A THEORETICAL AND EMPIRICAL INVESTIGATION OF THE BARRIERS TO THE ADOPTION OF STATE-OF-THE-ART INFORMATION SYSTEMS BY NIGERIAN INDIGENOUS OIL COMPANIES

BY

ISA ALI IBRAHIM

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Abstract

Currently, there are 49 indigenous oil companies (INOCs) and 28 marginal fields operators as well as 24 multi-national oil companies (MNOCs) operating in Nigeria. This study on Nigerian INOCs has found them to have inadequate state-of-the-art upstream information systems (IS) for their operations. Prior literature also indicates inadequate research on IS with respect to the INOCs. The sector has been essential to Nigeria due to its contribution of approximately 90% of the export revenues. In addition, at least 89% of the country's oil is produced by MNOCs while indigenous ones produce a maximum of 11%. This is as a result of many factors, including the upstream IS used by the INOCs. The main objective of the study investigated the significant barriers that limit the adoption of the state-of-the-art upstream IS by the Nigerian INOCs. Furthermore, the relevant literature reveals that the MNOCs have developed and sustained their technological expertise in using the state-of-the-art IS for all of their activities. The developed research questions of the study have been answered by the suitable parts of the research. Data were collected through the interviewing of 6 chosen stakeholders as well as the administration of 200 questionnaires to the relevant stakeholders, and finally, 140 valid questionnaires were retrieved. As a result of the significant differences which existed between the chosen groups of the stakeholders, follow-up interviews were conducted in which 12 stakeholders participated. 6 of them were the same stakeholders interviewed during the first interviews conducted prior to questionnaire-survey. A mixed-method approach was selected and was also triangulated. The study has also used objective statistical tools based on SPSS to critically discover the major obstacles that limit the adoption of the state-of-the-art IS. The study also discovered that the opinions which emerged from the research participants indicated that, cost of some state-of-the-art ICT resources, technical skill, managerial attitude, government policies, government incentives, corruption and insecurity were significant barriers that limit the adoption of state-of-the-art IS by Nigerian INOCs. The study concludes by suggesting the need to invest in sufficient resources, hold meetings between various stakeholders, develop skills in terms of quality and quantity, provide sufficient technical training, reformulate government policy towards the adoption of state-of-the-art IS, provide government incentives to adopt state-of-the-art IS, establish anti-corruption units and improve the safety of the oil workers.

Keywords: *Nigerian indigenous oil companies, information systems, upstream operations, significant barriers and ICT adoption*

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Dedication

This thesis is dedicated to all humanity. However, special dedication is to my dear father, my beloved mother and my lovely family, as well as all those promoting justice, kindness and peace globally.

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Abbreviations used in the thesis

AGC	Arab Gulf Countries
ALU	Arithmetic & Logic Unit
ATCON	Association of Telecom Operators in Nigeria
BP	British Petroleum
CBN	Central Bank of Nigeria
CISCO	Computer Information Systems Company
CPN	Computer Professionals' Council of Nigeria
CPU	Central Processing Unit
CSF	Critical Success Factors
CU	Central Unit
DEA	Data Envelopment Analysis
EC	European Commission
E&P	Exploration and Production
FGN	Federal Government of Nigeria
GDP	Gross Domestic Product
GIS	Geographic Information Systems
GCC	Gulf Cooperation Council
HQ	Headquarters
ICT	Information and Communication Technology
INOCs	Indigenous Oil Companies
IOCs	International Oil Companies
IS	Information Systems
ISO	International Standard Organisation
ISPN	Internet Service Providers of Nigeria
IT	Information Technology

ITAN	Information Technology Association of Nigeria
ITBV	Information Technology Business Value
JOA	Joint Operating Agreements
LC	Local Content
LOCs	Local Oil Companies
MNCs	Multi-National Companies
MNOCs	Multi-National Oil Companies
NCC	Nigerian Communication Commission
NCS	Nigerian Computer Society
NETCO	National Engineering and Technical Company Limited
NITDA	National Information Technology Development Agency
NNPC	Nigerian National Oil Companies
NOCs	National Oil Companies
OECD	Organisation for Economic Co-operation Development
OEL	Oil Exploration Licence
OML	Oil Mining Lease
OPEC	Organisation of Petroleum Exporting Countries
OSS	Open Source Software
PTDF	Petroleum Technology Development Fund
PENGASSAN	Petroleum & Natural Gas Senior Staff Association of Nigeria
R&M	Refining and Marketing
SIM	Society of Information Management
SIS	Schlumberger Information Systems
SISs	Safety Instrumented Systems
SMEs	Small and Medium Enterprises
SCADA	Supervisory Control and Data Acquisition
SPSS	Software Package for Social Sciences
UKERC	United Kingdom Energy Research Centre

