

ANALYSING OUTSOURCED SOFTWARE DEVELOPMENT IN THE
DOWNSTREAM PETROLEUM SECTOR IN GHANA

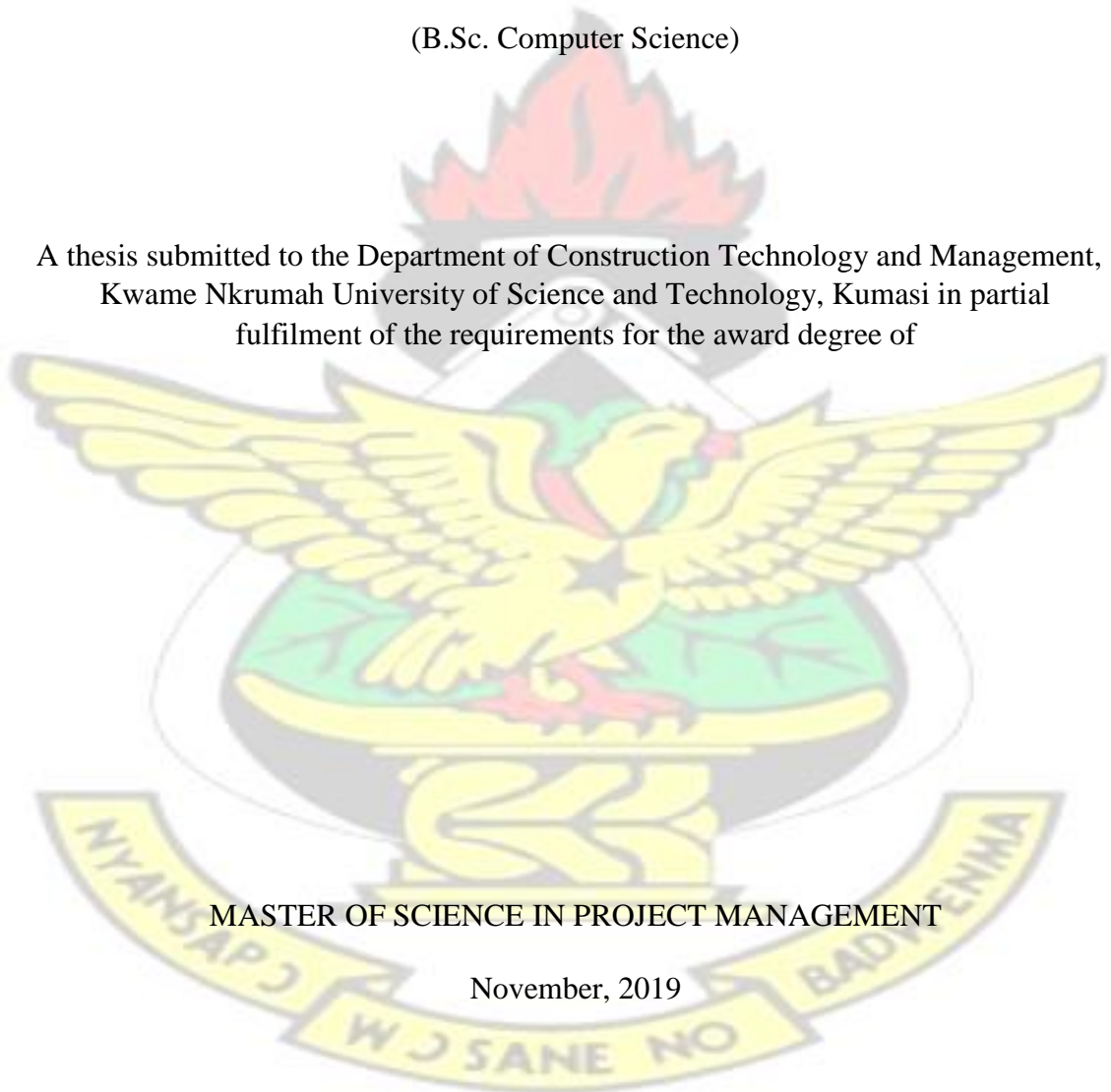
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A thesis submitted to the Department of Construction Technology and Management,
Kwame Nkrumah University of Science and Technology, Kumasi in partial
fulfilment of the requirements for the award degree of



MASTER OF SCIENCE IN PROJECT MANAGEMENT

November, 2019

DECLARATION

I hereby declare that this work is the result of my own original research and this thesis has neither in whole nor in part been prescribed by another degree elsewhere, except where due acknowledgement has been made in the text.

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ABSTRACT

Making a decision of going outsourcing for software development, can be a very confusing and difficult task. Both young companies and well-established ones are

adopting software development outsourcing (SDO). A lot of organisations, if not most, don't consider all the necessary factors needed to make the choice of developing software using the outsourcing approach. This study sought to make an in-depth analysis of developing software by contracting third-party developers(outsourcing), in the downstream petroleum sector in Ghana by outlining the merits and demerits of outsourcing software development in the industry, identifying vital technical and management decisions that influence outsourcing and identifying the effects that outsourcing software has on the project and operations of an organisation. The mixed methods approach was employed for this research work. Purposive and snowballing sampling methods were used to select individuals within the downstream petroleum industry in Ghana to be interviewed and administered questionnaires. The qualitative data helped in identifying some of the factors that influence outsourcing while also pointing out some of its advantages and disadvantages. The findings from the study indicated that, though the organisations within the industry share some of the merits and demerits, there were some of such that were organisation-specific. It also highlighted eight (8) factors that play a major role when deciding to outsource. Finally, the impact of outsourcing on an organisation; both on the project and the operations of the entity were realised. It is of worth to note that, both positive and negative impacts were realised, though the benefits outweighed the shortcomings. The study concludes with strategies that can be put in place to curb the shortcomings of the outsourcing approach to software development.

Keywords: Outsourcing, Downstream, Software development

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LIST OF ABBREVIATIONS	

NPA	National Petroleum Authority
BOST	Bulk Oil Storage and Transportation Company
TOR	Tema Oil Refinery
CBOD	Chamber of Bulk Oil Distributors
AOMCs	Association of Oil Marketing Companies
GNPC	Ghana National Petroleum Commission
GNPC	Ghana National Gas Company
BDCs	Bulk Distribution Companies
OMCs	Oil Marketing Companies
LPGMCs	LPG Marketing Companies
BRVs	Bulk Road Vehicles
ERP	Enterprise Resource Planning
SDO	Software development Outsourcing
PSAC	Petroleum Services Association of Canada
ACKNOWLEDGEMENT	

The first gratitude goes to the Almighty God for giving me life and strength to carry out this research.

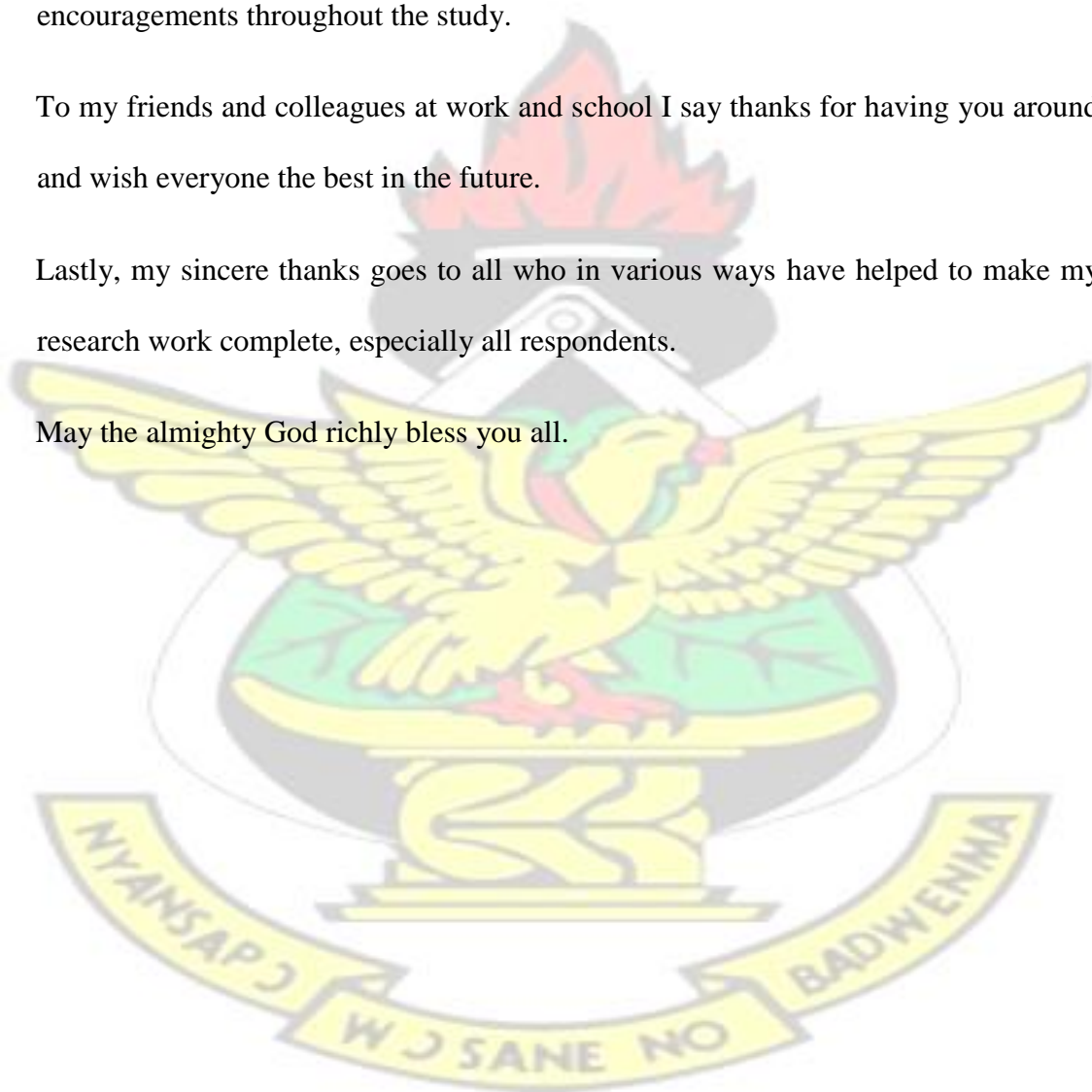
My heartfelt and profound gratitude goes to my supervisor, Dr. Ernest Kissi for his irreplaceable research guidance, constructive criticisms, suggestions, push and encouragement throughout the research process.

My special thanks goes to Naana Pomaa Agyapong for her immense support and encouragements throughout the study.

To my friends and colleagues at work and school I say thanks for having you around and wish everyone the best in the future.

Lastly, my sincere thanks goes to all who in various ways have helped to make my research work complete, especially all respondents.

May the almighty God richly bless you all.



DEDICATION

This thesis is dedicated to my mother, Gladys Tetteh and two sisters, Phyllis and Shirley Quist and also to Naana Pomaa Agyapong.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

According to Reporting Oil and Gas (2016), the Oil Industry in Ghana is made up of three sectors, thus upstream, midstream and downstream. The downstream sector of the petroleum industry is into the refining, processing, marketing, and distribution of refined petroleum products (Hassan, 2016). There are regulatory authorities in place to check and regulate the activities of the various companies (both state-owned and privately owned) in the sector. The main industry regulator is the National Petroleum Authority (NPA) (Reporting Oil and Gas, 2016). The NPA regulates, oversees and monitors the petroleum downstream in Ghana (NPA Act 2005, ACT 691). The authority is responsible for the efficiency, profitability and fairness in the industry while ensuring that consumers receive value for money (National Petroleum Authority, 2017).

Other institutions that play a major role in the petroleum downstream sector include Ministry of Petroleum, Energy Commission, Ghana Gas, Bulk Oil Storage and Transportation Company (BOST), Tema Oil Refinery (TOR), Chamber of Bulk Oil Distributors (CBOD), Association of Oil Marketing Companies (AOMCs) and Ghana National Petroleum Commission (GNPC) (National Petroleum Authority, 2017). In Ghana, Bulk Distribution Companies (BDCs) are companies that buy the petroleum products in bulk or process the natural gas and crude oil and sell to the Oil Marketing Companies (OMCs). OMCs usually have a number of retail outlets (filling stations) in various parts of the country. According to NPA (2019), there are 33 BDCs, 107 OMCs, 6 depots, 40 LPGMCs and 2814 BRVs.

In today's world of fast-growing economies, technology has become a major driving force. Many companies and industries are employing various technological means for positive gains. The use of software by companies cannot go unnoticed. This includes mobile applications, desktop applications and web applications. Cascio & Montealegre (2016) contended that, these technologies, in addition to making work easier and faster, are also facilitating profound changes in the way that work is done in organisations. Software development has therefore become a very important factor in the growth of organisations and the downstream oil and gas industry is no exception. The regulatory authority has systems, backed by software in place to help in the regulation of the companies and activities in the downstream sector. The representative bodies such CBOD also make use of software to regulate the operations of its members whereas the various companies under the umbrella also make use of software such as Enterprise Resource Planning (ERP) to manage their businesses.

Software development, as described by Techopedia (2019b), is a process by which standalone or individual software is created using a specific programming language. It involves writing a series of interrelated programming code, which provides the functionality of the developed software. Software are developed by software developers who are sometimes called software engineers or (computer) programmers. These software developers can be permanent staff of the company (in-house) or contracted to build the required software (outsource). Whether software is built inhouse or outsourced comes with its own advantages and disadvantages. Factors that may influence the choice to make include the availability of software developers in the company, the complexity of the application to be developed, the time required to complete the work, among other factors. A lot of organisations these days, are opting for outsourcing because it gives them the room to focus on their core activities. This

study seeks to make an analysis into the development of software in the downstream petroleum industry using the outsourcing approach.

1.2 STATEMENT OF THE PROBLEM

Deciding which source of software development to adopt; in-house or outsource, can be a very confusing and difficult task. However, Intelligent Software Engineering (2018) asserted that software development outsourcing is on the rise these days. Both young companies and well-established ones are adopting software development outsourcing. A lot of the organisations opt for outsourcing to avoid all the complications with the build while shifting some of the risk to the third-party company. Some also lack the technical know-how to develop their required applications either due to the fact that they do not have software developers employed or they lack the skill to develop such systems.

A lot of organisations, if not most, don't consider all the necessary factors needed to make the choice of developing software using the outsourcing approach. The realisation of a wrong choice may hit them during development or after development. The downstream petroleum sector in Ghana has a number of sub-sectors and these sectors make extensive use of software these days. Most of the companies in the sector choose the outsourcing approach because it comes as the most convenient and makes them focus on their fundamental activities without any proper analysis. Due to the frequent change in the business flow, improvements, enhancements, tweaks and upgrade to the systems become needful and important. Therefore, the effects of the development approach employed go a long way even after the development.

To choose outsourcing for software development, it is necessary to consider all the losses and benefits that come with it (Intelligent Software Engineering, 2018).

1.3 RESEARCH QUESTIONS

The research question that helped the researcher to attain the aim and specific objectives of the study were:

- What are the merits and demerits of outsourcing software development in the downstream petroleum sector of Ghana?
- Which factors influences the decision to outsource a software development project in the downstream petroleum sector of Ghana?
- What are some of the consequences of outsourcing the development of software?

1.4 AIM AND OBJECTIVES

This research aimed at making an in-depth analysis of outsourcing the development of software in the downstream petroleum sector in Ghana.

1.4.1 OBJECTIVES

Specifically, the objectives of this research included

- To outline the advantages and disadvantages of outsourced software development in the downstream petroleum sector;
- To identify vital technical and management decisions that influence outsourcing software development in the downstream petroleum sector; and
- To identify the effects of outsourced software development on the project and operations of an organisation.

1.5 SIGNIFICANCE OF THE STUDY

The benefits and drawbacks that accompany outsourcing as a software development approach cannot be ignored. Irrespective of the pros of outsourcing, if it is not the best-

fit for a particular software development project, the consequences thereof, will materialize.

This study will help educate the companies in the downstream petroleum industry who are always inclined towards a particular approach on the benefits of both approaches. This may help them make better analysis and realise the need for a different approach for a particular project, enjoying the benefits that come with it. When companies realise their need for in-house development, programmers will be hired as employees of the company, thereby boosting the employment rate in the petroleum industry, the Information Technology sector and the country at large.

1.6 SCOPE OF THE STUDY

This study emanated from the upsurge in outsourcing as a software development approach. The study focuses on the companies and organisations within the downstream petroleum sector in Ghana. The development and use of software in the regulatory authority, some BDCS, OMCs, LPGMCs and logistics companies that own and operate BRVs will be explored. The research will also be looking at outsourced software development (the pros, cons and factors to consider in selecting this approach).

