in identifying operating cost objects and explore for their respective drivers/activities in oil and gas operations as discussed below.

2.5.1 Critical Evaluation of Full Cycle Costing Technique in Oil and Gas Operations

Empirically, full cycle costing technique is described as a cost methodology designed to evaluate operating cost. An investigation into the literature demonstrates that this costing evaluation technique illustrates a systematic procedure that guides users to evaluate and estimate operating cost from the start of a project, product, or service to the end (Mohn 2015). Reflecting on this explanation and applying it to oil and gas operations, it can be used to evaluate and estimate operating cost from discovery to production and beyond in oil and gas project. An extant literature critically establish that full cycle costing methodology demonstrates that the operating cost build up relating to finding, development activities and cost of capital of the credit facility sourced from capital market in financing oil and gas projects. The literature further includes royalties and production taxes and overheads as some of the main cost build up components in oil and gas operations (Henriksen and Vorren 1996). Hence, full cycle costing is a summation of direct and indirect cost circle of a project. Relating full cycle cost to unit technical costing (UTC) technique which is discussed in Section 2.5.3, this study views full cycle costing technique as an extension of the UTC. As UTC covers only direct cost of lifting a barrel of crude oil from a reservoir as described in Section 2.5.3.

An analysis of empirical literature on full cycle costing methodology in evaluating operating cost in oil and gas operations suggests that development cost and cost of improving operational efficiency change the behaviour of the operation (Hinkin 2017). This suggests that technological improvement in drilling and completions, changes in a fiscal regime and overheads influence operating cost in the oil and gas operations (Bissell 2015). These results suggest that cost of capital, tax and royalties have an insignificant effect on the operating from full cycle costing standpoint reflecting on the cost components mentioned above. The cost of capital, tax and royalties as mentioned above as part of the cost built up are fixed in nature though tax and royalty are variable by function which is dependent on the fiscal terms and conditions governing tax and royalty. Based on these suggested pieces of evidence from the literature on the effects of the cost components, this study assumes that full cycle cost approach can technically be concluded that variables cost component in oil and gas operations predict cost behaviour as all the factors mentioned are variable costs. Coincidentally, this assumption is consistent with the concept of variable cost which dictates cost behaviours in business operations (Hinkin 2017).

The full cycle costing methodology also guides previous studies to collect relevant quantitative and qualitative data from funding, development and production phases and activities in oil and gas operations. The data from these stages are process via a computer software to produce results and analysed and interprets (Sun *et al*. 2011). The results analysed the technical and financial cost implications in oil and gas operations (Badiru *et al.* 2013). An empirical review of the full cycle costing analysis also shows that the techniques is used to predict production cost per well over a period and used to estimate well design cost for a period (Dale 2015). Additional literature evidence indicates that full cycle costing techniques is used to evaluate cost associated to depth of producing well and adopted to assess well completion and configuration of gathering network cost (Badiru *et al*. 2013). These substantial literature evidence suggests that full cycle costing is very useful costing tool in oil and gas cost evaluation. Notwithstanding the above considerable literature evidence of usefulness of full cycle costing techniques, additional literature establish that the technique quantitatively measures operating cost and demonstrates the numerical effect on operating cost objects (Taal *et al.* 2003). Further evidence indicates that full cycle costing techniques are very useful in economic decision making.

Despite the usefulness of Fully Cycle Costing techniques as discussed above, some literatures identify some flaws and limitations of the technique which include that the technique fail to address decommissioning cost in oil and gas operations. Meanwhile decommissioning cost is a significant cost in mature oil and gas fields especial in the UK North Sea cost (Worksafe NB 2014). Other flaws and limitations that this study identified which is associated to full cycle costing is that the methodology fails to provide the breakdowns of costs into cost objects that could have helped in identifying activities changing their behaviour but grouped the operating cost by phases such as development cost, drilling cost (Mgbame *et al.* 2015) instead of by cost objects. Most important flaw of the full cycle costing which limited the technique in this study is it failure to identify the operating cost drivers/activities changing the operating cost objects behaviours as the aim of this study.

Regardless of the above flaws of full cycle costing technique, the technique is still relevant in evaluating cost in oil and gas. Berend and Scheffers (2016) employ full cycle costing technique and analyse the operating cost of oil and gas project in the North America. The results demonstrate that 21 per cent of operating cost accounted for production cost, 20 per cent associated to royalties and taxes, 3 per cent accounted for overheads, 28 per cent accounted for finding and development, and 17 per cent accounted for cost of capital (Berend and Scheffers 2016). These results suggest that finding and development accumulate a significant cost in the measuring the full cycle cost in the North America oil and gas plays. However, the result failed to identify drivers/activities responsible for high per cent of finding and development, which clearly show that full cycle cost is not appropriate for this study as the aim is to identify cost drivers/activities in oil and gas operations.

2.5.2 Critical Evaluation of Life Cycle Costing Technique in Oil and Gas Operations

The life cycle costing technique follow total cost approach but more comprehensive than fixed plus variable or direct cost plus indirect or capital plus operating cost (Boiteau *et al.* 2014). The life cycle costing technique is an operating cost methodology designed to assess and evaluate operating cost in the entire operations of a business or project throughout the economic lifespan of a project. Hence, Life Cycle Cost evaluate cost generate from exploration to the decommissioning activities of oil and gas operations/project (Bustos and Mossolly 2015). A critical literature analysis demonstrates that the methodology keeps track of the economic lifespan cost of the projects (Chiang 2013). The life cycle costing unlike unit technical costing technique and full cycle costing as discussed in the Section 2.5.4 and 2.5.1, is a combination of the two with an extension to transportation and the decommissioning costs (Jojarth 2008). One common similarity of the three costing techniques is they all can be used to measure a wellheads price/revenue of a producing reservoirs or well. Furthermore, all of them can be used to measure the cost of operation (Evaluate Energy 2017).

A relevant literature on life cycle costing technique acknowledges that it is one of effective non-conventional cost techniques in oil and gas operations as the techniques used quantitative and qualitative data from exploration, development, production, transportation, overheads and decommissioning activities to generate results (Man *et al.* 2011; Acemoglu *et al.* 2017). The results can be generated via computer-aided program, where the quantitative results demonstrate the numerical effect of the cost elements, while the qualitative results suggest the phases that are sensitive to activities. Other studies suggest that life cycle costing analysis is useful in identifying the activities that influence operating cost in oil and gas operation, which partially fit in to addressing this study aim of the identifying operating cost drivers/activities, and partially failed in addressing classifying operating cost into cost objects. A literature from

Douglas and Westwood (2012) reviews of operating cost suggests that life cycle costing is an effective technique to use to understand cost behaviour in complex and integrated activities and process like oil and gas operations. However, the study fails identified what make life cycle cost an effective technique for understanding complex and integrated operations.

A literature of life cycle costing suggest that the costing methodology has some usefulness to understanding the operating cost behaviour in the oil and gas operations. One of the usefulness of the life cycle cost technique from the literature is that the methodology takes depreciation and depletion of oil and gas reserves in to accounts in estimating the economic life span cost where other forms of the cost methodology overlooked (Cassio *et al.* 2014; Hastenreiter *et al.* 2014; Emily 2014). The result generated from the technique in oil and gas operations help in resources optimisation through effective allocation of resources to cost sensitive activities as the literature establish that as one of the usefulness of the methodology (IHS Energy 2015; Boccardi *et al.* 2016). Further literature evidence establishes that the technique can be used to analysis and predict maintenance activities, production facilities, equipment and materials purchase cost behaviours individually (Simon *et al.* 2012). Reflecting on these benefits of the technique discussed above, this study establishes that life cycle costing is worthwhile in oil and gas operations cost evaluation which can be used to measure operational and financial performance and challenges. Furthermore, this study can further establish from the extant literature that life cycle costing technique is fit for evaluating complex and multidisciplinary industry like oil and oil. The data and formation collected on the entire activities is another usefulness of the techniques, as the results from such data cover the entire operations.

Notwithstanding the substantial usefulness of life cycle costing as discussed above, some literature exposes some limitations which constrain the understanding of behaviour in oil and gas operations. One of the main limitations identified in life cycle costing technique is time consuming via data collection and analysis as the process involve the entire economic lifespan of an oil and gas field, which is 10 years lifespan of a marginal oil filed, and over 25 years of a commercial oil field. Hence, 25 years of data collection means almost all the cost element figure will change (Ross *et al.* 2015; Jon *et al.* 2016). Additionally, change in technology in oil the operational cycle will change the cost behaviours and that can affect the full cycle costing analysis. Furthermore, the techniques fail to classify the cost into cost objects and rather by units of operation. Hence, life cycle cost is not very appropriate to identify operating cost objects and their drivers/activities as the aim of this study.

2.5.3 Critical Evaluation of Unit Technical Costing Technique in Oil and Gas Operations

The unit technical costing (UTC) technique is one of the costing concepts which demonstrates an expenditure of direct activities performance to lift a barrel of crude oil from a producing well or reservoir (Ritchie and Dowlatabadi 2017). Hence, any other indirect costs are not considered and accounted for under the UTC concept. Therefore, UTC concept is like marginal costing concept which measure unit contribution. An extant literature analysis described unit technical costing methodology measure and evaluate the wellhead price/revenue of crude oil in a producing reservoir or well (Fattouh 2016). Other studies suggest that UTC can be used to measure the wellhead price/revenue, because the technique measures the direct cost of lifting a barrel of crude which described the wellhead price/revenue. Additional literature synthesis of UTC cost evaluation indicate that it enables users to attain the breakeven point of production when the result of the UTC the wellheads price is compared to market price of the crude oil (Macdonel 2017).

Empirically, the UTC is a quantitative evaluation and measure of operation cost by dividing the number estimated barrels discovered by the total direct production cost in a reservoir or in a producing well (Silvaa *et al.* 2016). Supporting literature argues that the computation of direct include the capital and the operating cost components of the direct cost (Bret-Rouzaut *et al.* 2011). Hence, the unit technical cost methodology demonstrates the minimum cost require to lift a barrel of crude oil from a reservoir (Mohn 2015), which is very significant for economic decision making in oil and gas projects (Jawed *et al.* 2012). Furthermore, the costing methodology demonstrates subunits of each cost components contributing to the UTC. Beside that UTC further illustrate how the total unit cost is arrive at, which is very useful in making operational decisions. The UTC analysis also determine which component of operating cost form a significant portion of wellhead price/revenue (Kumar and Markeset 2018). A couple of studies implemented UTC methodology to estimate UK North Sea and Nigeria unit operating cost at $49.00 and $27 respectively (Rydell *et al*. 2016; Sarah and Kent 2017).

The above benefits of the unit technical costing methodology cannot be over emphases; however, the methodology fails to identify the impact of the individual cost objects on the overall unit technical cost, rather centred on the total unit cost (Darko 2014). Additionally, the costing technique disregards indirect cost which create huge operating challenges in the oil and gas operation especially legal cost and depreciation and depletion (Aleklett and Campbell

2003). Furthermore, the cost technique fails to demonstrate the qualitative component of operating cost behaviour via activities and process to identify the cost drivers. However, these elements are very important in understanding cost behaviour in a complex operational environment. Collectively, the evidence on unit technical costing methodology suggests that operating cost not influence by activities as not activities have been mentioned in the methodology. Based on those limitations of the UTC methodology and compare to the aim of this study, the UTC cannot be implemented in addressing this study aims, however the UTC approach of operating cost in oil and gas operations is relevant in estimating operating cost in the oil and gas operations.

2.5.4 Activity Based Costing Approach of Oil and Gas Operations

Activity based costing (ABC) is one of the non-conventional costing techniques which is used to account for operating cost. An empirical enquiry establish that the technique enables users to trace operating activities and transaction to operating cost objects to understand their influence in changing the operating cost objects behaviours (CIMA 2008). Relating this practical explanation of the ABC to the aim of this study in the introduction section of this study, the technique can be adopted in this study to assess and identify the activities influencing operating cost objects in oil and gas operations. Adding to the above discussion on ABC, Gupta (2003) establishes that activity based costing concept is very suitable for assessing and evaluating operation with a complex cost structure, as it traces activities, processes, system to individual cost objects. Further literature synthesis demonstrate that the technique further measures the frequency of activities and analyse the operation to predict operating cost behaviour and also enhances the reliability of the cost data relating to cost objects (Lingling and Guo 2013). Hence, ABC costing concept can be adopted to identify operating cost drivers/activities associated to the labour, suppliers and service, maintenance, health and safety and other overheads in the oil and gas operations.

The activity based costing methodology uses both quantitative and qualitative data from activities relating to the cost objects in the operations from the primary sources (Chong and Cable 2002). Hence, the results of the analysis of activity based costing reflect the exact cost behaviour in operations with respect to the activities and their associated cost objects. Consequently, ABC analysis yields reliable, dependable, and credible findings. The above synopsis of ABC suggests that activity based costing concept is the appreciate and effective costing concept in identifying and predicting the operating cost behaviour in the oil and gas operations as compare to FCC, LCC and UTC, as confirmed in literature. Though these other three non-conventional costing techniques can be adopted in oil and gas operations, but they deviated from this study aim and, rather stand to measure the unit cost of the operations but not to identify and predict operating cost behaviour.

The technique guides collection of quantitative and qualitative data relating to the activities with respect to cost objects. For instant, labour activities can be trace to labour cost object and collect data on the activities. The same process can be repeated for the other operating cost objects. At this point, the users have a fair idea of the drivers/activities of each cost objects based on the frequency of the activities relating to each cost object. Hence, the users can identify the cost drivers/activities in the operations. Furthermore, the results can establish sensitive activities relating to the operating cost objects and the operations. These critical discussions on ABC show that the technique is very important and effective in evaluating operating cost. A critical literature analysis demonstrates that the technique set basis for assigning resources to activities based on frequency and sensitivity of activities generated from operating cost objects (Mahal and Hossain 2015). Additional empirical evidence demonstrates that ABC technique help users to obtain detailed and reliable cost data from the operations which enable them to put strategies in place to optimise their operations (Nara *et al*. 2014). Beside that activity based costing technique enable users to systematically analysis activities by mapping them to cost object to improve upon their operational activities and costs (Kyoung *et al.*2003).

Activity based costing technique just like any other costing technique and concepts have limitations, though the limitation did not affect it adoption in this study. One of the flaws of ABC identified from literature is that the technique is time consuming. However, Hanim *et al*. (2012) explained that the technique collect data from numerous activities, trace and match them to individual operating cost objects. It takes longer time to do that. Notwithstanding that the technique demonstrate cost behaviours which is key to this study. Further critical evidence establish that activity based costing results of analysis failed to measure the profitability of the operations (Roya *et al.* 2015). However, this study establishes that the technique demonstrates operating cost drivers in operation. When the identified operating cost drivers are controlled and managed properly, the overall operating cost will be reduced, which will positively affect the profit (given that cost is function of profit). More literature analysis establishes that ABC concept fails to comply with the Generally Acceptable Accounting Principles (GAAP), International Standard of Accounting (IAS) and International Financial Reporting Standard

(IFRS) (Katrin *et al*. 2013). Regardless of the ABC non-compliance with these professional guidelines, it is a powerful management accounting tool that is adopted by many industries to evaluate and monitor operating cost for making production pricing decisions related to their operational activities.

The costing technique and concept have been used to evaluate operating cost in manufacturing, transportation, logistics, education, media, bank, medicine, insurance, and catering industries which produced reliable findings in the industries in understanding cost behaviours (Danish *et al*. 2013). Furthermore, the costing technique have been adopted in oil and gas operation to evaluate cost but not operating cost. An empirical analysis from Lingling and Guo (2013) study establish some sensitive and driven activities in drilling and cementation of oil and gas wells in relating to cost. The study adopts ABC, and the result demonstrates that the depth of the oil well, drilling and cementation activities accounted for 96.6 per cent of the cost, and the same activities drivers gas well by 85.581 per cent. Hence, oil well activities are more cost sensitive than gas well activities. Qualitatively, the study identified transportation activities driven the drilling and cementation cost in oil and gas operations. Other evidence from Chong and Cable (2002)'s study in the oil and oil operations which also adopts ABC to understand costs objects and their activities, establish that health and safety and maintenance activities drives operating cost in the oil and gas operations. Gebril and Elagili (2015) employ ABC to establish a causal relationship between activity and their cost objects. Rong *et al*. (2009) use ABC based on regression models to test for identifying sensitive cost drivers. These substantial discussions of ABC are aligned with this study's aim and objectives. Hence, this study relays its arguments on ABC in identifying operating cost drivers and their relationship to the operating cost objects in oil and gas operations.

2.6 An Overview of the Oil and Gas Operating Cost Drivers

The exploring and evaluation of operating cost in oil and gas operations is a very important approach of measuring operational performance. The cost evaluated leads to realisation of operating profit, hence, the operating cost influences all key performance indicators (KPIs) and affects the technical and financial performance of the operations (Imad 2012). In order to optimise operation and the KPIs in oil and gas operations, there is the need to management, control and minimise operating cost by identifying operating cost drivers. Menukhova *et al*. (2015) establish that operating cost drivers/activities are mostly the transactions that cause changes in the operations. Ryu *et al*. (2014) indicate that cost drivers relate to activities in operations which causes individual cost objects to change in behaviour. Hence this study investigates the drivers that causes changes and influence operating cost objects such as labour, suppliers and service, maintenance, health and safety and other/overheads in oil and gas operations with no excluding other cost objects.

A critical review of oil and gas operational reports establish that exploration, drilling and production activities are sensitive drivers of the oil and gas cost of operations (Walther *et al.* 2009; Javid 2012). The findings published in the reports on cost drivers are very broad, although they drive the cost of operations upward in the oil and gas operations. For instance, there are different individual activities at the production facility, drilling and explorations, which influences the cost of operations in the oil and gas industry. However, the reports failed to address the activities and how they affect the cost behaviours in the oil and gas operations. Hence, this study seeks to address the operating cost drivers and their behaviours. Other literature evidence establishes that operating cost drivers in oil and gas operations are related to location, complexity and the size of the oil and gas filed. For instant labour regulation which is identified to be a driver of labour cost object is related to south American. Local content law is identified to be cost driver in the Gulf of Guinea. However, these two labour cost object drivers are limited to those regions and are not drivers in the UK North Sea and the North America. An extant literature establishes that location is a key driver of the oil and gas operating cost (Hastenreiter *et al.* 2014). The evidence of the operating cost drivers associated with location suggests that each geographical location in the oil and gas industry has its own operating cost drivers. Hence, this study evaluates and identifies regional operating cost drivers as presented and discussed in the following subsections.

2.6.1 Gulf of Guinea Operating Cost Drivers

There are several operating cost drivers influencing the cost of operations in the Gulf of Guinea regional. A critical reviews of corporates reports and other academic articles establish that the local content law is one of the key drivers of the operating cost in the oil and gas operation in the Gulf of Guinea (Dina *et al.* 2016). For instance, the Ghanaian local content law establish that all upstream investment shall require 5 per cent of the local equity holding of operating interest. Critical evaluation of the local content law reveals that the this law fail to assess the financial and technical ability of the local equity holders as the law is salience on the financial and the technical capability of the local companies (Nchor *et al.* 2016). This evidence suggests that the 5 per cent drives the main operators cost, as most of the local companies are not financial capable due to the capital intensiveness of investment in the oil and gas operations.

From the same local content law again, operators are been restricted to 5% of outsourcing of services, and 95 per cent are been controlled and managed by Ghana Petroleum Commission (Emmanuel *et al.* 2013). This affects services delivery and consumption in oil and gas operation in the Gulf of Guinea, which drives the operating cost (Tuffour *et al.* 2010). The local content laws obligations are not limited to Ghana but very common in Gulf of Guinea operational region.

Other studies indicate that security and other related issues drives operating cost and operation in the Gulf of Guinea operational region. In Nigeria the giant of the Gulf of Guinea oil and gas producers suffer destruction of production facilities, pipelines and kidnapping of staffs for payment (Felix *et al.* 2014; Adrian *et al.* 2016). Bredenhann (2013) exploratory studies establish that social activism in Gulf of Guinea also drives operating cost. This includes the agitation of civil societies which campaign that oil and gas operators must provide all needs of the society (Paul 2016). Additional evidence on the operating cost drivers reveal that the government interference, geopolitical instability, conflicts are some of the issues driving oil and gas activities and cost in the Gulf of Guinea (Ekhator *et al.* 2016; Misund and Osmundsen 2017). Further assessment of literature within the Gulf of Guinea operational region establishes that financial cost in a form of high-interest rate on debt facilities drives the operating cost in the region **(**Ross *et al.* 2015; Chris *et al.* 2017). Goldman and Sachs (2017) literature analysis demonstrate that high cost of capital affects the payback period and net present value of oil and gas projects.

An extant literature evidence establish that a complex regulatory framework, bad ethical consideration, poor infrastructure and lack of skilled labour drive the operation and the operating cost in the Gulf of Guinea (Finn *et al.* 2014; Kellou *et al*. 2017). Further literature analysis demonstrates that the production tax and other bonuses in the Gulf of Guinea drive the operating cost, and Bigliani (2013); Pierre *et al.* (2013) research analysis demonstrate that inappropriate bureaucratic administrative procedures affect Final Investment Decision (FIDs) making and implementation which also drive the operating cost in the Gulf of Guinea.

2.6.2 North Sea Operating Cost Drivers

A critical review of oil and gas operational activities in the UK North Sea revel that the implementation of Enhanced Oil Recovery (EOR) technology at the mature oil and gas fields drives the operating cost via frequent chemical injections (Wood 2014; Newcombe 2017). Further literature analysis from Deirdre and Michie (2016) indicate that labour deficit due to higher retirement rate in the key workers in the UK North Sea drives operating cost as operators dependent more on contract staff and they are very expensive (Bergli and Falk 2017; John 2018). Besides these literature evidence, other study reveal that rental of drilling rigs and production facilities drives the operating cost due to long hours usage of the rigs (Olaniran *et al.* 2015; George *et al.* 2016). Furthermore, logistics relating to service and maintenance of long-overdue production facilities also drives the operating cost (Mick and Borwell 2016; Ben *et al.* 2016).

The UK North Sea operational region operating cost is identified to be influence by high environmental requirement activities to create operability environment for safe operations (Kumar and Markeset 2018), and Menukhova *et al.* (2015); Liu (2011) report review reveal that rapid depreciation and depletion of assets and reserves drives the operating cost in the UK North Sea. Furthermore, accidents and health and safety issues further drive operating cost in the North Sea (Mimmi and Goude 2017; Martin *et al.* 2016). Most importantly, health and safety regulation changes and become more restrict after the historic catastrophic disaster of Piper Alpha in 1988 (Cable *et al.* 2013; Henderson *et al.* 2017). However, an analysis by Wood (2014) establishes that the Basin cost is driven by decommissioning.

2.6.3 North and South American Operating Cost Drivers

The U.S. Energy Information Administration (EIA) statistics establish that about 60 per cent of operating cost is influenced by depth of water because of purchase of pipelines, and the fabrication and installations activities to extract the crude oil from the reservoir (EIA, 2016). Furthermore, transportation and security drive the operating cost as most of the oil plays in America are far from the shore, hence transporting the workers and equipment to oil and gas plays drives the operating cost (Mimmi and Goude 2017). Other related reports revel that the region operating cost in driven by the high insurance premium due to the high risk involved in the oil and gas activities in the region (Cochener 2010; Dittrick and Paula 2017). Further empirical enquiries establish that about 65 per cent of operating cost is driven by repairs and maintenance activities cost due to lack of maintenance experts within some part of the region (Woods and Darren 2016; Jean and Cristofari 2017). Timi and Familusi (2016) literature analysis suggest that the operating cost is driven by high consumption of the oilfields chemical to treat heavy crude by separating the impurities such as wax and sulphur content and also to reduce the viscosity for easy flow of oil from the reservoir (Martin *et al.* 2016; Barteau *et al.* 2014).

2.6.4 Middle East and North African Operating Cost Drivers

The operating costs in these regions are influenced by civil war and other form of the violent including political instability (Locatelli and Fhea 2015; Sawh *et al.* 2016). For instant, Libyan, Morocco and Egypt civil and political violent and wars led to destruction of operational facilities in the North Africa which cost millions of US dollars (Kevin *et al.* 2009; Fallahnejad 2013; Caselli *et al.* 2014). Furthermore, Iran Iraq war led to destruction of wellheads and pipelines and other production facilities which influence the operating cost (Fallet *et al.* 2010; Gonzalez 2010). These issues emerged as a global oil and gas problem, that led to demand deficit of crude oil in the global market causing prices jumped in those eras, especially Iran Iraq war (David *et al.* 2016). Furthermore, institutional instability is a factor of the operating cost in these regions (Henderson *et al.* 2017).

2.6.5 Global Operating Cost Drivers

Literature evidence suggests that crude oil market value drives the operating cost, where Cherian *et al.* (2013); Wardt (2014) argues that the market value indirectly influence the operating cost via low turnover on the crude oil and not on operating cost. Furthermore, low discovery rate and high-level of competition and market pressure drive the operating cost (Merrow 2012; Fallahnejad 2013; Lynn and Mike 2016). Furthermore, Abubakr and Anders (2007); Emeh and Okoli (2015) highlight that improper management of facilities drive operating costs globally. Besides that, stakeholders' approach to operations is very independent with different goals towards rent maximisation with little focus on willingness to collaborate by shifting the pressure onto the operators (Ruqaishi and Bashir 2009; Man *et al.* 2011; Bustos and Mossolly 2015). Eventually, those challenges escalate operating cost, weaken Key Performance Indicators (KPIs) which compelled some operators to discontinue existing projects and postpone and suspend FIDs of the new projects.

2.7 Critical Evaluation of Cost Management for Operational Optimisation

The cost control measures and strategies are very important aspect of management accounting in managing operating cost for operational optimisation. They strategies implemented in business operations for operating cost control and optimisation of operations are often an internal organisation policy and do not follow external standards. However, cost control and operations optimisations policies are theoretically related to the Working Capital (WC)and the Working Capital Requirement (WCR) in business operations. These two concepts measure how efficient business uses their assets and liabilities in their operations. Beyond these two concepts, the cost evaluation techniques as discussed above also enables cost control measures. When they are appropriately applied to identify individual cost drivers and predict their behaviours that can be managed and control to optimise operations. This study suggests that cost control and operational optimisation policies should be built around identifying and understanding cost drivers and their behaviours, if that is effectively done, the cost can be controlled, and the operations would be optimised. Hence this study critical investigates the operating cost control from other studies to understand their thoughts about operating cost management in oil and gas operations.

Furthermore, a literature analysis of Carson and Decagon (2015) suggest that effective policy implementation regarding resource allocation produce consistency in reporting on specific activities and their cost appropriately. This approach enable organisation to identify operational weakness affecting the performance and activities and cost (Ronay *et al.* 2013), hence, measures can be put in place to strengthen the weaknesses and control the costs. A synthesis of the literature indicates that diversification policy also enables operating cost saving in an oil and gas operation. A typical example of diversification among oil and gas players are BP, Shell, and Total. These major E&P operators diversify their investments and activities from main upstream activities into downstream, and often even into the renewable energy (Misenheimer *et al*. 2010; Akeem 2017). The diversification policy enables the operators to achieve a significant return on the other activities which enable them to reduce the operating cost in the main upstream operational activities (John *et al.* 2013; Nguyen and Huyen 2013).

Other critical reviews of financial and technical reports advocate collaboration and corporation strategies in the oil and gas industry to manage their operating cost. The analysis of those reports suggests that operators operating in a common zone can jointly outsource emergency and transportation services together and share the cost among themselves (Berg *et al.* 2012; Slade and Bauen 2013). This would enable the operators to efficiently use the service and halve the price of the services depending on the number of the operators coming together. Furthermore, other reports recommend effective procurement process and systems in oil and gas industry can also lead to operational optimisation and operating cost saving (John *et al.* 2013). Chawla (2017) provides evidence, which demonstrates that over 95 per cent of operational activities in oil and gas operations are outsourced via third parties. Hence, effective procurement process and subcontractors' selection can yield a significant amount of operating cost saving in the oil and gas operations. Additional suggestion indicates effective monitoring and evaluation of procurement and subcontracting activities would help in operating cost control in the oil and gas operations (Thokala *et al.* 2016). Further analysis from reports demonstrate that the operators can establish an effective relationship with other operators and suppliers which would help to share good and bad operational experience (Lotfian *et al.* 2010; Douglas and Westwood 2012).

The above literature evidence suggests that operators should critically evaluate their operation cost and they can do that by adopting non-conventional costing techniques specially Activity based costing. This costing concept as discussed in Section 2.5.5. provide substantial importance of the concept which include providing both quantitative and qualitative factors causing changes in the operating cost objects and can also predict the cost objects behaviours (Sherif *et al.* 2015; Jean *et al*. 2016). Hence, adopting Activity based costing operators would enable a critical assessment of the operating cost to understand their behaviour. Additionally, the technique can provide a comprehensive understanding on how operating drivers behaviour across the functional operational areas (Olajire 2014; Ernst and Young 2016). Besides that, Research and Development activities in oil and gas operations is also identified as an effective approach to operating cost management, such as new technology and smart ways of doing things would lead to cost reduction (Serova and Nøstbakken 2015; George *et al.* 2016).

Other literatures recommended that operating cost management can involve understanding the operational activities and their associated costs. When operators understand their operational activities, they would be able to structure their performance to improve on operations, which would lead to improvement in productivity and the fiscal outputs (Yakubu *et al*. 2010; Ajator 2014; Radda *et al*. 2015). Furthermore, adherence to regulation, standards and implementation of professional reports recommendations can yield a significant operating costing saving in the oil and gas operations.

2.8 Critical Evaluation of Petroleum Fiscal Regime and its Cost Implication

The Petroleum Fiscal System is a living written instrument, which contains the legal narratives of petroleum transactions. It demonstrates the responsibilities of the main stakeholders (Host and the Investor) and their ownership right which includes the percentage contributions of the investment (cost) and net return from the operations (Muhammed 2010). The instrument further describes operational obligations and regulations and their implication in the operations (Ernest *et al.* 2010). Besides that, Johnston (2003) explains that the Petroleum Fiscal Regime demonstrates the cash outflow and the inflows in measuring the fiscal benefits attributable to the stakeholders (the host nation and the investor/contractor). Moreover, Macartan *et al.* (2007) establish that the Petroleum Fiscal Regime basically demonstrates the dividend and rent and other financial gains from the operations. These discussions on the Petroleum Fiscal Regime suggest that the Petroleum Fiacal System accounts for the expenditure and revenue of the operations. Hence, the Petroleum Fiscal Regime form the foundation cost assessment in the oil and gas operations.

Essentially, the Petroleum Fiscal Regime is classified into three fundamental domains known as Royalty Tax System (Concession), Production Sharing Contracts (PSC) and Service Contracts (Smith *et al.* 2010). Practically, the Production Sharing Contracts and that of Concession contracts are predominantly adopt in production phases, with similar treatment of the transactions and the operational activities. The main differences between the Concession and Production Sharing Contracts are profit sharing, cost recovery and the ownership right. The Production Sharing Contract involve sharing of profit oil between the investor and the host, while the total cost incurred in generating the profit is limited to a threshold known as cost recovery limit and the wellhead is the own by the host. Hence, the Production Sharing Contract operational terms generates a systematic cost, where the investor is not allowed to recover the total cost incurred, and this generates negative impact on the operation as the cost balance carry forwards increase current liabilities weaken the working capital (Law Library of Congress 2015). Hence, Production Sharing Contracts facilitates increase in operating cost because of the cost recovery limit.

The Concession System also allows full cost recovery incurred from the operating activities. Additional, the System further permit the contractor/investor to own the wellhead, and profit oil is solely the investors own (Ghandi *et al.* 2014). Though operating cost is fully recovered in Concession System some cash outflow items such as Royalties and Taxes that is discussed in the next sections brings in the cost issues (Sedlar *et al.* 2017). These two main types of treaties are mostly used in Africa, Europe, and America. Specifically, Ghana, and the UK uses Concession and Nigeria, Angola uses Production Sharing Contracts. On the other hand, Service Contracts are adopted in exploration, development, and oilfield services, and can further be broken down to Pure Services and Risk Service Contracts. The Pure Service Contracts shift cost burden to host or the sponsor, as all agreed cost accrued from the activities are paid by the host regardless of the outcome of the activities. This suggests that Pure Service cost and benefits should be analyses by the sponsor not the contract, as whether positive or negative net return the contract shall recovered the agreed cost incurred (Feng *et al.* 2014). On the other side is the Risk Service, which is the direct opposite of Pure Service Contracts. Hence, in Risk Service, the sponsor and contractor agreed on the work plan and scope, and the contractor executes the project and are paid from project returns. Ultimately, in Risk Service Contracts, the contractor stands a high chance of recording sunk cost when negative return are calculated from the project (Ghandi *et al.* 2017). Hence, in Risk Services Contracts, the contractor needs to understand and evaluate the cost and the benefit of the project. Service Contracts are largely used in the Middle East and North Africa. Beside the above discussions of Fiscal System, there are Joint Operation Agreement (JOA), Farmout and Farmin Agreement, Unitization unit Agreement, and hybrid contract, Mutual Interest Agreement (MIA) which also have cost implication in the oil and gas operations (Ernest *et al.* 2010).

The above discussions on Petroleum Fiscal Systems suggest that Production Sharing Contracts have more cost implication to the investor with less benefits as the investor share the profit. In Concession the discussion suggest that the investor recover all the cost and own the profit oil and the wellhead. Comparatively, the Concession Systems encourage investors to save and the Production Sharing Contract does not. On the other hand, Pure Service favors investors while Risk Service favors the owners of the resources.

2.8.1 An Evaluation of Royalty Impact on Operating Cost in Oil and Gas Operation

Royalty is one the key fiscal components in non-renewable natural resources trading regardless of quality and market values of the resource. Royalty is not just price paid in oil and gas industry but paid in other industries. For instance, royalty is paid in construction industries from the usage of quarries, water, sand and land for building roads and buildings. Additionally, royalty is paid in the mining industry for using the land and extract the gold (Aklin *et al.* 2015). Royalty as discussed by many researchers described it as an intrinsic value paid for the right of an investor to explore, develop, produce or use a natural resource or turned it into a tradable commodity (Souza *et al.* 2014). Additionally, the International Financial Reporting Standard (IFRS 15; B63) recognise royalty as a legitimate expense and should be treatment as an expense in the comprehensive income statement in the investor books of accounts (Herald *et al.* 2015). Hence, these discussions on royalty suggest that royalty is a legitimate price paid by contractors, hence a cost to the investors.

Royalty as an expense is recognised by IFRS15; B63 but fails to follow economic rent principle where the rent is released as a result of change in output to input. However, Royalty price does not consider output or input hence royalty price generates an upfront cost issue as the price is paid before the resource is developed or produced. Additionally, in oil and gas industry accounting for royalty, royalty is charged on gross output when no cost is considered (Ackah *et al*. 2012). Furthermore, royalty has an agreed percentage to be paid on gross and sometime on sliding scale basis (Antonio and Postali 2015). At some regions like Canada and Brazil royalty is in Tier 2 where royalty is paid twice, part to the state government and the other part province governance, in Brazil, royalty payment is made to central government and other payment to landlords (Medeiros *et al.* 2016). The royalty price negatively influences operating revenue as it is charged on gross outputs, hence Royalty price paid is unfair as it does not consider any cost (British Columbia Ministry of Finance 2014). Hence, Obeng (2015) believes that royalty charge generates forward fiscal challenges to cash streams as no single cost item is considered at the point of royalty consideration.