IASB	International Accounting Standards Board
SEC	Security & Exchange Commission
SPE	Society of Petroleum Engineers
TAM	Technological Adoption Model
TBDF	Trans border Data Flow
TOC	The Theory of Constraints
TQM	Total Quality Management
USA	United State of America

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CHAPTER ONE

Introduction

This chapter provides an introduction to the research topic, aim, objectives, research questions, sub-questions, significance of the study, its scope and a concise description of the methodology and methods employed and adapted in conducting this study. Furthermore, the chapter also provides a general description of the study and a simple presentation of the subsequent chapters.

1.1 Background to the study

The oil and gas sector is the mainstay of Nigeria's economy and the source of the highest revenue, contributing approximately 85% of the government revenue (Allison-Madueke, 2013; Atakpu, 2007; World Bank, 2006). The sector has been engaged by both multinational and indigenous oil companies (INOCs) in performing upstream operations, while the former have been significantly more productive (Allison-Madueke, 2013; Adeniyi, 2013).

Currently INOCs produce approximately only 5%-11% of the collective production in the country while they have licences which are mostly valid for 20-30 years before their renewal or termination (Allison-Madueke, 2013; Adeniyi, 2013). This low production of the INOCs could be due to many factors, including information and communication technologies (ICTs), technical skill, environmental challenges and government policy which could all be significant constraints contributing to these poor and low exploration and production operations (Iheduru, 2011; Nwosu 2006; Kim, 2000).

Due to low oil production of INOCS in Nigeria and some other developing nations, some researchers, like Ozigbo (2008) and Nwosu (2006) have called for the immediate development of the information systems (IS) in the oil sectors in the developing countries by encouraging studies and investigations into the constraints and obstacles that impede or limit technological advancements. They also stated and emphasised the need for investigation into the availability or impediments of the state-of-the-art information and communication technology (ICT) resources and

world-class technical skill for exploration and production. Generally, it has been noted that ICT infrastructure is still poor in many developing countries including Nigeria, and this compelled World Bank to adopt internet and general ICT resources as one of the key strategies to promote growth and development (Yusuf, et al, 2012a; Iheduru, 2011a; UNESCAP, 1999). Similarly, in support of this argument, Okereke (2008) and Fulford & Granell-Zafra (2005) observed that lack of in-depth knowledge and awareness of the benefits and general performance of ICT could be one of the reasons why other countries, companies or freelance translators are not making serious progress.

The phrase ICT is a subset of IS, and both are interwoven (Bamiro, 2007). The convergence of various technologies and applications is what led to ICT, interlocking them will comprise three technological elements: computer hardware; computer software; and telecommunications (Bamiro, 2007; Schwalbe, 2002). While IS can be explained as a convergence of the three technological elements of ICT as well as data, procedures and the technical personnel that manipulate the systems (Bamiro, 2007; Schwalbe, 2002). This study adopts these definitions when making references to IS and ICT.

Nigeria's population, its estimated 36.5 billion barrels of crude oil hydrocarbon resources and commitment to Africa's stability make it the largest and most influential country in Africa (Adeniyi, 2013; Atakpu, 2007; Okoye, 2004). As this study argues, Nigeria's technological advancement, particularly in the oil and gas sector, could be beneficial and resourceful to some West African nations as a result of their dependence on Nigeria for importation of material and human resources.