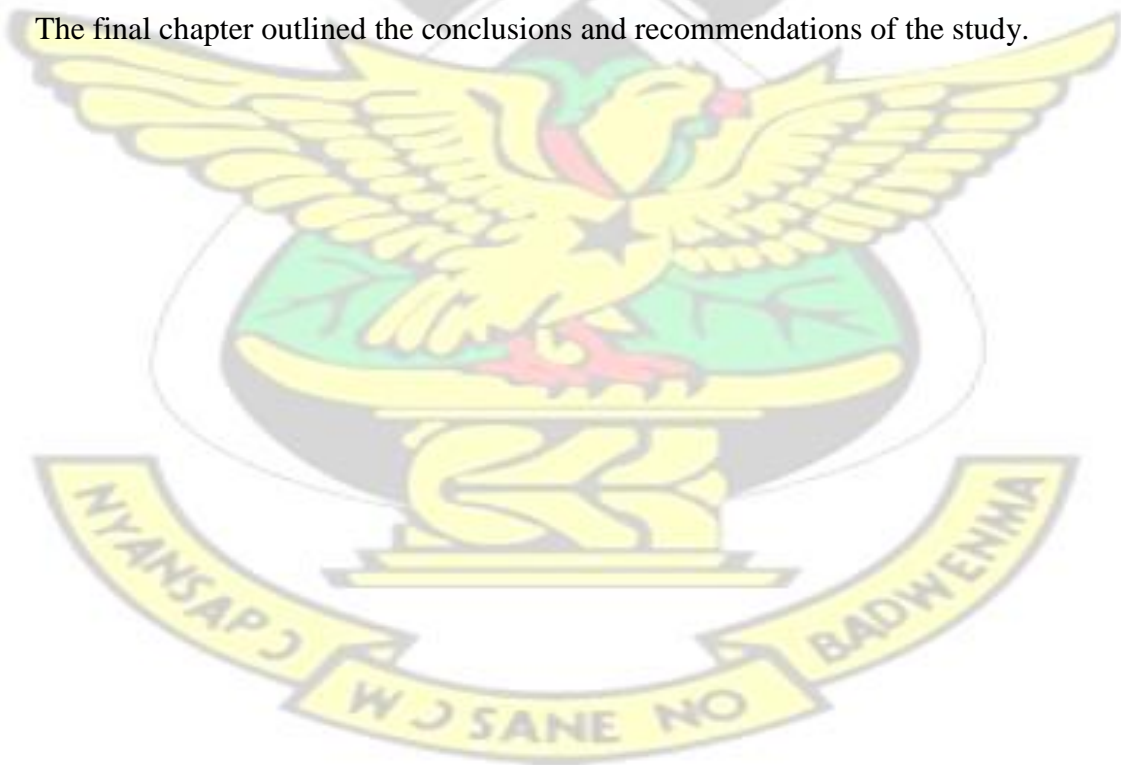
1.7 METHODOLOGY

The mixed methods approach was employed for this research work. A purposive sampling method was used to select individuals to be interviewed from particular disciplines related to the study in question. Furthermore, the snowballing sampling method was also employed. Creswell (2003) described the mixed methods approach as the type of approach where both qualitative and quantitative data are collated concurrently to provide comprehensive analyses of the study. Key staffers in the various organisations in the sector were interviewed in order to gather the information

needed for this study. Questionnaires were also administered to gather quantitative information needed for this research. These included system administrators, users of software, members in top-level positions such as managing directors, software development heads and project managers.

1.8 ORGANISATION OF CHAPTERS

The various chapters were organized as follows; chapter one is the introduction which covered the background of the study, statement of the problem, aims and objectives of the study, significance of the study, scope and methodology of the study. Chapter two put into perspective the relevant literature for the research. Chapter three presented the researcher's chosen methods and procedures adopted in collecting, analysing and the presentation of the report. Chapter four consisted of data presentation and analyses. The final chapter outlined the conclusions and recommendations of the study.



CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter gives a rundown of the downstream petroleum industry in Ghana and software development. It begins by giving an overview of the petroleum sector in Ghana; the structure and the various sub-sectors within the sector. The downstream sector of the petroleum industry which is the focus sector of this study is further explored. Software development is also discussed, taking a critical look at the outsourced approach to development. Finally, software development in the downstream petroleum industry is looked at.

2.2 OVERVIEW OF THE PETROLEUM INDUSTRY IN GHANA

When we go to the filling station to fill our vehicles with fuel, we are actually in the final link in a long chain of businesses that make it possible for us to enjoy these convenient and economical forms of energy. The entire chain is known as the petroleum industry (PSAC, 2019). As stated by the Petroleum Commission of Ghana (2019a), Ghana is an up and coming player in the oil and gas industry and has operations in the upstream, mid-stream, and downstream sectors. As cited by OfosuPeasah & Ackah (2017), the raw state of crude oil has limited uses; for this reason, it goes through a value addition process hence the tripartite stated above. Schedule Reader (2019) identified that, when someone wishes to explain the position of a company or service in the oil and gas supply sequence, they usually use the generic terms; upstream, midstream or downstream. In June 2007, Kosmos Energy, a premier international oil company working in Ghana, announced that commercial quantities of oil and gas had been found in Ghana (Skaten, 2018). This discovery gifted the country with the opportunity to explore oil, thereby venturing into the upstream sector of the petroleum industry.

2.2.1 THE STRUCTURE OF THE PETROLEUM INDUSTRY

I. The Upstream Sector

The upstream sector of the oil and gas industry shoulders the responsibility of finding crude oil and natural gas, along with their production. This industry is sometimes known as the exploration and production (E&P) sector (PSAC, 2019). The sector includes all activities that happen out in the field including drilling wells, trucking supplies, and mining oil sands (Donev et al., 2018b). This sector of the petroleum industry spotlights and operates around the wells, implying that it has significant interest about their location, how deep and far the wells are to be drilled, how to design, construct, and manage them (Schedule Reader 2019). Its processes and operations involve the search for potential underground(offshore) or underwater(onshore) crude oil and natural gas fields, drilling of exploratory wells, and consequently drilling and operating the wells that recover and bring the raw natural gas and/or crude oil to the surface (Schedule Reader 2019). Offshore and onshore are terms used to describe the drilling of oil off the shore, thus in the ocean and the drilling of oil on land respectively.

According to Donev et al., (2018b), the upstream sector has a number of subsectors and these include Offshore drilling, Oil sands mining, Supply and service, Manufacturing, Seismic surveys, Geological surveys and Reclamation. John Peter Amewu, Minister of Energy disclosed on February 5, 2019 that, as at the end of September 2018, about 600 indigenous Ghanaian companies had registered with the Petroleum Commission, providing goods and services to firms in the oil and gas industry (Ghanaweb, 2019). The Petroleum Commission which was established by an Act of Parliament, 2011 (Act 821) due to hydrocarbon discoveries in commercial quantities, has the mandate to manage and regulate the

utilisation of petroleum resources and also coordinate the policies in the upstream petroleum sector (Petroleum Commission of Ghana, 2019a). Other key players in the sector include the Ministry of Energy, who is responsible for the making of policies in the industry, The Ghana National Oil Company who is in charge of leading in the exploration and production, Environmental Protection Authority (EPA), the Ghana Atomic Energy Commission and Petroleum Commission who are also responsible for ensuring personnel, health and environmental safety in the sector whereas the Maritime Authority, Navy and other security agencies are mandated to secure the oil and gas resource and maritime boundaries (GNPC, 2016) as cited by (Ofosu-Peasah & Ackah, 2017). Other companies in the upstream petroleum sector in Ghana include Tullow Oil, Kosmos Energy, Springfield Energy Limited, Saltpond Offshore Producing Company Limited etc. (Petroleum Commission of Ghana, 2019b). It is not out of the ordinary for the activities of the upstream industry to take very long time, and a lot of investment is required, especially in the exploration phase (Schedule Reader, 2019). Figure 2.1 below summarizes the activities characterized by the upstream sector.

Upstream 🇳🇮



Figure 2.1: The Upstream Industry

Source: Schedule Reader, (2019)

II. The Midstream Sector

As the name suggests, the midstream petroleum industry comprises facilities and processes that rest between the upstream and downstream petroleum sectors. It serves as the link between the upstream and the downstream by delivering oil and (or) gas through pipelines or vessels (Ofosu-Peasah & Ackah, 2017). Its activities may include processing, storage and transportation of crude oil and natural gas (EKT Interactive, 2019b). Extractives Hub (2019) also stated that the midstream sector of the chain comprises transportation, trading, gathering, storing of oil and gas and processing of natural gas. In this sector, the first step is the gathering of oil and gas which are produce from the upstream sector. For oil, the movement is

through a network of pipelines, which has a small diameter, directly to a central site. With natural gas, the gathering process is slightly different; the storing of the gas cannot be at or near the well and because of that, there's the need to purify and process it to remove the water and other impurities. Once there's the separation of the natural gas liquids (NGL's), they can then be sent through pipelines, which are larger in diameter (Schedule Reader, 2019).

The services offered by the sector can be detailed out as follows: Diversified Midstream Pipeline and Storage, Crude Oil and Refined Products Pipeline and Storage of Excess, Marine Shipping and Transportation, Natural Gas Gathering and Processing, Natural Gas Pipeline and Storage, Oil Field Services (Schedule Reader, 2019). Transportation alternatives may vary from small connector pipelines to enormous cargo ships that makes crossings across oceans, subject to the commodity and distance covered (Schedule Reader, 2019). And there are three alternative methods for the transportation of oil and gas. Oil can be transported by trucks over short distances, and by barge or rail for medium distances while tankers and pipelines are the only method for the long-distance transportation of oil (Extractives Hub, 2019). The Ghana National Gas Company (GNGC) is the main operator in the midstream sector in Ghana (GNGC, 2019) while. The Public Utilities Regulatory Commission (PURC) and the Energy Commission of Ghana has the regulatory responsibility over the sector (Ofosu-Peasah & Ackah, 2017). This sector's policy, health, safety and security function roles is the same as the assigned institutions in the upstream sector (Ofosu-Peasah & Ackah, 2017).

So, in summary, this sector of the petroleum industry involves the storage, transportation and wholesale marketing of crude oil and natural gas. Among these three functions, transportation is the principal, and the use of pipelines is the most

common and effectual way of oil transport across land; while for transportation across large water bodies, tanker ships are the most preferred method. For shorter distances, trucks, trains, and other land vehicles can also be used. After oil has been shipped, there are dedicated facilities that store it before it reaches its final destination, and other companies are in the business of purchasing and selling the unrefined petroleum (Mixer Direct, 2019).

III. The Downstream Sector

The downstream sector is the last link in the oil and gas supply chain, and encapsulates the operations that take place after the production phase right to the point of sale to the end consumers (Schedule Reader, 2019). It includes oil refineries, petrochemical plants, petroleum products distributors, retail outlets and natural gas distribution companies (PSAC, 2019). Schedule Reader (2019) also describes the sector as one that comprises the refining, processing, distillation and purification before transforming it into utilizable, sellable and consumable products e.g. fuels, raw chemicals, finished products etc.

Figure 2.2 below provides an activity-summary of the various sectors within the petroleum industry.



Figure 2.2: The Petroleum Industry Structure Source: Donev et al., (2018b)

2.3 OVERVIEW OF THE DOWNSTREAM SECTOR

2.3.1 DEFINITION OF DOWNSTREAM

Harraz (2016) stated that the downstream is everything from refining to sales; the refining, processing, marketing, and distribution of refined petroleum products. Donev et al., (2018a) also describes the downstream industry as the portion of the oil and natural gas industry that is responsible for the refining, distributing, and retail of petroleum products.

2.3.2 THE CHARACTERISTICS OF THE DOWNSTREAM

The downstream is the final link in the petroleum industry supply chain. The industry provides several products such as jet fuel, gasoline, diesel, synthetic rubber, plastics, pesticides, pharmaceuticals, natural gas, and propane (PSAC, 2019). Retail marketing activities assists in moving these finished products from the energy companies to the end users and retailers. EKT Interactive (2019a) asserted that the downstream sector of the petroleum industry includes the following functions; acquisition and transportation of crude oil, refining, bulk distribution and supply, and marketing

(distribution, retailing and terminals/wholesale). There are a number of sub-sectors within the industry and they include: distributors, retail outlets (also called filling stations in Ghana) and production plants (Donev et al., 2018a).

The main regulator in the downstream sector is the National Petroleum Authority (NPA). The NPA was established by an Act of Parliament (NPA Act 2005, ACT 691) with its duty being to regulate the downstream sector of the petroleum industry in Ghana. The authority as a regulator is mandated to ensure that the sector remains efficient, profitable, fair, and at the same time, ensuring that consumers receive value for money (NPA, 2017). The health, safety, security and policy function roles in the sector is the same as the mandated organizations in the upstream and midstream sectors (Ofosu-Peasah & Ackah, 2017). The operations in this sector are categorized as follows: Bulk Distribution Companies (BDCs), Oil Marketing Companies (OMCs), Depots, LPG Marketing Companies (LPGMCs) and Bulk Road Vehicles (BRVs) (NPA, 2017).

The operations of all these categories are linked. The BDCs are companies that buy petroleum products in bulk or process the natural gas and crude oil and sell/distribute mainly to the Oil Marketing Companies. The Chamber of Bulk Oil Distribution Companies (CBOD) is the body that represents the Bulk Oil Distribution Companies. It serves as the advocacy, lobby and representative body of the industry and also functions as a research and strategy unit in the industry, dedicated to boosting the commercial viability and sustainability of the industry (CBOD, 2017). According to NPA (2019), the industry currently has 33 registered BDCs, 107 OMCs, 6 Depots, 40 LPGMCs and 2814 BRVs. The core business of the OMCs is the marketing and sale of petroleum products especially fuel and gas to end-users. The Association of Oil Marketing Companies (AOMCs) is the representative body of the Oil Marketing

Companies. It is a private initiative by the oil marketing operators in Ghana and an industry association. They also serve as an advocacy organisation instituted to assist direct policies at the downstream level, legislation and regulation and also functions as a research unit towards the growth of the downstream industry (AOMCs, 2019).

As stated by Rajat (2015), the OMCs purchase price is in direct relation to international crude price. This means that lower prices are actually beneficial for the OMCs. OMCs in Ghana have several retail outlets popularly called filling stations across the country. The well establish ones such as Ghana Oil Company Limited, which is a state-owned company have over 300 retail outlets across the country (GOIL, 2019).

2.4 OVERVIEW OF SOFTWARE DEVELOPMENT

2.4.1 OVERVIEW OF A SOFTWARE

As described by Computer Hope (2019), software is a collection of instructions which enable users to interact with a computer, its hardware, or perform tasks. Most computers, smartphones, laptops or tablets would be useless without software. All the programs that make the applications (apps) on our phones and computers work belong in the software category. Sommerville (2007) also had this to say about software: software is not only the programs, but it is also all the associated configuration data and documentation that is required to make the programs operate correctly. Humphrey (1989) had earlier stated that software refers to a program and all the accompanying information and materials that is needed to support its installation, functioning, fixes and improvement. As IBM (2019b) pointed out, “Software has emerged as a key differentiator in many products - from cars to washing machines to thermostats - with a growing Internet of Things connecting them.” Software is a broad term that is often used to describe computer programs. There are other terms often used to describe software and they include scripts, applications, programs and a set of instructions

(Techopedia, 2019a). Installing applications or programs therefore, on a computer is synonymous with installing software on the computer (TechTerms, 2019). In information technology, software is usually divided into three classes; System software, Application software and Programming software.

System software operates as a base for application software. It can be viewed as a program that supports application software. The management of hardware components and provision of basic non-task-specific functions also lies with the system software. A popular example of this class of software is operating systems such as Windows, iOS, Linux. Other examples include disk management, utilities and hardware management. Without system software installed on our computers, we would have to type the instructions for everything we want the computer to do. Application software are software that lie on system software and perform user tasks. They are specific to the tasks they are designed for and they can be a single program or a compilation of small programs. This class of software is what users mostly refer to as 'software'. Examples include, office suites, games, database applications, media applications, Enterprise Resource Planning (ERP) software etc. Applications also refer to mobile and web applications such as the ones used to shop on ebay.com, socialize with Facebook, connect with professionals on LinkedIn or post pictures to Snapchat (IBM, 2019a). The third class of software, programming software, is made up of tools that aid developers/programmers in creating, debugging, maintaining, or otherwise supporting other programs. Some of the tools available include compilers, interpreters, debuggers etc (Techopedia, 2019a). IBM (2019b) averred that there is the existence of a possible fourth type of software, and that is embedded software. This category of software is used in the control of devices and machines which are not typical computers; this may include telecommunications networks, microwave ovens,

refrigerators, cars, robots etc.

Unlike computer hardware, software is not physical; it is virtual and this makes it difficult to describe. In its place, software is made up of carefully organized lines of code in a particular programming language, written by computer programmers and have been compiled into an application. Because of its virtual characteristic, it does not occupy any physical space, making it far simpler and often cheaper to upgrade as compared to computer hardware (TechTerms, 2019). IBM (2019a) asserted that software is independent of hardware and makes computers programmable. Software is developed using what they call programming language. There are a host of programming languages available and the process of building or developing these software packages is termed software development.