Brown *et al.*'s (2017) analysis demonstrate that royalty treatment could create up-front cost accumulation because its deduction will reduce the net outputs for investors to recover their costs. Furthermore, Memphis *et al.* (2017) indicate that royalty is non-neutral levy charged on operations outputs as the process completely ignores all inputs costs, and Ngoasong (2014); Ovadia (2016) added that royalty is not an economic rent as economic rent is the net financial returns from an investment. The discussions on royalty suggest that royalty in oil and gas operations generates systematic cost in oil and gas operation.

2.8.2 An Evaluation of Taxation and its Impact on Operating Cost in Oil and Gas Operations

Taxation is a compulsory financial charge and deductive levies imposed on business entities and individuals for earning fiscal benefits or and additional cost added to consumption of goods and service (Lund 2009; Nakhle and Shamsutdinova 2012). Some taxes are charged on net earnings or returns on investments, either from a corporative entity or from an individual. Comparatively, tax is like royalty, because both tax and royalty reduce the net returns, and both are cost items and deducted from revenues or outputs. However, tax is charge on net profit while royalty is on gross return (Mas'ud 2016). Taxes are pay by entities includes Corporate Income tax (CIT), and this kind of Tax is one of the main Taxes levied on both limited and unlimited liability companies on the net profit (Ramírez *et al.* 2016). Furthermore, it is the major tax across in all industries, however, in oil and gas industry CIT is just one of the main tax (Aziah *et al.* 2017).

An evaluation of the literature on taxation systems in different economies reveals deferent kinds of taxes with different rates charge on the revenue and the market value of the good and service consumed (Abdo 2010). Further evidence reveals that the taxes rates and kinds various from industries to industry (Nakhle 2016). A literature synthesis reveals that oil and gas industry has the highest rates of taxes and has many taxes and levies charge at different level of the operations revenues (Bahati *et al.* 2014). Further investigation into the empirical evidence on various Petroleum Fiscal Systems establish that some of taxes rates are on progressive scales with respect to crude oil price and produced quantities (Carole 2007; Bahati *et al.* 2014). Further evidence from various enquiries listed Corporate Tax, Ring-fence Tax, Special Petroleum Revenue Tax, supplementary Tax, Local Government, Province, or State tax, Windfall tax, Production Tax /bonuses Value Added Tax (VAT) as some of the types of taxes often charged on oil and gas operations (Johnston 2003; Johnson 2003; Onwuegbuzie 2004; Muhammed 2010). Although some of these taxes are *ad hoc*, but they provide a long-run effect on operating revenue and operating cost.

Taxes in the oil and gas operations are sensitive cost drivers because they are compulsory and obligatory charges and deductions from net revenue and are treated in comprehensive income statement as expense and on the financial position statement as current liability (Daniel 2003). Taxes increases the current liabilities which provides negative effect on the Working Capital, Working Capital Requirements and Net Cash (Net Cash), and these financial analyses relate to operation hence operating cost (Rosdiana and Sidik 2015). The above evidence suggests that taxes influence operating cost, hence this study conducted investigation of oil and gas operations to understand how taxation affect the operating cost. A literature analysis of the Gulf of Guinea operational zone reveals that oil and gas operators are charged an average of 35 per cent CIT on net income as compared to an average of 25 per cent in other industries (Fjaertoft *et al.* 2015). More specific evidence related to Nigeria indicates that 2 per cent tax is charged as Tertiary Education Tax and 5 per cent as Value Added Tax (VAT) for any qualifying service consumed in the country (Beer and Loeprick 2017). These taxes charged on operating revenue suggest that about 37 per cent of the net revenue from oil and gas operating in the Nigeria goes for taxes. The same evidence can be discussed, as nearly 40 per cent of the cost in the Gulf of Guinea operations is influenced by taxations. Hence, this study concludes based on the literature evidence, taxes significantly influence operating cost in Gulf of Guinea oil and gas operations.

Further investigations conducted in the UK North Sea demonstrate a significant impact of Taxes on operating cost. An enquiry on the extant literature suggests that operators pay Supplementary Tax of 10 per cent on the operating revenue (Amyas 2019). Notwithstanding that, the operators further suffer 29 per cent of Decommissioning Tax with potential of increasing when the producing field increase in age (Nick *et al.* 2017). Besides that operators suffer 20 per cent of Ring-fence Tax and VAT of 20 per cent on goods and services consumed in the UK North Sea (Waller and Dabsak 2019). A review on taxation conducted within Norwegian portion of the North Sea reveals that operators suffer 25 per cent of CIT, and 53 per cent of resource Rent Tax (Nick *et al.* 2017). These analyses suggest that any net income generated from suffers taxes.

2.9 Critical Evaluation of the Gulf of Guinea Oil and Gas Operations

The Gulf of Guinea maritime territory covers north-eastern part of Atlantic Ocean. The territory contains countries such as Gabon, Equatorial Guinea, Cameroon, Nigeria, Benin, Togo, Ghana, Ivory Coast and Liberia. A contemporary study reveals that the various countries National Oil Companies (NOC) such as Ghana National Petroleum Corporation (GNPC), Nigeria Nation Petroleum Company (NNPC) statistics illustrate that these countries recorded a significant commercial discovers. The literature further highlights that the zone still have undiscovered reserves (Kastning 2019). Notably, Nigeria is currently the highest country with crude oil reserves in Africa and the leading producers of crude oil in Africa. A review of recent statistics illustrate that Nigeria is among the first ten highest producing countries of crude oil globally (Weaver *et al.* 2019). These statistics are not limited to Nigeria alone, but however are extended to some of the Gulf of Guinea countries such Ghana, Gabon, Côte d'Ivoire, as statistics have proven that these countries produce crude oil for good number of decades, and contribute significantly to the global oil and gas industry (World Bank 2018).

A review of the Gulf of Guinea provides evidence of a significant investment in the E&P activities, especially Nigeria and Ghana. A statistic suggests that over 150 active commercial producing fields are identified in Nigeria (World Bank 2018). Further reviewprovides additional evidence that, Nigeria currently produces crude oil from at least 1,400 active commercial producing wells (World Bank 2018). Besides the statistics, the other countries within the Gulf of Guinea, especially Ghana, have also recorded a substantial active commercial producing fields and reservoirs as well as some marginal fields (Felix *et al*. 2014). These substantial pieces of evidence suggest that Gulf of Guinea has a significant active operational fields and reservoir. A critical assessment of operational activities of Gulf of Guinea from empirical and exploratory perspectives reveal numerous operational changes affecting the operations, hence this section of this study sought to investigate the operational challenges and their effect on oil and gas operating cost in the Gulf of Guinea.

This study critically assesses various operational treaties and establish the effect of Fiscal System on the oil and gas operations in two regions. The review analysis reveals that regulations and obligations governing the fiscal and the operational returns in the oil and gas production in the Gulf of Guinea are complex by nature and inconsistent by function. An integrated analysis from both operational and fiscal standpoint by Jin and Jorion (2006); Ronay *et al.* (2013) establish that regulations and obligations are subjected to random changes and inconsistent reviews. An analysis on the existing literature emphasises that the inconsistency of these rules affect the existing E&P activities and turnover because, some changes of reviews of the regulations and obligations lead to suspending of the existing activities (Uyi *et al.* 2013; Franklin *et al.* 2013). Some studies subscribed that the Fiscal Systems within the Gulf of Guinea been very complex (Johnston 2003; Daniel; Jeffrey *et al.* 2007; Mazeel 2010; Yergin 2010; Ernest *et al.* 2017; Ayesha 2017). To explicitly depict the Fiscal System complexity, Daniela and Prosper (2011) ; Kankam (2014) conducted a critical review of Petroleum Fiscal System, Local Content Law, Taxation system, Petroleum Exploration Law in the Gulf of Guinea. Their findings on the reviews establish that Ghanaian Petroleum System has a relinquishment clause, which punishes operators for delays in activities, surface rental charges and Government Participating Interest (GPI) and JOAs. These findings relating to Fiscal Systems in the Gulf of Guinea suggests that the treaties pose both fiscal and operational threat to the operational activities, hence increase in the operating cost in the region.

A substantial evidence from a reviews of local content law establish that all upstream investment in Ghana are restricted by 5 per cent mandatory equity participating (Local Content Law 2013; GNPC 2016). However, the 5 per cent participating clause in the Local Content Law failed to advice the financial capability and technical ability of the local partner. Hence, the 5 per cent of equity ownership in the investment is a potential financial and technical hazard to the foreign E&P investor and activities, because the local partner might not be financially capable enough to contribute to the development of the reservoir. Hence, this can build a systematic operating cost in the operations. Further literature analysis, picked out from Local Content Law within the Gulf of Guinea, demonstrates further restriction in outsourcing supplementary activities to capable subcontractors and suppliers, but rather to local companies, all in the name of building local participating in the oil and gas operations (Local Content Law 2013; Petroleum Commission 2016). A review of the relevant literature establishes that the biding and selecting of the local suppliers and subcontractors are heavy influenced by government officials (Gyimah 2016).

Other literature findings from the region reveal that maritime territorial disputes as one of major operational challenges affecting E&P activities and operating cost. Evidence from just ended maritime territorial dispute ruling from International Tribunal Law of Sea (ITLOS) between Ghana and *Côte d'Ivoire* over prospect discovered at the maritime borders of the two countries by Tullow and HESS (Rouzaut *et al.* 2011; GNPC 2016). According to a reports, Ghana licence out the prospect to Tullow and HESS and commercial discoveries were recorded (GNPC 2018), then *Côte d'Ivoire* claimed that the prospect is located in their maritime territory (Philippe and Boualem 2017). During the ruling of the case, all E&P activities at the prospect were suspended for over a year, and the suspension of the activities affected Tullow and HESS investment (Graham *et al.* 2017). Potentially, the region stand to encounter more future disputes between Ghana and Togo, Benin and Burkina Faso where Ghana shared a border with these countries and are currently undertaking E&P activities at the Voltain Basin (Adda *et al.* 2013; Ghana Parliament 2018).

Further historical maritime disputes reveal from previous studies in Nigeria confirmed complex disputes where the literature shows that the nation recorded both internal and external border disputes (Chris *et al.* 2017). The literature confirms that Bakassi Peninsula dispute between Nigeria and Cameroon affects many activities, not just E&P activities and investment (Tordo 2007; Amoako *et al.* 2010; Kankam 2014). Further literature enquiries confirmed a border dispute between Akwa Ibom and Cross River, and further extended to Akwa Ibom and Abia (Yevi 2013). Additional evidence reveal that Bayelsa and Cross Rivers also encounter border dispute, these are crude oil rich state in Nigeria (Obeng 2015). These disputes lead to numerous operational challenges and causes oil and gas operation in Nigeria.

An extant literature verifies that security challenges within region threaten the operation which is relatively influence by the disputes (Wang *et al.* 2010). A critical enquiry into the effects of the security activities reveal that they led to destruction of production facilities and closure of the roads leading the production platforms (Henri *et al.* 2016). Additional evidence indicates that the weak security system led to foundation unregister pressure groups which kidnap and stage attacks on pipelines (Adda *et al.* 2013). A quantitative Statistics have proven that Shell is one of the major multinational E&P operator in the Gulf of the Guinea which lose over $9 billion worth of crude oil annually from one of their production filed located in Bayelsa state due to attacks on their transportation pipelines to smuggled crude oil for personal gains (Acquah 2014). Additional literature on the attacks confirms that other attacks on Chevron production facilities at Niger Delta costing millions of dollars (Anthony *et al.* 2015). These pieces of statistical evidence on insecurity suggest that security is a significant operational challenge, which affects the operations in many ways, such as slowdown operational activities, destruction of assets and kidnapping.

Furthermore, literature on the operational challenges in the Gulf of Guinea reveals a drastic reduction of skilled labour. Investigation into the literature show that the reduction in skill labour is due to high retirement rate of the key workers at technical areas are (Uyi *et al.* 2013;Yamoah and Foli 2016; David, *et al.* 2016). Statistics from the region illustrate that about 90 per cent of the technical positions such as Subsea engineers, Drilling Engineers, Derrickman are contract staff expatriates, except a considerable number of the managerial positions that are occupied by the indigenes (Anthony *et al.* 2015). Further analysis reveals the Gulf of Guinea operations attract high cost of capital on debt instruments (PWC 2016; KPMG 2017). Some literature analysis findings demonstrate poor compliance and strategic planning of E&P activities and corruption also affecting oil and gas activities in the Gulf of Guinea (Abrokwah 2010; Yamoah and Foli 2016). Conclusively, Gulf of Guinea is the hub of oil and gas activities in Africa, however, have many challenges as mentioned above, and this study stand to address some of them at the analysis sections from both quantitative and qualitative perspectives.

2.10 An Evaluation of the UK North Sea Oil and Gas Operations

The UK North Sea is geographically located at north-west continental shelf, a section of northeast Atlantic Ocean. The maritime territorial region includes United Kingdom, France, Belgium, Netherlands, Germany, Denmark, Sweden and Norway (Bauman *et al.* 2013). The maritime region is noted of rich economic activities where the two world's largest ports are located, one at Rotterdam in Netherlands and Hamburg in Germany where numerous maritime activities such as shipping, fishing, crude oil and renewable energy are produce (Voldsund *et al.* 2012). Statistically, about 30 per cent of European Union (EU) economic growth is from the North Sea maritime activities with a significant offshore oil and gas activities especial the UK portion of the North Sea (James 2014). Among the North Sea countries, this study considers the UK portion of the North Sea as it experiences operational challenges, which leads to increase in operating cost. Hence, this study seeks to investigate the causes and effect of the operational challenges in the UK North Sea.

Considerably, the UK North Sea oil and gas activities have been the economic lifeline of the UK government and the UK industrial sectors. Empirical evidence illustrates that oil and gas activities hold over 50 per cent of the employment in the UK economic (William *et al.* 2016). An analysis of the previous literature reveals that rent from oil and gas activities is one of the main fiscal inflows into the UK economy (Kemp and Stephen 2014). Further analysis establishes that the oil and gas activities influence the supply chain and petroleum chemical industry (Kemp and Stephen 2014). These pieces of evidence suggest that oil and gas activities are very instrumental to UK economy growth. A critical literature on the UK North Sea oil and gas operations highlights that previously the region was among the most efficient and profitable oil and gas operational zones within the North Sea and the world, until in the 20th century specifically 2014 that the region experiences operational challenges which led to increase in operating cost (James and Van 2014). However, the incident of increase in operating cost in the region coincided with the falling of the crude prices. Hence, literature associate the increase in operating cost to the decline in oil prices (Jackson 2014; Oil and Gas UK 2015). However, this study views these literature findings as misleading as the price is a function of revenue and profit and not cost. Hence this study believes that increase in operating cost in the UK is caused by other but not specifically to the falling of the market value of the crude oil. Based on the assumption that crude oil price is not the cause of the increase in operating cost in the UK North Sea this study conducted a critical study in the UK North Sea to identify actual causes of the operating cost challenges in the UK North Sea.

A critical review of the operational reports from the UK North Sea findings shows that one of the operational challenges identified is failure to comprehensively hold reservoir engineering analysis of an operation. This situation led to workovers in the operations which increase maintenance activities hence increase the operating cost. An empirical evidence from a survey of several reservoirs' analysis reveals that about 98 producing reservoirs were identified to be improperly diagnosed which led to workover and increase maintenance activities (Davies *et al.* 2014). Additional evidence indicates that the improper reservoir diagnosis increases maintenance cost by 17 per cent in 2014/2015 (Deirdre and Michie 2017). Further enquiries conducted show that the high operating cost in the UK North Sea is associated to long overdue operating equipment. The synthesis provided highlight that old operating equipment loses their mechanical advantage and efficiency. Hence, the equipment response to frequent malfunction which seek for maintenance intervention which increase in operating cost (England 2015; Hough 2017). These set of the evidence suggest that the UK North Sea operating cost is influenced by the improper reservoirs' analysis and the long overdue operating equipment which fuel operating cost are not the falling of the oil prices.

Further argument emerged from investigation into the literature via technical report indicates that the UK North Sea operating reservoirs are associates with high depletion due to the old age of the reservoirs. A critical literature show that depleting reservoir need to undergo aid excelling fluids, which is reservoir maintenance types. This reservoir maintenance and management is common in the UK North Sea Producing reservoirs and very expensive (Mkindi *et al.* 2017). Reflecting on the above evidence, McKinsey & Company (2015); Mahmoud and Etemaddar (2016) analysis demonstrate that old age equipment, improper reservoir analysis and depletion which are identified in the literature as some of the causes of operational challenges create hazards and acute health and safety incidents which lead to accidents in the UK North Sea oil and gas operation as confirmed in Section 2.5.5 of this study. Further critical review from a survey of a group of managers in the UK North Sea reveal that operators are reluctant in performance regular inspections, and monitoring of operational activities and this leads maintenance activities (McKinsey & Company 2016), and Haahr (2015); Maclean and Alastair (2016); Pettit (2017) analysis identified deficit labour and the Enhance Oil Recovery (EOR) influence the UK North Sea Operating cost.

The operations challenges at the UK North Sea affected most of the Key Performance Indicators (KPIs) and even declared the zone uneconomic where the operating cost exceeded the price of Brent (Samuel 2015). An empirical analysis from Elhuni and Ahmad (2017); Oil and Gas UK (2016) reveal a loss (operational deficit) of $2.7 billion in upstream investment 2015/2016. It is also documented in the extant literature that Return on Investment (ROI), which is a measure of the investment viability, has declined from 50 per cent to 0.2 per cent within the same year of assessment (Mitchell and Mitchell 2013; Adrian *et al*. 2016). A critical analysis of a couple of the operators' comprehensive income statements show such a decline in Earnings Before Interest Tax Depreciation and Amortization (EBITDA), while IHS Energy (2015); Samuel (2015) hightlight that the region has largely recorded operational loses. Subsequently, these issues increase operators liability with a high gearing ratio, which limits operators to raise debt finances (Edward *et al.* 2014; Elhuni; Ahmad 2017; Cherian *et al.* 2017).

Further evaluation of the literature reveals 15 per cent decline in E&P activities (Mckinsey & Company 2015), while labour statistics illustrate 30 per cent turnover in oil and gas sector as confirmed by Office of National Statistics (2017). Further evidence that emerges from the oil and gas performance reports establishes a decline in rent from 12.4 billion to 1.2 billion (Simon and Johnson 2017). The high operating costs are associated with decline in production of crude, which increases import of crude to meet the high domestic demand (Parkinson and Tom 2014; Macdonell 2017; Shane *et al.* 2017). A review of operational reports also reveals that the UK North Sea looses 20 per cent of total investment to Norway and North America which seems to have relatively stable operations as most project at the North Sea abandoned (Malcolm and Webb 2015; Jean *et al.* 2016). The literature evidence suggests that, the UK North Sea really has operational challenge, which this study addresses.

2.11 Conceptual Framework for Critical Evaluation of the Operating Cost

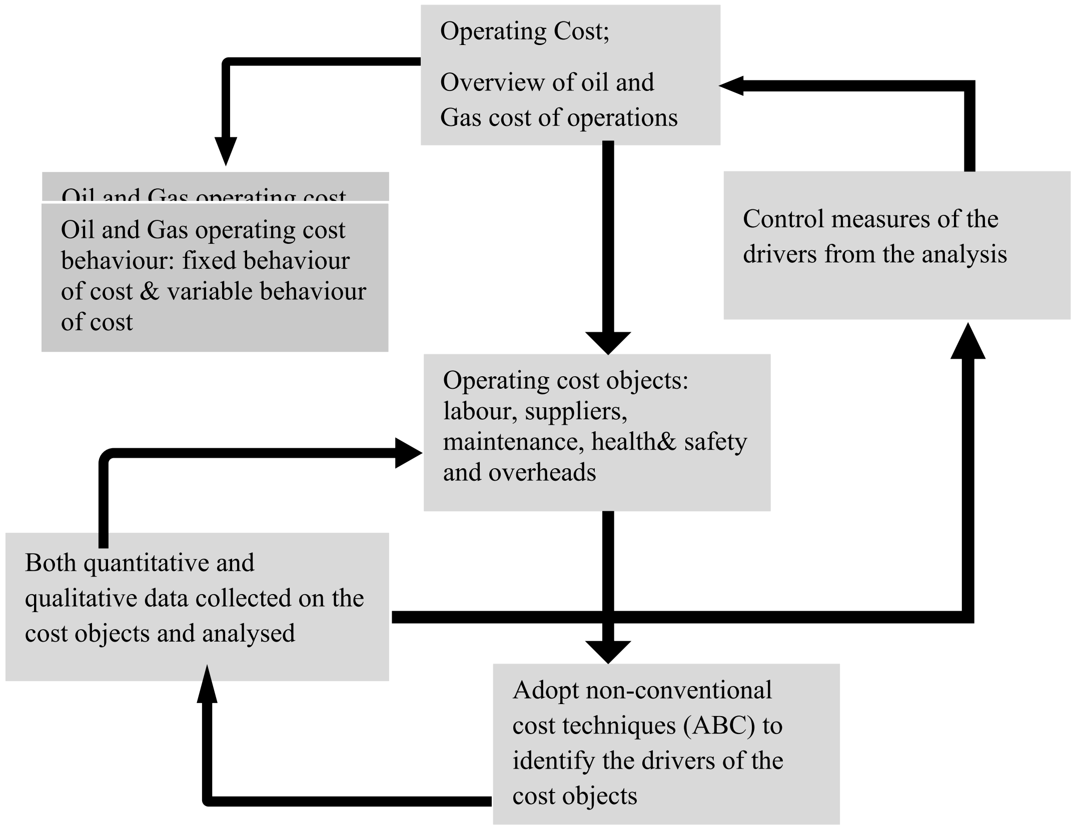
This study draws the conceptual framework on selected themes of cost evaluation techniques based on the empirical literature evidence which suggested several techniques and concepts that have been adopted to evaluate cost in the oil and gas operations. Following this study aim of the identifying and predicting operating cost drivers and their behaviour influencing the oil and gas operations, this study developed a conceptual framework in alignment to this aim by following the critical literature evidence which informed this study that non-convectional costing concepts are appropriate in evaluating operating cost in a complex extraction industry. This study conducts a critical literature within the non-conventional costing concepts and identifies that Activity based costing concept is the best costing tool that can be used to address the aim of identifying and predicting operating drivers' behaviours. Hence, this study adopts Activity based costing concept in tracking and identifying activities and transaction which changes the behaviour of operating cost objects in the oil and gas operations. In employing the Activity based costing concept, this study adopted a mixed research approach to solicit data from both qualitative and quantitative sources and analysed them by adopting content and VAR analysis to infer meaning regarding the operating cost drivers' in the oil and gas operations.

The conceptual framewok is developed based on the literature gap of the less depth and less criticality in evaluating operating cost drivers and their behaviour in the oil and gas operation. Furthermore, the operating cost challenged the oil and gas industry by designing some operators to bankruptcy, inability to meet their debt obligations which led to weak Working Capital and Working Capital Required. Meanwhile there is no any single study from the previous literature that investigates the causes, hence, the aim of this study is to fill the gap by conducting a study to identify and predict the operating cost drivers' behaviours by adopting ABC. During the critical literature review, this study identifies that oil and gas operation is complex by nature, hence, the traditional/conventional cost evaluation techniques are not best fit for the aim of this study because, their methodologies and concepts fail to identify and predict operating cost drivers and behaviours. Rather identified cost by nature such as variable and fixed cost behaviour and can measure contribution of the operations. Hence, this study based its argument on ABC to identify and predict operating cost behaviour in oil and gas operations. The literature critically identified and acknowledges some studies which adopted

Activity based costing concept in cost evaluating in the oil and gas industry but not identifying operating cost drivers.

This conceptual framework is developed from the literature and thoroughly guides this study to gain a holistic understanding in developing this study data collection tools to collect data on operations, operating cost objects, operating cost drivers and their management strategies in the oil and gas operation to address the operating cost drivers issues in the Gulf of Guinea and the UK North Sea and beyond. Hence, this conceptual framework relates to the operating cost is developed to organise this study by linking the existing empirical literature to analysis of this study and to demonstrate the achievement of operational optimisation in oil and gas operations. Furthermore, the development of the conceptual framework enables this study to meet and address the needs of the problem statement of this study which is in-depth investigation of the operating drivers in oil and gas operations as explained in the introduction section of this study. Additionally, the conceptual framework guides this study to explore issues of operating cost objects and map out their related drivers that change the behaviour of the operating cost objects to uptake effective operational decisions in the oil and gas operations. Bedsides, the framework of this study provides the basis for the findings on operating cost drivers and their optimisation strategies. It further ensures generalizability of the findings of this study and enhances the empiricism and rigor of the research.

Figure 2.1: Conceptual Framework of the Study



Source: Author's own work (2019)

The Figure 2.1 presents the conceptual framework of this study in order to investigate operating cost in the oil and gas industries. The framework demonstrates the flow of enquiries via critical theoretical and empirical reviews in identifying the literature gap of the operating cost drivers and their optimisation strategies in the oil and gas operations. The framework illustrates the systematic steps follow in identifying the operating drivers. In the First place, this study provided a critical and comprehensive literature review of oil and gas operations and the cost, which the evidence suggests that cost is either fixed or variable in behaviour. Furthermore, the literature review conducted from sub-sections 2.4.1 to 2.4.5, reveal that the common operating cost objects in oil and gas operations include labour, suppliers and services, maintenance, health and safety, and overhead but not excluding others cost. Hence, literature is concluded on those operating cost objects also as shown in Figure 2.1 and illustrated by the directions of the arrow. This study then collects and analyse data from both quantitative and qualitative sources on the operating cost objects to understand how the operating cost objects are influenced by the oil and gas operating cost. Hence the research concludes on policy implementation to sustain those strategies as discussed in the conclusion of this study.

2.12 Summary, Conclusion of the Chapter

The chapter by identifying the gap of less in-depth and less criticality of academic literature discussions on oil and gas operating cost objects drivers and their behaviours. This study identified the literature gap via a critical and through academic and corporate literature enquiries in the oil and gas operations. The study critically reviews oil and gas operational activities and the cost as discussed in Section 2.1 of this study which reveal several operational phases and their cost without a literature which critically identified operating cost objects and the respective drivers in the oil and gas operations. Additional discussions from the literature analysis analysed cost behaviour in oil and gas operation, which also reveals that cost can be fixed and variable cost behaviour. Further literature enquiry suggests that oil and gas operating cost is influenced by the activities, process and system in the oil and gas operation. However, the literature failed to identify the effects of the activities, process, and systems on the operating cost object. Additionally, the literatures failed to identify specific activities and process that changes the operating cost behaviour.

This study reviews non-conventional costing techniques which incorporate full cycle cost, life cycle cost, unit technical cost and activity based costing in evaluating operating cost in oil and gas operations, except for identifying operating cost drivers. The literature suggests that activity based costing is often used to identify cost drivers but have not also used in evaluation operating cost in oil and gas operating. Adding to these studies, this project critically investigates the measures and policies (generally referred to as strategies) adopted to manage operating cost. This reveals that some of the general policies adopted fail to specify what measures can be used in managing the operating cost objects. This study investigates the effect of the fiscal regime on the operating cost with royal and taxation been emphases. Finally, the literature concludes with a critical evaluation of the Gulf of Guinea and the UK North Sea operational challenges and cost, which reveal some key operational and cost challenges. Hence, this study develops a conceptual framework which guides this methodological approach for collecting and analysing existing data with a view to addressing the literature gap in this study.

Chapter Three

Research Methodology

3.1 Introduction

This chapter presents the procedures and stages involved in data collection, analysis and presentation of such data. More specifically, the chapter begins by presenting research philosophy, which discusses interpretivism and positivism research paradigms. The chapter further discusses research approaches, research methods and mixed methodology employed by the study. It also defines the population and sampling of the study, data sources, research tools (i.e. questionnaire and interview questions design and coding processes) are also covered in the chapter. Additionally, Pilot; Pre-testing quantitative of data collection tools, Delphi methods, participants and entities use for data collection profile are also discussed. The chapter discusses content analysis, Vector Autoregressive (VAR), Ordinary Least Square, validity and reliability, ethical consideration, and chapter concluded with a summary and conclusion of the methodology.

3.2 Research philosophy

Acquisition and contribution of knowledge in an academic environment follows fundamental principles of research philosophy, which guide studies to arrive at valid findings (Mkansi and Acheampong 2012). Mason (2014) admits that research philosophy is a collection of fundamental research assumptions, norms, values, and perceptions of an author in undertaking an investigation. Furthermore, Saunders *et al.* (2009)'s definition is supported in Mason (2014).However, Mason (2014) reiterates that research philosophy systematically directs researchers throughout the entire study process. Traditionally, research philosophy provides step by step procedures of generating knowledge in social science (Guba and Lincoln 1976; Agyepong 2012; Fossey *et al.* 2015).

Conventionally, there are different research philosophical assumptions often adopted by various studies based on the kind of data and analysis required to address the study aim. Positivism and interpretivism are the most commonly used research philosophical assumptions depending on use of qualitative and quantitative data (Guba and Lincoln 1983). A interpretivism philosophical assumption guides qualitative data while the positivism philosophical assumptions guides quantitative data (Creswell 2003; Bulsara 2014). A mixed method, which entailed both quantitative and qualitative data, adopts interpretivism and positivism philosophical assumptions. These two philosophical assumptions are associated with qualitative and quantitative research, which fit in with this study as the study because it uses both qualitative and quantitative data (Kevin *et al.* 2009). The choice of interpretivism and positivism assumptions are discussed in Holden and Lynch (2004). Furthermore, Guba and Lincoln (1983); Creswell (2003); Law (2004); Bahari (2010); Bulsara (2014); Fossey *et al.* (2015) admit that these two paradigms are appropriate in studies dealing with both qualitative and quantitative studies, and they are widely adopted in many social sciences studies.

3.2 Interpretivism Research Paradigm

Interpretivism is a research paradigm which is based on the interpretations and meaning attributed to action and event in a society. It also focuses on trying to gain an in-depth insight into society from individuals' and groups' opinions, often based their experiences on how they perceived the society and phenomenon (Elvik 1999). The individuals and groups within the society act in a specific and different context based on their unique experience which qualifies their independent opinions. Thus, interpretivist school of thoughts believes that the society is a construction of individual with freewill in presenting meanings to events rather than the society own narratives of events (Andrade and Andrade 2009). Qualitative studies are often associated with interpretivism research paradigm as qualitative studies completely depend on individuals and groups opinions and views based on their experience and expertise for data and the analysis rather than on the society and systems in the society to draw conclusions (Krauss 2005).

Therefore, in this study, interpretivism as a school of thought is considered important because it can handle the exploration of qualitative data from individuals based on their expertise and experience in oil and gas operations to understand operating cost drivers and firms' optimisation strategies in the oil and gas operations. This study basically applies semi-structured interviews and open-ended questionnaire to obtain the primary data from the experts. Additionally, this study further collects qualitative data from governance and the operational policies documents to corroborate the primary data sources in order to address the operating cost drivers and their optimisation strategies in the oil and gas operations. These tools used for data collection and analysis conform with the interpretivism paradigm, given that it permits sources of qualitative from the opinions of research participants amongst individuals and groups based on their experience in order to explore a given phenomenon or social challenge (Davis and Baulch 2011; Turner and Norwood 2013). Furthermore, many studies as indicated in the literature in this study, as highlighted in Chapter Two, have applied the tools for data collection.

Following the interpretivism philosophical assumption, this study uses semi-structured interviews and open-ended questionnaire to solicit primary data by contacting experienced senior managers with an in-depth knowledge of the oil and gas operations. Their responses are used to explore answers to the following research questions; what operating cost drivers affect operating cost objects in both Gulf of Guinea and the UK North Sea oil and gas operation? and what strategies are implemented to control operating cost drivers in order to optimise operation of Gulf of Guinea and the North Sea? As discussed earlier, this study also uses data from government policies and operational document which give a greater insight into the operational dynamism and operating cost issues of oil and gas operations. furthermore, the tools help the study to collect the most reliable data as the senior managers give most relevant information relating to oil and gas operations. The implementation of the interpretivism in the process of this study guides to explore individuals' views on operating cost drivers and their optimisation strategies on economic viability in both Gulf of Guinea and the North Sea oil and gas operations.

Furthermore, this study employs Delphi method to gather the experts' views where a follow-up questions are asked, which enable building of consensus amongst the experts' opinions on regional operating cost drivers and their optimisation strategies in the oil and gas operations. Similar previous studies that use Delphi method to achieve results include the followings: Memphis (2017); Ernest *et al*. (2017). Additionally, the literature reviewed in this study is a build-up of academic, corporate and technical reports on the oil and gas operations which are very resourceful in understanding views on operating cost challenges (from various stakeholders' perspectives) and their optimisation strategies in improving the fiscal performance of oil and gas operations. Furthermore, the interpretivism paradigm guides this study to uphold the validity of the results and findings as it exposes and consolidates the meaning and motivations of individuals actions vis-à-vis the Delphi method - from verbal interviews. Notwithstanding, interpretivism guides this study to access hidden operating cost drivers, similar to Turner and Norwood (2013). Furthermore, it enables the study to gain insight into hard-to-reach practical oil and gas operating cost optimisation strategies from the experts, and further guides the study to probe deeper into understanding nature of the oil and gas operations (Jeffrey 2007) and the variations and similarities in the two regions that help explain the universality of cost.

However, qualitative data part of this study and result are difficult to replicate as data is based on individuals' opinions and are subjective, which is a common flaw of interpretivism research

(Turner and Norwood 2013). Furthermore, the interpretivism paradigm can be overly influenced by researcher's bias and that questions the objectivity of the results. This study notes those limitations of interpretivism, however, in addition it adopts positivism to overcome the interpretivism limitations. Hence, the flaws of the interpretivism are offset by the positivism as this study employs both research paradigms for both primary and secondary data sources to cover for the qualitative and the quantitative parts of this study. Hence, it mainly focuses on pragmaticism as the paradigm that combines the two.

3.3 Positivist Research Paradigm

Positivism is a research paradigm that relies on the study of social factors in a systematic and scientific way. This enables the study to test theories and measure the consistency of the theories with social logic in relation to the behaviour of individual factors in a society (Saunders *et al.* 2009; Fossey *et al.* 2015). The positivist belief that society is more structural and views it in a bigger picture, and further see it to be shaped by social institutions rather than interaction of individuals' elements and their behaviours (Bahari 2010; Dieronitou 2014). As a consequence of the positivist's assumption, they look to collect quantitative data in a numerical form as they belief that numerical data is more objective and scientific rather than to rely on studies of events (Ofori *et al.* 2015). Reflecting on the belief of positivist in conducting studies, this study gathers quantitative data of operating cost and revenue from operators (Institutions) in the Gulf of Guinea and the UK North Sea to answer the research what are the relationship between operating cost and revenue in the Gulf of Guinea and the UK North Sea? Thus, the positivist belief in quantitative studies processes. Hence, this study follows the principle of positivism which guides it to predict the trend and the relationship between the operating cost and revenue which is more scientific and conformed with positivist belief of conducting studies (Remenyi 1998:32; Dieronitou 2014).