Furthermore, Ozigbo (2008) advised on the need to investigate impediments to the deployment of state-of-the-art ICT resources in Nigerian INOCs so as to improve performance. The study has academically reviewed many adjectives that explain the highest level of development, such as the latest, the newest, the most modern and the state-of-the-art. The phrase "state-of-the-art" has been carefully selected and adopted to describe the highest level of the development of the devices or of scientific innovation (Cambridge, 2013). Drilling experts and other technical personnel also agreed and emphasised the great advantage of state-of-the-art IS adoption for exploration and production of oil and gas (Skourup & Pretlove, 2009; Johnson, 2009; Shapiro & Randall, 1985).

In support of Ozigbo (2008) on the adoption of state-of-the-art IS, it has been observed that, for economic growth and social development, engaging in the highest level of scientific and technological development is a compulsory factor and a necessary ingredient that must be adopted (Yusuf, et al, 2012a; World Bank, 2006). Additionally, as this study argues, IS does not necessarily mean computer hardware only, but it includes system software, programming software, application software, human skill, networking devices, Supervisory Control and Data Acquisition (SCADA), online monitoring resources and mobile facilities. This study may also argue that the availability of the stated components of IS could be relevant to this research and will also be investigated. For example, the SCADA system is applicable for petrochemical engineering and computing technology for recording seismic signals of geophysics and 3-D visualisation for subsea engineering. Even further back in time, as observed by Okoye (2004), Nigeria's oil and gas industry needs the intervention of greater technological capacity to improve its organisational ability and achieve its mission. However, this can only be attained after identifying their impediments and constraints and addressing them accordingly as argued by researchers (Lawrence & Tar, 2010; Kapurubandara & Lawson 2007; Tarafdar and Vaidya, 2006).

In an attempt to carry out this research, the study will give more emphasis on investigation of the significant barriers, if any, to the adoption of state-of-the-art IS used for exploration and production by the INOCs. Prior to that, a review of relevant literature will also be conducted so as to identify the efforts of other researchers to establish what is already known as will be reviewed in Chapter 4 of this thesis. In addition, the relevant literature of other developing nations will also be reviewed and applied in the Nigerian context. Furthermore, there are many registered INOCs in Nigeria (Allison-Madueke, 2013; Adeniyi, 2013). As of 2013, there are 49 INOCs and 28 Marginal Fields Operators which are all categorised as companies in Nigeria. This includes the Nigerian Petroleum Development Company (NPDC) which is a subsidiary and the upstream arm of Nigerian National Petroleum Corporation (NNPC) (Allison-Madueke, 2013; Adeniyi, 2013).

The Nigerian constitution stated that the entire mineral oils and natural gas belonged to the government of the Federation (Constitution, 1999). The Petroleum Act provides three categories of licenses for upstream operations: i) oil mining lease (OML); ii) oil exploration licence (OEL); and iii) oil prospecting licence (OPL) (Shosanya, 2013; Adeniyi, 2013; Biobaku & Co, 2008). They observed that only

Nigeria's citizens and companies incorporated in the country can be approved and granted an OML and OPL.

Unfortunately, the INOCs were performing below expectations as noted by governor of the Central Bank of Nigeria (Sanusi, 2011). In the year 2012, an amount of 2.48 million barrels per day (bpd) was produced. Out of this, the collective production by INOCs totalled only 276, 040 bpd, which is the maximum level of production they have reached so far. Furthermore, the major production was achieved by the International Oil Companies (IOCs), such as Shell (Allison-Madueke, 2013; Adeniyi, 2013). As this study argues, the significant production of the IOCs could be as a result of many factors, including the state-of-the-art IS adopted for exploration and production.

Similarly, INOCs led by the exploration and production arm of NNPC of the Nigerian government, i.e. Nigerian Petroleum Development Company (NPDC), produced only 125, 828 bpd in the whole year of 2012. Followed by Seplat Petroleum which produced 40, 033 bpd, while -Pan Ocean produced 7, 387 bpd and all the remaining local oil companies produced 102, 797 bpd. Similarly, the only relatively significant production came from the NPDC, Seplat Petroleum and Pan Ocean (Adeniyi, 2013; Allison-Madueke, 2013).

As a result of this low upstream operation by indigenous and marginal field operators, the study will investigate the significant barriers, if any, which limit the adoption of the state-of-the-art IS by the Nigerian INOCs in upstream operations. Prior to that, the availability of state-of-the-art IS resources or otherwise in the indigenous sector will also be investigated in Chapter 5, Section 5.7 of this thesis.