2.4.2 SOFTWARE DEVELOPMENT

WhatIs.com (2016) described software development as the systematic process of developing software through sequential phases in a methodical way. The process doesn't only involve the actual writing of codes but additionally the preparation of requirements and objectives, designing the code before it is actually coded and validating that the final product satisfies the objectives for which it was developed. IBM Research (2014) also cited that software development refers to a set of activities in computer science dedicated to the process of designing, creating, deploying and supporting software

The phases of software development may vary slightly per developer. WhatIs.com (2016) lists the following as the various development stages:

- 1) Identification of required software
- 2) Analysis of the software requirements
- 3) Detailed specification of the software requirements

- 4) Software design
- 5) Programming
- 6) Testing
- 7) Maintenance

IBM (2019a) also stated the following as typical steps to follow in the development of software:

- 1) Selecting a methodology
- 2) Gathering requirements
- 3) Choosing or building an architecture
- 4) Developing a design
- 5) Constructing code
- 6) Testing
- 7) Managing configuration and defects
- 8) Deploying
- 9) Migrating data
- 10) Managing and measuring the project

IBM (2019a) further asserted that, the stages of the software development process fit into the lifecycle management of an application. The application life cycle management goes through these processes:

- 1) Requirements analysis and specification
- 2) Design and development
- 3) Testing
- 4) Deployment
- 5) Maintenance and support

The lifecycle helps in continuous improvement by recycling the process. For instance, issues that a user may bring up during the maintenance and support stage can be converted into requirements at the start of the next cycle.

Programming languages are used to create software. Although there are a host of them, relatively few are used (Encyclopaedia Britannica, 2019). Some common programming languages include C++, C#, Go, Java, Cobol, C, Fortran, Lisp, Python, Pascal and Visual Basic. Each language has unique set of keywords and a special syntax for instructing a computer to perform specific tasks (Webopedia, 2019). The product of software development (software), is actually a set of instructions following the commands of the chosen language. The development of software is predominantly done by computer programmers, software developers and software engineers whose roles intersect and interact, and the dynamics that exist between them vary significantly across development fraternities (IBM, 2019a). Computer programmers, sometimes referred to as coders, are involved in the writing of source code to program computers to perform particular tasks like consolidating databases, online order processing or displaying text and graphics. Coders usually do interpretation of instructions from the software developers and software engineers (IBM, 2019a). Chron (2019b) also asserted that the duties of programmers actually begin before they ever write any code. Their first line of work in the development process is meeting software developers to discuss about the program design.

Software engineers, as their name suggests, apply engineering principles in the development of systems and software to solve problems. They make use of modelling language and other tools to formulate solutions that can often be used to tackle problems in a general way, instead of simply solving for a particular instance or client (IBM, 2019a). As stated by Half (2019), a software engineer addresses the whole

software development lifecycle - analysing the requirements, and then designing, testing and developing the software in order to satisfy those requirements. They make use of diagrams and flowcharts in documenting the development process and also use algorithms to develop computer instructions. In light of the extent of a software engineer's role, he/she must have an in-depth understanding of computer systems. This will help in the detection of any hardware limitations that could affect software design. If a software engineer is the architect, a software developer is the carpenter (Fullstack Academy, 2019). Software developers' approach to development is by programming distinct units of the system and eventually coming up with the solution. As compared to the software engineers, they have a less formal role and usually doesn't focus on the entire project but on a single project as part of the whole. Nevertheless, they carry the responsibility of driving the complete software development lifecycle — including working with end-users to transform their requirements into features, managing the development processes and teams, and conducting software testing, maintenance and upgrade (IBM, 2019a).

IBM (2019a) stated that software development can be categorized into custom software development and commercial software development. Custom software development can be described as the process whereby the design, creation, deployment and maintenance of the software is done for a particular group of users, functions or institutions. Commercial software development on the other hand is designed based on a comprehensive set of requirements; this is mainly done for software meant to be marketed and distributed commercially. Some of the products of commercial software development are however open-source (meaning they can be customized by the purchaser/user). Software development has become very important for a number of

reasons. This includes helping companies to be more competitive and be set apart from others. It has what it takes to make processes more efficient, safe and productive, improve the experiences of customers and bring more ground-breaking, feature-rich products to market at a faster rate (IBM, 2019a).

2.4.3 OUTSOURCED SOFTWARE DEVELOPMENT

Sharma (2018) described outsourcing as simply a routine of hiring the services of a supplier to do a particular work for you. The job at hand is then completed by the vendors rather than on-site. When outsourcing emerged, it was just within the manufacturing industry but now almost every industry does outsourcing. A critical look at outsourcing reveals that, it is actually based on the principle of work delegation. Its significance is fast rising and firms now opt for outsourcing for numerous vital tasks. The emergence and ease of access of the internet is one reason for this fast upsurge (Sharma, 2018). When you hire outsiders to do tasks which either you are not good at or which follow predictable patterns, it leads to fluidity in business. There are numerous companies that are into software development who are ready to shoulder an organisation's software development tasks and do it with perfection, so they can concentrate on their core activities. Based on the location of the outsourcing firm, software development outsourcing can be categorized into local or offshore software development outsourcing (Sharma, 2018). Aitzaz et al. (2016) opined that outsourcing is mostly fruitful in those areas where face-to face interaction is not needed. In days past, it wasn't alien to hear of an outsourcing company disappearing with a firm's money without doing or completing the work but in present times, there are strong laws to guide the whole process and detain any such fraudulent activity. One very important requirement is for both parties to bind each other in suitable nondisclosure agreements and service contracts. With the evolvement of outsourcing, outsourcing

service providers these days make use of enhanced strategies in order to deliver products that fully satisfies the clients requirements.

2.4.3.1 ADVANTAGES OF OUTSOURCING SOFTWARE DEVELOPMENT

Since the development is done by a third-party firm, the organisation only needs to concern itself with the quality of the work offered by the outsourcing company. They can then focus their efforts and energies on core business operations. Outsourcing as viewed by some people, is a trigger of good relationships across borders and several organizational benefits which include cost, quality and goodwill. Sharma (2018) asserted that there's fluidity in business when third-parties are hired to perform tasks which an organisation is either not good at or which has predictable patterns. Other pros of outsourcing software development as outlined by Cafeto (2017) include

- Ease of access to high quality resources: the process of hiring an in-house development team and assembling the resources needed takes time. A thirdparty vendor can provide a high-quality development team with the needed resource much quicker.
- Flexibility: the organisation does not hire professionals for keeps but for a limited period, in accordance with the project requirements or per the contract. The third-party vendor is flexible to take up the job if the project schedule and needs are favourable.

- Scalability: software development projects are specific; it could be a website or a mobile application or a whole business management system and needs developers composed according to the requirements. Outsourcing enables the organisation to scale up the team of developers specialized for the task ahead.

Artellogic (2019) also pointed out 'Price-wise expertise' as an advantage of outsourcing. Outsourcing price turns out to be more reasonable than in-house pricing due to the fact that, an outsourced team is made up of experienced developers that can tackle unusual problems when they pop up. Whereas in-house may require hiring an expertise to deal with the issue. According to Aitzaz et al., (2016), around-the-clock working is another advantage of outsourcing. This advantage is realised when the organisation and outsourcing company are in different geographical continents and regions. In addition, Rochester (1995) also cited the availability of talent pool as another benefit. This helps to produce high quality projects with less effort and time.

2.4.3.2 DISADVANTAGES OF OUTSOURCING SOFTWARE DEVELOPMENT

Cafeto (2017) asserted that, in case of an emergency, an outsourced company will always view the client as a vendor and may not view the situation as top priority. Sharma (2018) also listed the following as some challenges that are associated to outsourcing:

- Employees develop a feeling of uncertainty; if the firm has an in-house developer, or a team of developers but for some reason, outsourcing is needed for a project, it's been noticed that, it dampens the morale of the in-house developer(s).

- Selecting the right outsourcing company: this is the challenge most firms face when they opt for outsourcing and choosing the perfect supplier is the main deal of the whole outsourcing process. Making the wrong choice can have dire consequences on the project and the organization as a whole.
- Legal issues coupled with deficiency in fully understanding the contract: if the contract is not clearly understood by both parties, it can bring problems to both vendor and client.
- Outsourcing has the tendency of birthing the practice ‘Outsource and forget’: delegating a work to a third-party doesn’t relieve you of the duty to check up and make sure the right work is being done.

Outsourcing as viewed by a section of people, is a cause of huge job loss, cultural and national conflicts and damage to reputation.

2.4.3.3 FACTORS THAT INFLUENCE OUTSOURCING

In most cases, outsourcing is preferred due to lack of expertise in some specific process of software engineering. Other reasons that call for outsourcing include cost saving and technological factors (Aitzaz et al., 2016).

- Cost Factor: cost is the most dominant factor that is considered. Hiring an inhouse team of developers is sometimes very expensive; especially for a project that is to be completed in a short period of time. Considering the technology that may be required to build a software, in-house development can come at a very high cost therefore organisations see it better to transfer their software development projects to external companies that can accomplish the task at a relatively low cost.

- Time Factor: most often, when projects are to be completed within a short duration, most organisations see outsourcing as a very beneficial option. When meeting the objectives of the project within the time frame seems unlikely, they generally outsource the software development project to third-party software companies who can deliver on time.
- Expertise/Speciality: a lot of organisations lack the expertise to develop software. Trying an in-house development may lead to quality and goodwill compromise risk (Doyle & Tapper, 2007). The project may also fail completely due to lack of in-house expertise. Organisations in such cases will rather outsource the software development to organisations with the skill and know-how in that particular project.
- Success Factor: generally, the success ratio of outsourcing is high. This is because, the organisation looks for software developing companies who have the requisite skills and expertise which may be lacking in the organisation.
- Global Access: most organisations have the desire to venture into the global market. This aspiration motivates them to acquire the services of off-shore software developers to carry out their software development projects.
- Quality Factor: when an organisation doesn't have the expertise to develop the required software, they will outsource the project to a company with the high expertise in that project (Aalders, 2002). The probability therefore of the product being of good quality is very high.

2.4.4 OVERVIEW OF IN-HOUSE SOFTWARE DEVELOPMENT

The other available approach to software development is in-house development. According to Artellogic (2019), in-house software development is a software development approach which is run for an organization by the organisation. As an



example for better comprehension, we can look at an Oil Marketing Company deciding to build a mobile application to send daily reports from their retail outlets. In this case, the company must use their own team of developers (called in-house developers) to develop the application. Sharma (2018), averred that monetary issues seemed to be the only concern for the maintenance of in-house software development, but after probing deeper, there's the realization of a plethora of issues that presents itself when one has an in-house software development team. Sensinum (2019) stated that some difficulties that accompany having an in-house team include the hiring of the right team, over expenses and varying intensity of work. Deciding to have an inhouse development team and having one, calls for major investment. Finding the right skilled software developers can be a very difficult task even if the required resources are in place. There is also the possibility of having idle workers since software development and maintenance may not be on a regular basis. This will end up pinching the organisation financially because, irrespective of the volume of work, the developers will have to be paid fixed salaries on regular basis. As established in Sharma's (2018) research, the following challenges can be associated with in-house software development

- Recruitment process is quite tough: financial challenges apart, recruiting the right people to do the work doesn't come easy. Significant amount of time and effort is required for this process coupled with the fact that other companies are also looking out for the best.
- The dearth of skilled people: even though there is a ton of developers on the market, getting the right ones for your organisation can be a daunting task. There scarcity of software development professionals with the right skills. And the good ones are also very expensive.

- Dependency: with an in-house developer or a team of in-house developers in place, all the organisations development work is dependent on them. This can affect project completion time when a developer goes on leave or is uptight with some issues.
- Tools and technologies: an in-house development team may lack the requisite tools and technology for efficient development. Though there are a number of development tools available at no cost and with no need of permission to use, there are still a chunk of important and helpful technologies that require payment or permission for distribution.

Artellogic (2019) also listed the following cons of in-house software development:

- Dismissal or resignation of employee. This happens to be one of the biggest risks of having an in-house development team. Irrespective of the investment made into in-house developers, they can go away and the firm will need to reinvest into new members.
- A huge amount of investment: the major issue that comes with in-house development is cost. When it comes to in-house development, one needs not only to employ a full team of programmers, but also put up the necessary infrastructure which includes space, computers, fast internet etc that will enable them effectively execute their work. As employees and most especially in the ever-evolving I.T sector, training will be needed to enhance knowledge and skill upgrade which calls for the spending of more money.
- Varying areas of domain expertise: software development has a number of aspects; there is mobile app development, app design, website development, back-end and front-end development etc. This presents the need for a domain

expert to take charge of the varying issues. This need can augment problems in efficient project development.

One very popular advantage of having a team of in-house developers is their dedication to working for the organisation. They can easily be reached in emergency situations and dealing with the situation becomes a top priority to them. Moreover, in course of time, all the needs and requirements of the organisation will be well understood and they will provide the needed solutions accordingly (Sharma, 2018).

Artellogic (2019) listed the following facts as reasons to choose the in-house approach:

- Absence of language/cultural boundaries: most often, an in-house team of developers consists of professionals from the same country/city, having the same language and cultural background and working with the same firm. This promotes face-to-face communication and therefore better understanding of the work to be done.
- Deep involvement: the engineering process of every minor software need (either new or upgrade) can be easily customized. Appropriate changes can be easily made to adjust the project to the business.
- In-project expertise: an in-house team tend to master the skills for developing and maintaining the project of the organisation. In the short to long run, they become professionals narrowly focused at the very highest level.

2.5 SOFTWARE DEVELOPMENT IN THE DOWNSTREAM PETROLEUM SECTOR

Almost every company in the downstream sector has a website. These websites could be products of in-house development or outsourcing. The NPA in 2017 launched a Bulk Road Vehicle (BRV) tracking system to track the trucks that carry products from

depots to the various retail outlets. The tracking system has an embedded Global Position System (GPS), sensors and a monitoring software that is web-based (Reporting Oil and Gas, 2017). NPA also has an ordering system where all the firms involved in purchasing and sale of products make orders and track the state of orders. Users of the systems include the OMCs who place the order to the BDCs. The Customs Excise and Preventive Service (CEPS) also play a role in the system and they can cancel an order if it fails any of its tests. The users of the system can track the stage of a particular order. Most BDCs and OMCs make use of systems such as Enterprise resource planning (ERP) to manage their business. Operation such as purchases, sales, accounting and inventory can all be managed from the ERP.

CHAPTER SUMMARY

This chapter gave an overview of the petroleum industry, making mention of the three sectors in the industry. Thus upstream, midstream and downstream. It then gave a detailed review of the downstream industry; which is the sector of focus for this research. The chapter also highlighted on software development and further discussed outsourced software development; its benefits, drawbacks and factors that influence choosing outsourcing. An overview of the other approach to software development (in-house) was given. Lastly, the chapter looked at some examples of software development in the downstream petroleum sector.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Research methodology, as defined by Kothari (2004) is a way to analytically solve the research problem. It can also be viewed as a science of studying how the research is scientifically done. In it, the various steps that a researcher usually adopts to studying the research problem along with the logic behind them are studied (Hallebone & Priest, 2009). This chapter details out the procedures adopted in collecting, analysing and interpreting the empirical data for this research. The chapter commences with introduction and explains the research design, strategy and research approach adopted for the study. It further defines the study location and explains the sampling procedures and techniques adopted, the data collection techniques and analysis as well as the ethical considerations.

3.2 RESEARCH DESIGN

A research design is the organisation of conditions for collecting and analysing data in a way that aspires to combine significance to the research purpose with economy in procedure. According to Baxter (2004), the design includes a framework of what the researcher will do from writing the hypothesis and its operational implications to the final analysis of data. It comprises of the blueprint for the collection, measurement and analysis of data. Kothari (2004) also asserted that, the research design is the conceptual structure within which research is conducted; it comprises the blueprint for data collection, measurement and analysis. A research strategy adopted for this study is the analytical type of research. In this type of research, the researcher makes use of information or facts already available, and analyses these data to make a critical assessment of the material (Kothari, 2004).

In achieving the first objective of this study, secondary data was gathered to identify some of the merits and demerits of outsourcing software development in the downstream sector of the petroleum industry in Ghana. The second and third objectives were also realised initially by the conduction of a detailed literature review to identify vital technical and management decisions that influence outsourcing software development in the downstream petroleum sector and to identify the effects of outsourced software development on the project and operations of an organisation respectively. In addition, semi-structured interviews of various stakeholders were conducted together with a questionnaire survey to gather data from system users and top-level executives on their views of outsourcing in the downstream petroleum industry.

3.3 RESEARCH METHOD

As described by Kothari (2014), research methods may be understood as all those methods/procedures that a researcher uses in the conduction of research. In other words, research methods can be termed as all the methods which the researcher uses during the course of studying his research problem. This research applied the mixed methods research to study and analyse the development of software in the downstream petroleum study in Ghana using the outsourced method of development. In view of this focus, literature reviews, interviews and questionnaires were used in the collection of data.

Tuli (2010) averred that there is a host of research approaches, however, no one recognized approach is necessarily perfect for all research problems because each research approach comes with its own merits and demerits. Creswell (2014) described research approach as the plans and procedures used in research that covers the steps from broad suppositions to the collection of data, the analysis and interpretation of

such in their detailed form. The ultimate decision here is to arrive at which approach will be ideal for the study. Creswell (2014) further stated that the choice of a research approach is partly determined by the nature of the research problem and also based on the philosophical assumption brought to the study by the researcher; the research designs (procedures of enquiry); and the research methods of collection, analysis and interpretation of data. The three main approaches are the qualitative, quantitative and the mixed methods approach (Maxwell, 2012).