Positivism studies usually ascertain data from lab experiment or field respect to time interval, location or a group and analyse the data to establish cause and relationship on factors at different degree. The principle of positivism guides studies to compare results of the different measurable variables as the data processes involve running statistics across the numerical data. The results from data can be compared with respect to different time intervals, locations and social groups and can further produce trends and patterns to predict and establishes relationship between or among measurable variables. Beside that positivist also obtain quantitative data from a structured survey close-ended (structured) questionnaires and interviews, which are quantifiable and can be replicated. Following these discussions of the positivist approach of studies data collection and analysis, this study collects operating cost and revenue data of Gulf of Guinea and the UK North Sea across different time interval among the operators and run statistics to establish the relationship among measurable operation variables and also to predict their influence and effect on the oil and gas operations. Hence, this adopts positivism paradigm to answer the question what relationship exists among operating cost objects and revenues in the Gulf of Guinea and the UK North Sea oil and gas operations?

The positivism research adopted in this study enables it to provide cause and effect relationship and correlations among operating cost objects, and operating revenue which is the second objective of this study. Beside that the positivist approach further guides this study results to be extended to other operational locations (generalised) which enhance operating cost policies formulation and decision making in oil and gas operations. Furthermore, the results of this study can be reproduced by other studies and the results can also be able to be disproved by other studies as this study adopt an established method to analyse the data collected and the data is numerical.

Most of the literature reviewed to date, reveal that positivism studies lack validity because they demonstrate trends and relationship but failed to provide the rationale behind the trends and relationships (Creswell 2003; Silvaa *et al.* 2016). Additionally, other studies disclose that positivism studies also focuses much on structure of the study elements which is more deterministic and ignores the agency and freewill on how the individual react to relationships of variables (Steyerberg *et al.* 2001; Bahari 2010). Furthermore, positivism is more objective and rigid to studies and fails to reflect on diversity and the influence of contemporary society in phenomenon, and this fails to gain insight in the lives of individuals and focuses on what they do and not why they do it (Antwi and Hamza 2015). Moreover, people's options and attitudes are often reduced into numerical values which do not demonstrates the importance of meanings and motivations why people do thinks. These limitations of positivism in this study are mitigated with the interpretivism which offset these weaknesses in this study. Fundamentally, this study employs a combination of both qualitative and quantitative data to address its objectives, and eventually answer the research questions.

3.4 Research Approaches

The idea behind research approach is to build an efficient strategy that can systematically guide the processes of inquiries and solve a specific phenomenon. Basically, research approach is classified into deductive and inductive reasoning (Han *et al.* 2018). A deductive research approach is described as top to down approach of a study, while inductive approach is centred on observation and grounded theory perspective in studies (Adebiyi *et al.* 2016). The deductive approach is widely used in studies exploring problems to find solution not to prove a theory, just like this study is investigating operating cost effects on revenue but not to prove a theory.

This study adopts both inductive and deductive approaches by investigating operational challenges from the broader view, narrowed down to cost and further to operations' cost drivers, which is consistent to deductive top to down approach as described by Adebiyi *et al.* (2016). This deductive approach is backed by the Activity-Based-Costing (ABC) concept at all the steps of the research which guides this study to trace the operational activities to their sources and respective operating cost drivers.

3.5 Research Methods, Design and Strategy

Research methods hold a vital position in doing research that demonstrate what data is collected, how it was collected, why and where the data is collected (Antwi and Hamza 2015). The methods also give narratives of analytical techniques and how the results were generated. Traditionally, research methods established the action plans and procedures developed and implemented to achieve the aim of the research (Crotty 2003; Yin 1984). Creswell and Garrett (2008); Cameron and Molina-Azorin (2010) established that research methods are set of research tools and techniques which can be deployed for data collection and analysis.

There are several kinds of research methods, however, the most applied ones in contemporary research are quantitative research methods, qualitative research methods and mixed research methods (Creswell 2009). A study which solely deployed qualitative procedures to obtain data is described as qualitative research (Kim *et al.* 2007). Furthermore, a study which adopts quantitative techniques to collect data and answered its objectives is known as quantitative research (Creswell and Garrett 2008). However, a study which integrates both quantitative and qualitative procedures and techniques into a single study for data collection and analysis is referred to as mixed research (Vieira *et al.* 2016). However, multimethod is similar to the mixed methods but rather adopts more quantitative or qualitative techniques independently to collect data and produce results (Sarah *et al.* 2015).

Mixed research methods are the most commonly applied methods in social science studies because of their overwhelming importance. Ann *et al.* (2003) explain that mixed research methods allows studies to use both qualitative and quantitative tools for data collection and analysis, which help to mitigate data inadequacy. Furthermore, Creswell (2009) admits that, in mixed research, qualitative results can be used to validate quantitative result. Based the importance of mixed research methods the study applied mixed research methods.

3.6 Mixed Methods

Mixed methods is a methodology that combines both qualitative and quantitative data in a single study, which has received tremendous and overwhelming attentions in social science research in solving multidisciplinary and multidimensional problems (Davis and Baluchi 2012; Norwood 2013; Kim *et al.* 2007; Weinhardt *et al.* 2009; Garbarino and Holland 2009). The application of mixed research in social science and multidisciplinary studies was centred on its integrating strategy of both quantitative and qualitative data in a single study, data adequacy and validation of results (Creswell and Clark 2007; Cameron 2009; Cameron 2010; Azorin and Cameron 2010).

The importance of mixed methods makes it suitable for this study. Fundamentally, this study is multidisciplinary in nature as this study explores health and safety, regulatory, governance, accounting, finance and management issues from both qualitative and quantitative aspects to ascertain the effect of operating cost drivers on operations and operating revenue which is consistent with the above description of mixed methods. An additional reason for implementation of mixed methods in this study is the motivation from the literature that no single study has adopted mixed methods to evaluated cost in oil and gas operations. This study seeks the opportunity to contribute to knowledge and also to cover the research method gap in oil and gas operating cost evaluation through implementation of mixed methods. This study implemented mixed methods as described below to arrive at results and findings of the study.

From a qualitative perspective, questionnaire, semi-structured interview schedule, policy documents and reports are used to source for data on the operating cost drivers to establish their behaviours in the oil and gas operations. On the other hand, quantitative data on costs and other related variables were collected from operators' internal and external sources including financial statements to assess the impact of operating cost drivers in optimising the operating revenue.

The analytical techniques are also a mixture of qualitative and quantitative tools, where consent analysis is deployed to reduce the volume of the report and also judge the content of those consensuses by identifying the recurring words and ideas from the participants on the operating cost drivers. Vector Autoregression (VAR) and Ordinary Least Square (OLS) models are used to measure the impact and the behaviour of individual operating cost drivers. However, the qualitative and quantitative techniques are deployed independently for both data collection and analysis, and their results are integrated and discussed in Chapter Six.

3.6.1 Justification of Chosen Mixed Methods Design

Consistent with the primary aim of this study to evaluate the impact of operating cost drivers and their optimisation strategies in oil and gas operations, three objectives are formulated with unique set of strategies in place to achieve each objective. In other words, each objective is mapped to set of techniques aimed at illustrating the evidence in order to answer the key research questions for this study. Because of the secrecy of data in this sector, combining both qualitative and quantitative research of this type will provide an important insight into understanding operating costs dynamics. In this regard, quantitative data are collected from operators in both the Gulf of Guinea and the UK North Sea. The quantitative data are analysed using VAR and OLS model, which is purely quantitative. Besides that, this study explores the cost behaviours from qualitative perspectives, experts' and policy documents and the data was analysed by employing content analysis, and these are also purely qualitative. However, results from both techniques are integrated to arrive at the overall impact of operating cost on operating revenue and recommended control strategies to optimise oil and gas operations.

The study adopts a pragmatic paradigm which combines both positivist and interpretivist research paradigms as described in Sections 3.1.1 and 3.1.2. Both are adopted in this single study, where the interpretivism guides the qualitative section of this study while the positivism guides the quantitative part as explained in the Sections, 3.1.2 and 3.1.3. These two research paradigms guide this study to generate results independently and the results from qualitative and quantitative are integrated and discussed in later chapters in this study. These processes in this study justified the implementation of mixed research methods.

3.7 The Population and Sample of the Study

The population of this study for the qualitative data collection entails all the senior management with rich experience in E&P operational transactions and activities in the oil and gas industry. Each member of workers from the category in the E&P oil and gas operations stands an equal chance of being selected in the sample because they possess the desired information that can be used for this study. This study sampled the experience senior managers because it assumed that these calibre of workers in the E&P oil and gas operation can provide a rich and consistent responses to answer the research questions operating cost drivers and their optimisation strategies in the oil and gas operations. Hence, the sampled senior experience managers which are experts provide an in-depth discussion of real case-oriented oil and gas operations and transactions which are relevant and very fundamental to understanding operating cost drivers and their optimisation as this study seeks to inquire in the Gulf of Guinea and the UK North Sea.

The selection of the participants which are the experience top level senior managers from the two selected regions is initiated by the virtue of their capacity to provide a detail textual and verbal information relevant to operating cost in the Gulf of Guinea and the UK North Sea which are very important to explore this study aim of operating cost driver and their optimisation strategies. Considering the nature of the senior managers activities and the locations, it is difficult but not impossible to contact the participants at their workplace, hence this study explores for an opportunity to meet participants at oil and gas programs (conferences and workshops) which participants are contacted for data. These programs delegates are senior manager who come to conferences and workshops to discuss oil and gas operational challenges their ways to overcome.

This study assumed that the delegates for the conferences and workshops which are senior managers and for that matter the participants of this study is a fair representation of the population of this study because, the delegates are top level managers in oil and gas operations which have diverse experience in the operations and also, the delegates are not just limited to the Gulf of Guinea and the North Sea. Additionally, the conferences and workshops discussions are centred on the operational challenges and the approaches to adopt with some of the presentations discussions precisely directed to Gulf of Guinea and the UK North Sea operational challenges. Furthermore, this study explores to know the number of the delegates of each program from delegates listed which are sent to delegates. The list contains a brief profile of delegates which include location and positions. Based on the list, this study decided to contact 80 delegates which are working either in the Gulf of Guinea or the UK North Sea. As each program delegates list are up to 50 delegates and this study is conducted in the three programs. Hence, the sampled senior managers are contacted via semi-structures interviews and open-ended questionnaires for data. This study assumes that these number of the senior manages a fair representative of the population by reflecting on characteristics of senior managers which provide this study a reliable and analysis.

3.7.1 Sampling Process: Non-Probability Sampling Technique

Sampling technique is broadly categorised into probability and non-probability sampling techniques, and the kind of sampling can be chosen and implemented in a study based on the nature of data require to address the objectives of the study. Fundamentally, probability sampling is a procedure of selecting a study participant by applying probability theory, where all the participants have equal chances of being selected for data in the study sample size (Peersman 2014). Probability sampling works under the condition that all participants within the sample framework should have common characteristics and should be in position to give equal information, hence, participants are randomly selected (Huyen 2013). With the aim of this study to explore and investigate operating cost drivers and their optimisations strategies of the Gulf of Guinea and the North Sea, probability sampling cannot be adopted and implemented for the data collection because not all workers in oil and gas operations have equal knowledge in operating cost. Hence, chosen probability sampling for this study will be misleading. Probability sampling will be more efficient if a study wants to investigate groups of people behaviours in a larger population, hence probability sampling cannot be adopted in this study because this study is precisely exploring the operating drivers and their optimisation strategies in the Gulf of Guinea and the UK North Sea.

The other category of sampling technique is non-probability sampling which the selection of participants follows a set of conditions. Non-probability sampling is generally adopted and implemented to collect a specific data where the sampling is target at participants with specific characteristics of the entire population. Sometimes, the non-probability sampling is termed as purposive or subjective sampling (Zaza *et al.* 2000; Jeffery *et al.* 2006). Unlike probability sampling technique which give equal chance for all participants, non-probability does not, hence selection within the non-probability sampling is subjective and aim to collect data to address the purpose of the study. Hence, participants are selected on the purpose that they would be able to provide data to answer the study questions. It depends on the study own judgement that the participants selected from the sampling framework would be able to provide comprehensive data to address the study aim and objectives. There are no restrictions of selection participants in the sampling framework, hence the study can select any participant from the sample framework provided the participants can provide an information and data to address the specific issues.

Considering this study aim which is very specific to explore for operating cost drivers and optimisation strategies of the Gulf of Guinea and the UK North Sea, thus not all oil and gas workers in these two regions have knowledge in operating cost drivers and optimisation strategies, this study adopts and implements non-probability sampling technique which allow it to target participants with comprehensive knowledge in oil and gas operating cost. Hence, this study sample senior managers from the target population of E&P workers for data collection. The sampling of the senior managers enables this study to achieve its purpose of exploring for operating cost drivers and optimisation strategies as they give a comprehensive and detailed operating cost discussions which enable this study to answer the research questions. Besides that, not all senior managers are knowledgeable and experience with in-depth knowledge in operating cost. Hence the participants of this study are recruited for the purpose of to gain in-depth knowledge in the oil and gas operating cost.

3.8 Primary Qualitative and Quantitative Data Sources

This study uses primary data from participants by using semi-structure interviews and open-ended questionnaire from Rocky Mountain Mineral Law Foundation (RMMLF) short course in International Oil and Gas Law delegates. Additionally, this study source qualitative primary data from delegates of Association of International Petroleum Negotiators (AIPN) contract modelling workshop, and delegates of Society of Petroleum Engineers (SPE) Petroleum Economics and Field valuation workshop. This study considered these programs for primary data collection based on the calibre of participants of the programs which are SMs at the E&P operations. Furthermore, this study can easily contact and interviews participants at such programs because the busy nature of their work. Additionally, these programs bring in together the SMs, hence this study cease the opportunity to contact them at the programs for primary data on the operating cost drivers and their optimisation strategies of the Gulf of Guinea and the UK North Sea.

Furthermore, the programs proceedings purely discuss oil and gas operating issues and the way forward to overcome them which are very relevant to this study. Most importantly the delegates of programs are senior managers at decision-making level which have a very rich knowledge in oil and gas operations. Additionally, the delegates have a common level experiences, hence their responses are consolidated as the interviews are based on Delphi approach to building consensus from their views. This study selection of the delegates is based on non-probability sampling where this study focuses on delegates from the Gulf of Guinea and the UK North Sea which are sampled and interview. The data collected are process using content analysis to address the operating cost drivers' challenges in Gulf of Guinea and North Sea.

The quantitative data of this study is the operating cost and revenues data which is obtained from operators' financial journals and ledgers from National Oil Companies (NOCs) for Gulf of Guinea. This operating cost and revenue data obtained in the Gulf of Guinea are integrated projects which involve operators such as Shell, Tullow, Chevron Total, Anadarko and Kosmos Energy and the NOCs. This study assumed these operators are fair representation of operators at the Gulf of Guinea as they are well-known in oil and gas operation with rich operational experiences. This study also obtained an integrated operating cost and revenue which entails operators operating in the UK North Sea from UK Oil and Gas Authority database for the UK North See. These two sets of the operating cost and revenue data obtained is used to establish the relationship between the operating cost and the revenues to address second objective of this study.

3.9 Questionnaire and Interview Questions Design and Coding

This study implements semi-structure interviews and open-ended questionnaires to solicit primary data on the operating cost drivers and their optimisation strategies to answer research questions. This decision made is based on the nature of the sampling technique and the kind of the participants involved in this study as discussed above under sampling technique (Abawi 2013). Other previous qualitative studies adopted observation and focus group discussions for data collection which could have be adopted in this study, however the nature of the participants of this study and the nature of the data require rejects observation and focus group discussion (Canals 2017). This study assumes that by simply observing the operational activities and other operational process cannot aid to explore and predict the operating cost drivers and their optimisation strategies in oil and gas operations. Furthermore, this study participants are delegates of the programs hence, it is very difficult to engaged participants in groups to have a focus group discussion. These reasons give the rationale of the chosen semi-structure interviews and open-ended questionnaire for the primary data collection of this study. Hence, this study develops the open-ended questionnaire and semi-structure interview with the same questions to obtain the primary data to answer the operating cost drivers and their optimisation strategies in the Gulf of Guinea and the UK North Sea.

The design and development of the semi-structure interviews and the open-ended questionnaire are underpinned by Delphi method, the pilot study recommendation, and Activity-Based-Costing (ABC) concept which guides this study to develop the questions to solicit data on operating cost drivers and their optimisation strategies. Besides that, this study further explores previous survey questions on operating cost which reinforces the quality of questions to solicit data to answer the research questions. Both semi-structure interviews and the questionnaire designed and developed seek to collect data on operating cost to address operating cost drivers and their optimisation strategies in the Gulf of Guinea and the UK North Sea. The questions are very direct and precise; and are developed with the aid of Bristol online survey software. The links generated from the software or platform – which contains the questions are distributed via email and WhatsApp to participants. Besides that, the semi-structure interviews conducted takes an average of 20minutes per participant. Some participants allowed audio voice recording and others rejected, hence, those participants who allow audio voice recording are recoded and those who rejected voice recording responses are jotted down and developed.

The participants and their responses are coded which give consistency of the data and the analysis. This study assigns a unique identity to participants and their responses to categorise the participants and responses in analysing qualitative survey data from semi-structure and open-ended questionnaire which involve individual opinions on an issue (Charles Stewart 2005). This coding process involve grouping the multiple responses from the qualitative survey into common themes and assign a unique identity to the participants. This process is carried out manually which is known as manual coding which this study implemented (Plümper and Neumayer 2013).

This study employs manual coding/categories the responses into operating cost objects such as labour cost, service and supplies cost, maintenance cost, health and safety cost and the legal framework/overheads cost which reflect on the literature on the operating cost objects. These themes enable this study to map the various responses from participants to each theme as the code of the responses and compare them to the literature. Additionally, this study coded the participants in the analysis to protect them, hence participants are identified in this study by their positions such commercial manager, business managers not by their name nor their operators' names. These coding and the themes are created by considering the objectives and the research questions and mapped them to questionnaire and the interviews responses. Hence, this study hand-coded the participants to their positions and their responses to operating cost objects which are the themes in analysing the data. The manual coding enables this study to capture and consolidate the responses from the participants with the aid of Delphi to build consensuses and to summarise the result of the survey under operating cost objects themes. Furthermore, Coding also enables this study to draw conclusions on the operating cost drivers and the optimisations strategies from the responses. Table 3.1 presents the coding used for the respondents / participants in this study.

Table 3.1: Codes for the Participants of the Semi-Structured and the Open-Ended Questionnaires

Participant(s)	Code
Senior Manager	SM
Senior Business Development Manager	SBDM
Senior Legal Officer	SLO
Senior Production Engineer	SPE
Senior Human Resource Manager	SHRM
Senior Maintenance Engineer	SME
Senior Negotiators	SN
Chief Energy Attorney	CEA
Senior Commercial Manager	SCM
Senior Accountant	SA
Senior Drilling Engineer	SDE
Senior Engineer	SE
Senior Solicitor	SS
Senior Petroleum Chemical Engineer	SPCE
Senior Geopolitical and Financial Analyst	SGFA

Source; Author's Own work (September 2019)

3.10 Pilot, Pre-testing Quantitative Data Collection Tools

Studies that involve primary qualitative data, where research tools such as interviews and questionnaires are administered in the data collection, the interviews and questionnaires need to be pre-tested to ensure suitability, appropriateness and validity of the tools in the study prior to rolling out to the wider and broad research participants targeted in the study (Arain *et al.* 2010). The pre-testing of the research tools before using will enhances the validity and credibility of instruments as the pre-testing process enables studies to eliminate ambiguity in the question, thereby allowing appropriateness and suitability of the tools for the purpose they will be targeted for in the research (Thabane *et al.* 2010). The process involves contacting potential participants, experts in the field of the study ranging from academics and industry professionals, in order to examine the extent to which the research tools are able to solicit their opinions as designed. Their views were backed up with the previous research which used questionnaires and semi-interviews for primary data collection process (Perry 2017). This enables the study to make amendments to the research tools and establish the effectiveness of the instrument by filtering the unwanted or ambiguous questions. Therefore, the remaining questions are highly likely to represents what the potential participants are comfortable with and for the tools to meet academic standard. This study initiates pre-testing processes by contacting participants electronically with the sample of the questionnaire for their professional advice on appropriateness and suitability in addressing the operating drivers challenges in oil and gas operations. Five academic staff and researchers were contacted and eight experienced experts in the oil and gas industry.

The opinions from the participants suggests that the questions should be straight, simple and precise, such as *"in your own opinion, what do you think are the factors influencing labour cost in your region of operation?"* This enables the respondents/participants to reveal all activities relating to labour causing an increase in the labour cost. This eliminates the ambiguity in the question, "*What are the factors affecting operating cost in oil and gas operation?".* Overwhelmingly, most participants agreed to semi-structured interviews and the open-ended structure of the questionnaire with the notion that these structures give the participants the opportunity to express their independent views, opinions and allow them to add any relevant comments related to operating cost information. This study applies their suggestions in designing and developing the final questions for the schedule interviews, keeping the questionnaire open, straight forward and centred on operating cost in the oil and gas operation. The implementation of their suggestions in the reconstruction of the questions yielded a high percentage turnover of 82.50%. Hence, it is concluded that piloting the qualitative data collection instruments is highly recommended in research of this type given the opportunity and outcome it achieves.

3.11 Delphi Technique

The Delphi technique is a research approach which aim to obtain a collective view from individuals experts about problem where there is limited existing evidence available (Rowe and Wright 1999; Ravonne 2014). The technique is designed to consolidate a broad range of opinions and views from a group of experts with relevant knowledge and experience on problem which will provide a comprehensive feedback on the problem (Hanafin 2004; Brian 2007). Its process involves the experts with the rich knowledge and experience express their independent individual views on the problem on several time at least three time on the same problem for consensus to be build. Their first response of the problem under investigation provides the basis for follow up questions, which delve deeper into the investigation to clarify specific issues to provide a precise and comprehensive opinions and views of problem. Hence, their views are collated, summarised and map up common viewpoints to build consensus from the responses.

The Delphi method is an effective process in obtaining data to address a problem with limited evidence as discussed above, thus this study implemented it based on the nature of participants recruited in this study. Delphi technique guides this study to develop the questionnaire for data collection where the questions are leading questions and seek to solicit operating cost drivers and their optimisation strategies of the Gulf of Guinea and the UK North Sea oil and gas operations. Additionally, Delphi technique guides this study in conducting the semi-structured interviews where leading questions and follow-up questions are asked for the experts' comprehensive views on the operating cost drivers and the optimisation strategies of the Gulf of Guinea and the UK North Sea. Furthermore, after developing the responses of the experts from both interviews and questionnaires, this study further sent the responses out to selected experts for their final views to the build consensus on the operating cost drivers and their optimisation strategies. Hence, the Delphi method enables this study to measure the consistency of responses of the experts to arrive at consensus on the operating cost drivers and their optimisation strategies.

The Delphi approach provides this study the most reliable consolidated data from the experts which brings cohesion in analysing and the data. The technique also enables this study to harness and organise experts' judgement that requires intuitive interpretation on operating cost. It further help to clarify and expand agreement and disagreement of the experts on operating cost drivers and their optimisation strategies in building consensus in the analysis (Skulmoski *et al.* 2007; Antwi and Hamza 2015). The Delphi process guides this study to summarise feedback from emails to reinforce the consensus built in the analysis (Avella 2016; Airaksinen *et al.* 2017; Lamb 2016). The implementation of Delphi methods provides a logical and coherent agreement from the experts' views on operating cost drivers, which is achieved by summarising the similar key ideas which enhances the analysis (Skulmoski *et al.* 2007). Besides that, the Delphi method enables this study comprehensively and collectively consolidate the experts' recommendations on the identified operating cost drivers' optimisation strategies.

3.12 Participants and Entities Use for Data Collection

The participants and programs where data is collected for this study play a vital role in this study primary data collected. The interviews are conducted at RMMLF short courses in International oil and gas Law, Society of Petroleum Engenderers (SPE) Petroleum Economics and Field Valuation Workshop and AIPN Contract modelling workshop. These programs bring top oil and gas experts and professionals together to discuss contemporary operational issues and their anticipated solutions in oil and gas operation. Hence, all discussions in the programs are relevant to this study. Furthermore, those entities (Organisers) are well-established oil and gas entities and association who existed for several decades and handling core oil and gas operational issues.

The delegates of the programs are sampled as the participants of this study. The author sampled participants from the registration list of the programs where delegates brief profiles are given including name, operator, position and country of operation. Hence this study focuses on delegates that are working at Gulf of Guinea and UK North Sea. Additionally, the study interviewed delegates who are working for operators at these two regions but in a different location. The delegates were identified and interviewed through tag which contains their names. Also, the author visited GNPC, Petroleum Commissioning, ENI and Tullow offices in Ghana and interviewed some of the SMs.

3.13 Data Analytical Techniques

This section of the study described the techniques and their application and implementation to analyse both qualitative and quantitative data to identify and optimise oil and gas operating cost drivers. Considering the sequential triangulation mixed research approach of this study which entails several qualitative and quantitative data collected to answer the operating cost driver challenges in the oil and gas operations, the study employed a set of qualitative and quantitative techniques independently to analyse each category of the data collected to achieve the study purpose. The results from qualitative and quantitative inquiries are integrated and jointly discussed in Chapter Five.

3.13.1 Qualitative Analytical Technique: Content Analytica Method

This study obtained both primary and secondary data. As indicated, the Delphi method is deployed for primary data process which is influenced by the sources and the tools applies. The secondary data in this study is obtained from existing reports, policy documents, fiscal systems, short courses and workshops materials and other operational reports as stated in this study. These secondary sources are considered carefully, especially their volume before applying content analysis in processing them.

Practically, each of these sources of the secondary qualitative data are more than 50 pages which cannot fit into this study. Additionally, not all sections of these documents contained the operating cost component, but in generally they are very relevant to this study because the contain operational information. This study reduced the volume of the documents and make sense out of them through the implementation of content analysis. Elo and Kyngä (2007); Linda (2013); Sándorová (2014); Ando *et al.* (2014) explains that content analysis in qualitative research is implemented to process existing written text, audio recordings and oral communication.

Application of the content analysis in this study is not limited to processing the secondary qualitative data but extended to primary data, where the content analysis guided this study to measure the ratio of opinions and words by simple hand-coding from experts' viewpoints on the various operating cost drivers which is adopted from Arthur *et al.*'s (2012) work. Additionally, some sections of documents and the interviews were quoted verbatim which gives the originality of this study (Rourke *et al.* 2000; Jennifer and Eimear 2006; Gavora 2015; Jones *et al.* 2011).

Furthermore, the content analysis guided this study to convert qualitative results into quantitative by measuring the number of times (frequency) an idea or a word is used. Moreover, it has been applied to participants too to measure the ratio of participants out of the total sample size who stick to similar ideas on a particular operating cost drivers (Mayring 2014). Hence this study is able to evaluate the percentage of the participants' opinions on operating cost drivers in oil and gas operations. For example, the percentage of participants who assumed that contract staffing and hiring of private security are the drivers of labour and security cost respectively. Content analysis guides this study to examine the patterns of communications and evaluate their meaning and integrate with the quantitative analysis to draw a conclusion on the operating cost drivers in oil and gas operations.

3.14 Secondary Data Sources

This study obtains both qualitative and quantitative data from relevant secondary sources in order to achieve the objectives of this study. This study handpicked operating cost and revenue data relate to the two regions from HIS, BP, Wall Street journal, EIA, IEA and Rigzone websites and their database to back the quantitative results. Additionally, secondary data is solicited from some of the major operators at the two regions published financial reports and statements which are used to argue the results from the primary quantitative data. Furthermore, secondary data on corruption, political stability and violent, government effectiveness and regulatory quality to measure their influence on operating cost and revenue are sources from World Bank database for the two regions. Secondary qualitative data is also solicited from the government policy documents, local content law, samples of petroleum fiscal regimes and previous studies on oil and gas operations, the workshops and conferences proceeding materials and some operational reports.

The qualitative secondary also significantly contribute to addressing the operating cost drivers and optimisation strategies. This study obtained relevant related operating cost and revenue information from government policy documents which contain the primary operating activities description such as sample petroleum fiscal regime, local content law, and other operational treaties. Additionally, this study obtained secondary qualitative data from the programs materials which contain contemporary operational information in oil and gas operations which are very useful to this study.

3.15 Vector Autoregressive (VAR) Model

VAR is generally described as a systems equation model which is capable of assigning a role of dependent variable to each of the variables contained in the model at a time with a view to establishing how it is influenced by the rest of variables (Dedola and Neri 2007; Kim and Lee 2008). VAR, as a multivariate framework, is a hybrid of time series and simultaneous equations models which can effectively evaluate the complex dynamics of associations in variables because of the following reasons. (I) VAR model extracts information from a variable and can further examine the dynamics association from itself or its own lag in both univariate and multivariate time series (Raeisian *et al.* 2012). (II) VAR model can create the flexibility to a variable to influence another variable by the time lag and can further comprehensively explain both variables by exploring how lags of other variables behave. This is because VAR models work as an integrated system which allows various equations operate within a single system (Alexander and Baptista 2002). (III) Because VAR collectively considers variable as vectors it enables the relationship between variables to be considered simultaneously and in multivariate form (Brooks 2008). Therefore, considering oil and gas operations where different operating cost drivers and other factors with the likely different impacts. VAR models can be applied to evaluate the dynamic in terms of their impact on each other.

Prior to application of VAR models, Bjørnland (2000); Raeisian *et al.* (2012); Baum (2013) indicate that there is the need to perform stationary test on the data to establish the behaviour of the variable as to possession of a unit root. Hence, stationarity test is first performed on the data followed by cointegration test and lag length selection (based on inverse roots of AR characteristic polynomial test) prior to the specification of the VAR. Although normality test prior data entry does not affect the outcomes of VAR model, additional robustness checks are carried out (such as normality test on the residuals and Kurtosis, Jargue-Bera test consistent with the previous studies (Bessler 1984; Andrei and Andrei 2015; Harris *et al.* 2016). Furthermore, Granger Causality test is performed on variables within the selected VAR framework in order to understand the direction of causality between the variables.

3.15.1 VAR Models Specifications

To evaluate and predict the complex relationship of oil and gas operating cost drivers and revenue, unrestricted vector autoregressive (VAR) models were estimated from which the impulse response functions (IR) and variance decomposition (VD) are generated to interpret the impact as shown in Chapter Five. The impulse response functions trace out over time the responsiveness of current and future value of each of the variables to shock in one of the VAR equations. while, the variance decompositions measures the proportion of the movements in the dependent variables due to their own shocks, and also the shocks of the other variables (Sahoo and Das 2012; Shrestha and Bhatta 2018).

The models estimate the influence of the entire variables on each other while holding the dependent variable constant in order to observe the degree to which operating cost impact other variables within a target time frame. The model is built in with labour cost, supplies and service cost, maintenance cost, administrative cost and operating revenue as the main endogenous variables, and government effectiveness, corruption, regulatory quality and political instability and violence were built in as exogenous variables.

3.15.2 VAR Modelling Estimation

Consider a VAR of order P:

$$Y_t = C + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + BZ_t + e_t \quad \text{.......................................(3.1)}$$

Where Y_t is a (n x 1) vector of endogenous variables, A_1 is a (n x n) vector of deterministic variables, and A_1 and B are coefficients matrices, C is the (n × 1) intercept vector of the VAR, Z_t stands for the vector of exogenous variables, and e_t is the (n×1) generalisation of a white noise process. In other words, equation (3.1) can be rewritten or expanded to include the number of variables in the models (i.e. all the five series (Y_t) of endogenous variables (for example y_{1t}, y_{2t}... y_{nt}).

Therefore Y_t= [$LOLC_t$, $LOSC_t$, $LOMC_t$, LOA_t, LOR_t]…………………………….(3.2)

Note that: LOLC stands for logged values of labour cost; LOSC stands for logged values of service and supplies cost; LOMC stands for Logged values of maintenance cost; LOAC stands for logged values of administrative overheads; and LOR_t stands for logged values of operating revenue.