Consequently, the state-of-the-art IS has been a very essential ingredient towards effective and efficient exploration and production of oil and gas (Talib and Malkawi, 2011; Lenhard, 2004). However, managerial attitude in the Nigerian INOCs may be a major obstacle towards the technological advancement of the indigenous sector particularly in the area of exploration and production (Shore, 1998; Glober, et al., 1994; Anwar & Shamim, 2011).

Unfortunately, approximately £6 billion is being sunk into the sector annually with no positive result to show in the right direction with respect to E&P as stated by many stakeholders (Ihua, et al., 2009; Iledare, 2008; Sachs, 2007; Ayobolu, 2006). In

addition, there could be constraints, such as environmental challenges, limiting the adoption of relevant technology for the production of oil by Nigerian INOCs as challenges to Nigerian development in general as stated by many researchers and other stakeholders (for example see: Hafid, 2009; Shore, 1998; Glober, et al., 1994; Anwar & Shamim, 2011; Obayelu, 2007; Amaraegbu, 2011).

Furthermore, this study observed a lack of relevant empirical research with regard to the IS used by the Nigerian indigenous oil sector. The type of IS used by the sector has not been investigated. Arguably, this makes this study very relevant and imperative for the development of the indigenous oil sector.

1.2 Aim, objectives of the study and the main research questions

The main aim of this study is to investigate and identify the significant barriers, (if any) to state-of-the-art IS adoption by Nigerian INOCs. The main research question formulated for the study stated that:

> *Do Nigerian indigenous oil companies adopt state-of-the-art information systems and, if not, what are the significant barriers that limit their adoption?*

The research question (RQ) has two parts: i) investigation into whether Nigerian INOCs have adopted state-of-the-art IS? And if the answer is not in the affirmative; then ii) what are the significant barriers that limit such adoption?

Furthermore, a general aim and five other objectives emerged in answering the research question(s) about the Nigerian INOCs. The aim is:

To investigate the significant barriers (if any), that limit the adoption of state-of-the-art IS by INOCs.

Other objectives are:

i) to investigate the importance of having state-of-the-art IS by INOCs;

ii) to investigate whether INOCs use state-of-the-art IS or not;

iii) to investigate the significant obstacles, if any, that limit the adoption of state-of-the-art IS by INOCs;

iv) to identify the way out for removing the impediments that limit the adoption of the state-of-the-art IS; and

v) to review government policy and support for Nigerian INOCs and provide recommendations appropriately on their modification (if any) and implementation in order to motivate INOCs to adopt the state-of-the-art IS.

The study has designed a chart that indicates the relationship between the aim, objectives, research questions and methods. The chart is presented in Figure 1.1 with an arrow indicating the direction of flow.