The distinction between the qualitative and quantitative research approaches is often based on the use of words (qualitative) instead of numbers (quantitative), or the use of close-ended questions for quantitative hypothesis instead of open-ended-questions for qualitative interview questions. The key feature of the qualitative research approach is that it is mostly applicable to small samples, whereas its outcomes are neither measurable nor quantifiable (Langkos, 2014). Collis & Hussey (2003), asserted that the fundamental advantage of qualitative research is that, it offers a thorough description and analysis of the research subject; at the same time, the scope of the research and the nature of participant's responses are not limited. The quantitative research has its basis on the measurement of amount or quantity; something that is quantifiable (Kothari, 2004). The mixed methods approach involves the systematic integration of both qualitative and quantitative research methods (Bamberger, 2013). This study adopted the mixed method approach which was also described by Creswell (2003) as the type of approach where both qualitative and quantitative data are collated concurrently to provide comprehensive analyses of the study.

The mixed methods approach, as stated by Halcomb & Hickman (2015), serves as an alternative methodological approach to the conventional qualitative and quantitative research approaches, enabling researchers to undertake exhaustive examination of

complex phenomenon. In combining these two methods of data collection, the mixed methods type of research capitalises on the strengths of both qualitative and quantitative research, whilst enhancing their limitations to provide an integrated comprehensive understanding of the subject being explored (Halcomb & Andrew, 2009). Creswell et al. (2004) contended that the mixed methods strategy is not just about simply collecting both quantitative and qualitative data; rather, it indicates that data are integrated, connected, or mixed at some stage of the research process. In addition, they also indicated that the fundamental logic for the mixed method is that quantitative and qualitative methods on their own are not sufficient to capture the trends and details of the situation; but when combined, both qualitative and quantitative data produce a more complete analysis while complementing each other. The study also espoused the convergent parallel (concurrent) style of the mixed method approach. This strategy involves the simultaneous collection of both qualitative and quantitative data which are then converged to provide complete analyses of the study (Creswell, 2003). The term 'mixed method research' is largely recognized to refer to a research strategy that incorporates both qualitative and quantitative data within a single research (Creswell & Plano, 2011). 'Mixing' can be described as the process whereby the quantitative and qualitative elements are interlinked to generate an ampler account of the research problem (Glogowska, 2011). The concurrent mixed methods approach was used for this research in order to obtain different but complementary data to help achieve the objectives of this study. In this type of mixed research strategy, equal priority is given to both qualitative and quantitative data (Halcomb & Andrew, 2009).

To determine which of qualitative or quantitative will be dominant in the mixed methods approach, research objectives were assessed to determine the nature of data that each

method will seek to capture. Objective one sought to outline some of the advantages and disadvantages of outsourcing software development in the downstream petroleum industry. This was addressed in chapter 2 where data was collected from literature. Objective two also sought to identify the motivations for outsourcing software development in the downstream petroleum sector. Management and technical decisions that influence outsourcing was sought and this constituted of both qualitative and quantitative data. The third objective sought to identify the effects of outsourcing on the project and operations of an organisation. The data collected in reference to this objective constituted of experiences of the respondents. Qualitative data constituted the majority of the information collected with a touch of quantitative data. An evaluation of the objectives implied that this study employs the concurrent collection of both qualitative and quantitative data. Hence the study adopted the concurrent mixed methods approach.

3.4 POPULATION AND SAMPLE FRAME

The population refers to the group of people with similar characteristics who are of interest to the research. The research is done for the benefit of the population. From this group, conclusions are drawn. However, because of the normally large sizes of populations, tests by researchers cannot be conducted on every individual in the population since it is often expensive and time-consuming; therefore, the term sample frame. LoBiondo-Wood and Haber (1998) referred to a sample frame as the portion or subsection of the research population that is selected to partake in the study; and they become the representatives of the research population.

The location for this study is the downstream petroleum sector in Ghana. Consequently, the stakeholders in the industry, which include management and system users of the various sub-sectors i.e. BDCs, OMCs, representative bodies, regulatory authorities, LPMCs and BRVs and who serve as the population for the study, were

interviewed and administered close-ended questionnaires. Even though the study targets the downstream sector of the petroleum industry in Ghana, most of the organisations have their head offices in the Greater Accra region of the country, therefore the data collection was within the Greater Accra region. Interviews were conducted at the various offices of the respondents while questionnaires were administered in both hard and softcopies. These sites for information gathering were chosen as it favoured both the researcher and the respondents.

3.4.1 Sample Size

Creswell (2009) asserted that due to large population of a study, it becomes necessary to determine a sample size. The size of the sample depends on such factors as the purpose of the study, the size of the population, the risk of selecting a bad sample and the allowable sampling error (Israel, 1992). The sample frame for this study was made up of the organisations within the downstream petroleum industry and software development companies in the country. The number of petroleum industry players, as revealed by NPA (2019) was 33 BDCs, 109 OMCs, 40 LPGMCs and 10 Authorities. The sample frame as presented in Table 3.1 below, with the data from NPA is summarized in the table below;

Table 3.1: Total number for sample frame

Institution Category	Count
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BDC	33
OMC	109
LPGMC	40
BRV	22
Authorities	10
Total	214

Three other criteria that needs to be specified for an appropriate sample size include; the level of precision, degree of variability and the confidence level in the attributes being measured. The level of precision is most often presented in percentage points ($\pm 10\%$) and the true value of the population is expected to be in that range. The degree of variability is the distribution of attributes in the population. The confidence level is centred on the Central Limit Theorem's ideas whose key idea states that when a population is repeatedly sampled with a finite level of variance, the mean value obtained from those samples is equivalent to the true population value.

There are several strategies that can be used to determine the sample size for a given population. These include the use of census for a smaller population, the use of published tables, the use of sample size of a similar study and using of formula. The study made use of Yamane (1967:886)'s formula to calculate the sample size for OMCs. This formula is simplified and it assumes a 95% confidence level and a proportion (P) of .5. The level of precision employed was $\pm 10\%$ The formula states

$$n = \frac{N}{1 + N(e)^2}$$

that:

Where n = sample size,

N = population size, and

e = level of precision

For the categories with smaller population, census was engaged. Using the two sample size determination strategies stated above, the sample size for the study is summarized in Table 3.2 as follows;

Table 3.2: Total number for sample size

Institution Category	Population	Sample Size
BDC	33	33
OMC	109	52
LPGMC	40	40
BRV	22	22
Authorities	10	10
Total	219	157

3.4.2 Sampling Techniques

Showkat & Parveen (2017) described sampling as the method of selecting a representation of the population called sample. Sampling enhances the accuracy of a research and makes it economical. The sampling techniques refer to the various methods adopted by the researcher in selecting the individual participants of the study. There are two main sample techniques from which the sample can be deduced; the probability and non-probability (Teddlie & Yu, 2007). Probability sampling involves the selection of a number of units from a population where each member of the population is determinable (Collins et al., 2006). In this type of sampling, each of the samples has an equal probability of being selected (Showkat & Parveen, 2017). NonProbability sampling technique on the other hand is a technique where items for the sample are selected deliberately by the researcher. Instead of randomization, participants are selected because they are easy to access (Showkat & Parveen, 2017).

This study sought to adopt the non-probability technique and specifically purposive sampling and snowballing sampling method.

- Purposive Sampling

Purposive sampling as described by Leiber (2009) is the type of non-probability sampling method where participants are selected because they are likely to produce useful data for the research. Purposive sampling is about selecting a particular sample on purpose (Kakulu, 2011). In this type of sampling, the researcher exercises his or her judgment about who will provide the best perspective on the phenomenon of interest, and then intentionally invites those specific perspectives into the study. According to Patton (2002) the rationale and power of purposeful sampling rests in the choosing of information-rich cases for in-depth study. The researcher used this technique to determine the workers in the petroleum downstream industry from which data was generated. This is because there are specific players in the industry with the power and knowledge to provide the information sought. These professionals were made up of project managers, procurement managers, system administrators and managing directors. Data was collected by the use of semi-structured interviews; each interview lasted for about 30 to 60. Answers were recorded in order to increase their reliability.

- Snowballing Sampling

It is also referred to as chain referral sampling. It is vaguely a type of purposive sampling. In this method, informants with whom contact has already been made use their social networks to refer the researcher to other people who could potentially contribute to the research (Family Health International, 2004). This sampling method helps to facilitate the identification of hard-to-find cases. Locate one or two key

individuals, and then ask them to name other likely informants (Bricki & Green, 2007). Due to the large sample size and the limited time and resources available for the study, respondents gathered via purposive sampling referred the researcher to the software companies they have or have had contracts with and also the direct users of their software. Questionnaires were administered to the system users to gather data from them.

3.5 DATA COLLECTION

Data collected for this study is a combination of primary and secondary data. Secondary data was acquired through literature; books, archival documents and scholarly journals sought from the internet and library. The primary data for this study is data obtained from

1. A semi-structured interview of some of the executives in the downstream petroleum industry.
2. A questionnaire survey for the industry professionals that interact with system.

This approach was sought because no one data collection strategy can completely cover the issues of the research (Bryman, 2004; Chaleunvong, 2009).

3.5.1 Secondary and Primary Information

The primary source of information is data gathered from players in the downstream oil and gas industry which includes software users, operations managers, project managers, system administrators and directors. Semi-structured interview and questionnaire survey was used to gather this data. Cohen & Crabtree (2006) were of the view that semi-structured interviews is one of the interview formats used to gather qualitative data. They are helpful for exploring specific cases or for complementing and confirming information derived from other sources. The interview was adopted

for high-profile players such as Chief Operating Officers, account managers, project managers and CEO's in the petroleum industry. These are people who play major role in the acquisition of software in their various organisations.

The secondary source of information is discussed as information gathered from the review of literature. Here, information pertaining to the study that was already documented was used. The literature review constitutes a very important component of the research because sets the pace for the design of the questionnaires and the issues that were raised during the interview (Saunders, et al., 2007; Denscombe, 2007). It therefore helped serve as evidence to support the analysis of the primary data drawn in order to achieve the set objectives.

3.5.2 Questionnaire Design

Bernard (2000) stated that questionnaires collect data by questioning people to respond to exactly the same set of questions - may be self-administered or it may be administered over the phone, in person or web-based. Salant & Dillman (1994) also opined that closed-ended questions with unordered choices, for example the multiplechoice questions are useful for ranking items in order of preference. A questionnaire design is made of two important aspects. These are the structure of the questions and the decisions on the types of response formats for each question (Siniscalco & Auriat, 2005). Krosnick & Presser (2010) and Mathers, et al. (2009) are of the view that survey questions can be classified into three structures:

1. close-ended
2. open-ended, and
3. contingency questions

This study adopted the close-ended questionnaire format. This type of questionnaire asks the respondent to choose, among a possible set of answers, the response that most closely represents his/her viewpoint (Fanning, 2010). The questionnaire designed for this study first introduced the study to the respondent with a preamble and then sought for the consent of the respondent. The questionnaire was then categorized into four sections. The first explored the demographic details of respondents. The second sought their view on the pros and cons of outsourcing, the third aimed to identify the factors that influence choosing outsourcing and the final section identified the influence of outsourcing on the project and the operations of the organisation. The questionnaire was administered to various staff in the downstream petroleum industry who also play a role in the acquisition of software and have interactions with them one way or the other. These included system users and administrators.

3.6 DATA ANALYSIS

This section describes the analysis processes and methods used to analyse both qualitative and quantitative data that were collected through semi-structured interview and questionnaire survey. The qualitative data was firstly analysed and it was then followed by the quantitative data analysis. Both qualitative and quantitative analysis involves labelling and coding of the data collected so as to ascertain their similarities and differences. The technique used for the analysis of the qualitative data collected from the interview was content analysis since it is a research tool that determines the presence of certain words or concepts within texts (Elo & Kyngas, 2008). Kakulu (2011) defines content analysis as a procedure for gathering and examining the content of text. This method helps to understand the overall themes that emerge in qualitative data. A key benefit of content analysis is that data collected can be reduced and simplified, while at the same time yielding results that may then be measured using

quantitative techniques. Additionally, content analysis affords the researcher the ability to structure the qualitative data collected in a manner that satisfies the achievement of research objectives. The qualitative data analysis involved the identification, examination and interpretation of the pattern and themes in the data collected.

The qualitative data is supported by quantitative data which was analysed by the use of frequencies and presented using graphical techniques such as charts and tables. The techniques used to analyse data are based on the type of data and their scales of measurement being it nominal, interval, ordinal or ratio (Gamage, 2011). Consequently, the identification of data scales of measurement is essential prior to a statistical analysis of collected data (Pagano, 2007; Gamage, 2011). The quantitative data was organised using tables, with records represented as rows and attributes represented by columns. A record may be identified as an identifiable piece of information which contains a set of values of attributes to the record (Taheri et al., 2016). The information collected from questionnaires was organised in the following way: each record corresponded to all the answers from a respondent, while each attribute was associated with the answer to one question. Moreover, the research applied the Likert scale to evaluate the factors that influence the choice for outsourcing software in the downstream petroleum industry (least to highest that is on five scale levels). The scores given by the various respondents were possible for the mean scores of the various variables to be computed. For example, the mean score “1” indicates “least”, mean score “5” indicates “highest” while mean score “3” indicates an average view on a motivating factor for making for choosing the outsourcing approach and it is deemed to be “neutral”.

3.7 ETHICAL CONSIDERATIONS

Ethical concerns are imperative when planning and conducting research, and very vital in the collection of data. The key ethical considerations adopted were that of informed consent, confidentiality and autonomy.

- Consent

Research participants were made aware of the implications of participating, and reassured that refusal to participate has no effect on any services they receive or render (Leiber, 2009). Participants freely consented to taking part in the study, without being forced.

- Confidentiality

Protecting the identity of the person the researcher gathers information from is a very essential part of the research; this is to help prevent the possible dangers or risks arising from the participation (Bryman, 2004). The research was devoid of the names of the prospective participants. Moreover, information provided was treated as confidential as possible. The researcher verbally explained to the participants that whatever information given was not going to be disclosed to the media or any other person who was not related to the study.

- Autonomy

The participants were made to understand that they could also withdraw from the study at any point in time and they have freedom from any external control or influence.

3.8 SUMMARY

This chapter discussed the research methodology that was adopted for the study. A mixed methods approach which applied both the qualitative and quantitative approaches

concurrently, was adopted to afford the researcher flexibility in the collection and analysis of data. A variety of techniques were also employed to aid in the collection of the various data and the analysis of such. Following in the proceeding chapter is the presentation of the research findings and the interpretation of the results.

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CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF RESULTS

4.1 INTRODUCTION

This chapter adds on to the report by presenting the analysis and discussion of the results of the fieldwork. The data analysis is in two parts; qualitative and quantitative respectively. Content Analysis was used to analyse the qualitative data gathered from top-level professionals in the downstream sector who are abreast with the acquisition of software by their organisation. The quantitative analysis involves the use of descriptive analysis, one sample t- test or mean score analysis.

4.2 PRELIMINARY SURVEY

Semi-structured interview was conducted for petroleum industry professionals in the downstream sector who are very familiar with the acquisition of software by their respective organisations. This was done through both face-to-face interview as well as telephone interview. The table below shows the various professionals that were interviewed.

4.2.1 Demographic Profile

Fourteen (14) top-level professional were interviewed based on their experience either through acquisition, management, development or administration of software and systems. Table 4.1 below, represents these respondents.

Table 4.1: Demographic profile of the respondents (N=14)

Position	Frequency	Percentage
Managing Directors	2	14.3
Accounts Managers	6	42.9
Apps Development Heads	2	14.3

Risk and Strategy Heads	1	7.1
Project Managers	3	21.4

Source: (Researcher's database, 2019)

4.2.2.1 The Concept of Software Outsourcing

The participants understood software outsourcing as a situation where by a third-party programmer or company is hired to offer software development services, especially the development of such as described by Saigon Technology (2019).

4.2.2.2 Need for in-house Developers

It was gathered that, some of the organisations still have in-house developers to manage and maintain their software. The developers in these organisations therefore need to understand the functionality of the software in order to resolve certain bugs that may pop up. In some cases, the code used to develop this software must be well understood by the in-house programmers since the task to upgrade and make certain changes to the software lies with them. As stated by one respondent:

“Although we outsource our software, we have an in-house team of developers. What they basically do is to maintain and manage these software packages. Sometimes, the outsourcing contract requires us to have the source code; in such instances, our development team do upgrades to the software by adding certain functionalities when needed.”

Another section of the organisations in the industry don't have in-house developers. They only have an administrator tasked with the management of the software. In these

organisations, when bugs are found or there is the need for enhancement, the call upon the outsource company. A participant in one of such organisations commented below:

“We don’t have software developers. We’ve never had one and I don’t think we need one. We seldomly build software and when we need one, we go out to the market”

4.2.2.3 Feeling of uncertainty amongst in-house developers

From literature, it was gathered that when an organisation outsources while there is the presence of an in-house development team, there is the feeling of uncertainty amongst the team (Cafeto 2017). Respondents rather declined this belief that there is no such feeling. They outsource the software development project when it is needful to do so and the team of developers they have understands. One respondent who happens to be the software development head stated that:

“I play a major role in the decision to outsource software. We outsource because we need to outsource and my team appreciates that”.