The remaining four exogenous variables stand for Government Effectiveness (GE), Corruption (COP), and Regulatory Quality (RQ) and Political instability and Violence (PIV) are presented in the equation where Z_t is considered a vector of exogenous variables:

Z_t= [GE_t Cop_t RG_t PIV_t……………………………………………………….(3.3)

By implication, equation (3.3) above can be further broken down into the following block of equations to make it much clearer (assuming p=1):

$$LOLC_t = \alpha_{0,1} + \beta_{1,1} LOSC_{t-1} + \beta_{1,2} LOMC_{t-1} + \beta_{1,3} LOAC_{t-1} + \beta_{1,4} LOR_{t-1} + \beta_{1,5} GE_{t-1} + \beta_{1,6} COP_{t-1} + \beta_{1,7} RQ_{t-1} + \beta_{1,8} PIV_{t-1} + e_{1,t}$$

$$LOSC_t = \alpha_{0,2} + \beta_{2,1} LOLC_{t-1} + \beta_{2,2} LOMC_{t-1} + \beta_{2,3} LOAC_{t-1} + \beta_{2,4} LOR_{t-1} + \beta_{2,5} GE_{t-1} + \beta_{2,6} COP_{t-1} + \beta_{2,7} RQ_{t-1} + \beta_{2,8} PIV_{t-1} + e_{2,t}$$

$$LOMC_t = \alpha_{0,3} + \beta_{3,1} LOLC_{t-1} + \beta_{3,2} LOSC_{t-1} + \beta_{3,3} LOAC_{t-1} + \beta_{3,4} LOR_{t-1} + \beta_{3,5} GE_{t-1} + \beta_{3,6} COP_{t-1} + \beta_{3,7} RQ_{t-1} + \beta_{3,8} PIV_{t-1} + e_{3,t}$$

$$LOAC_t = \alpha_{0,4} + \beta_{4,1} LOLC_{t-1} + \beta_{4,2} LOSC_{t-1} + \beta_{4,3} LOMC_{t-1} + \beta_{4,4} LOR_{t-1} + \beta_{4,5} GE_{t-1} + \beta_{4,6} COP_{t-1} + \beta_{4,7} RQ_{t-1} + \beta_{4,8} PIV_{t-1} + e_{4,t}$$

$$LOR_t = \alpha_{0,5} + \beta_{,5,1} LOLC_{t-1} + \beta_{5,2} LOSC_{t-1} + \beta_{5,3} LOMC_{t-1} + \beta_{5,4} LOA_{t-1} + \beta_{5,5} GE_{t-1} + \beta_{5,6} COP_{t-1} + \beta_{5,7} RQ_{t-1} + \beta_{5,8} PIV_{t-1} + e_{5,t}$$

As mentioned earlier, VAR is a systems of regression models (which signifies there could be more than one dependent variable at different times). Interestingly, the equations (3.2) could be rewritten where the Ai's are 5 x 5 coefficient matrix to produce the following vector (5.5).

$$\begin{bmatrix} LOLC_t \\ LOSC_t \\ LOMC_t \\ LOAC_t \\ LOR_t \end{bmatrix} = \begin{bmatrix} \alpha_{0,1} \\ \alpha_{0,2} \\ \alpha_{0,3} \\ \alpha_{0,4} \\ \alpha_{0,5} \end{bmatrix} + \begin{bmatrix} \beta_{11,1} & \beta_{12,1} & \beta_{13,1} & \beta_{14,1} & \beta_{15,1} \\ \beta_{21,1} & \beta_{22,1} & \beta_{23,1} & \beta_{24,1} & \beta_{25,1} \\ \beta_{31,1} & \beta_{32,1} & \beta_{33,1} & \beta_{34,1} & \beta_{35,1} \\ \beta_{41,1} & \beta_{42,1} & \beta_{43,1} & \beta_{44,1} & \beta_{45,1} \\ \beta_{51,1} & \beta_{52,1} & \beta_{53,1} & \beta_{54,1} & \beta_{55,1} \end{bmatrix} \begin{bmatrix} LOLC_{t-1} \\ LOSC_{t-1} \\ LOMC_{t-1} \\ LOAC_{t-1} \\ LOR_{t-1} \end{bmatrix} +$$

$$\begin{bmatrix} \beta_{11,1} & \beta_{12,1} & \beta_{13,1} & \beta_{14,1} & \beta_{15,1} \\ \beta_{21,1} & \beta_{22,1} & \beta_{23,1} & \beta_{24,1} & \beta_{25,1} \\ \beta_{31,1} & \beta_{32,1} & \beta_{33,1} & \beta_{34,1} & \beta_{35,1} \\ \beta_{41,1} & \beta_{42,1} & \beta_{43,1} & \beta_{44,1} & \beta_{45,1} \\ \beta_{51,1} & \beta_{52,1} & \beta_{53,1} & \beta_{54,1} & \beta_{55,1} \end{bmatrix} \begin{bmatrix} LOSC_{t-p} \\ LOSC_{t-p} \\ LOMC_{t-p} \\ LOAC_{t-p} \\ LOR_{t-p} \end{bmatrix} + \begin{bmatrix} e_{1,t} \\ e_{2,t} \\ e_{3,t} \\ e_{4,t} \\ e_{5,t} \end{bmatrix}$$

The main essence of VAR is to analyse the impulse response functions and variance decomposition of variables. Hence these batch of equations generated the impulse response functions and variance decomposition, and results are discussed in Chapter Five.

3.16 Ordinary Least Square

Considering the linearity between revenue and cost and the general regression equations, operating cost drivers and operating revenue can be substituted into the multiple regression equation below:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \cdots \beta_n x_n \text{-------------------------- (3.4)}$$

Where y is the independent variable constant/intercept is denoted by β_0, the first explanatory variable x_1 and associated coefficient β_1 and follow by x_n *and* β_n, where n is the number of explanatory variables and the coefficients

Whereas operating revenue represents the dependent variable and the operating cost drivers represent independent variables. In the equation, R denotes operating revenue, C_a denotes administrative cost, C_h denotes health, safety and security cost, C_l denotes labour cost, C_m denotes maintenance cost and C_s denotes service and supplies cost. Furthermore, in the equation, w_0 is the constant term, and w_a, w_h, w_l, w_m, w_s are the weights associated with the operating cost drivers' administrative, security health and safety, labour, inspection repairs and maintenance, and service and supplies costs respectively;

$$R = w_0 + w_a C_a + w_h C_h + w_l C_l + w_m C_m + w_s C_s \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3.5)}$$

To generate equations for each operating cost drivers which guided the study to measure each cost weight on the operating revenue, the study assumed that for a given data with N entries or data points, the individual operating revenues R^n $(n = 1, \dots, N)$ can be expressed in terms of each operating cost drivers, by using the equation (3.5) and (n) which demonstrated the number of cost drivers.

$$R^1 = w_0 + w_a C_a^1 + w_h C_h^1 + w_l C_l^1 + w_m C_m^1 + w_s C_s^1 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.6)$$

$$R^2 = w_0 + w_a C_a^2 + w_h C_h^2 + w_l C_l^2 + w_m C_m^2 + w_s C_s^2 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.7)$$

$$R^3 = w_0 + w_a C_a^3 + w_h C_h^3 + w_l C_l^3 + w_m C_m^3 + w_s C_s^3 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.8)$$

$$R^N = w_0 + w_a C_a^N + w_h C_h^N + w_l C_l^N + w_m C_m^N + w_s C_s^N \dots\dots\dots\dots\dots\dots\dots\dots\dots (3.9)$$

In equation (3.9) $C_a^n, C_h^n, C_l^n, C_m^n, C_s^n$ represents administrative cost, security health and safety cost, labour cost, maintenance cost, and service and supplies cost for the n^{th} data point. The set of equations (3.6) to (3.9) can be expressed in the matrix-vector form to generate equation (3.9).

$$\begin{bmatrix} R^1 \\ R^2 \\ R^3 \\ . \\ . \\ . \\ R^N \end{bmatrix} = \begin{bmatrix} 1 & C_a^1 & C_h^1 & C_l^1 & C_m^1 & C_s^1 \\ 2 & C_a^2 & C_h^2 & C_l^2 & C_m^2 & C_s^2 \\ 3 & C_a^3 & C_h^3 & C_l^3 & C_m^3 & C_s^3 \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ N & C_a^N & C_h^N & C_l^N & C_m^N & C_s^N \end{bmatrix} \begin{bmatrix} w_0 \\ w_a \\ w_h \\ w_l \\ w_m \\ w_s \end{bmatrix} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.10)$$

Equation (3.10) can be expressed succinctly as:

$$\mathrm{R} = \mathrm{Cw} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.11)$$

By applying multiplication rule, multiplying C by w to eliminate the brackets. Note that in the R*C matrix, where C_a^N, C_h^N, C_l^N C_m^N and C_s^N represent the operating cost drivers, the lower index refers to cost drivers notation in the columns and the upper index n refers to the number of observations in a row as shown in equation (3.10).

$$\mathrm{R} = \begin{bmatrix} R^1 \\ R^2 \\ R^3 \\ . \\ . \\ . \\ R^N \end{bmatrix}, \quad \mathrm{C} = \begin{bmatrix} 1 & C_a^1 & C_h^1 & C_l^1 & C_m^1 & C_s^1 \\ 2 & C_a^2 & C_h^2 & C_l^2 & C_m^2 & C_s^2 \\ 3 & C_a^3 & C_h^3 & C_l^3 & C_m^3 & C_s^3 \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ N & C_a^N & C_h^N & C_l^N & C_m^N & C_s^N \end{bmatrix}, \quad \mathrm{w} = \begin{bmatrix} w_0 \\ w_a \\ w_h \\ w_l \\ w_m \\ w_s \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots (3.12)$$

Technically, the task of ordinary least squares linear regression is to estimate the vector of weights w, given the vector of operating revenues R and the matrix of operating cost C as shown in equation (3.12). However, since C is not guaranteed to be a square matrix, the inverse of C may not exist, therefore w cannot be found as $\mathrm{w} = \mathrm{C}^{-1}\mathrm{R}$. This is because only square matrices have an inverse. Thus w is often estimated by the least-squares method. The least-squares solution of w is therefore obtained as follows. y detonated as the squared error between the true revenue R and the estimates Cw, as shown below, where R, C and W are substituted into Equation (3.4) to generate equation (3.13) by applying dot product matrix-vector rule (Ioannidis *et al.* 2003).

$$\mathrm{y} = ||\mathrm{R} - \mathrm{Cw}||^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.13)$$

Transpose the vectors and matrix and factorize equation (3.13) produced

$$\mathrm{y} = (\mathrm{R} - \mathrm{Cw})^T (R - Cw) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.14)$$

Expand equation (3.14) to form a linear equation for easy minimisation.

$$\mathrm{y} = \mathrm{R}^T\,\mathrm{R} - 2\mathrm{w}^T\,\mathrm{C}^T R + \mathrm{W}^T\mathrm{C}^T + Cw \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.15)$$

The least-squares method seeks to minimise y in equation (3.15)

$$\min_{\mathbf{w}} \mathrm{y} = [\mathrm{R}^T\,\mathrm{R} - 2\mathrm{w}^T\,\mathrm{C}^T R + \mathrm{W}^T\mathrm{C}^T + Cw] \ldots\ldots\ldots\ldots\ldots\ldots (3.16)$$

By differentiating y with respect to w, hence derivative of y with respect to w at a minimising point is equated to zero.

$$\frac{dy}{d\mathrm{w}} = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.17)$$

By applying the rules of matrix calculus,

$$\frac{dy}{d\mathrm{w}} = \mathrm{R}^T\,\mathrm{R} - 2\mathrm{w}^T\,\mathrm{C}^T R + \mathrm{W}^T\mathrm{C}^T + Cw \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.18)$$

Where C^T is the transpose of C. Differentiate equating (3.18) and equate it to zero as the rule of minimisation point assumed, which generates

$$-2C^T(R - Cw) = 0 \dots \quad (3.19)$$

Dividing through by -2, to obtain:

$$C^T(R - Cw) = 0 \dots \quad (3.20)$$

By sending $-Cw$ across the equal sign to obtain

$$C^T Cw = C^T R \dots \quad (3.21)$$

Thus, by finding the inverse of both sides of the equation, the solution of w is obtained as:

$$w = (C^T C)^{-1} C^T R \dots \quad (3.22)$$

Since w is the vector of the weights associated with the cost variables as well as the constant term as shown in equation (3.13), solving for w straightaway provides the weights associated with the administrative, health and safety, labour, maintenance, logistics and supplies costs, and the constant term.

3.17 Testing for Sensitivity using Partial Differentiation

With the knowledge of the weights associated with each cost variable, the sensitivity of the revenue with respect to changes in the cost variables can be tested from the regression equation (3.4). The sensitivities are tested by taking the partial derivative of the operating revenue with respect to each operating cost driver. The partial derivative of an operating cost driver is the test of sensitivity of the operating cost driver to operating revenue, holding all other cost drivers constant. Thus, the following partial derivatives were applied to test the sensitivitity of each operating cost driver to operating revenue.

The Partial derivative of administrative cost driver

$$\frac{\partial R}{\partial C_a} = w_a \dots \quad (3.23)$$

The partial derivative of health safety and security cost driver

$$\frac{\partial R}{\partial C_h} = w_h \dots \quad (3.24)$$

The partial derivative of labour cost driver

$$\frac{\partial R}{\partial C_l} = w_l \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots . (3.25)$$

The partial derivative of repairs and maintenance cost driver

$$\frac{\partial R}{\partial C_m} = w_m \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.26)$$

The partial derivative of supplies and logistics cost driver

$$\frac{\partial R}{\partial C_s} = w_s \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots . (3.27)$$

The results in equations in (2.23) to (3.27) imply that the weights associated with all the cost drivers, obtained from solving for the vector w, provide the teste of sensitivities of the revenue to the different operating cost drivers. A weight with a positive value indicates that the revenue increases if the associated operating cost driver increases and decreases if the associated operating cost drivers decreases. On the other hand, a weight with a negative value indicates that the revenue increases if the associated cost variable decreases and decreases if the associated cost variable increases.

3.18 Mixed Methods: Sequential Triangulation Mixed Design

Arguably, the mixed methods tool is a noteworthy research method. Generally, there are two main kinds of mixed methods, namely: sequential and concurrent mixed methods (Schoonenboom and Johnson 2017). Both techniques admit the use of qualitative and quantitative procedures in the research process (Tariq and Woodman 2013). However, they operate differently as concurrent mixed methods is designed to handle quantitative and qualitative data collection and analysis simultaneously, while sequential mixed methods is designed to handle qualitative followed by quantitative processes independently (Turner and Turner 2012). Mckim (2017) explains that both methods are appropriate but sequential mixed methods is more suitable for this study because it implements research processes independently, which helps this study to identify variables from the qualitative and quantitatively and subject them to test for consistency in the study's outcome.

Coincidentally, this study uses qualitative and quantitative procedures sequentially and independently for collecting data and analyse. Additionally, there were more than one technique implemented in both qualitative and quantitative methods for data collection and analysis which make the study conform to triangulation research approach (Perone *et al.* 2003; Burke *et al.* 2004; Brannen 2005; Creswell 2008). The triangulation approach enables this study to limit data insufficiency as the same data are obtained using distinct tools and from different sources.

3.19 Measuring the Validity and Reliability of the Study

Validity and reliability in this study are demonstrated from the consistency of qualitative and quantitative results generated from data sets (Bush *et al.* 2005). The data collection and analysis techniques and sources were very reliable, as the qualitative was collected in oil and gas conferences and workshops from delegates which are experience and experts, hence they gave an in-depth discussion in operating cost drivers and their optimisation strategies oil and gas operations.

Data collection tools were pre-tested to eliminate ambiguity before they were finally designed and developed and implemented to solicit data in operating drivers and their optimisation strategies in oil and gas operations. Sampling of participants was based on knowledge and experience participants accumulated in oil and gas operations in relation to operating cost. These criteria helped the study to generate consistency in their responses on the operating cost drivers' and their optimisation strategies.

Furthermore, quantitative data was obtained from GNPC, NNCP and UK Oil and Gas Authority, hand-picked data from BP, Shell, Tullow, ENI, and Chevron and others. This study assumed that these operators are multinational operators with good standing in the global oil and gas business and operating over decades, and some of them are the IOC at the research region. Additionally, operators also operate in both Gulf of Guinea and in the UK North Sea. Hence, the operators formed a fair representation of operators in Gulf of Guinea and UK North Sea, and also data from them is assumed to be the true reflection of their operating cost and also covers the study location. Moreover, many previous studies used the operators listed data to produce a report for decision-making in oil and gas operations (Krefting 1990; Harlen 2007; Cláudia *et al.* 2017).

The data from REMMLF, AIPN and government policy documents are also reliable sources of data because they have been previously used for studies in related area (Jeffrey 2007; Ernest *et al*. 2017; Memphis *et al*. 2017). Besides, these Institutions are well established professional Institutions in the oil and gas upstream investment activities and advice and train national and multinational operators on the oil and gas transactions. Hence, any relevant data collected from them is assumed reliable and valid.

The qualitative data was analysed by employing Delphi method to arrive at consensus from the experts' opinions, and content analysis to reduce the volume of the other documents without reducing the contents. Additionally, Vector Autoregression (VAR) and Ordinary Least Square (OLS) models were applied to measure the relationship among cost drivers. Previously, researchers apply those models to generate reliable results (Detmar 1989; Dalgleish *et al.* 2007). Additionally, this means that this study demonstrates reliability and validity is the application of mixed research on a single study (Chen *et al.* 2002; Steven 2003; Platz *et al.* 2005; Literature and Spooner and Pachana 2006; Davis and Baulch 2011; Mohajan and Mohajan 2017).

3.20 Ethical Consideration in this Study

This study demonstrates a strong ethical consideration by applying a range of acceptable ethical procedures in conducting research in social science rim (Resnik 2011). This study has completed an ethical application as a fundamental requirement for all research works at Coventry University to assess the appropriateness of the research, and also to fulfil the UK data protection act (Phil and Harrison 2018). The ethical application process details the kind of data required, potential participants and how the data are collected, analyse and protected. All these questions were appropriately answered as the ethical application was approved and an ethical certificate was issued to conduct the study.

The questionnaires first part contains participants' consent which comprehensively and precisely explained the purpose of the study, and also states the option to participate or to decline. Furthermore, this study has requested for participants' email address for the purpose of any follow up questions to clarify bordering issues in their responses. To ensure participants confidentiality, their personal details were not asked for, rather their operators and regions they operate. The design of questions for both questionnaires and interviews were guided by pilot study and previous questionnaires in similar studies which helped to eliminate sensitive and ambiguous questions (Haggerty 2004; Ellis 2007; Dingwall 2008). For the interviews, participants were asked for their consents on whether they would allow the discussions to be recorded. Some agreed and others declined. For those who have declined, they have been automatically withdrawn and eliminated from the study.

The data obtained from the operators and institutions and pieces of literature were duly acknowledged and referenced. The author signed nondisclosure of the data agreement with GNPC to third parties or party and should be solely use for academic purpose before the operating cost data was given. Additionally, the study has made available the operators the ethics certificate and an additional supporting letter from this research team to reinforce the ethical standards of the study. The analysis and reporting of the results were honestly interpreted and presented with very little author intuition base on the general cost concepts and behaviour.

3.21 Summary and Conclusion

This study concludes on sequential triangulation mixed methods because it is designed to independently handle qualitative followed by quantitative processes. This approach was adopted due to the complex nature of oil and gas operations and insufficient data on operating cost drivers. Where both qualitative and quantitative data were sourced from different sources by applying various research data collection tools. The primary qualitative data was collected by the implementation of semi-structured interviews and questionnaires though both data collection tools contained the same questions because they solicited for the same data on the operating cost drivers and their optimisation strategies. Furthermore, the secondary qualitative data was obtained from policy documents operational reports and workshops reading materials to augment the already collected data and use it for cross checking. These data sources were extracted and analysed by applying content analysis and Delphi method.

The quantitative data was obtained from IONs in the in Gulf of Guineas and the UK Oil and Gas Authority database for UK North Sea, and handpicked data from institutions and giant operators' websites. Furthermore, World Bank database was found as a useful source for government indicators data such as government effectiveness, corruption, regulatory quality and political instability and violence. These batches of quantitative data were analysed independently by applying VAR and OLS.

Chapter Four

Qualitative Data Analysis: Results and Discussions

4.1 Introduction

This chapter presents the qualitative results and discussions that address objectives one and three: namely to identify regional operating activities (operating cost drives) and their optimisation strategies in the Gulf of Guinea and the UK North Sea oil and gas operations. Data for this study is purposively obtained from the SMs using both semi-structure interviews and open-ended questionnaires. The main rationale for collecting data from this target group is twofold. First, this category of respondents possesses wide experiences and understanding of the nature of the activities and diversity in the oil and gas sector. Second, they have responsibility for decision making related to costs in their organisations. Therefore, the responses generated from them have provided some useful insights into cost dynamics in the oil and gas industry across different regions. The chapter is organised in two main sections. Section 4.1 presents and discusses the operating cost drivers from all the respondents, depending on the regional issues they have raised, in order to address the first objective. Furthermore, Section 4.2. presents data and discusses strategies of controlling and managing the operating cost to optimise oil and gas operation in order to address Objective 3. Section 4.3 concludes the chapter.

4.2 Data Collection and Presentation from Qualitative Sources

The qualitative data was collected from both Primary and secondary sources (see Section 3.8 and 3.14 of Chapter 3 for details on the data sources). The design of the questions included in the interviews and questionnaires was subjected to pilot testing (see section 3.10 of the same chapter) in order to enhance the validity of the instruments. In this regard, semi-structured interview format was used, and answers were coded to predefined open and closed questions (Millwood and Heath, 2008). The semi-structured interviews were targeted at the respondents with time availability during the data collection period. Whereas the open-ended questionnaires were targeted at the respondents with limited time availability for the interview. Hence, it was adopted to enable them to provide their opinion/responses as if they were interviewed. The data was collected around five key themes that informed the structure of the questions and follow up questions. These are Labour, Service and supplies, Maintenance, Health and Safety, and Regulatory Framework. The study is intended at 80 respondents, 40 for interviews and 40 for open-ended questionnaires. However, due to challenges of accessing and contacting the senior managers, this combined number has dropped to 66 respondents in total. Due to limitation in the qualitative data access in the oil and gas industry, the 66 respondents are considered appropriate for the following reasons. First, diversity, experience, age, qualifications (demographics). Second, the oil and gas managers are very difficult to get hold of for an extensive interview (see Needham *et al*. 2018). Finally, the respondents in this study have a cross-border experience because most of them have worked in different countries/regions which has equipped them with global skills. In order to provide appropriate data and corresponding discussions, each theme is discussed to cover the related question and responses provided. Hence, Sub-Sections 4.1.2 to 4.2.5 address the relevant themes.

4.3 The Effects of Government Indicators on Oil and Gas Operations

When the question was raised on the operating cost drivers (which seeks to specifically understand geopolitics and political instability and violent), the responses generated from the 66 participants (SM) vary in regions they are currently based in. The consolidated views of the SMs from the questionnaires and the interviews indicate that government interference in the operating activities and transactions is one the drivers of operating in oil and gas operation. The results further indicate that government interference, as a driver is generally not just related to an operating cost object. A couple of the SMs admit the driver is more common in Gulf of Guinea though other mentioned the UK North Sea. Additionally, a SCM who was interviewed also mentioned that South America and Asia have similar challenge, which drive the operating cost up. These views of the SMs on government interference as a driver for operating cost in the oil and gas operation correlate to literature where the literature indicates that host governments restrict some activities to local companies with less capacity, within the Gulf of Guinea (Ghana and Nigeria local Content Law 2013).

Furthermore, in the UK North Sea the government put more strict measure on operators' activities, which constrains their activities, and bring in more cost in their operations. Additionally, literature evidence connect to SMs opinion on governments interference demonstrates that both regions also have a Joint Operating Agreement (JOA) on paper with less technical and operational involvement and commitment by the government but rather concentrate on rent distribution. Examples Ghana Participating and Carrying Interest (PCI) and the Nigeria Joint Operating Agreements (JOAs) and the UK government put environmental policy with no financial plan and support (Ghebremusse 2014; GNPC 2016). Collectively, the government failure to effectively participate and coordinate its part of the operations creates a huge cost and operational burdens on the oil and gas operation in the Guinea of Guinea and the UK North Sea, which the SMs describe as government ineffectiveness.

The analysis of the SMs' views build a common understanding that corruption is one of the drivers of the operating cost in oil and gas operations. A substantial per cent of 80% of the SMs believe that corruption influences the operating cost in the oil and gas operations. Majority of them especially the SCMs who deal directly with the government official expresses their dissatisfaction and explain that some individuals hide under the ruling government to acquire and own oil fields. They explain that the illegal acquisition of fields could lead to huge cost to the any investor who invests in such an oil and gas field. A typical example in the Gulf of Guinea when a minister register oil fields in his name in Nigeria during Ex-president Jonathan era and this filed is cease in current president Buhari's error. Hence, any external investment in the fields sunk cost, which affect the operating of the oil and gas activities. Others also mention that some government official also register companies illegally and use them to forcefully win service contracts.

According to a SCM, these practices are in both regions; however, they are more predominant in the Gulf of Guinea as far as this study is concern, but when considering global oil and gas operations corruption as a cost driver is not limited to Gulf of Guinea and the UK North Sea operations. These syntheses explain how corruption influences operating cost in the oil and gas operations. Further to the literature evidence, a SBDM interviewed said, "*Ruling government officials sometimes threaten operators for subcontracting jobs to be awarded to a particular company with less capacity for self-gains which is very common in both regions but predominant in the Gulf of Guinea especially in Nigeria*". Corruption has received intensive literature critic affecting business operations in the Gulf of Guinea hence the SMs' opinion of corruption as a driver of operating cost in oil and gas operation correlate with the literature.

The SMs' views also identify the regulatory framework as ones of the operating cost driver which influence operating cost in the Guinea of Guinea and the UK North Sea oil and gas operation. They explain that the regulations governing the operations are very fragile and inconsistent with non-timely review and modifications, and these affect planning in the operations. According to some senior commercial and business development managers, this put the operators in a very difficult situation to estimate and forecast the operating activities and cost, and this relates to both regions. Two of the SMs indicate that the UK had modified some of their fiscal items including exemption of production tax and reduction in royalties which is confirmed in HM Revenue and Customs (2017) report. Though these changes favour the operators, it makes planning and forecasting very difficult. On the other hand, in the Gulf of Guinea, Ghana and Nigeria revised their Local Content Law for almost every year; 2013, 2012 and 2011. All these create inconsistency in regulations governing the operations. Arguably, the SMs believe that the inconsistencies create poor regulation quality if operators cannot understand it, which is a driver within the two regions under investigation.

Subsequently, the SMs believe that geopolitics and political instability and violent are sensitive drivers of oil and gas operating cost. Some SMs' mentioned violent and politics instability in the Gulf of Guinea especially in Nigeria, which leads to the kidnapping of expatriates in the oil and gas industry. Furthermore, these issues generated internal border disputes in the Gulf of Guinea with some example in Nigeria are Cross River and Ebonyi, Abia and Akwa Ibom states. Additionally, Bakassi Peninsula dispute between Nigeria and Cameroon, which also centred on the geopolitics and these drives oil and gas cost activities in the Gulf of Guinea. Ghana also recorded maritime border disputes with Ivory Coast where Tullow and HESS exploration and appraisal activities were kept on hold which led to a loss in investment in those prospects (Graham *et al*. 2017). These views of the SMs are consistent and correlate to literature evidence on Venezuela, Libya and Iraq geopolitical and political instability effects on oil and gas oil operations (Walid 1996; Smith *et al*. 2009; Darbouche *et al*. 2011; Shiraz 2012). Addition to this evidence, Timothy (2017); Indra (2015); Zohar 2010; Doron (2004) have intensively argued the effects of violent in oil and gas operations.

4.4 Labour Cost Drivers in the Oil and Gas Operations

The responses from the SMs demonstrate that labour cost object plays a very important in oil and gas operation. For example, in any five out of six SMs have reiterated the critical role that labour cost play the operating cost dynamics. A retired commercial manager who worked in Africa, US, UK and in South America said that "*Labour regulation and Obligations in both Local Content Laws and fiscal systems and Labour unions actions affect labour cost object and its activities in the oil and gas operations"*. Consistently, most of the SM's views correlate to the retired commercial mangers views on labour regulations and are connect to the literature's findings of this study. A SCM emphasis and states that "*the labour unions' radical approach to labour issues in oil and gas operations generally affects labour cost because they unions want more people to be employed and more incentive to be paid to regardless of the cost implication"*. Subsequently, five out of six SMs from South America also seconded the labour unions and one of them states that, *"the labour union controls 75 per cent of the workforce in the South American region, and this 75 per cent is the local people with very little work experience in oil and gas operations*". Additional evidence from a SCM who works in South America states that, "*An operator in the South America region signed a treaty which* *states 4:1 ratio of labour of nation to the investor, as part of the treaty to the granting instrument which increases labour cost by 50 per cent".* Though some of these evidence are not within this study scope but very relevant to the understanding operating cost drivers in the oil and gas operation which this study seeks to address. Hence, they are very resourceful to this study.

Beside labour regulations, the views of the SMs collated unanimously identified political power as a driver of labour cost which influences the regulations governing oil and gas operational activities and in general business operations. A SPE explains that the EU free immigration and work permit policy might not have issues with labour regulations in the UK North Sea. But most of SMs working in the UK North Sea believed that with the twist in decision of the UK to leave the EU which even cause Theresa May job as the Prime Minister of UK will have a huge impact on labour regulation transformation in the UK. The Brexit in the UK would be a potentially terrifying issue in the UK labour market, as there would potential restrictions to work permit of other EU member when Brexit happens without deal, which will badly hit the UK labour market and increase labour cost in the UK North Sea. These labour cost discussions are consistent to the literature evidence where labour regulation and political power affect labour issues in the oil and gas operation. The SMs believe that these issues have present and future impact in oil and gas operation in the Gulf of Guinea and the UK North Sea. Reflecting on both literature evidence and the common opinion of the SMs on labour cost object in the oil and gas operation in the Gulf and the UK North Sea, this study can conclude that regulatory complexity and quality are drivers of labour cost object in the Gulf of Guinea and the UK North Sea.

Another common views on labour cost object driver which received substantial discussions from the SMs is skills and experienced labour deficit as most of the SMs contacted highlighted on skills and experience labour deficit as well as the final feedback from the selected SMs also highlighted that. Consistently, majority of the SMs believe that labour deficit affects labour cost object in the oil and gas operations in the two selected regions. A SPE from Nigeria, SHRM and a SBDM provide their views which is centred on lack of adequate experience and skill labour workforce compel operators outsource labour from retirees which is unsustainable and very expensive. A SCM working in the Gulf of Guinea states that, *"The skill and experience labour deficit of compels operators to depend more on the expatriates, overtime, and contract staffs, and these expatriates have a very high wage rate, operators require work permit and renewal and other cost which increase the labour cost,*". This received a substantial debate from majority of SMs working in the Gulf of Guinea. Furthermore, some of the SMs working in the UK North Sea explains that the UK has one of the most complex immigration systems when it has to do with work permit and very expensive; getting Non-EU experienced candidates to work in the UK is very frustrating. These qualitative syntheses of the results correlate with quantitative results of this study, where overtime and contract staff significantly impact labour cost in the Gulf of Guinea and the UK North Sea due to lack of experienced workers. Furthermore, literature evidence also indicates that skill and experience work deficit drive the labour cost (Austin 2012; Obeng-Odoom 2015; Nancy *et al.* 2016; Harald Petterson and Anette 2016).

Besides the labour deficit, which could have reduced salaries and wages and entitlements, the SMs describe the situation rather drive labour cost object in oil and gas operations. A SHRM, SCM and a SA collectively admit to the fact that based on their individual views that it drives labour cost object. The SA said, *"Salaries, wages and entitlements are the workers' legal entitlements and deemed fixed, hence the fewer experience and skilled workers asked for more of these and other incentives which increase the labour cost.* Adding to that, some SMs explain that employees in the oil and gas have endless entitlements, and their demands are backed by labour laws and Acts, oil and gas employment ethics where these opinions are consistent with literature evidence analysis of Global salary guide (2017) and John and Duncan's (2017) studies. Moreover, one of the senior SHRM said, "*The experience workers in the oil and gas industry can demand for high wages and other entitlements and failure to meet them they will leave you in a middle of a project that he/she service is needed*."

The Government interfering and influence in the recruitment process is highlighted by the SMs which is aligned to corruption as another driver of labour cost object in the oil and gas operations. Most SMs from Gulf of Guinea and others from South America maintained that and collectively argued that this is a common practice in their regions and extended to the UK North Sea. According to a SCM who worked in both regions states that, "*Some government officials force and even threaten the operators if they failed to recruit a list of people from them who have no working experience"*. This synthesis correlate with literature evidence of (Shah *et al.* 2012; David 2012; Donwa *et al.* 2013 Sandra 2016; PWC 2017).

Concisely, the arguments from the SMs on labour cost drivers enables this study to build consensuses based on Delphi methodology. Consistently, four labour cost drivers are common among most of the SM, which also reflects on the feedback from the selected SMs for their final feedback. These include labour regulations, skill and experience labour deficit, salaries, wages, and corruption. The feedback for the selected SMs and synthesis of the individual views highlighted that salary is a global labour cost issues, while the rest of the factors are on regional basis. The UK North Sea oil and gas operation labour cost is influenced by regulatory complexity and skill experience labour deficit, while Gulf of Guinea oil and gas operation labour cost is influenced by all the three factors identified. Critically, about 93 per cent of the SMs' discussions indicate that deficit labour market drives oil and gas operating cost, while 90 per cent assumed the regulatory system influence operating cost and 80 per cent assumed corruption and 75 per cent hold to salaries. Substantially, 95 per cent of the SMs demonstrate that labour cost is a big concern in oil and gas operations.

4.5 Service and Supplies Cost Drivers in the Oil and Gas Operations

The service and supplies cost object received a considerable debate from the SMs on the activities that drive and influence their behaviour in the Gulf and Guinea and the UK North Sea. Most of the SMs described the service and supplies activities as very central and instrument to the entire value chain processes in oil and gas operations. Clarifying that, a SCM states that, "s*upplies of the pipeline, drilling bits, chemical and equipment and other operational consumables are used and applied on daily basis throughout the operational lifespan of an oil and gas filed including decommissioning"*. Fundamentally, the service and supplies significantly affect all operational process in the oil and gas operations. From the interviews, the SMs indicate that depth of water, reservoir properties influence the service, and supplies cost object behaviour. one of the SDE emphases that "*when an offshore oil filed water depth exceeds 1000ft, its development can no longer be support with fix-lay-pipeline manifold system, where many pipelines are connected to a junction but rather a flow-lay-pipeline system where many pipelines and manifolds need to build the pipelines networks"*.

Hence, the supplies of both manifolds and pipelines to complete the development increase in the case of a depth water oil and gas fields. Hence, the SDE suggestions conclude that, Gulf of Guinea and the UK North Sea region offshore operations water depth is beyond 1000ft. An extant literature evidence correlates to this views that an average water depth of 4265ft in the Gulf of Guinea and 369ft water depth in the UK North Sea (Watkins 2002; Balson *et al.* 2002; Chukunedum and Ijeoma 2012; GNPC 2016; EIA 2016; Skaten 2018; Weimer 2018). On the other hand, the SMs indicate that reservoir properties. Many of the SMs admit that the higher values of the reservoir properties such reservoir temperature, permeability, thickness and pressure influence the service and supplies cost object by high consumption of the consumables including energy. Comparatively, this view of the reservoir properties is consistent to the literature analysis (Hussain *et al.* 2012; Malcolm 2014).

Many of the SMs over 70% believe that oilfield chemicals cost drives service and supplies cost object in the two regions under investigation, as these oilfield chemicals are use on daily operational activities and in diverse activities with many different functions. Hence, majority of the SE agreed to impact of the oilfield chemicals on the supplies and service cost oil and gas operations. Some of them explain that the chemicals are used to separate crude oil from impurities, some are used to separate oil from gas, and some are used to treat produced water before disposal. The SEs further highlights that some of the oilfield chemicals aid in softening the source rock for easy penetration and other are used to prevent corrosion of operating equipment. Hence, they are very important in the oil and gas operations. A SPCE added that each activity and process require a different chemical, which has a different quotation, different manufacturer and located at a different part of the world.

Therefore, bringing the chemical to operators involves transportation and other indirect which influence the repricing of the chemical to operators as the Local Content Law in Gulf of Guinea restricts E&P operators from such business rather the local companies. Furthermore, a SDE, SCM and SPE also maintain the chemicals cost and explain that Enhance Oil Recovery (EOR) as an unconventional method to increase the recovery factor by developing injecting wells and injecting chemicals or steam or gas on daily basis increase the cost of chemicals. These views correlate with Karl (2012); Kalland (2014); and Aklin *et al.* (2015). Reflecting of the oilfield chemical cost, the SMs believed that Gulf of Guinea service and supplies cost object is influenced by the indirect cost it is associated with, while the UK North Sea service and supplies cost is influenced by the by the EOR (Puckett and Lindsay 2016; Erik 2018).