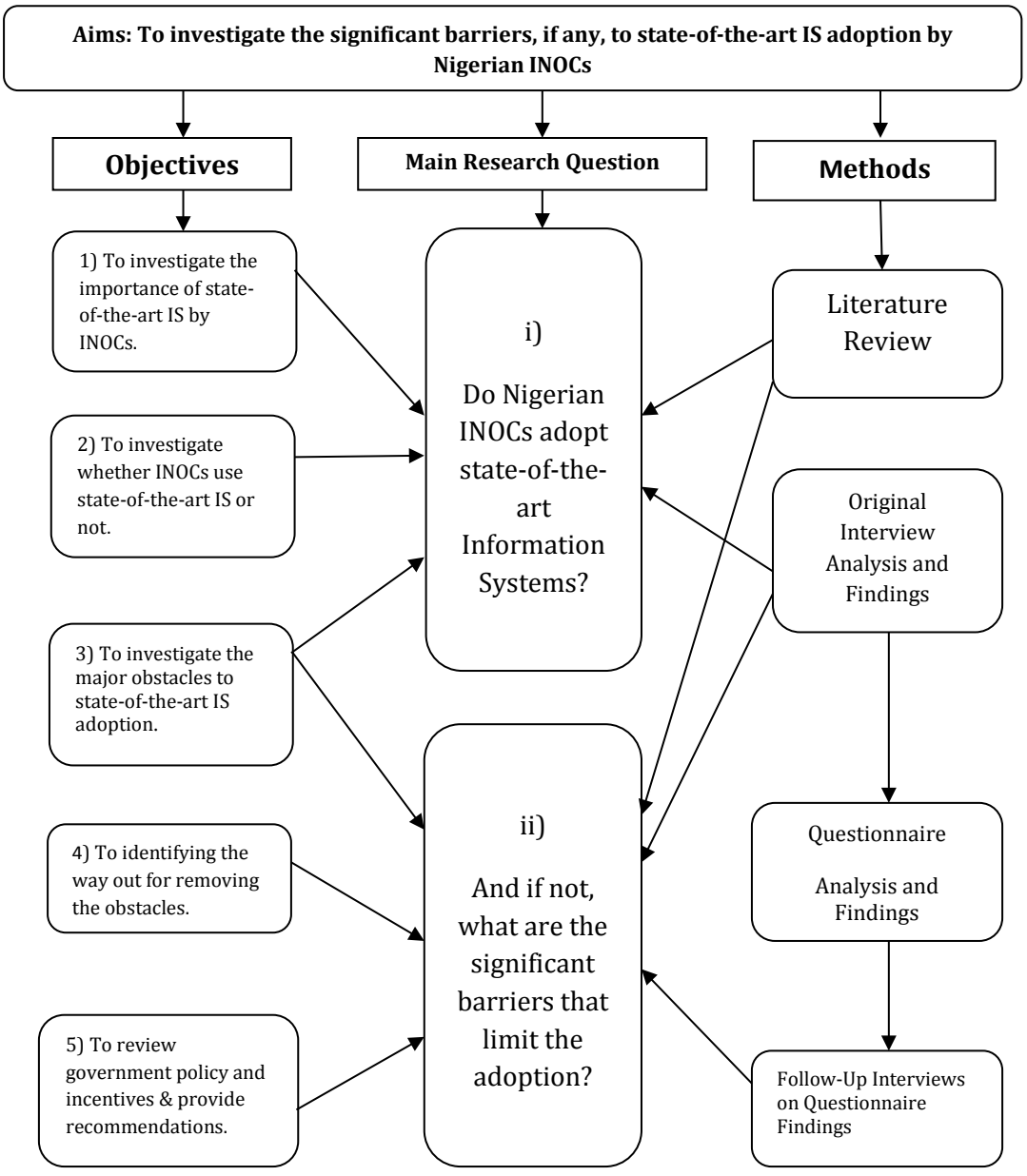


Figure 1.1: The chart of aims, objectives, RQ and methods

The chart begins with the aims of the study which investigates the significant barriers, (if any) to state-of-the-art IS adoption. The objectives, research questions and methods to be used were derived from the aim of the study.

Furthermore, 5 objectives, 2 major questions and 3 methods emerged for the study. Objective 1, 2 and 3 address the first part of the research questions, while objective 3, 4 and 5 address the second part of the research questions. And the two part research questions assist in addressing the 5 objectives.

As in Chapter 6, Section 6.3, the methods used for the study include a review of relevant literature, original interviews and questionnaire approach. However, another follow-up interview is also designed in order to address some significant differences that may arise on questionnaire findings and also serve as "member checking."

1.3 Sub-questions of the study

Formulation of research questions and sub-questions or testing of hypotheses is among the most significant elements of research (Collins & Hussey, 2009; Mason, 2006). These questions should be answered on the basis of their compatibility and agreement or disagreement with the findings of the study. The following sub-questions have emerged from the main research question on state-of-the-art IS in Nigerian INOCs.

Q_1- Is the cost of ICT resources a significant barrier that limits the adoption of state-of-the-art IS by Nigerian INOCs?
Q_2- Is inadequate technical skill a significant barrier that limits the adoption of state-of-the-art IS by Nigerian INOCs?
Q_3- Is poor managerial attitude a significant barrier that limits the adoption of state-of-the-art IS by Nigerian INOCs?
Q_4- Is government policy a significant barrier that limits the adoption of state-of-the-art IS by Nigerian INOCs?
Q_5- Is government incentive a significant barrier that limits the adoption of state-of-the-art IS by Nigerian INOCs?
Q_6- Is environmental challenge a significant barrier that limits the adoption of state-of-the-art IS by Nigerian INOCs?