4.2.2.4 Benefits of Outsourcing

Here, participants pointed out some of the advantages they’ve realised and some successes they’ve chalked up from outsourcing a software development project. One notable merit stated by most of the participants is its cost-saving benefit. This has been emphasized by Otuonye & Udunwa (2016) in their report on the impact of software development outsourcing on the growth of the IT sector in developing countries. The respondents further stated that, they don’t need to acquire and maintain the equipment needed for such projects. From the data acquired from Literature, one benefit as stated by (Sharma, 2018) is that, the organisation gets to focus on their core business activities when software development is outsourced. Four (2) of the respondents

confirmed this when this was specifically asked by the researcher. One of them in confirmation of the above stated, said that:

“Yes. We are into oil and gas; not software. So, we will rather give that responsibility to someone else while we concentrate on what we do. All we have to do is give our requirements, and at the end, make sure they did what we asked. You know some of the software can take a long time to build.”

Two (2) participants, in stating one of the benefits, pointed out a challenge they’ve faced with in-house development. According to one respondent,

“Sometimes, developing in-house takes a far longer time than desired because we spend time to procure the equipment needed and the skill of our developers are sometimes not up to task so they need time to learn. Outsourcing however, relieves us of these challenges”.

4.2.2.5 Challenges of Outsourcing

Four (4) participants said that they sometimes outsource to off-the-shore companies and the difference in time zones with some of the countries makes communication very difficult. Three (3) of them stated that, language hasn’t been a barrier to them because the companies they’ve hired over the years have English speaking representatives and that is even a requirement for them in choosing a vendor.

According to a participant;

“There was this time we outsourced to a company in China. There is about eight (8) hour interval between us. When we are supposed to be sleeping, they will be up. So, to have a meaningful conversation, I had to stay up late in the night. The funny thing is, we knew of this challenge but they were the best company that could offer the services we required so we went with them.”

In relation to outsourced companies not prioritizing an emergency situation as asserted by (Cafeto, 2017) in the article, In-House vs. Outsourced Software Development, five (5) of the participants lamented on this situation. One respondent said;

“Sometimes, it’s difficult to get swift response in cases of emergency...Like when we need to add or omit a feature. Let me give you a typical example: NPA once gave a directive and made a change in our ordering process, therefore their system which we’ve integrated to. This required us to also enhance our software in order to comply but the company we outsourced to was slow to react.”

Three (3) of the participants bemoaned that, some projects require that they give out confidential and private data to the outsourced company. According to a participant;

“Sometimes, we give out information we deem as private to vendors in order for them to produce the software we desire. Thought we sign (NDA) Non-Disclosure Agreement with them, it’s a major risk”.

4.2.2.6 Outsourcing Motivating Factors

There are a number of managerial and technical factors that influence a decision to outsource. Four (4) respondents said that, they always outsource when they need to build a software. This is because, they have no developers in-house. In this category, it is quite clear that other factors that may influence outsourcing are not considered by these organisations. One of these respondents said that;

“Whenever we need software, we look outside. Either we buy it on the market or we look for someone to build it for us. We don’t have a development team here so we don’t even consider building in-house.”.

Six (6) respondents also pointed out that, they outsource sometimes due to the urgency of the applications need. *“When we need an application in a very short time period,*

we mostly look to outsourcing. Because either our developers have their hands full with something else or our resources will inhibit the fast delivery of the application”; this was the comment of one respondent. Another factor that was shared by three (3) participants is that, the company doesn’t have to bear all the risks associated with the development. Rather, the risks are either shared with or transferred to the outsourced company. Because in-house developers have other tasks they may be performing, the deliverables of software development projects are sometimes not on time. When outsourced, vendors are dedicated to producing on time and this sometimes is a reason for choosing to outsource. According to a participant;

“Our developers are not only tasked to build applications: they maintain and monitor existing ones, fix bugs etc. Software development is sometimes interrupted by these activities therefore affecting the delivery schedule. When this will pose a major problem, we rather outsource so we can concentrate on what we are doing here”.

4.3 ANALYSIS AND DISCUSSION OF OBJECTIVES

This chapter is in three sections, which represents the various analysis and findings in relation to the specific objectives set. These are:

- The advantages and disadvantages of outsourcing software development in the downstream petroleum industry in Ghana
- The factors that influence outsourcing software development
- The effects of outsourcing software on the project and operations of the organisation

4.3.1 Respondent Profile from Questionnaire Data

The presentation of the results from the survey on the demographic of respondent was analysed using descriptive analysis. The goal was to present both the background

information of professionals and contractors who took part in the study. Knowing the background information will help generate confidence in the reliability of data collected. Table 4.2 shows the category of organisations from which the respondents fall into. Oil and LPG Marketing Companies had formed the majority of 59% of the respondents. This was followed by BDC (23%), BRVs (14%) and the authorities made up the final 4% of the participants. These numbers are an indication of the number of organisations within the various sectors. The highest response came from the sector with the greatest largest of organisations. Figure 4.1 is a representation of the roles played by the various respondents in relation to their organisation's software packages. Majority of the respondents, thus 44.35% were system administrators. 34.27% were involved in the acquisition of the software; this may include the decision to outsource and where to outsource. Users of the system were also prominent, forming 31.25% of the respondents; these people interact with the software packages on a regular basis. Those that do not fall under any of the listed groups were the remaining 17.13% of the respondents; some of these were software developers.

The academic qualification of the respondents was also sought and can be seen in Figure 4.2. BSc holders (53%) greatly outnumbered the other academic qualifications.

MSc/MPhil holders (39%) and had the second. HND (5%) and unlisted qualification (3%) least dominated the study. There were no PhD holders among the respondents.

The experience of the participants in the Oil and Gas industry and their experiences with the software packages of their organisations as shown respectively in Figures 4.3 and 4.4, was between 1 to 15 years. Majority of the respondents had 1 to 5 years of experience in both the industry and with their organisation's software packages. This was followed by 6 to 10 years of experience and then lastly, 11 to 15 years of experience.

Table 4.2: Category of organisation

<u>Categories</u>	<u>Count</u>	<u>% of Total</u>
Bulk Distribution Companies	27	23
Oil & LPG Marketing Companies	69	59
Bulk Road Vehicle Companies	15	14
Authorities	5	4

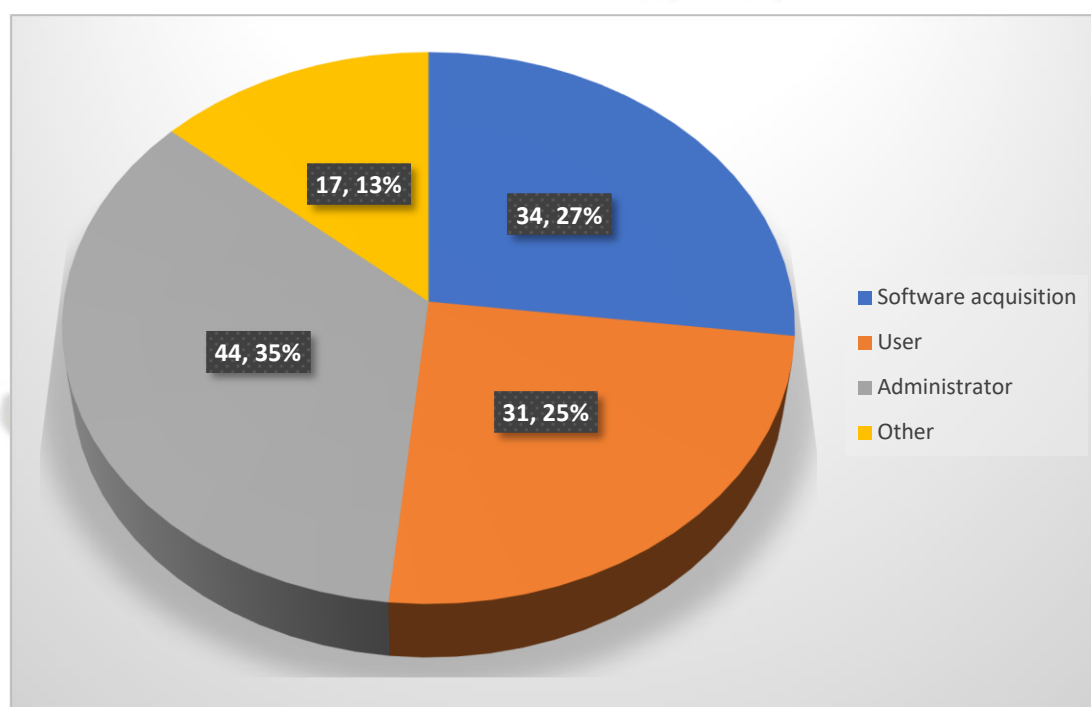


Figure 4.1: Role of respondents in relation to Organization's software packages

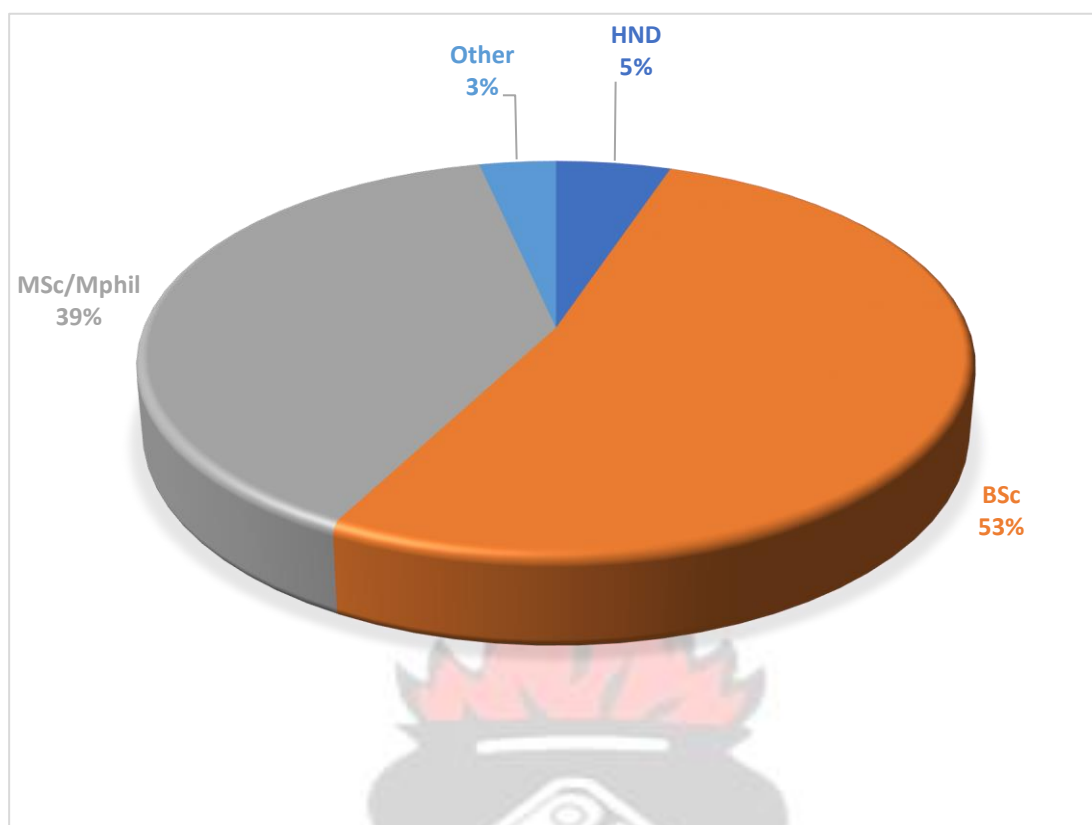


Figure 4.2: Academic Qualification of Respondents

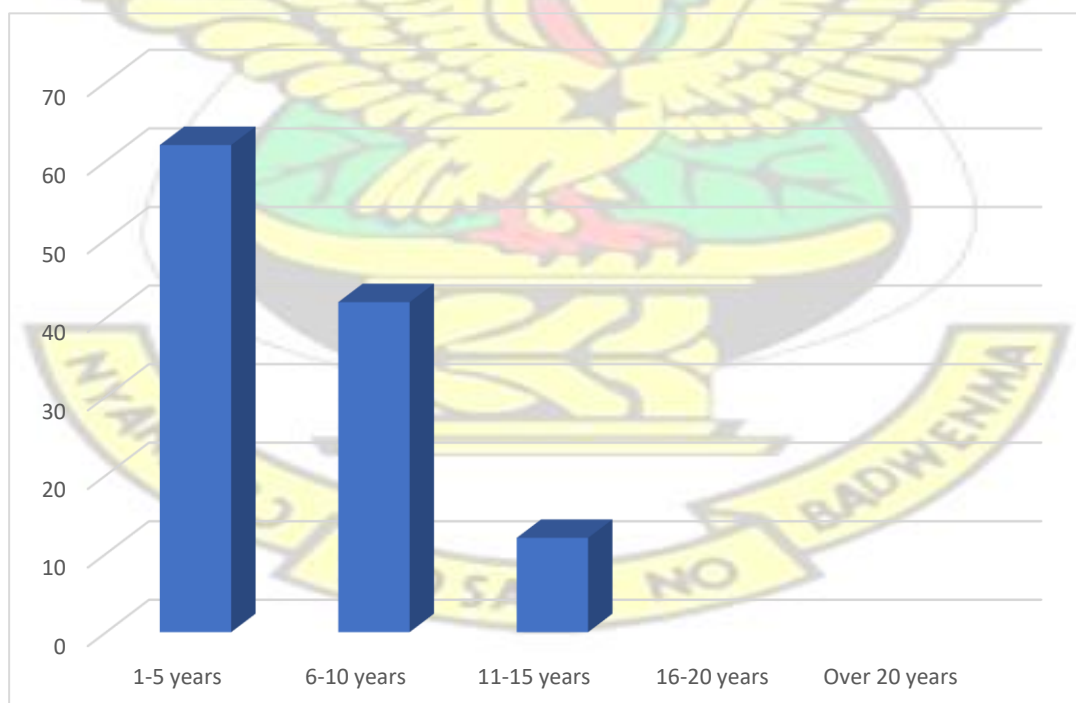


Figure 4.3: Experience in the Oil & Gas Industry

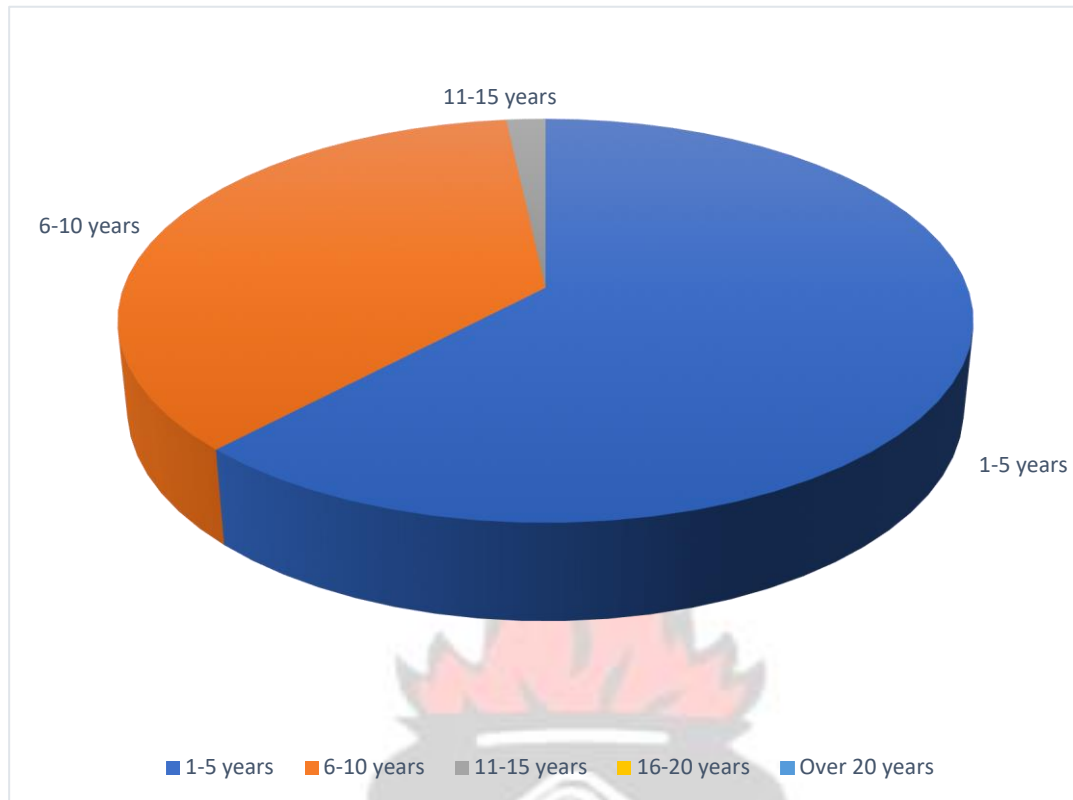


Figure 4.4: Experience with Organization's software packages

4.3.2 The Advantages and Disadvantages of Outsourcing Software Development in the Downstream Petroleum Industry in Ghana

This section identifies the merits and demerits of outsourcing the development of software in the industry. A total number of one hundred and fifty-one (151) questionnaires were administered. One hundred and sixteen (116) questionnaires were retrieved which represent 77% response rate. The respondents were therefore asked to indicate their experience by ranking the advantages and disadvantages on a Likert scale of 1 to 5, where 1=Strongly Disagree, 2=Disagree, and 3=Neutral, 4=Agree, 5=Strongly Agree.