The SMs further explain that local content obligations also influence the service and supplies cost object. This received an intensive debate from individual SMs and collectively believed that the local content obligations influence the service and supplies cost. Some explain that the obligations protect local companies and stipulate that service and supplies jobs shall be outsource to local companies. One of the SCM interviewed shared a real-life subcontract of food supplies service to rig workers at one of the offshore oil and gas fields in Gulf of Guinea. According to the SMs, the operator advertised the supply jobs per the provision of Local Content Law *"Section 4, Sub Section 4.3, which stipulate that such contracts shall be outsource to local companies. The estimates received from the lowest bidders exceeded the market value of the service plus 10 per cent profit margin"*. The SMs added that according the operator there was pressure and threats from government some officials to award the project to a contractor who is among the highest bidders. Hence, the operator has no option than to award the contract with the outrageous estimates to the government official favourite.

The SMs subscribed to poor procurement processes influence the service and supplies at both selected regions. One of the SCM indicates that over "*90 per cent of oil and gas operational activities are outsourced through a procurement process to third parties"*. Other SMs highlight that operators' failure to consider market quotations and quality of service, which leads to high service prices. Furthermore, some SMs added that sometime some of the subcontracts are awarded for personnel gain, which affects the time for service delivery and increase the service cost.

The summary of the SMs' views demonstrate consistency on the service and supplies cost object drivers. The views demonstrate that the Gulf of Guinea service and supplies cost object is influenced by local content obligations, while depth of water, oilfield chemical cost influence both the Gulf of Guinea and the UK North Sea service and supplies cost object. Quantitatively, about 90 per cent of the SMs' views demonstrate that depth of water and the reservoir properties drive the service and supplies cost object in the oil and gas operations. Furthermore, 89 per cent of the SMs' views indicate that oilfield chemicals cost drives service and supplies cost, and 75 per cent of the SMs, opinions identified local content obligations triggers service and supplies cost object. Besides that, 82 per cent of the SMs' views assumed poor procurement influence service and supplies cost in the oil and gas. Conclusively, 95 per cent of the SMs express their concern for supplies and services cost drives in the oil and gas operations.

4.6 Maintenance Cost Drivers in the Oil and Gas Operations

The SMs provide an insightful view on maintenance cost object and its associated drivers/activities in the Gulf of Guinea and the UK North Sea. They give an in-depth and intuitive explanation of the drivers/maintenance activities that influence maintenance cost object behaviour in the Gulf of Guinea and the UK North Sea. Some of the SMs include a SME explain that maintenance activities are conducted and performed to improve on the mechanical efficiency of the operational equipment. Some added that the activities also enable the operating equipment to performance up to their require capacity and increase their integrity. These enquires from the SMs correlate with the previous literature analysis (Hasrulnizzam *et al.* (2011); Lloyd's Register (2017). Health and Safety Executive Reports KP3[2] and KP4[3] (2017).

Majority of the SMs representing 70 per cent of the sample size argue that the sudden breakdown of operation systems and equipment, which require immediate maintenance and repairs influence the maintenance cost object behaviour. A SE emphasis and states that "*getting maintenance experts to immediately fix the problem increase the cost because they might be executing other jobs as over 95 per cent of maintenance activities requires expertise attention"*. Others SMs highlight that operators cannot predict the sudden breakdown of the operation system as oil and gas operation are associated with high risk that triggers accidences, which causes the sudden breakdown of the operation systems. Additionally, the SMs indicate that the complexity of maintenance activities further influences maintenance cost object behaviour as the need much time to expend to investigate to understand the multi-malfunction of the operating system before the can start to work on the faults. Time is money, thus more time spent on the maintenance complexity activities influences the cost.

Furthermore, A SME provides a detail process involve in maintenance activities why they are time-consuming activities, which drive the cost. the SME states that, "*there is inspections activities, which are conducted to detect faults and malfunctions, testing activities which are conducted to trace and identify fault and their causes and what kind of maintenance is needed to be perform on the system, these take a longer time to obtain the result on the system"*. Interestingly a petroleum chief engineer admits that most of the maintenance activities are '*long lead activities,*' which means that they demand more time to be executed. Other SMs added that experts conduct these tasks and oil and gas professional are very expensive. Other SMs explain that mature oil and gas operating fields are associated with complex maintenance activities. Empirical literature evidence reveals that both selected region under investigation has a substantial mature operating fields and gas fields. Thus, complexity of the maintenance activities triggers maintenance cost object in both regions.

The SMs view the attitude of both workers and operators towards maintenance activities and works in the operations is very poor and perceive that maintenance works stop production activities and they loss monies. As a result, they operators do ignore some routine maintenance activities, which eventually turn to complex maintenance and influences the maintenance cost object behaviour. One of the SME states that, *the* "*E&P operators defer and ignores preventive and corrective maintenance activities scheduled because they believe that the systems are functioning effectively and efficiently.* The SME adds that *when the system finally breakdown because of the failures and malfunction that would have be detected early if the operators had implemented preventive and corrective maintenance, the entire system have to shutdown,* *performed inspection and trace to identify the fault and work on it*". Apparently, when the system is broken-down, it cost more and lost production because the entire production system is shutdown. Other SMs highlight that some workers equally failed to report minor operational faults and malfunction, which eventually developed to huge maintenance issues. Empirical literature evidence demonstrates a direct relation of the SMs' views on the poor routine maintenance in the Gulf of Guinea that correlate where one of the major operators in the Ghana Floating Production Storage and Offloading (FPSO) turrent bearing unexpectedly broke down in February 2016 (Paul McDade 2016). The situation caused a complete shutdown of the production platform over a couple of weeks for maintenance to be conduct and this affected their maintenance cost. Interestingly, the quantitative results of this study demonstrate a significant maintenance cost of 22 per cent relate to demand and conditional maintenance at the Gulf of Guinea.

A substantial number of the SMs (65 per cent) demonstrate that poor maintenance cultures practices in E&P operators' operational system also influence the maintenance cost object behaviour. Some of the senior highlight that E&P pay less attention to training and empowering the workers on how to use the equipment and good housekeeping, which result breakdown of operating equipment and demand maintenance and that influence the maintenance cost. One of the SCM states, *"Poor maintenance culture develops a reduction in equipment integrity, which cannot hold on to pressure and workload which leads to frequent breakdown systems*". A petroleum engineer and others SMs added that, the E&P operators see these activities as less importance and slowdown productions. Eventually, this built-up technical operational challenge in operational system and cost operators' monies to fix the fault (Lavery 1990; Baiyu *et al.* 2008; Majid *et al.* 2012). A couple of the SMs including a SGFA and others argue that political instability and violence also influence maintenance cost object. They indicate that political instabilities and violence set ground for formation of pressure groups, which cause destruction of operators' facilities, which correlate with the literature analysis, which demonstrates their affect in Nigeria, Libya, Iran and Iraq.

Uniformly, the SMs' views are summarised into four factors that are assume the main drivers of the maintenance cost object in oil and gas operations. From the results, 95 per cent and 85 per cent of the SMs assume complexity of maintenance and poor maintenance culture are the overriding maintenance activities, which influence maintenance cost object. Furthermore, 88 per cent and 86 per cent of the SMs indicate political instability and the attitude of operators and work towards maintenance activities influence maintenance cost object. Interestingly, 97 per cent of the SMs demonstrates that maintenance activities and cost are very important and sensitive to all kinds of operational activities in the oil and gas operations.

4.7 Health, Safety and Security Cost Drivers in the Oil and Gas Operations

Health and safety practices are key requirements and standards, which enhances the operability of the entire operational system in oil and gas operations as explain by the SMs. Some of the SMs highlight that the health and safety practices seek to protect both the workforce and the physical facilities, therefore when there is a failure it results to accidents, which cause a substantial financial and operational challenges. Emphases from a SDE reflect on occurrence of Piper Alpha in 1988 at North Sea and Macondo Blowout in 2010 in Gulf of Mexico. These two historic accidents in the oil and gas industry are unforgettable. The SDE states that, "*these accidents occurrence was as a result of safety failure and their consequence were enamours to the operators, environments and the entire oil and gas industry"*, hence, the SMs view consent that poor implementation of health and safety systems in the oil and gas operations drive health and safety activities and cost.

Additionally, a substantial number of the sample size of the SMs (70 per cent) believe that the safety cost object activities is most influence by human error and action. This triggers by inadequate training that would have created awareness of how to handle and operate with equipment and precautions to increase safety system operation in the oil and gas operations. One of the SCM added that lack of safety and health kits and equipment, and signpost at hazardous and confined areas to notify people on site about hazards triggers safety issues in oil and gas operation. Others further explain that failure to follow procedures, expert's advice and money saving mentality is very detrimental to the safety measures in the oil and gas operations. They concluded that these practices have a likelihood of trigger accidents in the entire oil and gas operations. The SMs identify emergency services, which is a key requirement in oil and gas operations, which involve provision of helicopter, small vessels and divers to hover and patrol around the operations zone 24/7 create a substantial cost though very important as these services intend to protect human lives. A SCM states, *"These services are paid for whether they have been used or not*, *as it is obligatory requirement in the oil and gas operations especially at the North Sea after Piper Alpha accident"*. These views correlate with Elisabeth (1992); Julie *et al.* (2006); Najmedin Meshkati (2012); Alpha, and Mohammed *et al.* (2017).

The SMs indicate that security issues also raise panic in oil and gas operations as the affect the operations and cost. Most of the SMs highlight that both regions under investigation including others have security issues at different scenarios. A SCM and SPE explain that the common driver of security issues is lawlessness because of political instability and violence. A commercial manager state that, “*lawlessness leads to formation pressure such as Niger Delta oil militant which staged many attacks and vernalises oil and gas facilities and kidnapped expatriates and asked for ransom”.* The action of the pressure groups causes a lot of operators' operations in the Gulf of Guinea as literature analysis confirmed that Shell, Exxon Mobile, Chevron are some of the victims of these groups' actions (Akpan 2010; Kemi 2016; Emmanuel 2017; Benjamin *et al.* 2018; Ademola). Subsequent discussions on the security reveals that by a senior engineer that *“the insecurity accounted for 70 per cent of oil and gas operational challenges and cost in the Gulf of Guinea*”. Even other SMs from the Middle East and South America confirmed that security causes many issues in their regions too because of political instability and violence.

The SMs further linked the security challenges to corruption, where they explain t government officials and some opinion leaders in the oil and gas producing communities divert the oil rent to their personal gains. A SCM states that, *“these categories of people in the oil-rich states and communities usually divert the allocated dividends for state and divisional government projects for selfish gains, instead of applying the funds on the designated purposes, hence, the community people get upset and cause violent and destroy facilities”*. These view of the corruption correlate with literature analysis (Oyefusi 2007;Udida; Joseph *et al.* 2012; Worksafe NB's 2014; PWC 2016; Chatham House 2017; Nwosu 2017; Undiyaundeye 2018).

In summary, 96 per cent of the SMs believed that the poor implementation of health and safety practice triggers operational challenges which drives health and safety cost. Furthermore, 94 per cent of the SM commonly consent that human actions are the main causes of the health and safety issues in oil and gas operation and 93 per cent consent that emergency response service bring in a lot of cost in oil and gas operation which affect the UK's operating cost. On the other hand, the SMs unanimously argue that corruption and lawlessness are the main challenges of security in oil and gas operation where 95 per cent and 90 per cent argue for them respectively. Consistently, 94 per cent of the SMs see the health safety and security issues as important in oil and gas operations.

4.8 Regulatory Framework Drivers in the Oil and Gas Operations

Regulations, policies, and obligations according to a CEA, *“Are rules formulated, enacted and implemented to govern the operational activities in the oil and gas industry*”. A SN added that rules are implemented to protect the state interest and for economic rent collections as Memphis *et al.* (2017) study on petroleum fiscal. A SLO and SCM highlights on the various upstream treaties. The SLO states that, *"granting instrument/treaties permits operators to conduct exploration and eventually production activities at a particular acreage or field, local content law is enacted to protect local participation in oil and gas activities, taxes are implemented to collect economic rent and environmental laws are formulated to protect the environment*". Collectively, they explain that formulation of these laws and regulations are guided by a constitutional requirement on exploitation, development and management of natural resources and their economic benefits to the nations and the citizens. See piece of evidence in Law Library of Congress (2015); Kirsten and Bindeman (1999) ideas on of fiscal formulation with reference to the Indonesian Production Sharing Agreement.

From the SMs views, indicate that the laws fundamentally seek to assess and evaluate the net economics from investment and then to determine the economic rent. Hence, the SMs unanimously argued that regulatory complexity within the laws and others in oil and gas operations especially those directly associated with the upstream investment and the core activities weaken the operational models in the oil and gas operations. A SCM maintains regulatory complexity and states that, "*almost all the entire oil and gas transactions from granting instrument to decommissioning are legally binding*". Each transaction has its own legal language, which is not common, hence, parties' resort to legal services, which are very expensive. Additionally, the legal companies or individuals are not responsible for employing the obligations and failures or bridge of contract terms. According to a SCM, "*there is no legal remedy to a failure of contract after your lawyers negotiates and you sign and sealed an investment treaty"*. A presenter at Rocky Mountain Mineral Law Foundation (RMMLF) workshop highlights that, *"when terms and conditions to the treaty are agreed on and signed and sealed it cannot be changed, however third parties sometimes argued against indemnity and* force majeure *when unforeseen circumstances occur, they turn and say it is negligent of duties"*. This indemnity and "*force majeure"* raises a huge concern among parties involved in the Macondo Blowout accident according to a retired commercial manager, and further to this primary evidence, Ernest *et al.* (2010) study provided further previous evidence on such petroleum transactions.

Besides that, most of the SMs subscribes to the type of petroleum fiscal regime with a strong association with operating activities and cost. A CEA states that, "*traditionally, there are three predominant petroleum fiscal systems, which includes service contract which is limited to exploration, development and oilfields services, but have operational and transactional limitations*. He added, *"Risk Services is a kind of service contract which generates an* *accumulated sunk cost when the service provided is not economically viable. From risk service position, the contractor is paid out of the project net output, risk service contract stands the chance to change operators cost structure as we all know the high uncertainties in oil and gas operations"*. Further to discussions, a SS from the UK also maintains the contract type and clarifies by given a detailed accounting entry for a Production Sharing Agreement (PSA). According to him, "*Royalties are first deducted from the gross production to the government. The contractor recovers cost subjected to a threshold known as recovery limit, thereafter, Government Participating Interest (GPI) is deducted if there is any*", and this clause conformed to the Jubilee oil and gas in Ghana with 10.75 per cent of (GPI) from operating revenue which is confirmed in Public Interest Accountability Committee Report (2016) and Tullow Ghana contract.

In this regard, "*profit oil is realised"* like Angola and Nigeria PSA see Muhammed (2010:167 & 256) and government take it "*share of profit oil"* and the contract portion of the *"profit oil suffers taxes and other levies*". Collectively, the SMs assumed PSA with its complex accounting structure as captured in Daniel (2003:14-36); Mazeel (2010:44-70); Stiglitz *et al.* (2007:53-89); AIPN PSC draft (2016) does not encourage operators to save cost. A SBDM concludes that most of the PSA treaties operating fields always have cost balance carry forwards, which accumulate and increase the operators' current liabilities by weakening the working capital because of the cost recovery clause, as Smith *et al.* (2010) analysis establish an inverse relationship between current liability and working capital. According to a SCM, *"technically, operators are not encouraged to save cost with SPA treaties because any dollar saved will suffer government interest, profit and taxes*".

Other solicitors who worked in the UK, US and Africa discuss Royalty Tax System which they explain to have a straight accounting procedure, which is royalty percentage on gross production or revenue, total cost recovered, net profit oil, payment of tax as established in Daniel (2003:48-50). Hence, not cost recovery limit, however, Medeiros *et al.* (2016) argued that, generally, the royalty charge is unfair and influences the cost as its deduction does not consider any cost and this can generate progressive cost implications in oil and gas operations.

The SMs further subscribe to the impact of Local Content Law in oil and gas operations. A SCM provides evidence in the Gulf of Guinea with reference to Ghana Local Content Law. He explains the Local Content Law stand to protect and encourage the involvement of local companies without a careful assessment of the capacity and ability of the local companies and peoples in oil and gas operations because there are no assessment criteria of the locals in the

Local Content Law. Ghanaian Local Content Law adjudicates, *"5 per cent of equity holding interest in any upstream investment, 100 per cent of training to local workers, and 80 per cent of the workforce of locals and outsourcing and subcontracting restrictions"*. These pieces of evidence are comprehensively captured in the legislative Framework Section 4; clause 4.1 and 4.2 2013 revised version of Ghana Local Content. Presumably, these local companies and the people are financially and technically incapable considering the economic situation and great uncertainties and how expensive oil and gas operations are. In summary, the SM unanimously consent to the fact the laws and regulatory complexity brings in substantial challenges especially in the UK North Sea and US, and Local Content Law beings a huge challenge to operators in Gulf of Guinea. Overwhelmingly, the SMs demonstrate that the regulatory framework is a very important driver in oil and gas operations where over 98 per cent of the experts' views subscribe to that.

4.9 Strategies of Controlling and Managing Operating Cost Drivers

This section presents results and discussions that address the third objective of this study, which is the strategies, adopt to manage and control operating cost to optimise oil and gas operations in the Gulf of Guinea and the North Sea. This is address via the semi-structure interviews and the open-ended questionnaires responses from the seniors' managers on the optimisation strategies of operating cost aided by Delphi method, which enable this study to build consensus from the reviews on the on individual operating cost objects optimisation in the Gulf of Guinea and the UK North Sea.

4.9.1 Optimisation of Labour Cost Object

In response to the labour cost object drivers as discussed in Section 4.4 where the SMs views sampled demonstrates that skill and experience labour deficit, salaries and wages, Labour regulations and corruptions activities drives labour cost object in the oil and gas operations. When the follow-up question of how those activities influences the labour cost object drivers can be optimise, the SMs respond positively with in-depth discussions of optimisation strategies implementation to manage and control the drivers to minimise the labour cost object. The SMs' response to deficit skills and experience labour indicate that operators can manage it if they can initiate and implement internship, graduates and mentorship programs, this point of the SMs correct to (Demond *et al*. 2018). They collectively believe that these programs can facilitates in fixing the labour deficit drivers if they effectively implemented. A SHRM states that, "*Shell and BP and the others initiate and run these programs but have limit their focus to* *engineering positions*. the SHRM added that *the programs enable the operators to identify candidates with unique talents which replace the older when they are due retirement*".

Other SMs added that the programs create an opportunity for the young ones to gain practical experience on the job as the they have the chance to learn from the experience with no key responsibility and become practically equipped to take over from the old ones when they due retirement. Brent *et al* (2013) literature analysis indicates the technique is use in construction industry which yielded positive labour optimisation. Besides that, a SCM suggests that "*the operators can also create platforms that bring in young talented individual or group of graduates from various professional backgrounds to approach problems, and those with unique and innovative ideas, operators can develop them, and they will eventually become great asset to the operator"*. The SMs believe that if operators can initiate and implement these programs effectively, those candidates identified can become a long-term asset to the operators will reduce the labour deficit in their operations.

The SMs' response to high salaries and wages come with a proposal that operators can engage more of entry-level workforce against the more experience ones. They explain that the entry-level workface executes the actual work with a moderate wage bill as compare to the experienced ones who supervised with a high wage bill. A SA recommends that, *"operators can limit the managerial positions to the core technical areas like production manager, commercial manager, procurement and outsources other services to avoid payment of monthly full salaries for ad hoc activities managerial positions"*. Other SMs advocate that operators can resort to employment agencies for contract staff and other short forms of engagement to respond to high salaries. A SHRM added that, "*this approach will give operators the opportunity to request for staff on demand, like peak production and discontinue their engagement via the agencies during off peak*". A SBDM added, *"Using the employment agencies will enable operators to eliminate idle workforce"*. The SMs believe that if operators subscribe to these measures effectively, they will be able to minimise full salaries payment, medical insurance and other bills, social security, holiday allowance of employees. They collectively believe that these initiatives can help to minimise the cumulative salaries in the oil and gas operation.

Regarding labour regulation as a driver, most of the SMs maintain that operators should comply with the labour obligations and some propose that operators should negotiate and dialogue with the lawmakers to reduce some labour restrictions in the recruitment progress. See Kevin McQuillan (2013). An CEA states that, *"recruiting the local people has a long-run benefits,* *as they are legally eligible to work in their country, no work permit requirements, no provision of other incentives such as feeding, accommodation as compared to expatriates, moreover they have low wage"*. The SMs believe that corruption is very external and relates to government, but some of the SMs still believe that corruption can handled when governments involve some independent organisations to handles oil and gas operations and make reports and data publicly available.

4.9.2 Optimisation of Supplies and Service Cost

The SMs' views identified depth of water in the offshore operations, oilfield chemical, poor procurement and Local Content Law are the main drivers, which influence supplies, and service cost object in the Gulf of Guinea and the UK North Sea oil and gas operations. The SMs based on their long-time experience and their expertise in the oil and gas operations, which they have, encounter similar challenges and overcome them; hence they shared their experiences on how to minimise those identified drivers of supplies and service cost object. A SE states, *"the depth of water in offshore oil and gas fields is inevitable and cannot be controlled artificially, however, the deep waters regions operators should acquire modern Floating Production Storage and offloading (FPSO), which are designed and developed to fit for offshore operations only and also a multipurpose vessel which permits more operators and reservoirs connection. Additionally, operators can give the manufacturer the reservoir properties and other oceanic features so that the FPSO designers will take them into consideration"*. These will enable the operators to avoid a lot of minor cost and other subcontracts for the pipelines and manifolds. See Jong *el at*. (2016) In the Gulf of Guinea specifically in Ghana deep waters operations, operators use FPSOs as compared to the traditional rigs such as Jack-up, semisubmersible and submersibles rigs that are common in the North Sea (Sadeghi 2007; Kaiser *et al.* 2013).

The SMs subscribe to implementation of resourceful and effective procurement system to mitigate poor procurement systems and to help to minimise high consumption of pipelines and the manifolds. This point of the SMs correct to Shuva *et al*. (2017). A SBDM suggests that the procurement system should include assessment and evaluation of tenders to "*flush out waste and elimination of idle supplies orders"*. Some of the SMs advocate that operators should engage in competitive shopping to identify the best alternative route to obtain the high-quality standards supplies with lowest possible rates and deliver on time. Besides, operators should discuss and negotiate with suppliers for flexible payback periods to eliminate default payment penalty. The SMs believe that if these proposed strategies adopt and effectively implemented the oilfield chemical and the poor procurement challenges will be minimised. The SMs also encourage operators to build a good working relationship with suppliers and the governments which can lead to trust and create a platform for mutual benefits to foster long-run businesses relationship and that can allow for renegotiating with the government to minimise the local content restrictions.

4.9.3 Optimisation of Maintenance Cost

The SMs identified complexity of maintenance activities are the main driver of the maintenance activities. They believe that the challenge can be minimise and mitigate when the operators outsource their maintenance works from giant oilfield servicing company which have multiple diversional experiences in servicing activities (see Nahdatul *et al*. 2014). The SMs highlight that giant oilfields servicing companies have a wider scope of service delivery and technology, which they can use to detect potential maintenance and conduct corrective and preventive maintenance to reduce the system breakdown. A SME states that "*from servicing standpoint, now the giant oilfield servicing companies have collaboratively designed, and developed oil and gas project services model known as Integrated Project Service (IPS). The model incorporates all forms of maintenance service activities from a project exploration to decommissioning. However (IPS) is an intellectual property of Halliburton, Schlumberger and Baker Hughes, not for all oilfield servicing companies, now these oilfields servicing companies collectively performance all maintenance service in one contract. Operators just need one contract or contractor to handle all maintenance servicing activities throughout the project lifetime which allow them operators to enjoy all maintenance service activities and to have a clearer knowledge and understanding of maintenance activities and work towards operational efficiency".*

Other SMs suggest operators should integrate technology into their operations, which can detect potential system failures and they will conduct corrective and prevent maintenance to reduce the complexity of the maintenance. A SPE states that, *"Some operators in the US install sensors on pipelines and other operational equipment to check and detect faults which reduce complete system breakdown of their operating system"*. With poor maintenance culture and bad attitude challenges, the SMs suggest that operators should adhere to and uphold to implementation of experts' recommendations and further educate all workers on good housekeeping and comply with appropriate operability to ensure safety operational system. Furthermore, the SMs encourage operators to follow procedures and instructions and further monitor and evaluate operational performance to detect potential operational failures (this is consistent Humaidan *et al*. 2015). They SMs believe that violence and political instability can be minimise when operators establish a good relationship with communities' opinion leaders and some influential members of community because violent activities in the communities are led by these kinds of people hence, establishing a good relationship with them will reduce the violence and destructions.

4.9.4 Optimisation of Health, Safety and Security Cost

The SMs indicate that poor implementation of health and safety practice, human act and action and emergency services triggers health and safety while corruption and lawlessness threaten security in the oil and gas operations. They believe that these challenges triggers oil and gas operational activities and influence the financial expenditure. The SMs' response to the health and safety challenges suggests ways and means for the operators to implement to overcome some of the challenges in oil and gas operations. The SMs suggest refreshers health and safety program to keep workers up to date knowledge and practice in health and safety to mitigate the poor implementation and practice in the oil and gas operations (see James *et al* 2011). A SCM suggests that *"operators should implement quarterly refresher health and safety programs and a frequent at least one every month reviews of the health and safety performance report to rectify the shortcoming in safety and health performance".* The commercial manager added that *"safety training should involve all worker not limited to particular but all workers".* Further opinions from the SMs to address these challenges, suggest that all stakeholders should show commitment to health and safety procedures, abide by them, and provide safety equipment on site for workers and visitors on site. The SMs suggest to operators regarding emergency service challenges that operators should cooperate and collaborate with one another to provide and use these services. A SCM added that operators at the same zone can collectively come together to provide and use emergency services such as a helicopter, small vessels, and divers and share the cost.

The lawlessness as a security threat in the oil and gas operations can be manage and control at the host communities' levels according to the SMs. They explain that operators should empower host community opinion leaders to solve the insecurity problem with no cost. A SCM who worked in the Gulf of Guinea states, "*The kidnapping and the attacks on facilities are executed by the communities' members, sometimes through some opinion's leaders. By empowering the opinion leaders by including them in some of the decision-making processes, they feel honoured and respected and be part of the resource management and community development, hence they can help to cease violence and the attacks."* One of the SMs states, *"These strategies of involving and empowering the community leaders have reduced the kidnapping and destructions of facilities drastically for over five years in the Gulf of Guinea."*

Some of the SMs suggests fulfilment of Corporate Social Responsibility (CSR) is prudent strategy in minimising the insecurity issues in the oil and gas operations in the Gulf of Guinea. See Carroll (2010). A SLO states that *"providing the community with social amenities, specifically physical structures such as roads, schools, health facilities and scholarships incentive for the younger ones would let the community members see and feel the impact of the operators' good work in the community rather than to channel the resources through government officials"*. When community members see and use these facilities, they would protect the operator's facilities because they know more will come when more oil produced in the community. Other SMs explain that this approach worked for some operators in the Gulf of Guinea. A couple of the SMs explain that politics and corruption could handle at government level; however, operators should concentrate at the community level.

4.9.5 Optimisation of Regulatory Framework Cost

The SMs' views on regulatory framework as the measure for operational optimisation in oil and gas operations is overwhelming and concentrated on negotiation, dialogue and building good relationship and trust, which they believed that these could respond to regulatory complexity and the Local Content Law challenges.

The regulatory complexity can be address according to the SMs based on their long working experiences indicate that all laws and regulations in the oil and gas operations are negotiable and can be sample when the operators communicate the *"language"* that the host understands. A SN states "*operators need to know and understand the fundamentals beliefs and cultural practices of the host and act according to them as negotiation is a game to play by the rules no instructor but guides by the host beliefs of doing things not the operator ways. For Example, Africans like respect and like to be address by their titles rather than by their given name and like to be ask of family members like wife, children, father, and mother. Middle East people like to give gifts and British are policy-oriented"*. Collectively, they believe that if operators uphold to these cultural norms and the ways host does things their negotiation can yield positive business treaties. Some of the SMs testified that this strategy worked for them under various deals in Africa, Middle East in the UK and this can help to renegotiate for Local Content Regulations too.

4.10 Findings, Summary and Conclusion of Qualitative Results and discussion

Overwhelmingly, the SMs' views from both questionnaires and semi-structured interviews discussions and result reveal regulatory quality, government effectiveness, corruption and political instability and violence are the main drivers of operational challenges in oil and gas operation though these challenges are global by description but very predominant in Africa and South America. Besides these findings, labour deficit and salaries also drives labour cost while poor procurement, Local Content Law and water depth drives supplies and service cost. Furthermore, the results suggest poor maintenance culture and complex maintenance activities are some of the driving forces of the maintenance cost in oil and gas operations. However, health and safety security cost are presumably influenced by poor implementation of health and safety systems and emergency services while lawlessness triggers security issues and complexity of regulations is associated with regulatory framework.

Interestingly, the results suggest that these issues could be addressed via implementation of graduate and internship programs and engagement of employment agencies for the recruitment process to respond to the labour problems, while the same results recommend IPS, technology and training and good housekeeping implementation to respond to maintenance cost challenges. Moreover, quarterly health and safety refresher program and commitment to safety procedures and speak their language for regulations can address health safety and security and regulatory framework issues.

Chapter Five

Quantitative Analysis: Results and Discussions

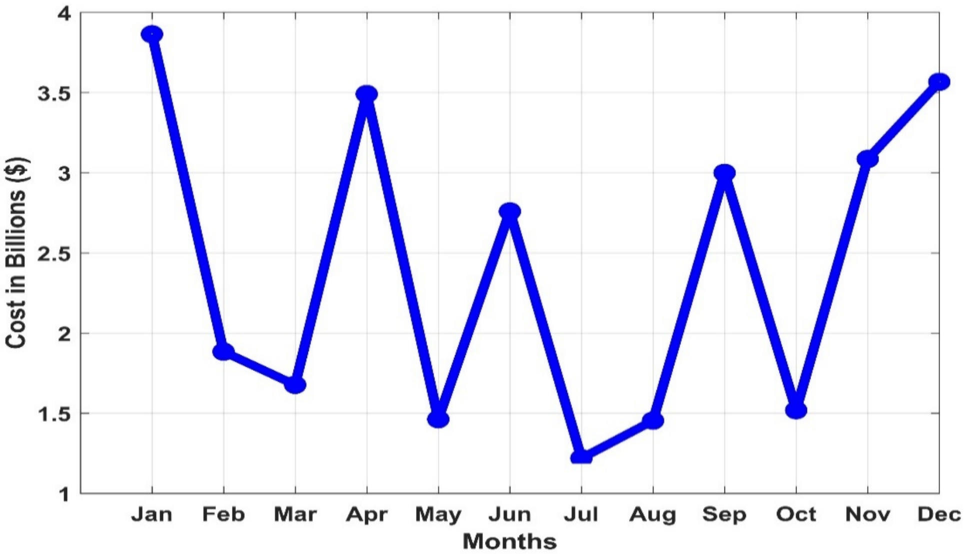
5.1 Introduction

This chapter evaluates the individual operating cost objects and their association with operating cost in the Gulf and Guinea and the UK North Sea with a view to addressing the second objective of this study. This chapter produces the analysis based on multiple tools (such as excel and EViews software) in order to produce line graphs (used in illustrating the operating cost pattern in the two regions under investigation) and other statistical results. Therefore, the chapter begins by exploring the descriptive statistics on individual operating cost objects to evaluate the basic characteristics and properties of the data. The second section of this chapter presents VAR and OLS results that are presented in Tables 5.1 to 5.10. These demonstrate the relationship between of the operating cost objects to one another. Furthermore, VAR results demonstrate the impact of the operating cost objects on one another using the readings from the impulse response functions and the forecast error variance decompositions. Thus more specifically, the dynamics in the operating cost objects in the oil and gas operation in the Gulf of Guinea and the UK North Sea are analysed. The OLS results also explain the return on investing in the operating cost objects which illustrate how sensitive the operating cost objects are to the investments in the Gulf of Gulf and the UK North Sea.

5.2 The Empirical Evaluation of the Gulf of Guinea Operating Cost Objects

This section evaluates the operating cost data collected on the operating cost objects in the Gulf of Guinea oil and gas operations. The discussions in this section focus on identifying activities that influence operating cost objects via trend analytical approach where excel tools are used to generate line graphs from the operating cost data, which demonstrate monthly trend of the operating cost in the Gulf of Guinea oil and gas operation.

Figure 5.1: Labour Cost Object Behaviour in the Gulf of Guinea



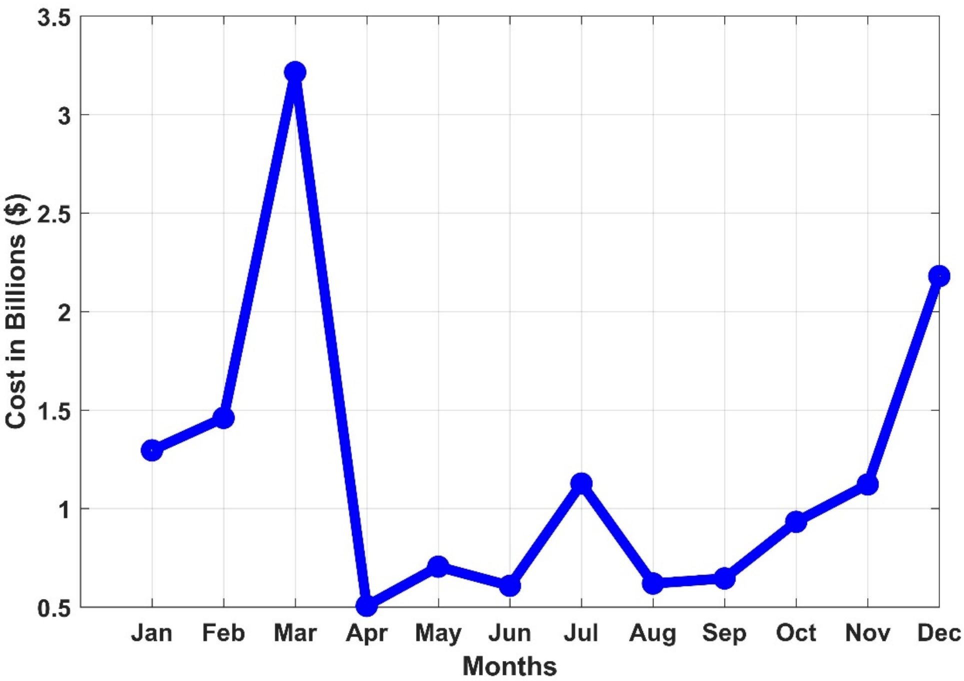
Source: Author's own work (2019)

Figure 5.1 illustrates the trend in labour cost object on monthly basis from the selected projects to identify the factors which influence operating cost behaviour in the Gulf of Guinea. From the operating cost data obtained from the NOCs in the Gulf of Guinea which this study critical evaluates the labour cost object by using simple percentage computation where some key transaction under labour cost object is taken as the percentage of the total of labour cost object to measure the percentage portion of them on the labour costs. Heather *et al.* (2013) uses the same method to evaluate projects cost in the transportation industry. From the evaluation, 35 per cent of the labour cost object accounts for the permanent staffs' salaries. Consistently, this key factor of salaries correlates to qualitative results, which is also identify salaries as a major driver of labour cost object in oil and gas operations. Further critical evaluation of the labour cost object records reals that a significant amount of the salaries accrued from managers' salaries and this directly reflect on the SMs view of the many line-managers accrues huge amount of the salaries.