4.3.2.1 Analysis of the Advantages of Outsourcing

The essential theory underlying the factor analysis is the capacity to statistically manipulate the empirical relationship among several variables to help disclose

conjectural constructs of the relationships (Kreuger and Neumann, 2003). This helps address some relevant issues in relation to the appropriate sample size for undertaking and establishing the reliability of factors analysis (Field, 2005). Kaiser-Meyer- Olkin measure of sampling adequacy (KMO-test) was used to check reliability that samples are big enough to subject to factor analysis. According to Field, (2005) the sample is adequate if the value of KMO is greater than 0.5. Consequently, as presented in Table 4.3, the KMO measure of this study achieved a value of 0.660 indicating the adequacy of the sample size for the factor analysis. The Bartlett's test of sphericity was also significant suggesting that the population was not an identity matrix; therefore, there are some relationships between the variables (Field, 2005). Bartlett's Test for this study was highly significant ($p < 0.001$).

Table 4.3: KMO and Bartlett's Test (Advantages of outsourcing)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.660
Bartlett's Test of Sphericity	Approx. Chi-Square	59.285
	df	10
	Sig.	.000

After establishing the adequacy of the sample and the population matrix, the data is then subject to principal component analysis (with varimax rotation). Succeeding the principal component analysis, the communalities involved were established.

Communality can be defined as the total amount an original variable shares with all other variables included in the analysis and it is very useful in deciding which variables to finally extract.

Table 4.4: Communalities (Advantages of outsourcing)

Advantages of Outsourcing	Initial	Extraction
There is more concentration on core business activities when software development projects are outsourced.	1	0.591
Third party developers come in with all the resources required to build the software.	1	0.651
Outsourcing is less expensive as compared to in-house development.	1	0.824
There is no need for in-house developers.	1	0.743
Outsourcing exposes your organisation to project management and development cycle best practices from multiple companies across the globe.	1	0.598

Furthermore, as indicated in Tables 4.4 above, the average communality of the variables for both advantages and disadvantages after extraction was above 0.50. The orthodox rule about communality values is that; extraction values (eigenvalues) which are more than 0.50 at the initial iteration indicates that the variable is significant; and should be included in the data for further analysis or otherwise removed (Field, 2005). However, in the application of the latent root criterion on the number of principal components to be extracted implied that two (2) components should be extracted, as their respective eigenvalues were greater than one (1). In addition, as indicated in table 4.5 and the scree plot in Figure 4.5, two (2) components with eigenvalues greater than 1.0 were extracted using the factor loading of 0.40 as the cut-off point. Both of the extracted components cumulatively explained 58.389% of the variation in the data, which confirms to the proportion of variance criterion, which says that the extracted components should together explain at least 50% of the variation. Scores are numbers that express the influence of an eigenvector on a specific sample.

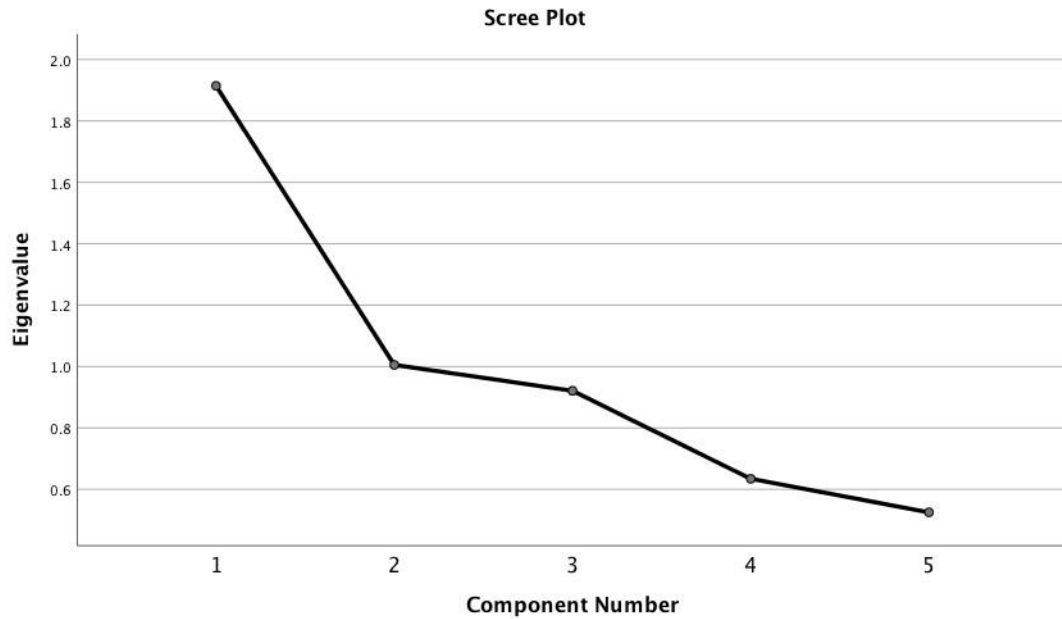


Figure 4.5: Scree Plot (Advantages of outsourcing)

Table 4.5: Rotated Component Matrix (Advantages of outsourcing)

Advantages of Outsourcing	1	2
There is more concentration on core business activities when software development projects are outsourced.	.784	
Third party developers come in with all the resources required to build the software.	.700	
Outsourcing is less expensive as compared to in-house development.		.480
There is no need for in-house developers.		.908
Outsourcing exposes your organisation to project management and development cycle best practices from multiple companies across the globe.		.052

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a Rotation converged in 8 iterations.

The purpose of rotation is to achieve a simple structure, from the large loading factors in absolute value for only some of the variables, making it easier to identify and interpret. It is desirable that each variable has large loadings for only a few factors,

preferably one, helping to differentiate the factors from each other. If several factors have high loadings on the same variables, it is difficult to determine how factors differ. As asserted by Chris, (2004) results after factor rotation indicates the amount of variance between the variables that each factor accounts for and provides loadings of all the variables on each factor. As demonstrated from Table 4.5, both components had more than one variable loading on them. However, one variable: *Outsourcing exposes your organisation to project management and development cycle best practices from multiple companies across the globe*, had no component with the value greater than the cut-off point of four (4), therefore ignored for further analysis. The two (2) components formed 58.389% of the total variables of five (5). Thus, total variance explained by each component extracted is as follows: The first principal component (component 1) accounted for 38.284% of the total variance whilst the second (component 2), explained 20.105% of the remaining variation not explained by the first component.

Table 4.6: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.914	38.284	38.284	1.914	38.284	38.284	1.803	36.054	36.054
2	1.005	20.105	58.389	1.005	20.105	58.389	1.117	22.335	58.389
3	0.921	18.421	76.811						
4	0.634	12.687	89.498						
5	0.525	10.502	100						
Extraction Method: Principal Component Analysis.									

4.3.2.1.1 Discussion of Results

From the results of the study, it can be deduced that most of the advantages of outsourcing runs generally throughout the organisations. While some companies reap certain benefits, other companies do not or are neutral to them. The following section discusses each component individually.

Component 1:

Component 1 is made up of two (2) variables, which accounted for 38.284% of the total variance. These are: *there is more concentration on core business activities when software development projects are outsourced* (0.784); *third-party developers come in with all the resources required to build the software* (0.700). The figures in the bracket indicate the loadings of each variable's impact on the component. According to Sharma (2018), since the development is done by a third-party firm, the organisation only needs to concern itself with the quality of the work offered by the outsourcing company. They can then focus their efforts and energies on core business operations. Cafeto (2017) also asserted that, access to high quality resources come at ease. A thirdparty vendor can provide a high-quality development team with the needed resource much quicker.

Component 2:

Component 2 is also made up of two (2) variables, which accounted for 20.105% of the total variance. These are: *outsourcing is less expensive as compared to in-house development* (0.480); *there is no need for in-house developers* (0.908). Artellogic (2019) pointed out 'Price-wise expertise' as an advantage of outsourcing. Outsourcing price turns out to be more reasonable than in-house pricing due to the fact that, an outsourced team is made up of experienced developers that can tackle unusual

problems when they pop up. Aitzaz et al. (2016) also cited less development cost as a benefit of outsourcing. Software projects are mostly outsourced when cost of in-house development is more than other regions due to higher wage rates and salaries. It was gathered that, some of the organisations still have in-house developers to manage and maintain their software. The developers in these organisations therefore need to understand the functionality of the software in order to resolve certain bugs that may pop up. In some cases, the code used to develop this software must be well understood by the in-house programmers since the task to upgrade and make certain changes to the software lies with them. Another section of the organisations in the industry don't have in-house developers and have not seen the need for them.

4.3.2.2 Analysis of the Disadvantages of Outsourcing

Kaiser-Meyer- Olkin measure of sampling adequacy (KMO-test) was used to check the reliability of the data. According to Field, (2005) the sample is adequate if the value of KMO is greater than 0.5. Consequently, as presented in Table 4.7, the KMO measure of this study achieved a high value of 0.815 indicating the adequacy of the sample size for the analysis. The Bartlett's test of sphericity was also significant suggesting that the population was not an identity matrix; therefore, there are some relationships between the variables (Field, 2005). Bartlett's Test for this study was highly significant ($p < 0.001$).

Table 4.7: KMO and Bartlett's Test (Disadvantages of outsourcing)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.815
Bartlett's Test of Sphericity	Approx. Chi-Square	452.009
	df	78
	Sig.	.000

After establishing the adequacy of the sample and the population matrix, the data is then subject to principal component analysis (with varimax rotation). Succeeding the principal component analysis, the communalities involved were established.

Table 4.8: Communalities (Disadvantages of outsourcing)

Disadvantages of Outsourcing	Initial	Extraction
In-house developers develop a feeling of uncertainty when software development projects are outsourced.	1	0.704
It is difficult to get the right outsourcing company.	1	0.684
Outsourcing comes with a lot of legal issues.	1	0.731
In case of emergency, outsourced companies do not prioritize the issue.	1	0.689
Organisations often outsource and forget about the project.	1	0.54
There is language or culture barrier when projects are outsourced outside the country.	1	0.456
Upgrade and customization of software is difficult.	1	0.621
Confidential and private data is at stake.	1	0.534
Organisation may lose control of the project to the outsourced company.	1	0.729
Integration with current/old system is difficult if developed by a different vendor.	1	0.715
Outsourcing companies may disappear with the firm's money.	1	0.701
Deploying completed software for use is difficult.	1	0.599
Vendors find it difficult to understand the business and its operations in acquiring the requirements for the project.	1	0.627

As indicated in Tables 4.8 above, the average communality of the variables for the disadvantages after extraction was above 0.50. This indicates that the variables are significant; and should be included in the data for further analysis (Field, 2005). In the application of the latent root criterion on the number of principal components to be extracted implied that four (4) components should be extracted, as their respective eigenvalues were greater than one (1). In addition, as indicated in table 4.9 and the scree plot in Figure 4.6; four (4) components with eigenvalues greater than 1.0 were extracted using the factor loading of 0.50 as the cut-off point. All the four (4) extracted components cumulatively explained 61.639% of the variation in the data, which confirms to the proportion of variance criterion, which says that the extracted components should together explain at least 50% of the variation.

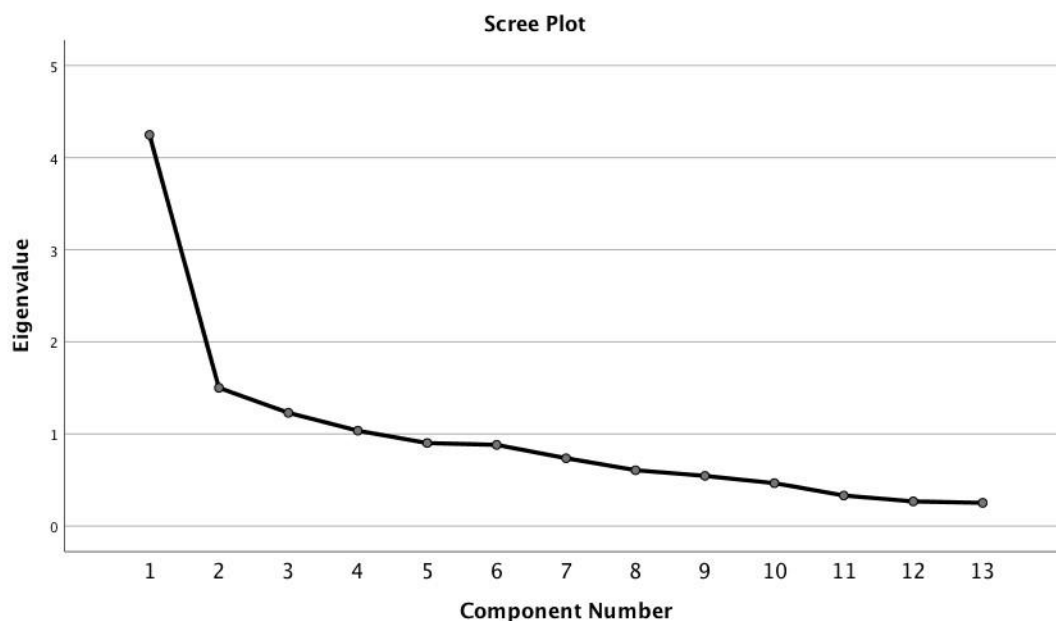


Figure 4.6: Scree Plot (Disadvantages of outsourcing)

Table 4.9: Rotated Component Matrix (Disadvantages of outsourcing)

Disadvantages of Outsourcing	1	2	3	4
In-house developers develop a feeling of uncertainty when software development projects are outsourced.	.734			
It is difficult to get the right outsourcing company.	.691			
Outsourcing comes with a lot of legal issues.	.765			
In case of emergency, outsourced companies do not prioritize the issue.				0.750
Organisations often outsource and forget about the project.			.746	
There is language or culture barrier when projects are outsourced outside the country.		.540		
Upgrade and customization of software is difficult.				.716
Confidential and private data is at stake.		.627		
Organisation may lose control of the project to the outsourced company.			.615	
Integration with current/old system is difficult if developed by a different vendor.		.724		
Outsourcing companies may disappear with the firm's money.	.759			
Deploying completed software for use is difficult.	.699			
Vendors find it difficult to understand the business and its operations in acquiring the requirements for the project.			.699	

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a Rotation converged in 8 iterations.

As demonstrated from Table 4.9, all four (4) components had more than one variable loading on them. They formed 61.639% of the total variable of thirteen (13). Thus, total variance explained by each component extracted is as follows: The first principal component (component 1) accounted for 32.670% of the total variance whilst the second (component 2), explained 11.546 % of the remaining variation not explained by the first component. Component 3 accounted for 9.459% while the last component accounted for 7.964.

Table 4.10: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.247	32.67	32.67	4.247	32.67	32.67	3.307	25.441	25.441
2	1.501	11.546	44.216	1.501	11.546	44.216	1.705	13.112	38.553
3	1.23	9.459	53.676	1.23	9.459	53.676	1.66	12.772	51.325
4	1.035	7.964	61.639	1.035	7.964	61.639	1.341	10.315	61.639
5	0.901	6.932	68.571						
6	0.882	6.781	75.352						
7	0.736	5.665	81.017						
8	0.606	4.664	85.681						
9	0.545	4.19	89.871						
10	0.466	3.583	93.454						
11	0.332	2.55	96.004						
12	0.267	2.057	98.061						
13	0.252	1.939	100						
Extraction Method: Principal Component Analysis.									

4.3.2.2.1 Discussion of Results

From the results of the study, it can be deduced that most of the disadvantages are shared by the various organisations while a few of them are related to some organisations. The following section discusses each component individually.

Component 1:

Component 1 is made up of five (5) variables, which accounted for 32.670% of the total variance. These are: *in-house developers develop a feeling of uncertainty when software development projects are outsourced* (0.734); *it is difficult to get the right outsourcing company* (0.691); *outsourcing comes with a lot of legal issues* (0.765); *outsourcing companies may disappear with the firm's money* (0.759); *deploying completed software for use is difficult* (0.699). The figures in the bracket indicate the loadings of each variable's impact on the component.

The view that in-house developers develop a feeling of uncertainty when software development is outsourced as stated by (Cafeto, 2017), is also held by a number of the respondents though the minority of them. Nevertheless, this seems to be a disadvantage that runs across a number of organisations in the industry. Obviously, only organisations who have developers in-house can share in this. Organisation with no in-house developers can be said to be on neutral grounds since there is no in-house team to develop a feeling of uncertainty anyway. Software developing employees in the organisations that experience this disadvantage have a certain degree of mistrust emanating from management. One can say that "If you didn't want be to develop, then why did you hire me". This is mostly the case when developers think they can produce the work but are not given the opportunity to. On the other hand, some in-house developers are comfortable when projects are outsourced. From the preliminary study,

it was gathered that, the in-house team even plays a part in the decision to outsource. A number of factors are considered before the decision to outsource is taken. The factors that enhance the decision to outsource is normally beyond the in-house team therefore no feeling of uncertainty stems from them. There is difficulty in getting the right outsource partner to build the required application (Sharma, 2018). Choosing the perfect supplier is the main deal of the whole outsourcing process. Making the wrong choice can have dire consequences on the project and the organization as a whole. Sharma (2018) asserts that, this is a problem for most organisations when they opt for outsourcing. The many legal issues associated with outsourcing was asserted by Farid (2017) as one of the challenges encountered when one outsources. This is a challenge that received a mixed report from the survey. Even though the legal issues are present, some of the respondents, therefore their respective organisations are not of the view that the legalities are a disadvantage but rather a necessity because it is in their own good interest. Via these legal issues, the client, thus organisation, is able to bind the vendor legally to ensure that the required product is delivered. This also binds the organisation to ensure they execute any action required of them for the successful running and completion of the.

Component 2:

Component 2 is also made up of three (3) variables, which accounted for 11.546% of the total variance. These are: *there is language or culture barrier when projects are outsourced outside the country* (0.540); *confidential and private data is at stake* (0.627); *integration with current/old system is difficult if developed by a different vendor* (0.724). When the client organization and the outsourcing organization are in different geographical regions, then there is the tendency of lingual and communication barriers (Aitzaz et al., 2016). This may in turn cause misinterpretation

of some business processes especially requirement understanding. Miscommunication can result from differences in languages. Good communication is unquestionably a must, since it is the basis to appreciate the right requirements while developing a software (Vogel & Connolly 2005). Tervonen et al. (2013), in their research also highlighted on the notion that cultural misunderstandings present the biggest challenge for both clients and their outsourcing vendors. The respondents from the downstream oil and gas industry in Ghana also expressed this same view. Aitzaz et al., (2016) emphasised that, when an entity outsources any software development project, then privacy and confidentiality of the organization's data and the privacy of their customer is also put at stake because they may have to provide confidential data to the external organization.

Component 3:

The third component is made up of three (3) variables, which also accounted for 9.459% of the total variance. These are: *organisations often outsource and forget about the project* (0.746); *Organisation may lose control of the project to the outsourced company* (0.615); *vendors find it difficult to understand the business and its operations in acquiring the requirements for the project* (0.699). Outsourcing has the tendency of birthing the practice 'Outsource and forget' (Sharma, 2018). Because a third party has been delegated to do the work, organisations may forget about the project, leaving the outsourced company to just build. Organisations in the downstream petroleum industry in Ghana however, don't abandon their software development projects when they outsource. Regular checks are made and updates are collected regularly to ensure the vendor is on the right track. As Sharma (2018) rightly stated, delegating a work to a third-party doesn't relieve you of the duty to check up and make sure the right work is being done.

Component 4:

The fourth component is also made up of two (2) variables and they accounted for 7.964% of the total variance. These are: *in case of emergency, outsourced companies do not prioritize the issue* (0.750); *upgrade and customization of software is difficult* (0.716). In case of an emergency, there is the likelihood that an outsourcing company will not prioritize the work of the client. As stated by Cafeto (2017), in such times, an outsourced company will always view the client as a vendor and may not view the situation as top priority. This was emphasized in the participants' response on the disadvantages of outsourcing. Because vendors deal with other clients and the main task of software development has been completed, the willingness to jump right at an organisation emergency issue, such as fixing bugs may be absent. This also affect upgrades and customizations. Aitzaz et al., (2016) also asserted that, when an upgrade is required by the organisation, they have to get the services of the software outsourcing organization. If the outsourcing company lacks the time or the willingness to provide the service, the home organization will suffer. Also, changes are sometimes introduced by regulating authorities that calls for a change in the software to enable the smooth running of operations. These changes from the authorities such as the National Petroleum Authority usually have deadlines and therefore the swift response from the outsourcing vendors is very important but it's hardly so.

4.3.3 Technical and Management Decisions That Influence Outsourcing Software Development in The Downstream Petroleum Sector

This section identifies vital technical and management decisions that influence software development outsourcing (SDO) in the industry. To achieve this, just like the first objective, a total number of one hundred and fifty-one (151) questionnaires were administered. One hundred and sixteen (116) questionnaires were retrieved which

represent 77% response rate. Descriptive statistics were conducted to examine the mean values and standard deviations of the factors that influence outsourcing. In establishing the relevance of the items on the five-point Likert scale rating, a success criterion was deemed significant if it obtained a mean value greater than 3.0

4.3.3.1 Reliability of data analysis

Analyses were executed to observe the reliability of the factor variables scales.

Reliability is concerned with the degree to which scores on a scale can be replicated. Thus, internal consistency reliability measures the reciprocal relation of an item set. Cronbach's Alpha coefficient (α) was employed in this research to establish the reliability of the survey mechanism. According to Hair et al. (2010), a ' α ' value of .70 or higher has largely been recognized by researchers as demonstrating a reliable measurement.

Table 4.11: Reliability statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.764	0.801	9

As shown in Table 4.7, reliability coefficients of the study variables under investigation was .764. This reveals that the internal consistency of the measurements was satisfactory.

4.3.3.2 Data analysis

All the nine (9) items (100%) had a mean value over the mid-point (3.0), indicating respondents generally agreed with the factors that influence outsourcing in the downstream petroleum industry. The nine items in descending order are "F1" (4.66),

“F2” (4.64), “F3” (4.62), “F4” (4.61), “F5” (4.59), “F6” (4.53), “F7” (4.53), “F8” (4.43), “F9” (3.81). Standard deviation (SD) was used to check the internal consistencies in the data collected in order to be able to generalize the results. Standard deviation values of less than 1.0 indicate consistency in agreement among the respondents of the reported level of results (Stevens, 1996). In the SD column, all the values are less than 1.0. These suggested that respondents had consentaneously given high ratings when defining their level of agreement with the nine (9) factors.

Table 4.12: Item statistics of the factors that influence outsourcing in the downstream petroleum industry

Item	Description	Mean	SD	Ranking
F1	Limited time to complete project	4.66	0.492	1
F2	The overall cost of the project	4.64	0.5	2
F3	Company gets to concentrate on core business activities	4.62	0.505	3
F4	Software success factor	4.61	0.507	4
F5	Resources needed for the software development project are not the burden of the company	4.59	0.512	5
F6	Timely delivery of project deliverables	4.53	0.518	6
F7	Lack of in-house expertise for the project	4.53	0.501	7
F8	Risk is either shared or shifted to the vendor	4.43	0.578	8
F9	No need to employ in-house developers	3.81	0.884	9

4.3.3.3 Discussion of the factors that influence outsourcing software development in the downstream petroleum industry

The results of the study indicated that the factors that influence the decision to outsource runs through the organisations in the industry. Having limited time to complete a software development project was highlighted and agreed upon by the respondents. According to Aitzaz et al. (2016), organisations consider outsourcing their software development projects extremely beneficial when the projects are expected to be completed in very short period. In every project, time is a very significant factor to be considered. For organisations with in-house developers, when they are not sure whether they will be able to meet the required objective in the specified time period, they generally outsource the software project to a third-party expert software development organisation.

Cost factor is one of the most important factors that is considered when deciding to outsource a software development project. According to Artellogic (2019), SDO is generally less expensive as compared to in-house development. Hiring an in-house team of developers is sometimes very expensive; especially for a project that is to be completed in a short period of time. Considering the technology that may be required to build a software, in-house development can come at a very high cost therefore organisations see it better to transfer their software development projects to external companies that can accomplish the task at a relatively low cost (Aitzaz et al., 2016). The organisations in the downstream sector of the petroleum industry in Ghana are obviously not into software development; the main business is the trading of petroleum products. Therefore, being able to concentrate on their core business activities while the task of building a software is shifted to an outsourcing organisation is a very

important factor that is considered. According to Chron (2019a), outsourcing permits management to focus on larger issues within the organisation. Daitan Group (2014) also asserted that, by outsourcing the development of software, organisations would be able to focus the resources at their disposal on functions that are specific to their core business.

From literature, the success ratio of outsourcing is high. This is because, the organisation looks for software developing companies who have the requisite skills and expertise which may be lacking in the organisation (Aitzaz et al., 2016). Clydebuilt (2012) averred that, outsourcing software development is tried and tested because the outsourcing organisation comes with experience from developing for other clients. The respondents were of the view that resources needed for the software development project are not the burden of their company as the vendor comes with the resources needed to complete the project. Software development outsourcing has afforded organizations with the technical proficiency that was absent from their technology portfolio (Daitan Group, 2014).

Timely delivery of project deliverables as emphasized by Aitzaz et al. (2016) became crucial in the study as respondents agreed with this as a factor that influences their SDO decision. According to Aitzaz et al., most software projects exceed their deadlines due to the tight business schedules of organisations. Software development outsourcing in this case, provides a solution for the organisations to complete their software development projects within schedule. When an organisation lacks in-house expertise to build a software, this becomes an important factor in the decision to outsource. The sharing of risk with the vendor was also a factor highlighted by the respondents. According to YSBM Group (2019), in outsourcing, the organisation receives the service needed, which is implemented in a very professional approach and

is afforded with the material obligation of the contractor for the quality of its application. This is so because the software development outsourcing company, as a legal entity, has assets that can recompense for probable damage. *No need to employ in-house developers* had a low mean score of 3.81, therefore ranking 9th. The indication is that, this factor is not regarded as important in the decision to outsource the development of software in the downstream petroleum industry in Ghana. It also had the highest standard deviation of 0.884 indicating variability in the data collected and inconsistency in agreement among the respondents.

4.3.4 Effects of Outsourced Software Development on the Project and Operations of an Organisation

The effects of outsourcing the development of software on the project and the organisation's operations in respect to the use of the software is of paramount essence to the researcher. As part of the data collection, it was necessary to identify, from the respondents, in their experience with SDO and the use of the software packages, how this has affected their operations and even its effect on the project during build. A total number of one hundred and fifty-one (151) questionnaires were administered. One hundred and sixteen (116) questionnaires were retrieved which represented 77% response rate.

4.3.4.1 Descriptive Statistics

Preceding the principal non-parametric test of the research, preliminary descriptive analysis such as mean scores, standard deviations and standard mean error of each of the variables conducted were used to ascertain the outcome of the survey; and the outcomes are tabulated in Table 4.5. In establishing the relevance of the items on the five-point Likert scale rating, a success criterion was deemed significant if it obtained

a mean value greater than 3.0. As stated by Lakens, (2013) the significance level was also set at 95% in accordance with predictable risk levels.

The standard error is the standard deviation of sample means and it is a measure of how representative a sample is likely to be of the population (Field, 2005). A large standard error reflects a lot of variability between means of different samples and a small standard error suggests that most sample means are similar to the population mean and so the sample is likely to be an accurate reflection of the population (Field, 2005).

From Table 4.5 almost all the variables have mean values above the test mean of 3.0, it is reasonable therefore to conclude that these are effects of outsourcing software development experienced in the downstream petroleum industry in Ghana. The standard error related with all the means were closer to zero suggesting that the sample chosen is an accurate reflection of the population. As a final point, from the results in Table 4.5 most standard deviations of a recognised percentage are less than 1.0 beckoning that, there is little variability in the data collected and consistency in agreement among the respondents.

Table 4.13: Descriptive Statistics

Factors	N	Mean	Std. Deviation	Std. Error Mean
Using outsourced software is very efficient	116	4.59	0.512	0.048
The software offers a competitive advantage	116	4.53	0.501	0.047
Projects are usually completed on time	116	4.64	0.5	0.046
Takes a long time to fix bugs	116	4.66	0.492	0.046

Company may lose customers if software requirements are not met	116	4.62	0.505	0.047
There is limited face-to-face communication with vendors during project	116	4.43	0.578	0.054
The organization has less control <u>over the software</u>	<u>116</u>	<u>3.81</u>	<u>0.884</u>	<u>0.082</u>

The t-test (Table 4.6) shows the mean values (that is, test value) of the population mean, t, which is the one sample t-test, Df, which is the degree of freedom and the significance (that is, p-value). This p-value provides a basis for a statistical decision to be made as to whether or not the population mean and sample mean are equal. From the t-test table, the p-value is for two-tailed test and since the study is interested in one-tailed test, the p-values are divided by two but it is of worth to note that the p-values from the results are .000 for all variables. The results of the factors are detailed in Table 4.6

Table 4.14: Results of One Sample Test Showing Test Significance

Test Value = 3						
Factors			Sig. (2tailed)	Mean Difference	95% Confidence Interval of the Difference	
	t	df			Lower	Upper
Using outsourced software is very efficient	33.372	115	.000	1.586	1.49	1.68
The software offers a competitive advantage	32.99	115	.000	1.534	1.44	1.63
Projects are usually completed on time	35.256	115	.000	1.638	1.55	1.73
Takes a long time to fix bugs	36.389	115	.000	1.664	1.57	1.75
Company may lose customers if software requirements are not met	34.575	115	.000	1.621	1.53	1.71

There is limited face-to-face communication with vendors during project	26.656	115	.000	1.431	1.32	1.54
The organization has less control over the software	<u>9.875</u>	<u>115</u>	<u>.000</u>	<u>0.81</u>	<u>0.65</u>	<u>0.97</u>

4.3.4.2 Further Examination

The descriptive analysis of the results has indicated that the respondents agreed with the identified variables as being effects of software development outsourcing on the project and operations of the organisations in the downstream petroleum industry in Ghana. Nevertheless, there exists a possibility that these observations might be due to chance, rather than being the true reflection of the entire population. It was therefore necessary to test the data with an appropriate statistical method. The mean scores compared to a hypothesised mean of 3.0 (as previously noted) to know the level of impact respondents regarded the effects of software development outsourcing on the project and operations of the organisations in the downstream petroleum industry in Ghana.

Thus, the impacts are ranked with their mean scores. From Table 4.7, *Takes a long time to fix bugs* ranked the most noted impact of software development outsourcing. Likewise, *Projects are usually completed on time* ranked second. *Company may lose customers if software requirements are not met* ranked third as an effect of software development outsourcing in the downstream petroleum industry. The fourth most noted effect of SDO was *Using outsourced software is very efficient*. *The software offers a competitive advantage* and *There is limited face-to-face communication with vendors during project* ranked 5th and 6th respectively.

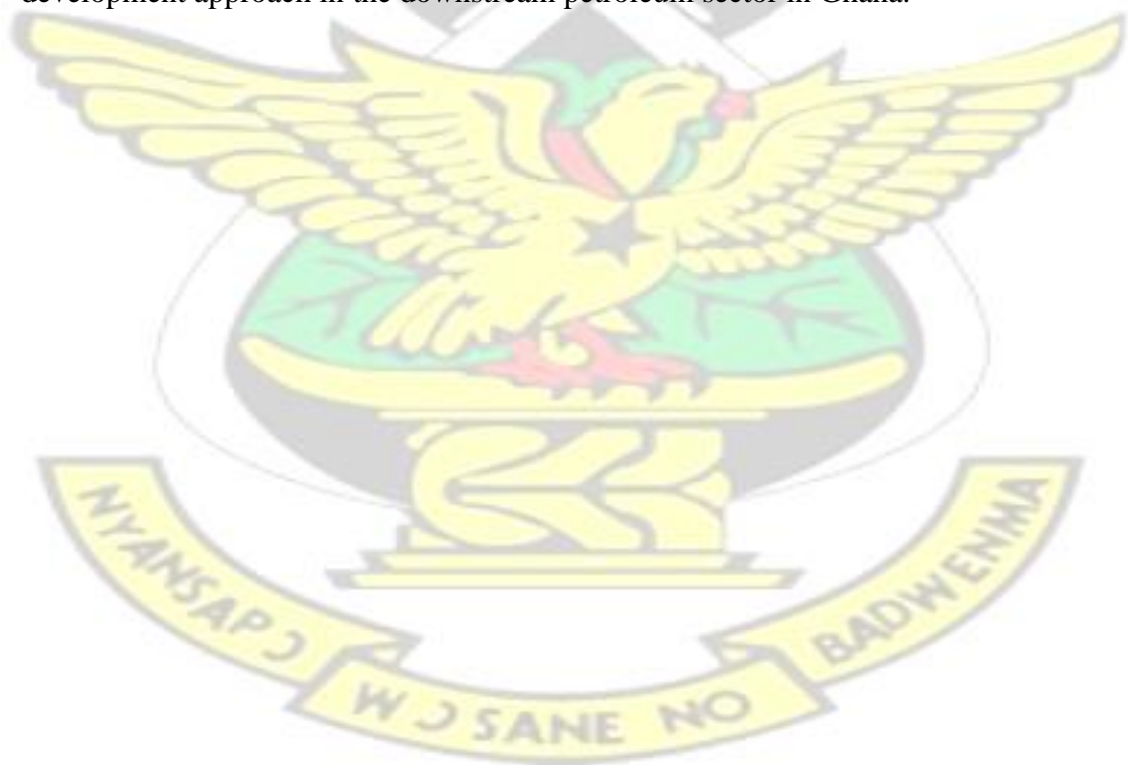
Table 4.15: Summary of t-test showing rankings, results of 1-tailed test and significance

Factors	Mean	Std. Deviation	Ranking	Sig. (1tailed)	Statistically significant
Takes a long time to fix bugs	4.66	0.492	1st	.000	Yes
Projects are usually completed on time	4.64	0.5	2nd	.000	Yes
Company may lose customers if software requirements are not met	4.62	0.505	3rd	.000	Yes
Using outsourced software is very efficient	4.59	0.512	4th	.000	Yes
The software offers a competitive advantage	4.53	0.501	5th	.000	Yes
There is limited face-toface communication with vendors during project	4.43	0.578	6th	.000	Yes
The organization has less control over the software	3.81	0.884	7th	.000	No

The seven effects of SDO passed the test value of 3.0. However, one effect: *The organization has less control over the software* had the lowest mean score of 3.81, therefore ranking 7th. The indication is that this effect is not one that is experienced by all organisations in the downstream petroleum industry in Ghana. It is also interesting to note that, this variable had the highest standard deviation of 0.884. Though less than one (1), it still indicates a certain level of variability in the data collected and inconsistency in agreement among the respondents.