Subsequently, further evidence from the same cost data evaluates 25 per cent of the labour cost object attributes to staff pension gratuities, which demonstrates higher retirement rate causing skill labour deficit, which is also indicate by the seniors' managers as a driver of the labour cost object in the oil and gas operations. Besides that, 15 per cent of the labour cost object accounts for staffs' emolument as compensation to downturn workers, and 10 per cent accounts for payment of contract staff. Meanwhile, recruitment and engagement process also accrued 15 per cent of labour cost object in the Gulf of Guinea oil and gas operations.

This study takes a critical evaluation of the periods of the cost data and records, which demonstrates that the months January recorded the highest percentage of the cost representing 17.13 per cent of the total labour cost followed by December. This study across checks the monthly transaction of the labour cost ledger to identify the factors which influence the high labour cost in the two months, and it reveals that payment of part-time, contract and overtime workers influence the labour cost object in those two months. At those months, most of the permanent workers are on Christmas break to celebrate Christmas with their families and loved ones, which increases the demand for part-time and contract workers. In two months, the operators pay both permanent and contract work salaries and wages, which increase the labour cost. Extant literature from Marion (2011) and the SMs indicate labour is a challenge in the Gulf of Guinea.

Figure 5.2: Illustration of Supplies and Service Cost Object Behaviour in the Gulf of Guinea

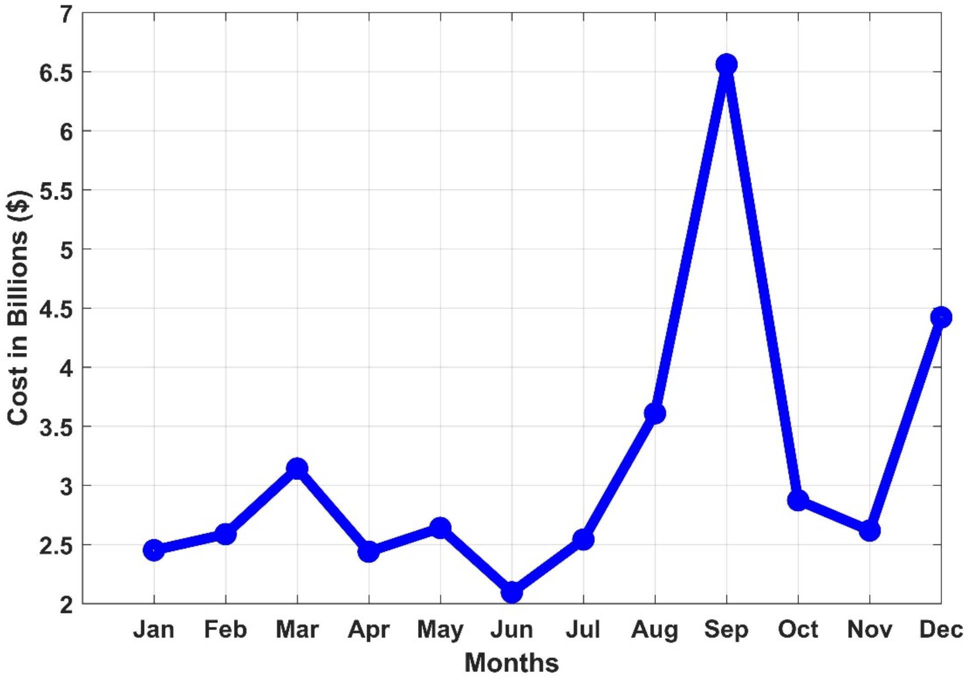


Source: Author's Own work (2019)

Figure 5.2 presents the trend of the supplies and service cost object, where this study conducted a critical evaluation of the cost and the financial data to identify the kay cost factors which influence the supplies and service cost object. The evaluation of the kay cost items under supplies and service follow the same simple percentage computation to ascertain the weight of the key cost items on the supplies and service cost object. This study critical evaluates the transactions of the supplies and service cost ledger and identified that the supply of equipment parts for replacement accounts for 22 per cent of the supplies and service cost object which deflect from the qualitative results and discussions which indicate supplies of pipelines drives the supplies and service cost. Further computation of the cost items to measure percentage weight of the individuals cost factors which influence supplies and service reveals that 21 per cent of the cost is generated from supply of office equipment with Information Communication Technology (ICT) equipment reoccurs for many times. Which is lack of strategic order of ICT as indicated by the SMs as a driver to supplies and service cost object.

Notwithstanding the key cost items with their various weight on the supplies and service cost, this study identifies energy consumption also contribute 29 per cent of supplies and service cost which was not indicated as a driver by the SMs. Overwhelmingly, food and oilfield chemical expenditure weight of 30 per cent of supplies and service, which directly reflect on the SMs views, as they identified oilfield chemical food as one of the key supplies and service cost object driver. An analysis of the graph demonstrate that March and December are the two months which recorded the highest cost figures which means that operators engage in an intensive supplies and service activities in the first and the last quarters of the operation years. Additionally, payment for the activities is paid in lump sum in those quarters. Literature from Wazir *el at*. (2018) indicate some the raise in the above analysis.

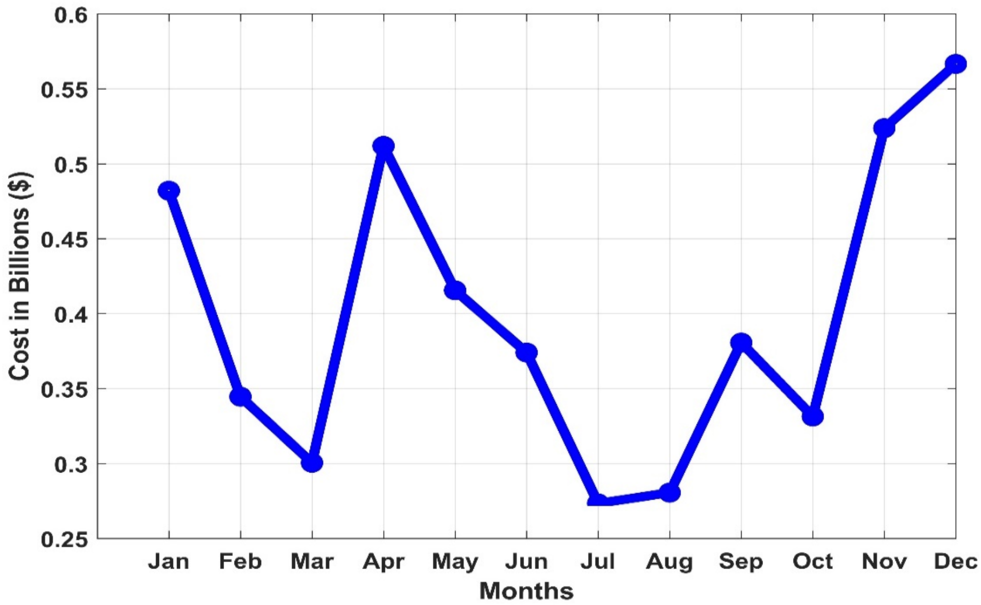
Figure 5.3: Illustration of Maintenance Cost Object Behaviour in the Gulf of Guinea



Source: Author's Own work (2019)

Figure 5.3 presents a graph which illustrates the monthly trend of maintenance cost object of the selected projects from their maintenance cost ledgers in the Gulf of Guinea. This study critically evaluates the maintenance cost ledgers and identified that 30 per cent of the maintenance cost object is generated from maintenance activities of production facilities which indicate frequent malfunction of the production equipment which the SMs responses and literature from Ahmed *et al*. (218) indicate poor maintenance culture as a cause of some system breakdown. Further adjustment of the maintenance cost ledger reveals that 25 per cent of the maintenance cost object is associated to reservoirs' and production well intervention activities, which influence by the age of oil and gas filed which yield complex reservoir and production wells diagnosis. This finding also correlates to the long lead maintenance activities and complexity as indicate in the qualitative result from the SMs. Moreover, 23 per cent of the cost is attributes to maintenance activities of flow lines, risers and pipelines and flow-station, and 22 per cent accrued from other regular maintenance and inspections. Additional evidence reveals a monthly recurring expenditure of maintenance activities of production platform equipment and storage facility and terminals' maintenance, which suggested that poor maintenance culture and attitude and ignoring corrective and preventive maintenances, as confirmed in the qualitative result, as a driver. See literature Wan (2011) analysis.

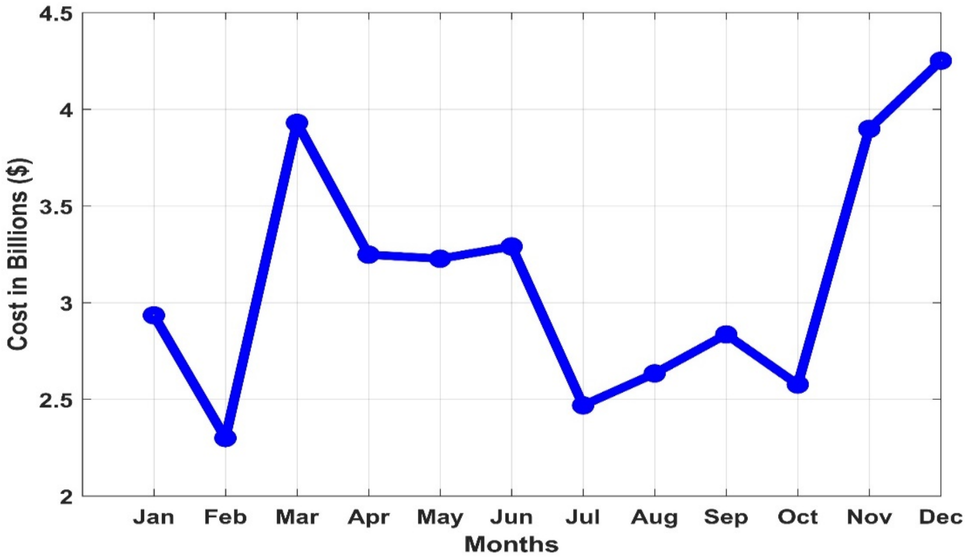
Figure 5.4: Illustration of Health, Safety and Security Cost Object Behaviour in the Gulf of Guinea



Source: Author's Own work (2019)

Figure 5.4 illustrates trend in the health, safety, and security cost object in the Gulf of Guinea. The graph is constructed from the cost data obtained from the integrated selected projects health safety and security cost ledgers, where this study evaluates and consolidates the cost data to measure the percentage weight some of key cost items influence on the cost. This study evaluates the health safety and security cost ledgers and identified that 37 per cent of cost accounts for an expenditure on police, armed forces, and some security services to provide security to protect the operators and their assets. Further evaluations of the cost ledgers reveal that hiring of vessels, helicopters, and vehicles to patrol around the production platforms to response to security threats and emergency services accrues 30 per cent of health safety and security cost. This evidence directly correlates to the SMs views on these activities influence health, safety and security cost in oil and gas operations. Additional evaluations of the cost ledgers disclose that accident prevention activities, safety inspection and medical-related issues account for 15 per cent of the health, safety, and security, and 12 per cent of the cost is trace to health and safety training and environmental related issues, while 6 per cent is associated to waste management and pollution control. See Alex *el al*. (2010)

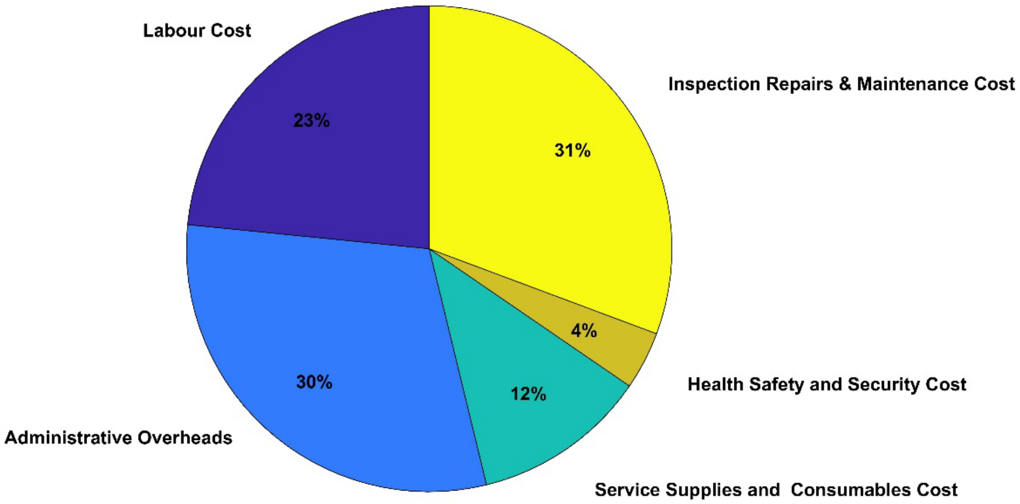
Figure 5.5: Illustration of Administrative Overheads Object Behaviour in the Gulf of Guinea



Source: Author's Own work (2019)

Figure 5.5 illustrates the trend of administrative overheads object in the Gulf of Guinea. This study critically evaluates the administrative cost to identify key cost elements influence on the administrative cost in the Gulf of Guinea oil and gas operations. From the various administrative cost ledgers, this study evaluates the cost and identifies that 35 per cent of the cost accounts for travelling cost, which includes flight tickets, accommodation, feeding, travelling insurance and allowance for workshops and training. Further evaluations of the administrative cost ledgers reveal that 30 per cent of the overhead cost is associated with office rent and expatriates' accommodation and feeding, and 20 per cent cost is attributed to meetings, refreshment and honorarium, professional subscription fee and donation at social events. Additionally, 15 per cent of cost accounts for general administrative services including stationaries, telephone bills, and internet and electricity bills. A critically investigation conducted in the administrative cost ledgers of the various selected projects reveals that the management meetings, Stationaries and travelling expenses appear many times within a month with substantial amount. Additionally, payments of professional fees also carry a substantial amount without any breakdown to demonstrate what professional subscription fees they paid. Further inquiries in the cost ledgers reveals that the managers' offices are typical 'living room', as this traces some administrative cost to beverages for breakfast. Hence, these are the elements this study identified as the factors which influence administrative cost in the Gulf of Guinea. See Rajesh *el at*. (2015)

Figure 5.6: Illustration of Distributions of Operating Cost Objects in the Gulf of Guinea



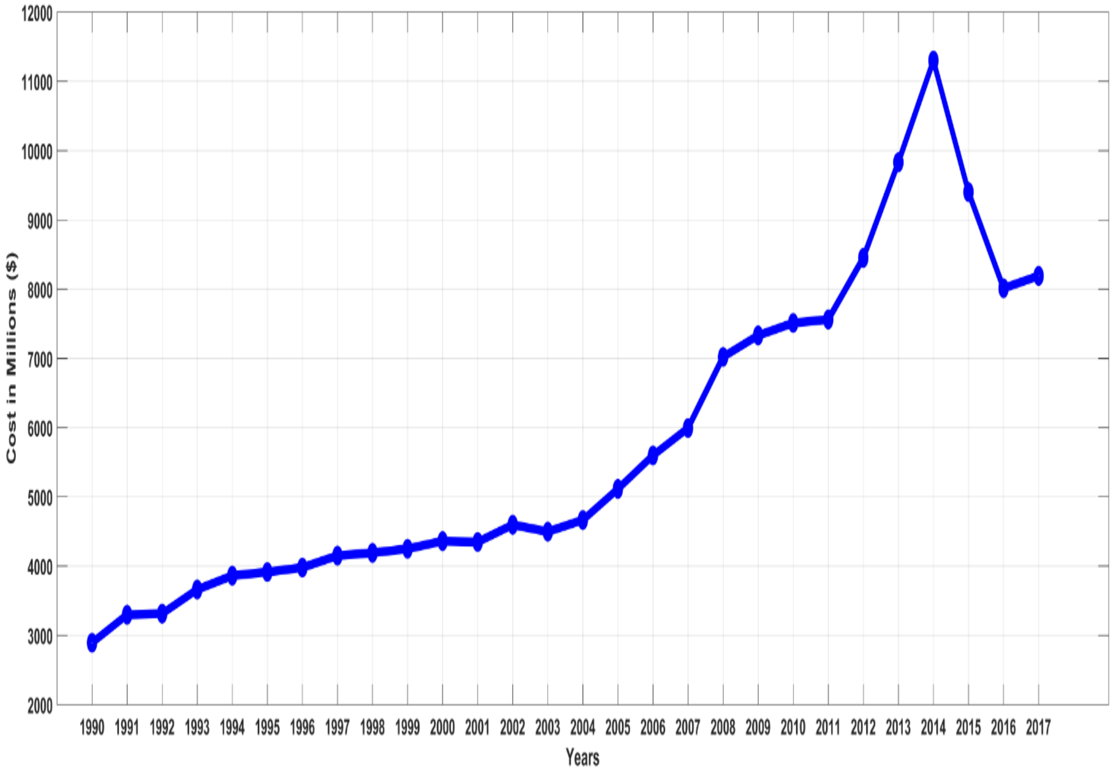
Source: Author's own work (2019)

Figure 5.6 presents the percentage portion each of the operating cost objects contribute to operating cost of Gulf of Guinea. In the pie chart maintenance cost object recorded the highest portion of the operating cost in the Gulf of Guinea, which suggests that in the Gulf of Guinea oil and gas operation spend more on maintenance activities that is 31 per cent of the operating cost is influenced by maintenance cost object. Next to maintenance cost object is administrative cost object with 30 per cent weight on the operating cost and labour cost with 23 per cent. However, 12 per cent and 4 per cent are for service and supplies and health safety and security respectively.

5.3 The Empirical Evaluation of the UK North Sea Operating Cost Objects

This section presents analysis of the operating cost objects in the UK North Sea oil and gas operation. Excel tools are used to construct line graphs which demonstrates yearly trends of the operating cost in the oil and gas operations in the UK North Sea. This study further investigates operating cost sources and other financial reports to establish the reasons influence the operating cost in the UK North Sea. The section further measures the percentage representation of some individual operating cost objects influence in oil and gas operating cost in the UK North Sea.

Figure 5.7: Illustration of Labour Cost Object Behaviour in the North Sea operations



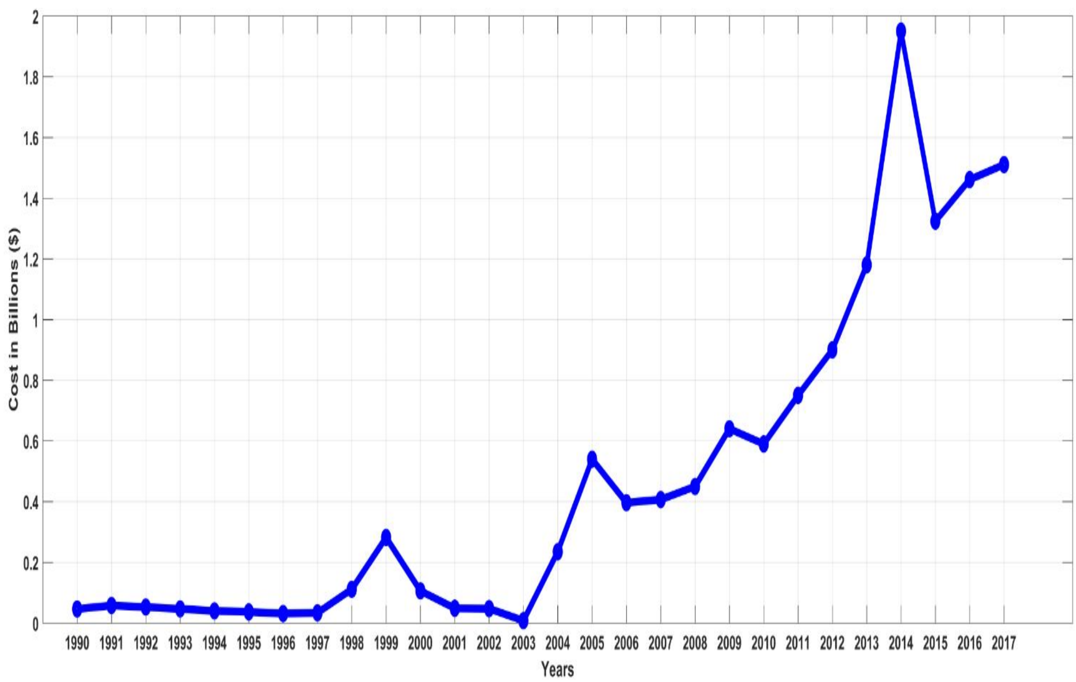
Source: Author's own work (2019)

Figure 5.7 illustrates the trend of labour cost object in the UK North Sea from 1990 to 2017. The graph demonstrates a progressive trend of the labour cost object which translates that increase in years of operations (matured fields) leads to increase in labour cost object in the UK North Sea as shown in the graph. This study evaluates the data sources and other relevant sources of information, which reveal that mature oil fields have more operational activities which demand more workers and high labour cost. Additionally, the literature maintains and confirmed that mature fields or zones or basin generally develop into reservoirs and production wells complexity due to continues modification of the original engineering design and development to enhance reservoir performance (Bea 2013; Ryu *et al.* 2014), and this increase work at the fields by demanding more labour, hence the UK North Sea is a mature zone. This study further evaluates 6 per cent annual increase of the labour cost object in the UK North Sea is influenced and driven by the increase in operational activities in the twentieth century.

Further evaluation of the data and consolidation with other operational reports in the North Sea commonly indicate that strikes of workers, agitation for better wages, allowance and service significantly influence the labour cost object in the North of Sea. A relevant literature in the UK North Sea confirmed that Royal Dutch Shell and Wood Group which are some of the main operators in the UK North Sea encounter a few workers strikes which lead to increase in part-time and contract workers to cover the strike period (Hisain 2017). These operators paid both the permanent (strike workers) and the part-time and contract workers, which increase the labour cost, object in the UK North Sea.

Besides the above evidence identified in the UK North Sea that influence the labour cost objects and behaviours, a critical assessment of the data sources further reveals that compensation paid to laid-off workers during the crude oil market turndown increase the labour cost object by 34 per cent in the UK North Sea. Additional evaluation of data and its sources reveals that the few retained ones also agitate for better working conditions, which include increase in allowances, and remuneration and these assume to influence the labour cost object by 10 per cent in the UK North Sea. Subsequent assessment and evaluation reveal the few workers due the lay-off cause pressure on the workers which leads to engagement of the overtime and contract staffs which increase the labour cost object by 15 per cent. Additionally, technical operating reports indicates that deficit skill labour due to the high rate of retirement of experienced workers influence labour cost object in the UK North Sea. The above factors are identified from the data sources as the factors affecting labour cost object in the UK North Sea.

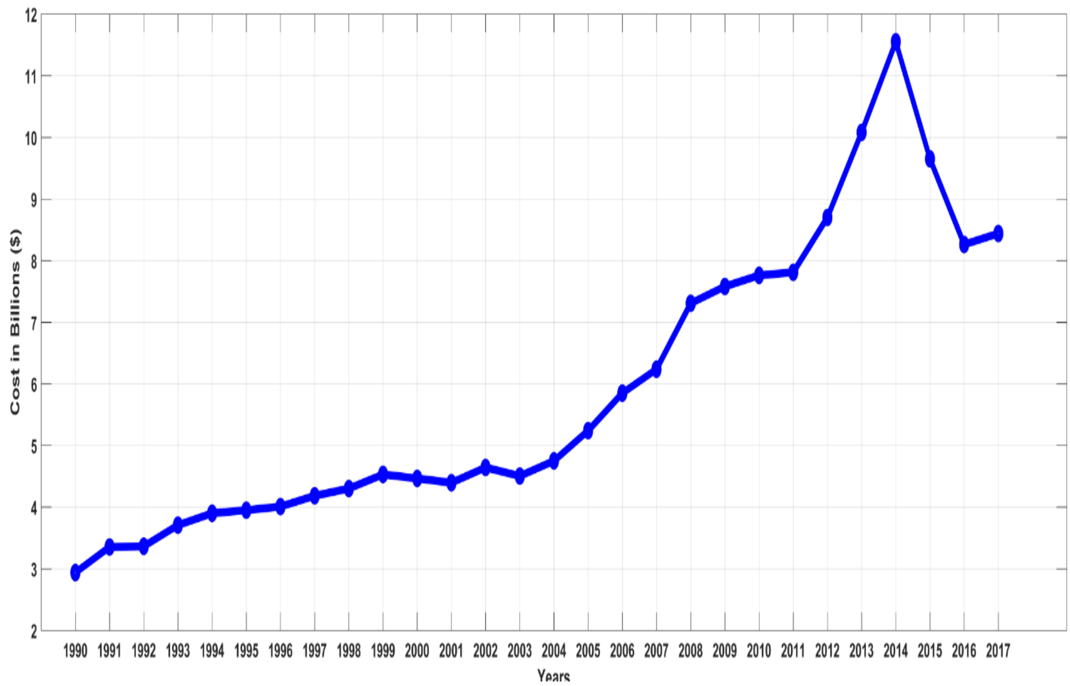
Figure 5.8: Illustration of Supplies and Services Cost Object Behaviour in the North Sea Operations



Source: Author's own work (2019)

Figure 5.8 demonstrates the trend of supplies and service cost object in North Sea oil and gas operations. This study critically evaluates the operating cost data and other technical report and identifies that a significant amount of expenditure relates to subcontractors and third parties service costs. A critical assessment of the data reveals that the third parties service cost influences the supplies and service cost due to poor procurement progress, which directly reflect on the senior management views as a driver in oil and gas operations. Besides the poor procurement system, this study identified supplies of equipment parts to replace the long-overdue operational equipment part with low efficiency and to enhance the integrity of the equipment influence 20 per cent of the supplies and service cost object in the UK North Sea. Additionally, evaluation of data reveals that supplies of oilfield chemicals, lubricants and fasteners to provide support to the old reservoir and equipment influence 15 per cent of supplies and service cost in the UK North Sea. Furthermore, 14 per cent accounted of the supplies, service in the UK North Sea is associated to supplies of safety equipment, and 18.40 per cent is influenced by energy and other consumables. These findings directly correlate to the qualitative findings where the SMs argued that poor procurement affect all the other drivers in the in oil and gas operations. See Irati *et al*. (2018) and Wongnarin *et al.* (2018).

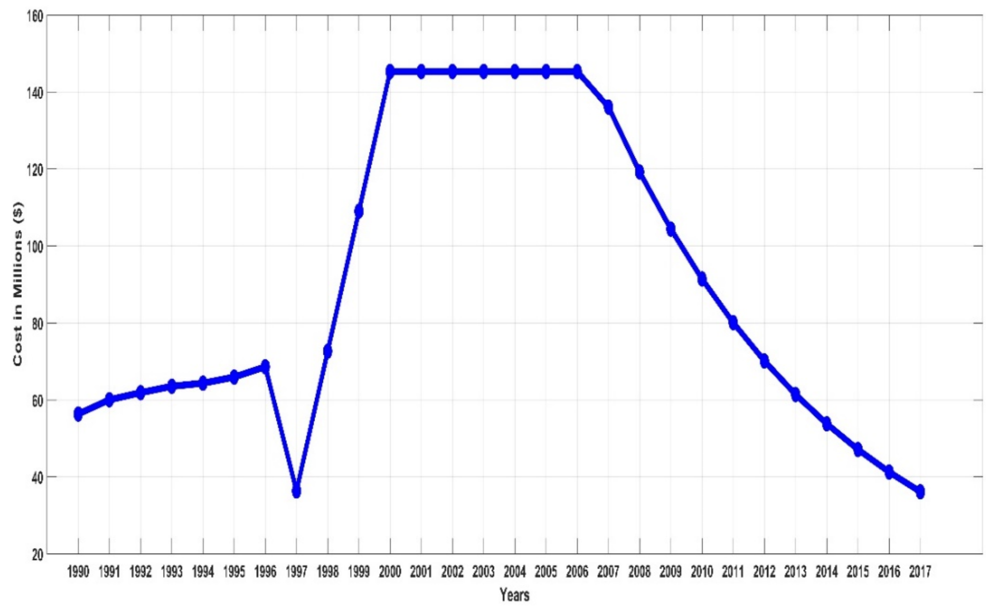
Figure 5. 9: Illustration of Maintenance Cost Object Behaviour in the North Sea Operations



Source: Author's own work (2019)

Figure 5.9 presents a graph that illustrates the trend in maintenance cost object in the UK North Sea from the data obtained from the UK Oil and Gas Authority database covering from 1990 to 2017. This study critically assesses the data and consolidate with other relevant technical reports in the UK North Sea oil and gas operation to identify factors which influence the maintenance cost object. The enquiries reveal that the aged of operational infrastructure and the high reservoir depletion rate due to the mature nature of the Basin influence maintenance activities, which influence the maintenance cost object in the UK North Sea. Technically, the maturity and the aged of operational equipment lost their mechanical integrity and causes frequent faults and breakdown of the production facilities. A critical analysis of BP (2018) statistics reveals that these issues influence the maintenance cost object in the UK North Sea by 57 per cent. Further analysis from the data sources indicate that 11 per cent of the maintenance cost is influenced by production wells intervention. Additional evaluation of the data indicates 16 per cent of maintenance cost accounts for production facilities. Further inquiries reveal that subsea maintenance engineering works, flowlines, pipeline, fixed and floating platforms influence the maintenance cost. Further, evaluate of the data reveals that producing wells logging to optimise production are frequent in the North Sea which drive the maintenance cost.

Figure 5.10: Illustration of Administrative Cost Object Behaviour in the North Sea Operations

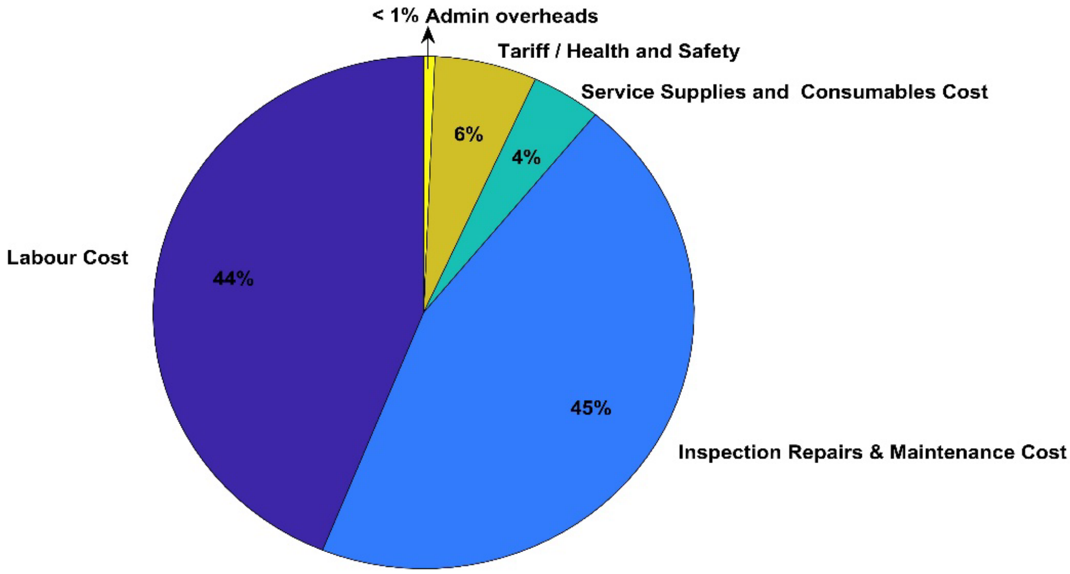


Source: Author's own work (2019)

Figure 5.10 illustrates the trend of administrative overheads in the UK North Sea. This information is process from the operating cost data obtained from UK Oil and Gas Authority database and other relevant reports relating to oil and gas operation in the UK North Sea. This study critically evaluates administrative overheads and identified that a cost build-up from general administrative support services cost, health and safety and decommissioning expenditure. A critical assessment and evaluation of the data reveals that general administrative cost in UK North Sea is significantly influence by payment of office rent and bills. The replacement of the office equipment such computers also influence the administrative cost object. Further assessment of the data indicates that a substantial amount of the cost is influenced by travelling cost, travelling insurance and accommodations for managers attending workshops and other training programs hence, these findings correlate to Gulf of Guinea administrative cost driver. The cost of managing oil and gas project also constitute a significant component of the administrative cost.

A critical assessment of the data reveals that the health and safety cost in the UK North Sea is influenced by the mandatory provision of health and safety services and emergency service, where operators must provide small vessels, divers and helicopters which become intensified after Piper Alpha disaster. Further inquiries conducted on the operating cost data reveal that decommissioning activities influence 35 per cent of the administrative cost, and these findings are consistent with Cole (2014) and Eze *et al.* (2016). Additional evidence from Gas Authority report 2017 indicates that over £2.1 billion decommissioning cost is recorded in 2015 and this went up marginally in 2016/2017. Additional statistics from the same report indicates 20 per cent of decommissioning tax on progressive scale towards the age of the reservoirs.

Figure 5.11:Piechart Displaying Proportion of Operating Cost Drivers in the North Sea



Source: Author's own work (2019)

Results from Figure 5.11 indicates maintenance cost object and the labour cost object are the main operating cost objects driving the UK North Sea oil and gas operating cost as both contribute 89% of the operating cost in the UK North Sea as shown in the Pie chat.

5.4 Vector Autoregressive Estimates for the Variables

This section presents the VAR estimates for based on the recommended lag selection criteria of 2 periods with lag 1(-1) which illustrates the influence of current operating cost object on the immediate past year, and lag 2 (-2) which illustrates the influence of the current operating cost object on the past two years. These results are organised in tables as shown below from Table 5.1 to Table 5.5. The results demonstrate how the operating cost objects influences individual operating cost for lag 1 and lag 2. The data used for this analysis is a combination of the various operating cost data collected for both regions.

Table 5.1: Vector Autoregression Estimates for Labour Cost Object

Variable	Labour	Service & Supplies	Maintenance	Administrative Overheads	Operating Revenue
Labour (-1)	-0.7188	-0.3091	-1.3821	-0.1028	-34.9314
	(1.90011)	(1.08480)	(1.91687)	(0.07964)	(16.3640)
	[-0.37829]	[-0.28492]	[-0.72101]	[-1.29044]	[-2.13466]
Labour (-2)	-5.5729	-0.3465	-5.0669	0.0514	-25.0164
	(2.28598)	(1.30510)	(2.30615)	(0.09582)	(19.6871)
	[-2.43786]	[-0.26552]	[-2.19711]	[0.53624]	[-1.27071]

Note: Vector Autoregression Estimates, Included observations: 26 after adjustments

Coefficient of the variables is the first figure, in an open bracket,

Standard errors second figure in a round bracket ()

T-statistics third figure in a square bracket []

Table 5.1 illustrates VAR estimations of labour cost object for lag 1 and lag 2. The estimates of the both lags illustrated in Table 5.1 show that in the lag 1 period, none of the operating cost object influences the labour costs as all the operating cost objects recorded an insignificant t-statistics value. However, the VAR estimates indicate that maintenance cost object and labour cost object influence labour cost in lag 1 as these two operating cost objects record the highest coefficient of the variables. However, the operating revenue has recorded the highest t-statistics of 2.13 in lag 1, which shows significant association with labour cost object. This indicates that labour cost object strongly predicts operating revenue of Gulf of Guinea and the UK North Sea.