SUMMARY

In general, the results of the surveys as discussed are found to reflect the true situation in the downstream petroleum industry in Ghana. It shows that all participants responded to questions based on the experiences within the industry over the years. The chapter began with a brief discussion of the survey participants and the descriptive statistics of the results obtained from the field thereof. The chapter concluded with mean score index (in the form of one sample t-test) of effects; both positive and negative of software development outsourcing on the project and operations of an organization in the downstream petroleum industry. In addition, KMO and Bartlett's Test, factor analysis (principal component) were used to analyze other specific objectives of the research. The finding helps analyze outsourcing as a software development approach in the downstream petroleum sector in Ghana.



CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

The aim of the study was to make an in-depth analysis of developing software by contracting third-party developers(outsourcing), in the downstream petroleum sector in Ghana. To accomplish this aim, a number of objectives were set. In this chapter, the research objectives are revisited to bring into light the extent to which the aim of the study has been achieved throughout the various phases of the study. The chapter also presents recommendations of the researcher based on the findings of the study and the states of difficulties that were encountered throughout of the study. Lastly, recommendations are made for further studies.

5.2 MOTIVATION FOR THE STUDY

The study was motivated by a number of factors. This included;

- The upsurge of technology, which has become a major driving force in economies as noted by Cascio & Montealegre (2016).
- The emergence of many software development companies in Ghana and the world at large.
- The emergence of many companies in the downstream petroleum industry in Ghana who are making use of various software packages.
- The rise of software development outsourcing as asserted by Intelligent Software Engineering (2018)

5.3 SUMMARY OF FINDINGS

The aim of the research was to make an in-depth analysis of developing software by contracting third-party developers(outsourcing), in the downstream petroleum sector in

Ghana. In pursuing this aim, three (3) objectives were established. The fulfilment of each of the three (3) research objectives is set out in the following subsections.

5.3.1 Review of First Objective

The first objective concentrated on outlining the advantages and disadvantages of outsourced software development in the downstream petroleum sector. This objective has been achieved by undertaking an extensive review on software development outsourcing as expressed in the literature review (see **chapter 2**). The literature revealed various advantages and disadvantages of outsourcing software development. Interviews and questionnaires administered in the downstream petroleum industry helped to narrow these factors to the area of focus of this research. The study revealed that outsourcing the development of software to third-party organisations comes with both advantages and disadvantages. All the benefits and drawbacks however, cannot be generalized for the downstream petroleum industry in Ghana. Though it was discovered from the study that some of them are shared by all the organisations, there are other merits and demerits that are organisation specific. While some companies see a factor as an advantage, others do not; also, a point seen as a disadvantage by one organisation could even be seen by another as an advantage

5.3.2 Review of Second Objective

The second objective of the research was to identify vital technical and management decisions that influence outsourcing software development in the downstream petroleum sector. In achieving this objective, interviews involving key figures in the industry who are involved in the acquisition and/or use of software in their respective organisations were conducted to ascertain the factors that influence outsourcing as a software developing approach. For the same objective, questionnaires were administered to various workers in the sector who pointed out reasons why their

organisations opt for outsourcing. The organisations in the industry do take some factors into consideration before any outsourcing decision. Unlike the advantages and disadvantages of outsourcing in the industry, the factors that influence outsourcing runs across the organisations. It was noted however that, not all factors are considered for every project. Some of the notable factors included *limited time to complete project, the overall cost of the project and company gets to concentrate on core business activities*.

5.3.3 Review of Third Objective

The objective three was to identify the effects of outsourced software development on the project and operations of an organisation. 152 questionnaires were administered to various workers in the downstream petroleum industry whose roles ranges from software acquisition, users, system administrators and developers. The results presented by this exercise helped address the third objective. From the results, it was noted that, outsourcing software development impacts the organisation in one way or the other. It has impact on the software development project and also impacts the operations of the organisation in respect to the use of the software. Majority of the impacts, as revealed, are positive impacts with a few being negative.

5.4 CONCLUSION

From the above, it can be concluded that outsourcing the development of software in the downstream sector of the petroleum industry comes with both advantages and disadvantages. These advantages and disadvantages may depend on the software that is built or the outsourcing vendor. For this reason, a benefit of outsourcing as appreciated by an organization may not be appreciated by another organization. Likewise, a factor seen as a disadvantage by one organization may not be seen as such by a different organization.

Furthermore, it can be concluded that, certain factors are considered before an outsourcing decision is made. The organisations in the industry don't just outsource but have reasons for outsourcing. These factors run across the organisations although not all are considered for every software project.

Lastly, it was deduced from the study that, outsourcing impacts the organisations in one way or the other. Some of these impacts are positive and others are negative; although the positive effects are often more than the negative effects. Some of these impacts are experienced during the project while the other effects are on the operations of the organisation as related to the use of the software.

5.5 CONTRIBUTION TO KNOWLEDGE IN THE GHANAIAIAN CONTEXT

There are key contributions that are the outcome of this research. These have not been addressed by other studies. These are as follows:

- All the advantages and disadvantages outlined in preceding researches doesn't apply generally to all industries in the downstream petroleum industry.
- Organisations are now employing software developers to handle if not all, some of their software related issues.

5.6 LIMITATIONS OF THE RESEARCH

Conducting interviews for the professionals to determine their views on outsourcing involved adhering to procedures which was time consuming. Again, it was difficult to reach out to respondents for the interview due to their busy schedules but this was overcome through constant follow-ups. Those who could not arrange for face-to-face interview were granted telephone interviews which was helpful. There was also

possibility of sampling and measurement errors and the effects of these errors on the data collected.

5.7 RECOMMENDATION FOR INDUSTRY AND FUTURE RESEARCH

Recommendations have been made for industry and future research based on the findings and discussions of the study. Summarized below are the suggestions that will aid in successful software development projects via outsourcing in the downstream petroleum industry in Ghana and also leave room for further studies on the topic.

5.7.1 Recommendation for Industry

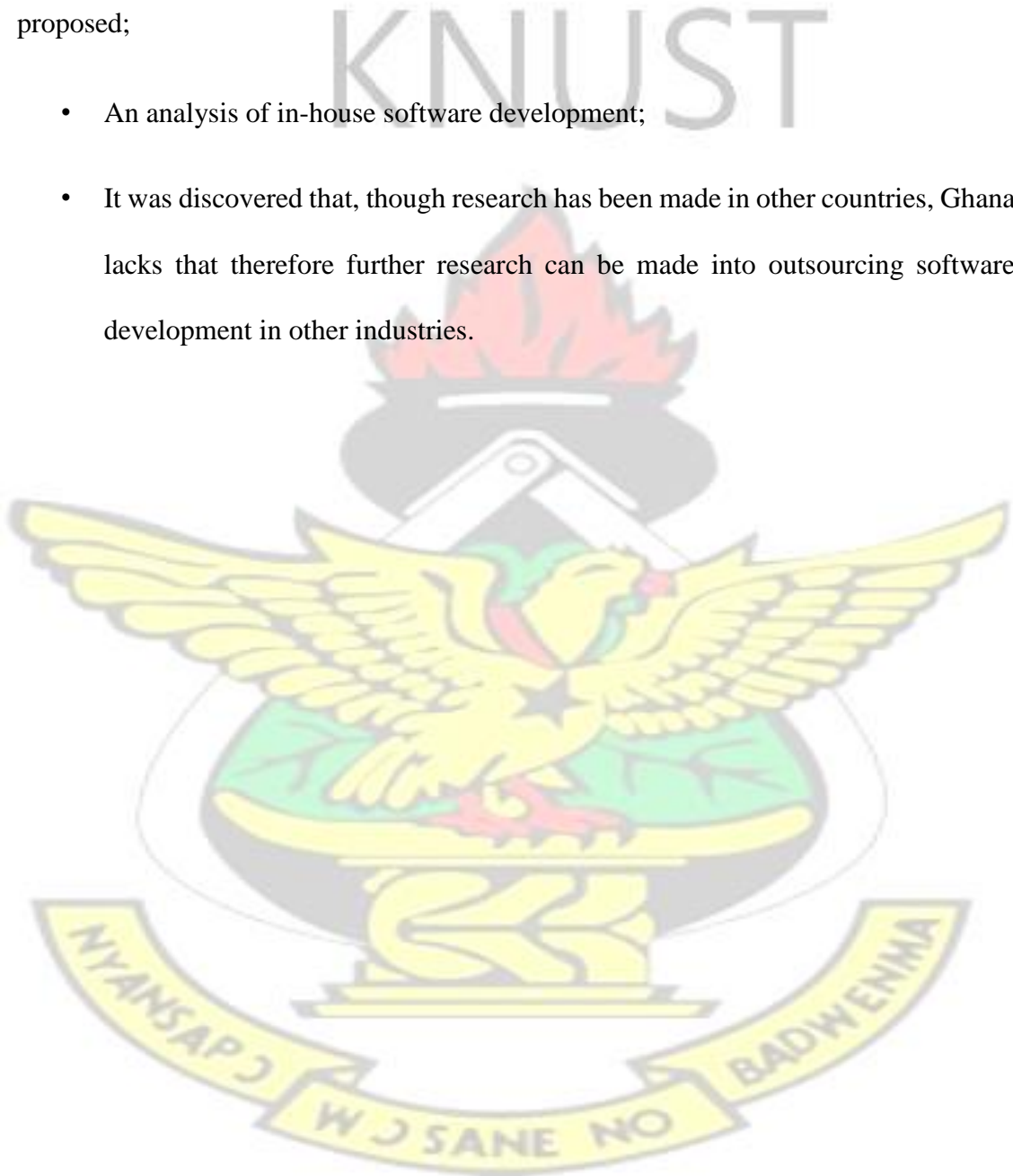
The following recommendations are being made bearing in mind the findings from the research.

- Organisations shouldn't see software development as just a service therefore no need to employ in-house developers. Sometimes, in-house development of software pays more than outsourcing;
- Organisations should make extensive analysis before taking an outsourcing decision. A bad outsourcing decision can have dire consequences;
- The companies in the industry must ensure that they choose the right outsourcing vendor. The vendor should have the skills to meet all the requirements of the system to be built and on time;
- All the legal issues that come with outsourcing should be considered as a good thing by the organisations and use that to make sure the outsourcing vendor delivers as expected; and
- Contracts should be signed to ensure that the vendor acts swiftly in times of emergency, especially with bugs that come from the software.

5.7.2 Recommendation for Future Research

This research looked into outsourcing software development in the downstream petroleum sector in Ghana but outsourcing happens to be one leg of software development approach. For future research, the outlined recommendations have been proposed;

- An analysis of in-house software development;
- It was discovered that, though research has been made in other countries, Ghana lacks that therefore further research can be made into outsourcing software development in other industries.



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APPENDIX: QUESTIONNAIRE FOR THE STUDY

To whom it may concern

Dear Sir/Madam,

Invitation to Participate in A Research into Outsourcing Software Development in The Downstream Petroleum Industry

I write to seek your assistance as a figure in the oil and gas industry who plays a role in the acquisition of software by your company and has interactions with these software packages to complete the attached questionnaire. I am currently a Master of Science in Project Management student at the Kwame Nkrumah University of Science and Technology under the supervision of Dr. Ernest Kissi. The research is entitled “**Analysing outsourced software development in the downstream petroleum sector in Ghana**”.

This research aims to make an in-depth analysis of developing software by contracting third-party developers(outsourcing), in the downstream petroleum sector in Ghana. Your experience and knowledge therefore, will be particularly valuable for this research in taking a critical look at outsourcing software development in the petroleum industry’s downstream sector.

The questionnaire will take 15 to 20 minutes. All your responses will be treated with strict confidentiality and used only for academic purposes. Your views are valuable for the success of this research. After the research, we are willing to share a summary of the outcomes with practitioners in Ghana and anyone who shows interest. For any enquiries, please contact Sylvester Quist {Mob.: +233242832756; or email: aureliaquist@gmail.com}.

Sincerely,

SNBQ

Quist Sylvester Nii Blebo, MSc Student

Dr. Ernest Kissi, Supervisor

Department of Construction Technology & Management

The Kwame Nkrumah University of Science and Technology, Ghana

Analysing outsourced software development in the downstream petroleum sector in Ghana

Questionnaire Survey

Important Instructions:

1. Please duly fill this questionnaire with reference to your role in software acquisition by your company.
2. Please answer the questions by ticking {such as “✓”} or checking {such as “☐”}.
3. If you wish to have a copy of the report on research findings, please provide your email address below:

Section A: Background of respondent

Q1. Please indicate the sub-sector in the downstream industry you are associated with.

BDC ☐; OMC/LPGMC ☐; BRV ☐; Regulatory Authority ☐

Q2. Please indicate your role in the relationship with the software used by your organisation.

Software acquisition ☐; User ☐; Administrator ☐; Other (please specify):

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Q3. Please indicate your academic qualifications.

HND ☐; BSc ☐; MSc/MPhil ☐; PhD ☐; Other (please specify):

.....

Q4. Please indicate your years of practical experience in the downstream oil industry.

1-5yrs ☐; 6-10yrs ☐; 11-15yrs ☐; 16-20yrs ☐;

Over 20yrs ☐

Q5. Please indicate your years of experience with the software packages(s) used by your organisation.

1-5yrs ☐; 6-10yrs ☐; 11-15yrs ☐; 16-20yrs ☐;
Over 20yrs ☐

Section B: The Pros and Cons of Outsourcing Please indicate your agreement or disagreement with the cons and pros of outsourcing as identified by your company by ticking (v) or clicking in the box [☐] where appropriate.

1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree



No.		Degree of agreement
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	The advantages and disadvantages of outsourced software development in the downstream petroleum sector	1	2	3	4	5
1.	In-house developers develop a feeling of uncertainty when software development projects are outsourced.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.	It is difficult to get the right outsourcing company.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.	Outsourcing comes with a lot of legal issues.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.	In case of emergency, outsourced companies do not prioritize the issue.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.	Organisations often outsource and forget about the project.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.	There is language or culture barrier when projects are outsourced outside the country.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.	Upgrade and customization of software is difficult.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8.	Confidential and private data is at stake.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9.	Organisation may lose control of the project to the outsourced company.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10.	Integration with current/old system is difficult if developed by a different vendor.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11.	Outsourcing companies may disappear with the firm's money.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12.	There is more concentration on core business activities when software development projects are outsourced.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13.	Third party developers come in with all the resources required to build the software.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14.	Outsourcing is less expensive as compared to in-house development.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15.	There is no need for in-house developers.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16.	Deploying completed software for use is difficult.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17.	Vendors find it difficult to understand the business and its operations in acquiring the requirements for the project.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18.	Outsourcing exposes your organisation to project management and development cycle best practices from multiple companies across the globe.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

19. Kindly state any other advantage(s) you've realized in your adoption of outsourcing as a software development approach.

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20. Kindly state any other disadvantage(s) you've realized in your adoption of outsourcing as a software development approach.

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SECTION C: What influences outsourcing decisions?

Please indicate the level of significance of these factors in deciding to outsource a software development project by ticking (✓) or clicking in the box [X] where appropriate.

1 = Extremely low significance; 2 = Low significance; 3 = Moderate significance; 4 = Very significant; 5 = Extremely significant.

No.	Technical and management decisions that influence outsourcing software development	Degree of agreement				
		1	2	3	4	5
1.	The overall cost of the project.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.	No need to employ in-house developers.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.	Company gets to concentrate on core business activities.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.	Risk is either shared or shifted to the vendor.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.	Resources needed for the software development project are not the burden of the company.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.	Timely delivery of project deliverables.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.	Lack of in-house expertise for the project.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8.	Software success factor.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9.	Limited time to complete project.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

10. Kindly state any other factor(s) that influences the decision to outsource.

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SECTION D: Effects of outsourced software development

Please indicate your agreement or disagreement of the effects of outsourcing on the project and operations of your organisation by ticking (✓) or clicking in the box [X] where appropriate.

1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

No.	Effects of outsourced software development on the project and operations of your organisation	Degree of agreement				
		1	2	3	4	5
1.	Using outsourced software is very efficient.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.	The software offers a competitive advantage.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.	Projects are usually completed on time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.	Takes a long time to fix bugs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.	Company may lose customers if software requirements are not met.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.	There is limited face-to-face communication with vendors during project.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.	The organization has less control over the software	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

8. Kindly state any other effects of outsourcing software development on the project and operations of your organization.

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--This is the end of the survey---Thank you for your time

Definition of Terms

Vendor(s)/ Third-party developers: the outsourcing company.

In-house developers: employed staff who are in-charge of building and maintaining software.