Apart from the effect of the labour cost object on operating revenue in the lag 1, all other operating cost objects show weak impact on labour cost object in the two regions under investments.

In lag 2 results presented in Table 5.2, the estimates show that the labour cost object itself and maintenance cost object exhibit a strong association with labour cost object in the Gulf of Guinea and the UK North Sea. Confirming that the two operating cost objects in Table 1 recorded the highest t-statistics values of 2.44 and 2.20 for labour cost object and maintenance cost object respectively. Consistent with the t-statistics values, the VAR estimates illustrate that labour cost object has a strong association of 557 per cent influence on itself in lag 2. Furthermore, the maintenance cost object also influences labour cost object of 506 per cent as shown in Table 5.2. Comparatively, supplies, service, and administrative cost objects show insignificant impact on the labour cost in both lag 1 and lag 2 in the Gulf of Guinea and The UK North Sea oil and gas operations. Conclusively from the Table 5.1, labour cost object and maintenance cost object significantly influence labour cost object in the Gulf of Guinea and the UK North oil and gas operation, and these findings correlate the two pie chat results of labour and maintenance play significant role from operating cost evaluation of the two regions.

Table 5.2: Vector Autoregression Estimates for Supplies and Service

Variables	Labour	Supplies &services	Maintenance	Administrative Overheads	Operating Revenue
Supplies & Service & (-1)	-2.0571	-0.5987	-1.9517	-0.0185	-4.6245
	(0.95722)	(0.54649)	(0.96567)	(0.04012)	(8.24369)
	[-2.14901]	[-1.09558]	[-2.02109]	[-0.46024]	[-0.56097]
Supplies& Service (-2)	0.1503	0.1973	0.1217	-0.0136	-11.4820
	(0.84603)		(0.85350)	(7.28615)	(0.48301)
	[-0.38419]	[0.14259]	[0.17762]	[-1.57586]	[0.40849]

Note: Vector Autoregression Estimates, Included observations: 26 after adjustments
Coefficient of the variables is the first figure, in an open bracket,
Standard errors second figure in a round bracket ()
T-statistics third figure in a square bracket []

Table 5.2 presents the VAR estimates of supplies and services object and demonstrates the influence of other operating cost objects on supplies and service cost object in the Gulf of Guinea and the UK North Sea oil and gas Operations. From the Table 5.2, the analysis indicates that labour and maintenance cost objects demonstrate a significant influence in the supplies and service cost object in the Gulf of Guinea and the UK North Sea. This quantitative result is shown in Table 5.2 as these two operating cost objects recorded the highest t-statistics values of 2.45 and 2.02 for labour and maintenance cost objects respectively as shown on the table based on lag 1. Consistently, the VAR estimates also indicate that the labour and maintenance cost object predict supplies and service cost object significantly as the two operation cost objects recorded the highest VAR estimates of 205 per cent and 195 per cent respectively. Apart from the two operating cost objects which a significant influence of supplies and service cost objects based on the significant of the t-statistics, the rest of the operating variables exhibit a weak influence on the supplies and service cost objects.

Using lag 2, the analysis show that all operating variables have weak influence on the supplies and service cost object as all the operating variables t-statistics values are below 2. The administrative cost object is the only operating cost object that demonstrates significant level of the influence of supplies and service as it recorded the highest t-statistics of 1.58 and demonstrates 729 per cent influence on the supplies and service cost object in the Gulf of Guinea and the UK North Sea operation. Apart from the administrative cost object none of the operation variables shown a significant impact on the supplies and service in the lag. Conclusively from the analysis presented in Table 5.1, labour and maintenance cost objects again influence the supplies and service cost in lag 1, and administrative cost object influence the supplies and service cost object in lags, in nutshell labour maintenance and administrative cost influence operating cost in the Gulf of Guinea and the UK North Sea from the analysis which correlate to result in Section 5.2.

Table 5.3: Vector Autoregression Estimates for Maintenance

Variables	Labour	Supplies & Service,	Maintenance	Administrative Overheads	Operating Revenue
Maintenance (-1)	1.7835	0.5772	2.4028	0.1099	33.6793
	(1.99064)	(1.13648)	(2.00821)	(0.08344)	(17.1436)
	[0.89593]	[0.50788]	[1.19652]	[1.31682]	[1.96453]
Maintenance (-2)	4.9780	0.2527	4.4963	-0.0548	27.5307
	(2.15728)	(1.23162)	(2.17632)	(0.09042)	(18.5788)
	[2.30752]	[0.20520]	[2.06602]	[-0.60639]	[1.48184]

Note: Vector Autoregression Estimates, Included observations: 26 after adjustments
Coefficient of the variables is the first figure, in an open bracket,
Standard errors second figure in a round bracket ()
T-statistics third figure in a square bracket []

Table 5.3 illustrates VAR estimates of operating other variables on maintenance cost object for the lag 1 and lag 2 of the Gulf of Guinea and the UK North Sea oil and gas operations. The results from lag 1 show that none of the operating variables significantly influence the maintenance cost object in the Gulf of Guinea and the UK North Sea, as all the measurable variables t-statistics are statistically insignificant (below 2). However, the VAR estimates of operating revenue exhibits a strong exogenous association of the maintenance cost object, which indicates that the maintenance influence operating revenue from lag 1 results in Table 5.2. Additionally, labour cost object and the maintenance cost object also exhibit a strong associate to the maintenance cost in the same lag 1. Notwithstanding these VAR estimates, the t-statistics justified in the lag 1 that none of the operating variables significantly affect the maintenance cost object in the Gulf of Guinea and the UK North Sea.

The lag 2 prediction in Table 5.3 shows a high significant of labour cost and maintenance cost objects influence on maintenance cost object in the Gulf of Guinea and the UK North Sea. The quantitative information in Table 5.3 indicates that labour cost object recorded the highest t-statistics value of 2.31 and the maintenance cost object itself recorded a significant t-statistic values of 2.07, where the t-statistics indicate the significant level of variables. Analytically from Table 5.2 under lag 2, the VAR estimates indicate that the labour cost object influence

498 per cent of maintenance cost object in lag 2 and the maintenance cost object influence 450 per cent of the maintenance cost in lag 2 of the Gulf of Guinea and the UK North Sea oil and gas operations as shown in Table 5.2 above. Apart from the labour and maintenance cost objects in lag 2, none of the operating variables influences maintenance cost object. Conclusively, the labour cost object and the maintenance cost objects affect operating cost in the Gulf of Guinea and the UK North Sea oil and gas operations. In nutshell from the Table 5.2 labour cost and maintenance cost influence operating cost in the Gulf of Guinea and the UK North Sea oil and gas operations.

Table 5.4: Vector Autoregression Estimates for Administrative Overheads

Variables	Labour	Supplies & Service	Maintenanc e	Administrative Overheads	Operatin g Revenue
Administrative (-1)	26.7679	8.3669	27.2733	0.8045	203.7545
	(10.5117)	(6.00129)	(10.6045)	(0.44060)	(90.5283)
	[2.54648]	[1.39419]	[2.57186]	[1.82594]	[2.25073]
Administrative (-2)	-25.2755	-6.6533	-25.7317	-0.0418	-88.2464
	(11.9896)	(6.84505)	(12.0954)	(0.50255)	(103.256)
	[-2.10811]	[-0.97198]	[-2.12739]	[-0.08310]	[0.85464]

Note: Vector Autoregression Estimates, Included observations: 26 after adjustments

Coefficient of the variables is the first figure, in an open bracket,

Standard errors second figure in a round bracket ()

T-statistics third figure in a square bracket []

Table 5.4 presents VAR estimates of administrative cost object, which demonstrate the impact of the other operating variables on the administrative cost object for both lag 1 and lag 2. From the quantitative results in the Table 5.4, labour and maintenance cost objects and the operating revenue demonstrate statistically significant influence on administrative in lag 1 because these three measurable operating variables t-statistics values indicate a significant level of 2.55 for labour, 2.57 for maintenance and 2.25 for operating revenue as shown in Table 5.2. This is an indication that labour and maintenance cost objects, influence administrative cost in lag 1. The VAR estimates also indicate similar significant level of the labour and maintenance cost objects, which predict administrative cost object. Maintenance and labour cost objects predict

273 and 268 per cent respectively of the administrative cost object in the Gulf of Guinea and the UK North Sea. However, administrative cost object itself and that supplies, and service show less impact on the administrative cost in lag 1.

Lag 2 results are very similar to the lag 1 own as labour and maintenance cost objects exhibits statistically significant influence of administrative cost as these operating cost objects recorded 2.11 and 2.13 t-statistics values respectively. Further to the statistically significance outcome of the two operating cost objects, VAR estimates indicate that labour cost object influences 253 per cent of administrative cost object while maintenance cost object explains 257 per cent of the administrative cost object in lag 2. Conclusively, labour and maintenance cost objects influence administrative coat and operating cost in the Gulf of Guinea and the UK North Sea oil and gas operation. in nutshell labour and maintenance cost object decades operating cost in the Gulf of Guinea and the UK North Sea oil and gas operations.

Table 5.5: Vector Autoregression Estimates for Exogenous Variables

Variables	Labour	Supplies &Service	Maintenance	Administrative Overheads	Operating Revenue
Government Effectiveness	-12106.5400	-4726.7760	-11692.4600	-252.7979	5142.9540
	(5687.50)	(3247.07)	(5737.68)	(238.392)	(48981.4)
	[-2.12862]	[-1.45570]	[-2.03784]	[-1.06043]	[0.10500]
Corruption Control	-77166.0700	-22950.5100	-78290.8100	2.3702	- 306937.6000
	(17423.1)	(9947.07)	(17576.8)	(730.289)	(150050.)
	[-4.42896]	[-2.30726]	[-4.45422]	[0.00325]	[-2.04558]
Regulatory Quality	10936.3100	4360.4230	11939.9600	94.10180	35141.8900
	(7599.97)	(4338.93)	(7667.03)	(318.553)	(65451.9)
	[1.43899]	[1.00495]	[1.55731]	[0.29540]	[0.53691]
Political and Violence	143.2280	-80.84360	67.13930	1.6744	796.4984
	(675.290)	(385.532)	(681.248)	(28.3048)	(5815.67)
	[0.21210]	[-0.20969]	[0.09855]	[0.05915]	[0.13696]

Note: Vector Autoregression Estimates, Included observations: 26 after adjustments
Coefficient of the variables is the first figure, in an open bracket,
Standard errors second figure in a round bracket ()
T-statistics third figure in a square bracket []

Table 5.5 presents the results for exogenous variables of VAR estimates and their association with the operating cost objects in the Gulf of Guinea and the UK North Sea oil and gas operations. The quantitative results in Table 5.4 illustrate that government effectiveness has a significant influence in labour and maintenance cost objects. These two operating cost objects recorded 2.13 and 2.04 of t-statistics values in Table 5.5 and this shows that government involvement in the oil and gas activities in the Gulf of Guinea and the UK North influence labour and maintenance cost objects. Apart from labour and maintenance cost object, the results further indicate that government effectiveness has insignificant influence on the other operating cost objects. Additionally, the VAR estimates also exhibit a strong influence of government effectiveness on those two operating cost objects as shown in Table 5.5. Additionally, the results on corruption indicate an influence in labour, maintenance, supplies and service cost objects. Similarly, those operating cost objects mentioned above recorded a significant t-statistics values as shown in Table 5.5. The three operating cost objects equally indicate a higher prediction level by the corruption level as shown in Table 5.5. However, regulatory quality and political and violence shown insignificant impact on the operating cost objects in the two regions. Conclusively labour and maintenance cost objects are influence by both corruption and effect government effectiveness while supplies and service cost object is influenced by the corruption. Additionally, reflecting on the results, critically corruption and government effectiveness influence operating cost in the Gulf of Guinea and the UK North Sea oil and gas Operation.

5.5 VAR Variance Decomposition of Operating Cost Drivers

The VAR model variance decomposition predicts the forecast error variance of operating cost objects future influence on another. Data from both the Gulf of Guinea and the UK North Sea is used to forecast the impact of future operating cost objects, and this guide this study to understand the future short-run and long-run operating cost objects behaviours in the Gulf of Guinea and the UK North Sea oil and gas operations. The results are organised in the into the individual operating cost objects and their influence in changing the short-run and long-run operating cost object behaviours as explained in the tables below. This study assumed that from period 1 period 2 as short-run and from period 3 to 10 as the long-run cost as discussed below

Table 5.6: Variance Decomposition of Labour Cost Object

Period	S.E.	Labour	Supplies & Service	Maintenance	Administrative Overheads	Operating Revenue
1	394.3445	2.9899	0.0917	94.4691	2.35762	0.0917
2	577.9400	2.3154	3.8304	44.0494	48.8860	0.9189
3	806.5933	40.9660	3.6665	24.2019	27.7779	3.3877
4	1131.5460	47.5627	6.4176	18.7635	19.4988	7.7574
5	1394.3640	41.4910	8.7328	17.9425	22.0240	9.8098
6	1444.9290	39.7209	9.1907	18.5567	22.2175	10.3142
7	1463.3720	39.1638	9.2527	18.2527	23.1303	10.2005
8	1567.5380	35.3474	9.2653	17.0402	28.2320	10.11516
9	1654.1860	32.5799	9.0387	16.0349	32.0686	10.2778
10	1681.0960	31.8983	8.8737	15.6438	33.2230	10.3612

Table 5.6 illustrates the forecast error variance of labour cost object in the Gulf of Guinea and the UK North Sea oil and gas operating. The results illustrate that maintenance cost object explains 94.46 per cent of short-run (period 1) labour, which correlate with the t-statistics value of maintenance cost object in Table 5.1 records the highest value among other operating cost objects. Analytically, the higher forecast error variance decomposition for the maintenance cost object exhibits a strong association with labour cost in the Gulf of Guinea and the UK North Sea oil and gas operations. This analysis shows consistency with VAR estimates in Table 5.1 which predict that maintenance cost object influences labour cost in the lag 1 and lag 2 in the Table 5.1. Though labour cost object itself demonstrates a high VAR estimate and t-statistics value in the table, it however fails to predict its future short-run as confirmed in the Tables 5.6. These results suggest that maintenance activities in the Gulf of Guinea and the UK North Sea dictate future short-run labour cost object. However, other operating cost object show a weak prediction of future short-run labour as other operating cost objects record insignificant forecast error variance as illustrates in Table 5.5.

Additionally, in Table 5.7 above, the labour cost object, predict future long-run of itself as it records the highest forecast error variance between in the periods 3 to 10 as shown in the Table 5.6. Furthermore, the predictions of future labour cost object influence by itself reflects on VAR lag 2 estimates, where labour cost object recorded the highest coefficient than other operating cost objects as shown in the Table 5.6. Conclusively, maintenance cost object predicts future short-run labour cost object while labour cost object predicts future long-run of itself in the UK North Sea and Gulf of Guinea oil and gas operations. Hence, maintenance and labour costs objects influence future operating cost in the Gulf of Guinea and the UK North Sea.

Table 5.7: Variance Decomposition of Supplies and Service Cost Object

Period	S.E.	Labour	Supplies & Service	Maintenance	Administrative Overheads	Operating Revenue
1	225.1367	0.8816	5.8145	86.7498	0.0748	6.4793
2	272.0646	1.4436	5.8544	60.0475	25.7437	6.9108
3	282.5460	3.1493	5.5196	59.7390	24.9292	6.6629
4	300.2171	3.8941	6.0059	55.3750	26.3654	8.3597
5	350.5552	6.6856	7.4746	44.0188	32.5852	9.23579
6	380.2267	8.5297	7.9177	39.8826	33.9418	9.7281
7	385.6692	8.8121	7.9205	38.9799	34.5353	9.7523
8	386.6082	8.8922	7.9120	38.8294	34.6304	9.7360
9	392.4478	8.979006	7.9573	38.0317	35.3164	9.7155
10	398.3023	8.9996	8.0188	37.2386	35.9910	9.7520

Table 5.7 illustrates forecast error variance decomposition of supplies and service cost object. The results indicate that maintenance cost object predict the future short-run of supplies and service cost object, where maintenance cost object exhibits a strong exogenous association of 86.75 per cent of short-run supplies and service cost objects as shown in Table 5.7 under period 1. Additionally, maintenance cost object predicts the future long-run supplies and service cost object in the Gulf of Guinea and UK North Sea as shown in Table 5.6 that maintenance cost objects records the highest forecast error variance as shown in Table 5.6 from period 2 to period 10. Though labour cost object exhibits a significant influence of the supplies and service cost object in Table 5.3 VAR enstatites with significant t-statistics values, it fails to predict future supplies and service cost in the Gulf of Guinea and the UK North Sea. Additionally, the other operating cost objects also failed to predict future supplies and service cost in the Gulf and Guinea, and this reflects in the VAR estimates in Table 5.2, where the other operating cost objects exhibit a weak association with supplies and service cost object. However, administrative cost object in Table 5.6 exhibits moderate influence, though not as significant

as maintenance cost objects. Conclusively, maintenance cost object strongly predicts the future supplies and service cost in the Gulf of Guinea and the UK North Sea. Hence, maintenance cost object influences future operating cost in the Gulf of Guinea and the UK North Sea oil and gas operations.

Table 5.8: Variance Decomposition of Maintenance Cost Object

Period	S.E.	Labour	Supplies & Service	Maintenance	Administrative Overheads	Operating Revenue
1	397.8237	0.3016	0.3016	97.8959	1.1993	0.3016
2	593.4992	0.1503	3.3297	44.0748	51.5776	0.8676
3	831.8609	39.2461	3.4995	24.16529	29.2571	3.8320
4	1147.623	45.7151	6.3811	19.3201	20.5728	8.0109
5	1405.347	40.5314	8.6229	18.5220	22.3520	9.9717
6	1454.207	38.9433	9.0780	19.1653	22.3856	10.4277
7	1472.549	38.2899	9.1221	18.8526	23.4452	10.2902
8	1577.1190	34.5331	9.1074	17.5221	28.6680	10.1693
9	1666.5610	31.7570	8.8904	16.4359	32.5992	10.3175
10	1696.2400	30.9821	8.7287	16.0101	33.8832	10.3960

Table 5.8 illustrates the forecast error variance decomposition of maintenance cost object in the Gulf of Guinea and the UK North Sea oil and gas operating cost. The results show that the maintenance cost object predicts the future short-run of itself as maintenance forecast error variance decomposition is 97.90 per cent as shown in Table 5.8 under period 1. This shows that the future short-run maintenance cost in the Gulf of Guinea and the UK North Sea is influenced by the maintenance activities, which reflects on the VAR Estimates in Table 5.3. Though labour cost object exhibits a strong association to the maintenance with a significant t-statistics values in lag 1, it failed to reflect in predicting the future short-run maintenance cost object. Hence, maintenance cost object predicts short-run maintenance cost in the Gulf of Guinea and the UK North Sea. The long-run future prediction of the maintenance cost object is associated to labour as the labour cost object records the highest per cent of the forecast error than other operating cost object as shown in Table 5.8 from period 2 to period 8. This reflects on VAR estimates in Table 5.3 where labour cost object exhibits a very strong exogenous association with maintenance cost object. However, other operating cost objects exhibit weak

association with in predicting future maintenance cost in the Gulf of Guinea and the UK North Sea. Conclusively, maintenance cost determines short-run maintenance cost object and labour cost object influence long-run maintenance cost object in the Gulf of Guinea and UK North Sea. Hence, labour and maintenance cost object influence future operating cost in the Gulf of Guinea and the UK North Sea.

Table 5. 9: Variance Decomposition of Administrative Overheads

Period	S.E.	Labour	Supplies & Service,	Maintenance	Administrative Overheads	Operating Revenue
1	16.5290	0.0000	0.0000	0.0000	100.0000	0.0000
2	26.0429	5.6946	0.5879	0.4401	92.7993	0.4780
3	31.6987	6.7288	1.4243	1.4525	88.5521	1.8423
4	33.7478	6.5760	1.7563	1.8622	86.0541	3.7514
5	35.05607	8.1471	1.8646	2.3843	83.69116	3.9129
6	35.8207	8.5489	2.1638	2.7671	82.4849	4.0353
7	36.4186	8.6096	2.4269	3.0119	81.6679	4.2836
8	36.69986	8.5942	2.5083	3.0815	81.3360	4.4799
9	36.78272	8.5993	2.5224	3.0939	81.2897	4.4947
10	36.8269	8.6732	2.5366	3.1064	81.1788	4.5050

Table 5.9 illustrates the forecast errors variance of administrative overheads and the results demonstrate a strong endogenous systematic prediction of the administrative cost from period 1 to 10 as shown in Table 5.9 above. Though labour and maintenance cost objects exhibit strong association with administrative cost object as shown in the Table 5.4, the two operating cost objects failed to predict administrative cost object into future as their forecast error variances shown in Table5.9 are insignificant as compare to administrative cost object itself. Additionally, supplies and service cost object also show insignificant future prediction of administrative cost. Conclusively, the future administrative cost object in the Gulf of Guinea and the UK North Sea is influenced by the administrative cost itself. Hence, administrative influence future operating cost in the Gulf of Guinea and the UK North Sea.

From the VAR estimates and the Vector Decomposition, the results identify maintenance cost and the labour cost objects are the two main operating cost objects which influence operating cost in the Gulf of Guinea and the UK North Sea oil and gas operation. Additionally, the two operating cost objects predict both short-run and long-run future operating cost in the two regions. These findings indicate in both the VAR estimates and the Vector Decomposition where maintenance and labour cost objects exhibit strong association in predicting the other operating cost objects including themselves. Hence, in order to optimise oil and gas operation through operating cost controls, much attention is need to maintenance and labour activities in the Gulf of Guinea and UK North Sea understand them for optimisation of oil and gas operations.

5.6 Sensitivity Analysis: OLS Machine Learning Aided Approach

This section of the study evaluates the return on investing in the operating activities via labour, supplies and services, maintenance and security health and safety cost objects. This study adopts Ordinary Least Squares (OLS) a machine learning technique to evaluate the return on investing in the individual operating cost objects in the Gulf of Guinea and the UK North oil and gas operations. the data collected on the operating cost objects is used to generate the results. The return on investing in the operating cost objects explains how sensitive individual operating cost objects influences the investment. Hence, the equation $w = (C^T C)^{-1} C^T R$, is used as explained in the methodology chapter to measure the returns. In the equation, W represents the sensitiveness/the return (weights) of the operating cost objects, C is the operating cost object and the R is the operating revenue. The results are interpreted, where the weight (W) is a positive value, it indicates the amount gain in return investing in operating cost objects and negative values represent loss on return in investing in the operating cost objects in the Gulf of Guinea and the UK North Sea.

Table 5.10: Illustration of the Sensitivity of the Operating Cost to Operating Revenues

Regions	Labour	Supplies & service	Maintenance	Health safety security	Admin
Gulf of Guinea	1.83	0.37	1.21	3.87	0.81
North Sea	-2.68	1.00	-6.00	Non	1.94

Source: Author's own work (2019)

Table 5.10 presents the sensitivities (Weights) of the various operating cost objects with the operating revenue which are computed using the formula $w = (C^T C)^{-1} C^T R$ and

Labour Cost Objects; the results in Table 10 indicate that, for every £1.00 of expenditure on labour yield £1.83 revenue in Gulf of Guinea oil and gas operations. Critically, this demonstrates the importance of the labour cost object on the fiscal return in the oil and gas operations in the Gulf of Guinea. Analytically, Gulf and Guinea labour activities brings in £0.83 net revenue by comparing input of £1.00 of labour which yield £1.83. Hence, if labour activities are efficiently managed more net return will be realise which will enhances the over fiscal performance of the regions. At the UK North Sea, the result suggests that for every input of £1.00 of labour cost the operations yield a loss of (£2.68) as shown in Table 11 above. This indicate that operators in the UK North Sea need to invest £3.00 in labour cost in order to yield positive fiscal returns on the labour. This huge labour cost fiscal deficit suggests the UK North Sea is economically disadvantage and the spend more on labour than the return on labour. Operators in the UK North Sea need to understand the labour activities and effectively managed to break-even in to stay in business than to opt out. These evidence of OLS results for both regions signify that Gulf of Guinea looks economically viable as compared to the North Sea as operators in the UK North Sea need to invest £2.68 in labour to break-even while Gulf of Guinea earns £1.83 on return in investing in labour. See Chuanyu *et al*. (2014) for similar conclusion.

Supplies and Service Costs Object; the results suggest that for every input of £1.00 in supplies and service in the Gulf of Guinea and the UK North Sea operations it yield an output of £0.37 and £1.00 for Gulf of Guinea and the UK North Sea respectively. This means that supplies and service activities bring in positive return into oil and gas operations in the two regions. From the analysis, both regions are economically viable and can earn returns if operators efficiently manage to optimise the supplies and service activities in the two regions as indicated by the SMs and supporting literature evidence from Juneng *et al.* (2013).

Maintenance Cost Objects: the results in Table 10 illustrates that for every £1.00 input of maintenance activities yield £1.21 of output in the Gulf of Guinea. In the North Sea, for every £1.00 input yield a negative return of (£6.00) realise. Comparatively, the Gulf of Guinea is economically viable as the operations yield positive return and the UK North Sea is not as to record a loss of (£6.00). These results suggest the need for strategies to implement to reduce and control the maintenance cost in the UK North Sea to optimise maintenance activities to record positive returns (see Jan *et al.* 2001).

Security, Health and Safety Object*:* the results in Table10 above indicate that for every £1.00 inputs of security health and safety to protect the workers, the investment yield £3.87

return in the Gulf of Guinea oil and gas operations. This suggests that when more investment is committed into security health and safety activities in the Gulf of Guinea oil and gas operations, more positive return on investment. This is consistent with Zanko *et al.* (2012).

Administrative Overheads Object*:* the results in Table10 above predicts that for every £1.00 of inputs of resource in administrative activities it yields a return of £0.81 return in investing in the Gulf of Guinea and yield £1.94 in the UK North Sea. Though, both regions investment in administrative brings in positive returns the UK North Sea records the highest returns on investment (as documented in Gregory *et al*. 2013)

5.7 Conclusion

Conclusively, the OLS analyses show the Gulf of Guinea is more economically viable as compared to the UK North Sea out the five operating cost objects. In this regard, the Gulf of Guinea records positive returns in the investing in the operating cost objects as compared to the UK North Sea which records positive returns in investing in supplies and services and administrative cost objects. However, record native returns in investing in maintenance and labour cost objects. additionally, the native returns in investing in labour and the maintenance cost objects are greater than the positive returns in investing in the supplies and the administrative cost objects. Hence, these findings from OLS correlate to VAR estimates, the qualitative result and the literature where these sections of this study identify maintenance and labour cost objects influence operating activities and cost in the oil and gas operation in the Gulf of Guinea and the UK North Sea.

Chapter Six

Conclusion and Recommendations

6.1 Conclusion

Oil and gas companies are complex organisations because of their high cost of operations, uncertainties in the exploration activities, volatility in prices, climate change challenges and specialised process of production which are collectively affected by the fiscal regime. However, despite a huge literature documented about their operations, there exists a limited literature about the behaviour of operating costs, drivers of the operating costs and strategies in place by different regions to deal with operating costs and optimise the oil and gas operations in order to remain relevant in the market. More specifically, studies in the context of Gulf of Guinea are very limited given the data limitations. However, comparison of Gulf of Guinea with a more developed region, such as UK North Sea will bring additional understanding of the dynamics and differences between the two regions in relation to operating cost. In this connection, this study sets to achieve three important objectives, namely: i), to critically explore the operating cost drivers in the upstream oil and gas operations of the Gulf of Guinea and the UK North Sea; ii), to critically evaluate the relationship that exists among operating cost objects in the Gulf of Guinea and the UK North Sea; and iii), to critically investigate the effect of optimisation strategies for operating cost drivers on economic viability of oil and gas operations in the Gulf of Guinea and UK North Sea.

Based on the literature reviewed on operating cost drivers, this study adopts activity based costing (ABC) to guide the process of tracing various activities to their associated cost object. This is primarily carried out with a view to identifying the driving activities (cost drivers) associated with the selected operating cost objects in oil and gas operations. To enhance on the quality of this study by reflecting on the literature, a mixed methods research, which provides both qualitative and quantitative elements, is adopted to thoroughly investigate and better understand the factors that influence the operating cost in oil and gas operations. More specifically, the study employs open-ended and semi-structured interviews to solicit operating cost information from senior managers with significant number of years of work experience in the oil and gas industry.

The analysis, results, and discussions from both set of both quantitative and qualitative data about operating cost, consistently show that maintenance and labour cost objects drive oil and gas operation in both Gulf of Guinea and the North Sea operations. The implication of this finding is that, regardless of the region, cost of maintenance and labour constitute the largest portion of operating costs in the oil and gas industry. Additionally, the results correlate to the literature analysis and the findings of both regions. The qualitative evidence identifies that labour deficit and maturity of operating fields influence the operating activities, which drive these operating cost objects in the two regions. Furthermore, the qualitative results acknowledge that health safety and security are very important in oil and gas operation and can improve on operations when operators invest more in them. Failure to implement health and safety has been taken as having a serious consequence (e.g. to disasters) and that leads to commitment of both regions to focus on this element of operating cost. Hence, the optimisation strategies of operating suggest to oil and gas operations in the Gulf of Guinea and the UK North Sea is one of the originalities and contributions of this study.

6.2 Original Contributions to Knowledge

The topic for this research is original and requires wider investigation in order to understand the cost dynamic in the volatile sector. Hence, the results of this study are very significant and important to academic literature and the oil and gas operators because they have reveal specific issues relating to oil and gas operating cost in the Gulf of Guinea and the UK North Sea. For example, the findings provide useful empirical evidence and insights into operating cost dynamics. The magnitude of the impact from each cost object is examined with 31 per cent and 45 per cent of maintenance cost object and 44 per cent and 23 per cent of labour cost object found to influence operating cost in the Gulf of Guinea and the UK North Sea respectively. The analysis of literature shows that there are no studies that evaluated operating cost and numerically measures the impact of maintenance and labour cost objects in the oil and gas operation at the two selected regions. This is an important contribution to the literature by providing empirical evidence on the peculiarities of the two regions and the behaviour of the operating costs in the oil and gas industries of two distinct regions (namely: Gulf of Guinea and UK North Sea). Additionally, the comparison between these two regions is original within operating cost context in oil and gas literature and it is important towards understanding the universality of the oil and gas operations. Having reviewed the literature, it was found that none of the previous studies has carried out a robust comparison between the regions, which are crucial in the global oil and gas production.

This study contributes significantly to methodological literature as it is viewed the first study that adopts both qualitative and quantitative methods (mixed methods) in form sequential triangulation to explore the operating cost dynamics. Furthermore, it employs both qualitative and quantitative in form of primary and secondary data respectively to identify factors that influence the operating cost in the oil and gas operations. This is an important contribution and significant to both academia and the industry because the sector is highly secretive and data on the operating costs are not publicly available for this type of research. Additionally, the findings also show a great significance to both academic literature and industry particularly on the need for implementation of Integrated Project System (IPS) and the graduate scheme and other programmes that can help to overcome the maintenance and labour challenges in the two regions. As stated earlier that literature findings and suggestions on specific strategies to optimise operating cost are very limited. Hence, the findings of this study can provide relevant and useful framework for academic literature and the industry given the robust methodology based on combined primary and secondary data sources used in this study. This is a very significant academic contribution of this study. Furthermore, operators and other stakeholders now know from the findings that IPS can help to optimise maintenance activities and the graduates and internship program will help to overcome the labour deficit challenges in the oil and gas operations in the two regions. This is a huge contribution to industry as most stakeholders now will be able to depend on this finding to optimise their maintenance activities and the cost in oil and gas operations. Besides the findings of this study further reveals an important contribution on the degree of government involvement and size of regulations governing the oil and gas operations and how they influence the operating cost. Furthermore, the findings are very significant to oil and gas operators, investors, regulators as they now know from these pieces of evidence that government involvement create a huge operating cost burden and they can adjust the level of regulations to mitigate the effects of regulations in an already volatile market. Additionally, the findings identify that establishing social relationship with all stakeholders and understand host government approach of doing business will help to overcome governance challenge. Furthermore, the findings are very resourceful and useful to the industry, the stakeholders, as they now know from this study findings that labour, and maintenance cost objects influence the operating cost in the two regions. Hence, operators and other stakeholders at the two can make feasible economic decision based on the optimisation strategies suggested to optimise their operations.

6.3 Implications of the Study

6.3.1 Academics

In view of the empirical evidence reported in this study, this project will be a useful source of literature to subsequent studies on the operating cost in the oil and gas industries. This has a very important implication because, data limitation has made it very challenging to conduct studies on sensitive cost issues, like operating costs, in the oil and gas industries. Hence, by combining both qualitative and quantitative data sources to conduct this study, the evidence will form part of the future literature on this topic. Because of data insufficiency, there is lack sufficient evidence because academics are unable to explore the dynamics in oil and gas operational activities. This leads to lack of standardised academic literature that informs how to fix operating cost related challenges based on peculiarities of the two regions examined in this study. This may well be to the wider industry disadvantage as many oil and gas firms have collapsed in the past due their inability to understand the dynamics in the operating costs which may influence the choices in the accounting standards (i.e. full cost and successive effort methods). However, this study contributes significantly by providing a methodological approach and tools based on both quantitative and qualitative data to triangulate the key dynamics. Thus, it provides an opportunity to extend to other regions, such as Gulf of Mexico, in order to understand it differs from Gulf of Guinea and UK North Sea. This triangulated evidence could be an evidence for the academics to explore design of a software package that can model the operations of the companies with a view to helping them control some of the operational activities in the industry.

6.3.2 Policy Makers / Oil and Gas Regulators

Furthermore, this evidence can be used as a reference material to policy makers or regulators of the oil and gas industry given that, it is informative in terms of the key influential factors that affect the operations of the firms within the industry. Hence, the empirical evidence from this study can provide the basis for development of policy documents and regulation that inform the operations and strategies of the oil and gas industries towards achieving effectiveness and efficiency. For example, the concept of the Integrated Project System (IPS) software amongst the giant oil and gas servicing companies may well be a good area for regulators to identify and explore all possible advantages that can be extended to smaller companies with a view to providing adequate operational data that can help the growth of the companies. Although this is an important topic to the regulators, it remains relatively unexplored as there is no literature on the operating cost objects, owing to lack of access to operational data. Additionally, the study exhibits potential evidence for the need for oil and gas operators to collaborate and work with the oil and gas companies to initiate research and development programs within the topic for more academic literature in oil and industries to be produced without compromising the strategies of firms by the competitor firms. Another important implication of this study is the establishment of the need for more transparency in the oil and gas industry**.** As mentioned previously, there is difficulty in obtaining operating cost data in oil and gas industry because the industry operates on secrecy of the information and many thinks that by revealing their operating costs their strategies are exposed to competitors. However, this study demonstrates the need for collaboration between the operators and academic institutions to explore operating data for research purposes. There is the need for the National oil and gas companies to make operating information available for research purpose and encounter transparency in the oil and gas operations which will remove the idea of data security which will make data available for research purposes. The regulators should also know that governance involvement and regulations governing the oil and gas operating influence the operating cost. The regulatory bodies should consider the impact of the some of the regulations on the operations. They should open-up renegotiation of the operation obligations and regulation (Local Content Participating, Reenlistment clauses and the labour clause to help the operators to operates efficiently). In this connection, the accounting reporting standard boards (both internationally and locally) can be informed on how the operating costs can be integrated into further accounting standards development by making the debate more evidence-based.

6.3.3 Oil and Gas Industries

The findings of this study provide some useful information about the operating cost behaviour which would help oil and gas companies to understand operating cost dynamics in oil and gas industry. The study findings indicate that operators should establishing social and business relationship with other stakeholders which foster long term operational efficiency. This study further indicates the need for understanding the role of host government approach prior to any contractual commitment when doing business in order to help to overcome governance-imposed challenges during the oil and gas operations. The study highlights the materials importance of health and safety cost in the oil and gas industry operations when making any effort to safeguard the interests as well the reputation of the company. The methodological approach can be useful to oil and gas companies by providing them with sequential process to model variables and triangulate both qualitative and quantitative sources given the companies data in order to understand their dynamics in operating costs. This could serve as strong motivation for oil and gas companies to collaborate with all relevant agencies in oil and gas towards generating and sharing operations information for the benefit of wider stakeholders, which can lessen the cost of compliance to the regulators of the industry.

6.3.4 Oil and Gas Investors

Oil and gas industries are highly capital intensive and risky, most particularly with the falling prices caused by low demand due to climate change commitment and awareness. Thus, investors are more cost-conscious in this era than ever. This study has an implication on the investors because of the framework it has created for understanding the operating cost dynamics. For example, the study documents evidence of strong need for collaboration between wider stakeholders towards building an integrated system that reduces costs of the firm's operations. It also brings about the important awareness of the important operating cost drivers which can provide opportunities for investors to input their ideas via the board selection in directing the affairs of the companies given the level of understanding of the strategies required by the person that manage the business on their behalf. Bearing that maintenance and labour activities occupy the highest portion of the operating cost in oil and gas operations, the smooth implementation of the IPS and the internship and graduate programs can be facilitated by the investors when the managers/board presents any proposal to them in order to overcome the maintenance and labour issues in the oil and gas operations.

6.3.5 General Public

In the interest of the general public, this study establishes the need for all stakeholders in oil and gas industry should uphold to implementation of the health and safety system to safeguard the operations and the workers in order to optimise the operations in the oil and gas industry. Additionally, the study shows that oil and gas companies need to consider the general public needs and concerns for environment in order to influence the level of operating costs. Furthermore, this study recommend that all stakeholders should corporate, collaborate, and establish both social and business relationship among one other, which will foster mutual benefits and set grounds for renegotiation among stakeholders to optimise oil and gas operations. Besides that, this study recommend that operators should consider establishing a good relationship with the academic institutions that encourage research into operating cost as there very little academic literature, and this will expose effective and efficient ways of managing operating cost to optimise oil and gas operations

6.4 Recommendations of the Study

This study reveals that government involvement and regulations surrounding the oil and gas operating influence the operating cost. This is an important conclusion in the context of the two regions examined in this research. On this basis, this study recommends that more research is required into understanding how the operating costs vary across different regions globally depending on the degree of government involvement and regulations in order to establish the most effective operating cost associated with the costs or extent of regulations. In this connection, this study proposes a strong need for collaboration between academic institutions, in collaboration with the international oil companies to conduct research in the areas to discover more new opportunities that can contribute to oil and gas operations. Despite the fact that different This study, therefore, recommends the formulation of policies and regulations (such as local content laws, fiscal regimes, and the labour policies) governing oil and gas operations that should take into consideration the operational activities and cost to ensure viability of oil and gas projects and the sustainability of their operations.

6.5 Limitation of the Study

Like any other academic studies, this project suffers from certain limitations worthy of noting at this juncture. The most important one relates to data. Given the focus on two regions, longitudinal data for an extensive period of time, mostly from the start of oil and gas operations in the two regions, would have provided more insight into the dynamics of oil and gas operating costs. More segregation of cost based on the stage of operations would have helped this study to understand how the management scepticism and accounting prudence influence the decisions associated with processes and how they influence cost of operations. For example, it would be more useful during the exploring and evaluation of operating cost to understand and identify the factors that influence operating cost and their optimisations. This study has made effort to overcome this shortcoming by exploring data from multiple sources to validate the quality of the conclusion drawn by this study. Another limitation is related to the lack of sufficient evidence from the literature to substantiate the findings of the study with the previously documented literature. The literature limitation arises where there is a very limited academic evidence on the operating cost in oil and gas operations. Even the few literature on operating cost, is very generic and centres in locations other than Gulf of Guinea and the UK

North Sea. However, effort was made to ensure the few literature within the reach of the study is put together to achieve the advantage offered by the critical comparison. This study would have benefitted from large collection of data across oil and gas firms and regulators within the industries in both regions. This would eventually require huge resource budget – including employment of research assistants to facilitate the primary data collection process.

6.6 Future Research Opportunities

As replicability is a key component in doing research, if this study is to repeat using the same data, it will use same data to measure relationship between the operating cost objects and the key performance indicators (KPIs) in oil and gas operations. This study will adopt non-linear structural autoregression models to evaluate the complex and dynamic relationship among operating cost objects and the KPIs. The results will be used to augment the outcome from the thematic analytical technique and other qualitative data analysis tools. In future, other researchers can extend this study to North and South American regions as these regions historically have produced oil and gas for a long period of time and should have a sufficient historical data in oil and gas operation given that they are experiencing some operational challenges as suggested in other literature sources reviewed in this study. There is a need for further investigation on the extent of government involvement and how that affect the operating costs in the oil and gas operations.

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Appendices

Appendices I: Ethical Certificate

Certificate of Ethical Approval

Applicant:

Ibn Benin

Project Title:

A Critical Economic and Operating Cost Evaluation of Oil and Gas Plays: A Retrospective View of Ghana Keta Basin and the UK North Sea

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Low Risk

Date of approval:

24 March 2017

Project Reference Number:

P45461

Appendices II: Questionnaire

These questions are intended to help address some of the objectives in the research titled***:*** The Economic Cost, *A Critical Evaluation of Operation Cost of Oil and Gas Plays: A Retrospective review of the economic viability of Ghana and UK Offshore operations*, for the fulfilment of the requirement of Doctorate of Philosophy (Ph.D.). The research work is completely academic work and all data provided by respondents would be solely used for academic purpose. The questions are intended to address the operating cost drivers, how to control and manage them to maximise net return in oil and gas operations. The research questions have passed through ethical approval and have been accepted by Coventry University Ethical committee for data and respondents' identity protection. For any question please contact the research team.

Content removed on data protection grounds

Please indicate your profession:

Email address just for further discussion:

Region/Country

1 In your opinion, what are the operational activities you consider to be cost sensitive in upstream oil and gas industry in your country?

2 among the production/operating cost drivers listed below and any other you can think of, identify (with reasons) those cost drivers that are sensitive to unit technical cost (UTC) of operation in your country.

I. Inspection/maintenance cost
II. Labour Cost
III. Health and Safety
IV. Logistic and consumables cost

3 In your opinion, explain effect of each of the below elements on operating cost in upstream oil and gas industry.

I. Local content obligation

II. Petroleum fiscal regime
III. Geopolitical regime
IV. Others (please specify)

4 What are the strategies in your opinion that operators should adapt to manage and control the UTC in the upstream offshore oil and gas operations to maximise the net returns?

Appendices III: Support Letter

Content removed on data protection grounds

Appendices IV: Significant of the Quantitative Results

	Labour	Sullies & Service	maintenance	Administrative Overheads	Operating Revenue
R-squared	0.988761	0.941542	0.989343	0.939965	0.926525
Adj. R-squared	0.968781	0.837618	0.970399	0.833235	0.795903
Sum sq. resids	1399568.	456178.7	1424373.	2458.861	1.04E+08
S.E. equation	394.3445	225.1367	397.8237	16.52897	3396.141
F-statistic	49.48738	9.059856	52.22214	8.806960	7.093190
Log likelihood	-178.5089	-163.9355	-178.7373	-96.03404	-234.4913
Akaike AIC	15.03915	13.91811	15.05672	8.694926	19.34549
Schwarz SC	15.86175	14.74071	15.87932	9.517528	20.16809
Mean dependent	5964.586	506.8509	6122.017	92.32163	24060.71
S.D. dependent	2231.862	558.6978	2312.248	40.47557	7517.403

Determinant resid covariance (dof adj.)	1.33E+26
Determinant resid covariance	2.29E+23
Log-likelihood	-920.5983
Akaike information criterion	78.66140
Schwarz criterion	83.59701

Appendices V: Lag Stability Condition

Roots of Characteristic Polynomial

Endogenous variables: LAB SVS INS ADM OPR

Exogenous variables: C GEF COC REG POL

Lag specification: 1 2

Date: 04/06/19   Time: 14:22

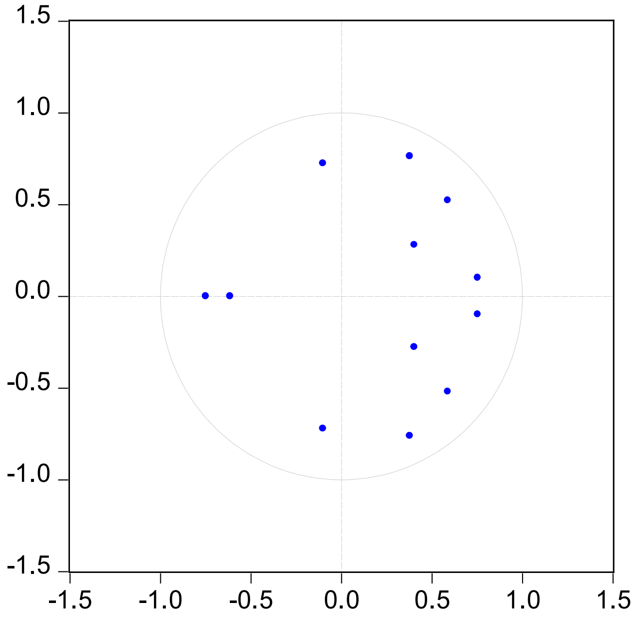
Root	Modulus
0.379357 - 0.762673i	0.851811
0.379357 + 0.762673i	0.851811
0.590431 - 0.521307i	0.787635
0.590431 + 0.521307i	0.787635
0.754619 - 0.099688i	0.761175
0.754619 + 0.099688i	0.761175
-0.748029	0.748029
-0.100021 - 0.722423i	0.729314
-0.100021 + 0.722423i	0.729314
-0.613044	0.613044
0.404682 - 0.278430i	0.491213
0.404682 + 0.278430i	0.491213

No root lies outside the unit circle.

VAR satisfies the stability condition.

Appendices VI: Inverse Roots of AR Characteristic

Inverse Roots of AR Characteristic Polynomial



Appendices VII: VAR Residual Normality Tests

Orthogonalization: Cholesky (Lutkepohl)

Null Hypothesis: residuals are multivariate normal

Date: 04/06/19 Time: 14:27

Sample: 1990 2017

Included observations: 26

Skewness Test

Component	Skewness	Chi-sq	df	Prob.
1	-2.164073	20.29392	1	0.0000
2	0.730090	2.309806	1	0.1286
3	0.599094	1.555292	1	0.2124
4	-0.652151	1.842970	1	0.1746
5	-0.168300	0.122741	1	0.7261
6	-0.003740	6.06E-05	1	0.9938
Joint		26.12479	6	0.0002

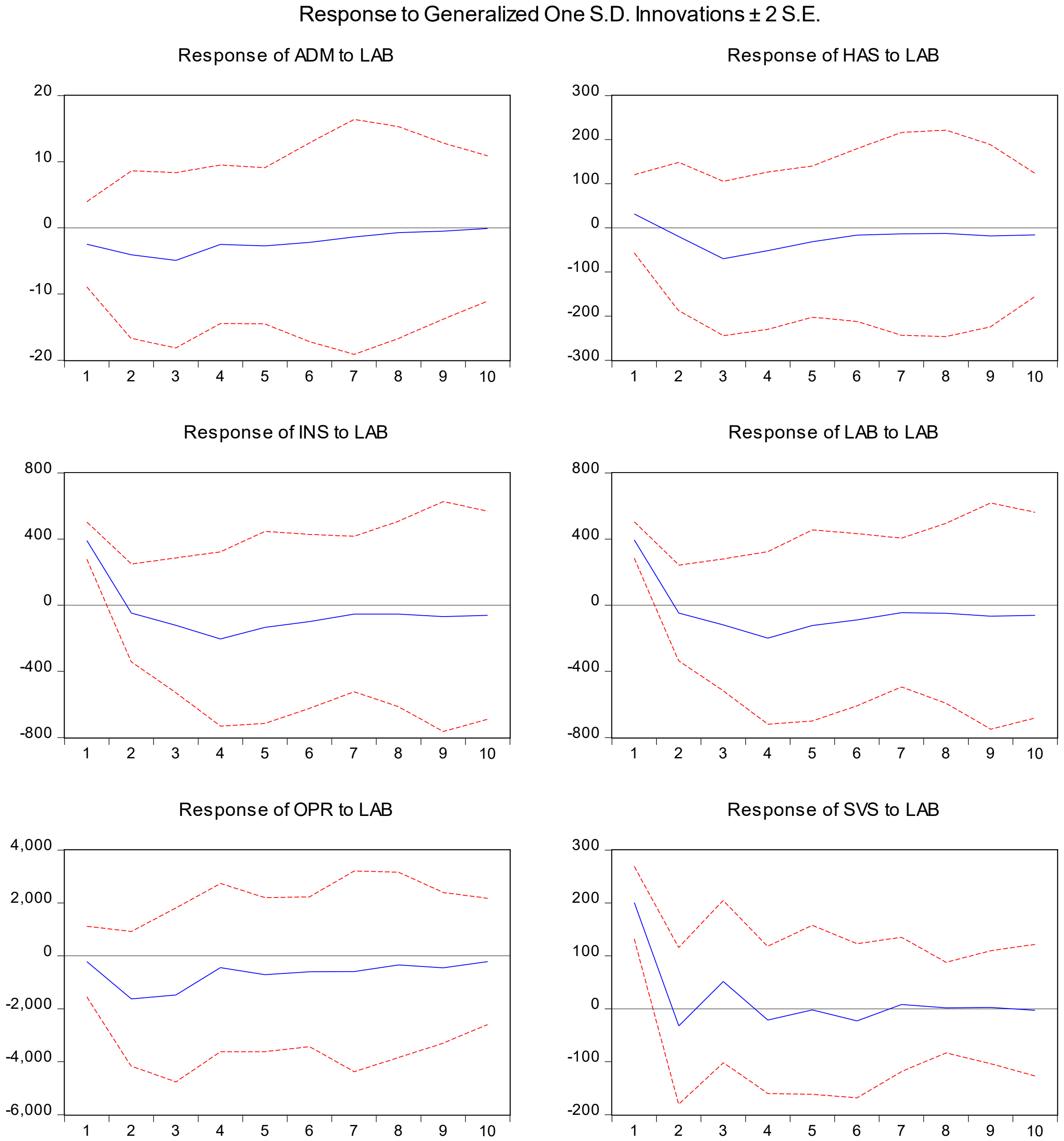
Appendices VIII: Kurtosis Tests

Component	Kurtosis	Chi-sq	df	Prob.
1	10.67282	63.77825	1	0.0000
2	3.796671	0.687575	1	0.4070
3	2.725333	0.081729	1	0.7750
4	3.063431	0.004359	1	0.9474
5	2.458668	0.317460	1	0.5731
6	6.299056	11.79075	1	0.0006
Joint		76.66013	6	0.0000

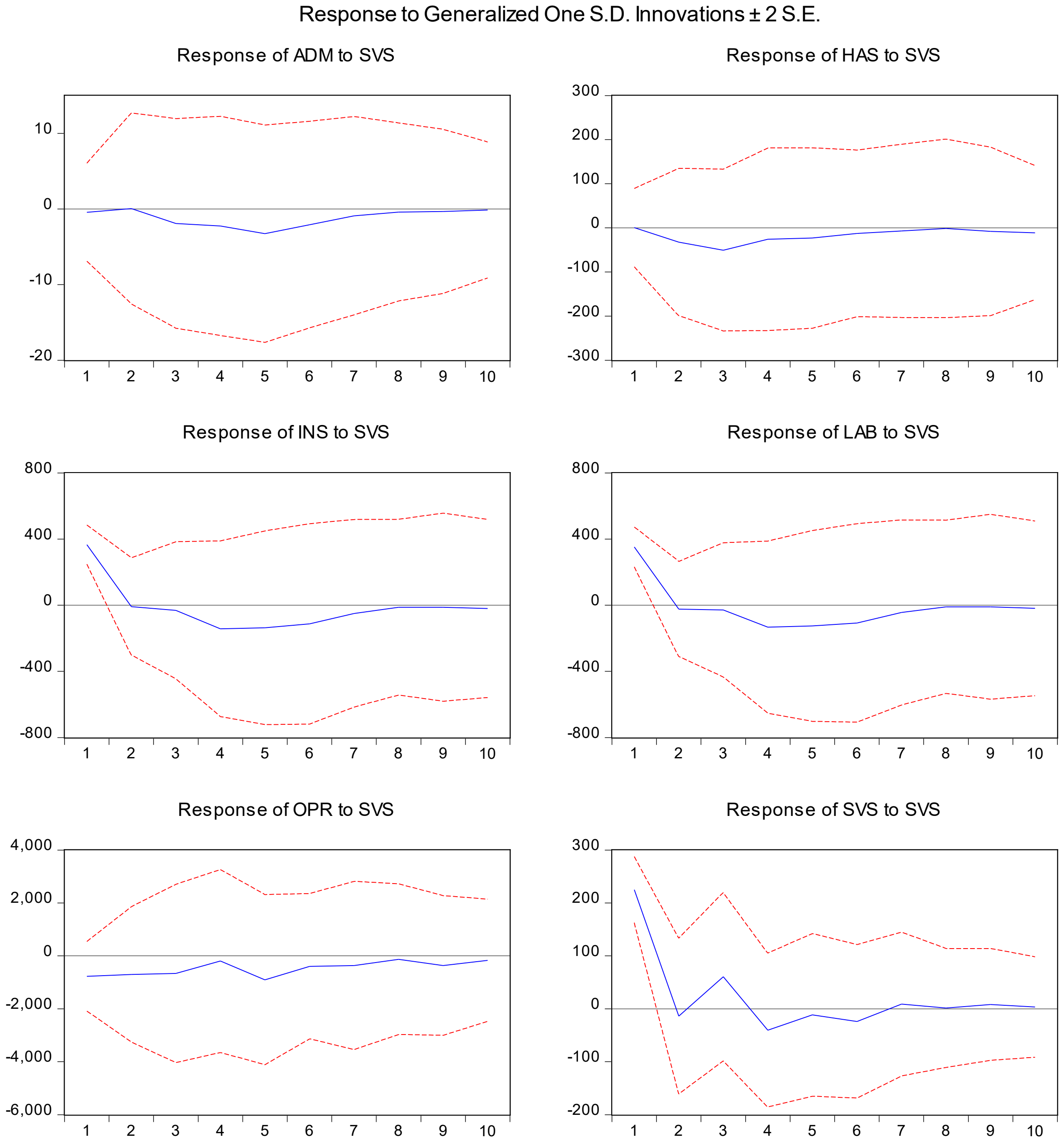
Appendices IX: jargue-Bera Test

Component	Jarque-Bera	df	Prob.
1	84.07218	2	0.0000
2	2.997380	2	0.2234
3	1.637020	2	0.4411
4	1.847328	2	0.3971
5	0.440202	2	0.8024
6	11.79081	2	0.0028
Joint	102.7849	12	0.0000

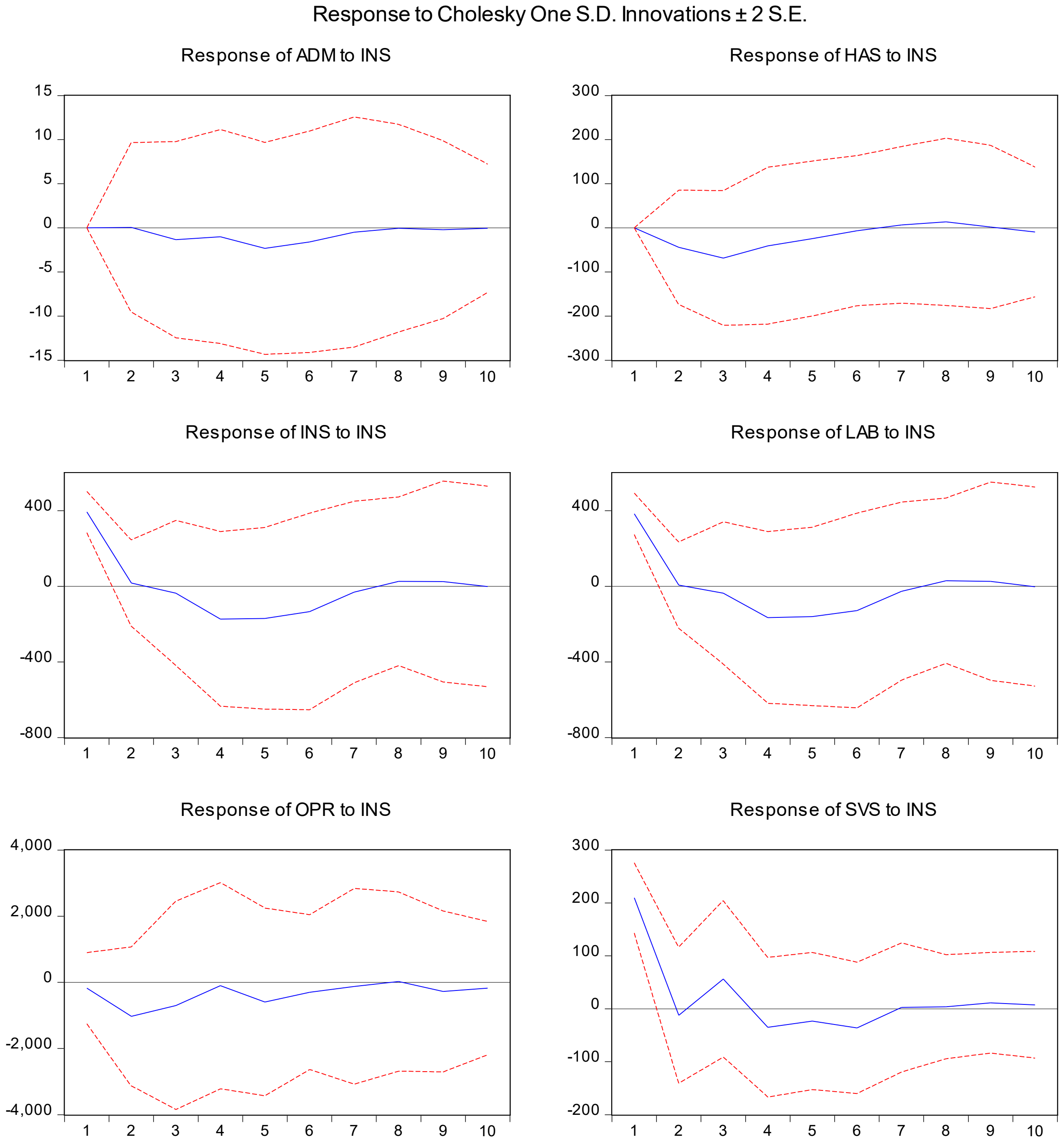
Appendices X: Labour Cost Object Impulse



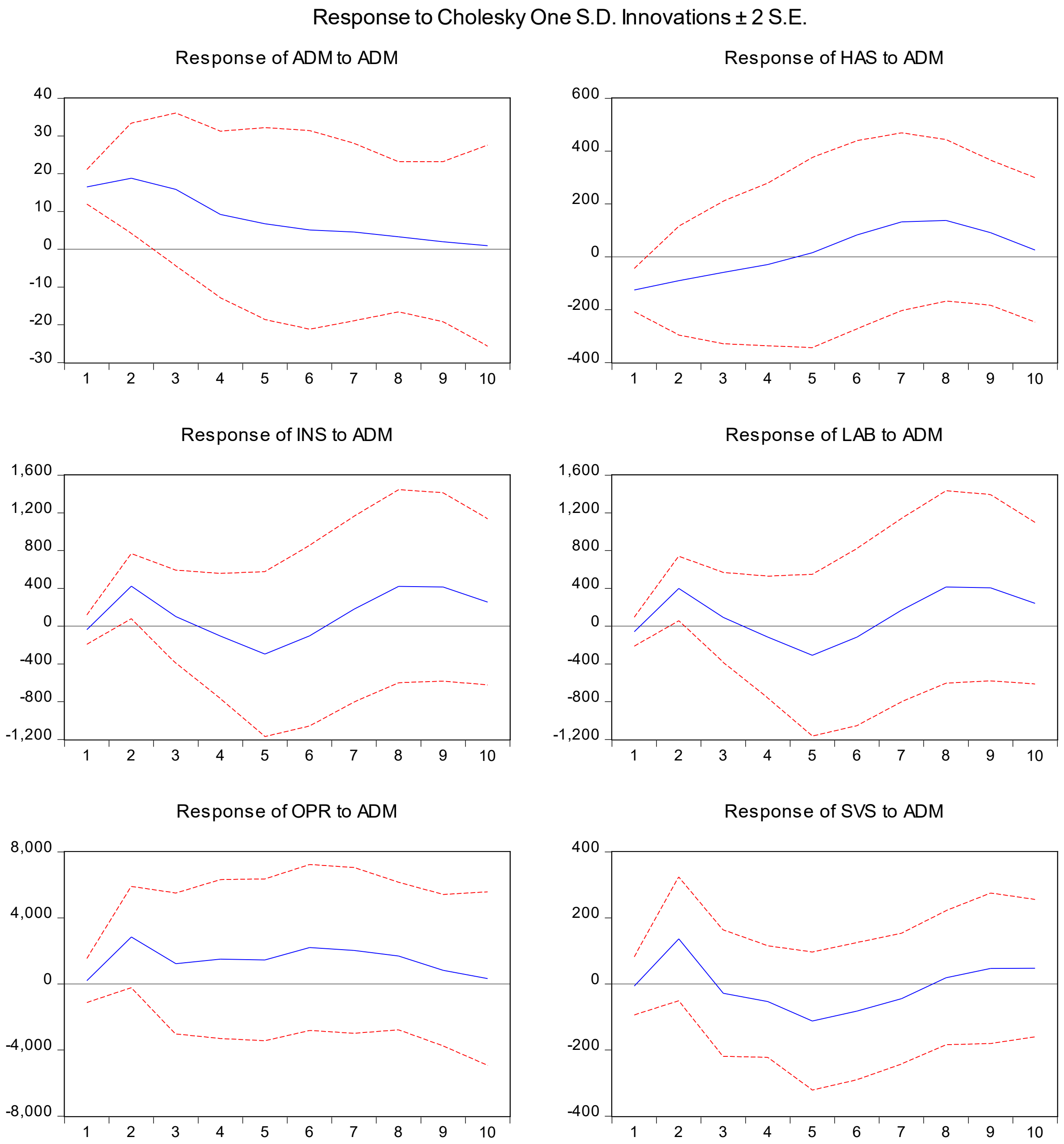
Appendices XI: Supplies and Service Cost object Impulse Responses



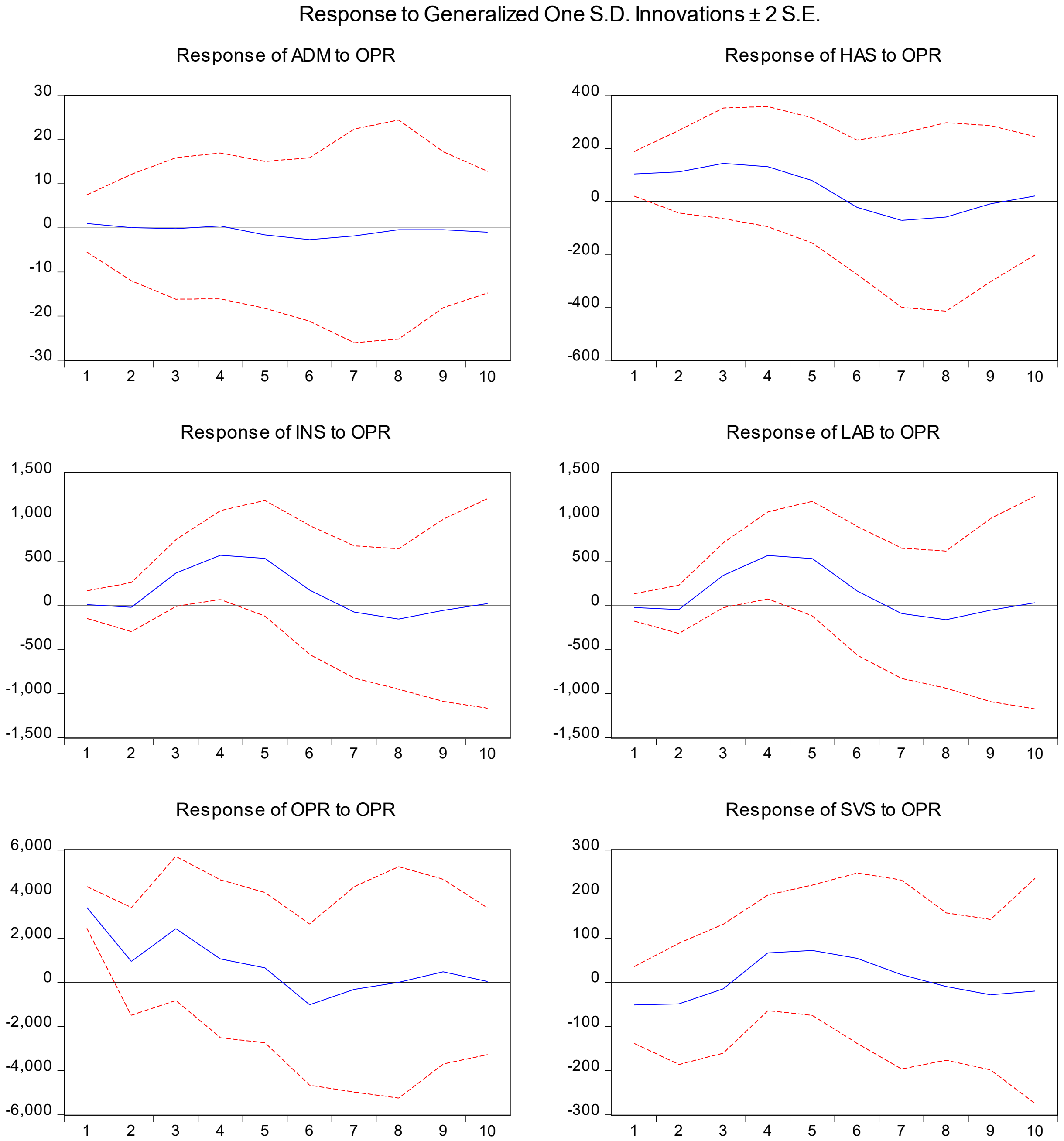
Appendices XII: Maintenance Cost Object Impulse Responses



Appendices XIII: Administrative Cost Object Impulse Responses



Appendices XIV: Operating Revenue Impulse Responses



Appendices XV: VAR Granger Causality: Dependent Variable Labour

Excluded	Chi-sq	df	Prob.	Outcome
Supplies& Service	4.626447	2	0.0989	Accept null hypothesis
Maintenance	7.985937	2	0.0184	Reject null hypothesis
Amin Overheads	7.303495	2	0.0259	Reject null hypothesis
Operating Revenue	2.809405	2	0.2454	Accept null hypothesis
All	32.79066	10	0.0003	Reject null hypothesis

Appendices XVI: VAR Granger Causality; Dependent variable: Supplies and Service

Excluded	Chi-sq	df	Prob.	Outcome
Labour	0.225729	2	0.8933	Accept null hypothesis
Maintenance	0.392938	2	0.8216	Accept null hypothesis
Admin Overheads	2.022899	2	0.3637	Accept null hypothesis
Operating Revenue	1.097729	2	0.5776	Accept null hypothesis
All	8.966721	10	0.5353	Accept null hypothesis

Appendices XVII: VAR Granger Causality; Dependent variable: Maintenance

Excluded	Chi-sq	df	Prob.	outcome
Labour	7.160423	2	0.0279	Reject null hypothesis
Supplies& Service	4.096843	2	0.1289	Accept null hypothesis
Amin Overheads	7.446111**	2	0.0242	Reject null hypothesis
Operating revenue	2.853880	2	0.2400	Accept null hypothesis
All	32.24065	10	0.0004	Reject null hypothesis

Appendices XVIII: VAR Granger Causality; Dependent variable: Administrative Overheads

Excluded	Chi-sq	df	Prob.	Outcome
Labour	1.679383	2	0.4318	Accept null hypothesis
Supplies& Service	0.409778	2	0.8147	Accept null hypothesis
Maintenance	1.789894	2	0.4086	Accept null hypothesis
Operating Revenue	0.102057	2	0.9503	Accept null hypothesis
All	5.464917	10	0.8580	Accept null hypothesis

Appendices XIX: Aggregate Weight of Operating Cost on Operating Revenue

Fields	Labour	Supplies and service	Maintenance	Health/Safety	Admin
Field 1	1.84	0.37	1.21	3.88	0.81
Field 2	1.95	-1.07	0.69	-12.37	3.33
Field 3	1.68	-1.54	1.67	-4.66	0.04
Field 4	1.26	-6.85	0.88	-4.66	1.17
Field 5	-1.19	0.18	0.64	2.18	1.15
Field 6	3.02	1.14	-16.97	1.28	1.13
Gulf of Guinea	1.83	0.37	1.21	3.87	0.81
North Sea	-2.68	1.00	-6.00	Non	1.94

Appendices XX: Statistical Significance of Data

Gulf of Guinea/North Sea	R Squared	Root Mean Square Error (RMSE)	P-value
Project 1	0.90445	5.7551e+05	0.0051215
Project 2	0.87884	3.743e+06	0.01012
Project 3	0.87822	1.1009e+06	0.010269
Project 4	0.92229	3.6322e+06	0.0028147
Project 5	0.78281	1.184e+06	0.051541
Project 6	0.97898	2.8583e+05	5.9495e-05
Project 7	0.87664	7.0293e+06	4.2964e-07
Project 8	0.90445	2.8583e+05	5.9495e-05