1.4 Theoretical framework of the study

The issue of framework development or adoption has been an important and old area in the field of research because for more than half a century, engineers, IS analysts and philosophers had been working tirelessly so as to construct an exact theory and model capable of unifying the many available branches of the scientific enterprises (Rajagopal, 2002; Venkatraman, 1989). They noted that these scientific enterprises include information technology, communication technology, analogue technology and digital design. However, it was not until the 1980s that the desired excellent articles in this field of study began to emerge seriously following their publication by relevant journals (see: Tornatzky & Klein, 1982; Bailey & Pearson 1983; Doll & Torkzadch, 1988; Ives et al., 1983; Davis, 1989). For example, Tornatzky and Klein (1982) emphasised the need to use a model to conduct research in the field of technology.

As a result, there have been many studies conducted on theoretical framework, model and instrumental development of measuring the perceptions of organisations and individuals towards the adoption of innovative ICTs as well as barriers to their successful adoption (Kapurunbandara & Lawson, 2007; Moore & Benbasat, 1991).

Moore and Benbasat (1991) argued that there had been inconclusive and contradictory outcomes due to the lack of authentic theoretical foundation for such research and insufficient measurement of constructs. This limitation led to the development of their innovative diffusion theory model.

An in-depth review of framework for barrier-technology developed by Lawrence and Tar (2010) expounded some strengths and weaknesses when applying it to some developing nations. Arguably, the greatest weakness discovered by this study is the failure to effectively and extensively address environmental factors as major obstacles to ICT and e-commerce adoption in developing countries.

This study adopts a significant idea from Kapurubandara and Lawson's model (2007) which will be presented later in the thesis. As part of this study, a new model will be developed which could be applied to all national oil companies of developing countries.

1.5 Methodology and methods

The aim of this study is to investigate whether the Nigerian INOCs adopt state-of-the-art IS, and if otherwise, then to investigate the significant barriers that limit such

adoption. Mixed-method is most suitable and appropriate to this study as extensively discussed in Chapter 6, Section 6.4 of this thesis. Because mixed-method approach comprises both qualitative and quantitative methods, they are all suitable to the study. In addition, interview and questionnaire surveys will all be applied in their more suitable areas (Yusuf, et al., 2012; Fulford & Granell-Zafra, 2005). The rationale for the selection of mixed-method is provided later in Chapter 6 of this thesis. Primary data will be collected from the key stakeholders of the Nigerian indigenous oil sector that have special interests in the operations of the INOCs and related IS application.

As stated earlier, the primary data will be generated through interviews and questionnaires. The data to be collected through the interviews will help to answer the research question, which is to establish whether the Nigerian INOCs have adequate state-of-the-art IS, and subsequently investigate significant barriers and their solutions. The data to be collected through questionnaires was meant to answer only the second and most important part of the research question- which was to investigate the significant barriers that limit the adoption of adequate state-of-the-art IS by the Nigerian INOCs. And finally a follow-up interview will be conducted on the significant issues that may arise from various groups of stakeholders on the findings of the questionnaire and also serve as "member validation."

1.6 Significance of the study

There are several justifications for this study. First, Nigeria largely depends on oil for the sustenance of its economy. Approximately 90% of Nigeria's export revenue is generated from the oil sector (Onadipe, 2011; World Bank, 2006; Atakpu, 2007). In addition, so far, there has not been any determined effort from the government to diversify its revenue from other sectors, such as agriculture. Oil remains the main source of revenue for running the economy (Onadipe, 2011). As a result, this study which aims to investigate the significant barriers (if any) to the adoption of state-of-the-art IS by the Nigerian INOCs may be invaluable to the country.

Second, the low oil production of Nigerian INOCs is another issue of concern (Adeniyi, 2013; Sanusi, 2011; Ozigbo 2008; Nwosu, 2006). As a result, the study also examines the state of ICT governance as well as any relevant issues, whether they limit the adoption of state-of-the-art IS or not - and this could be of interest to researchers,

academics, consultants and other stakeholders who want to undertake further research on IS in the oil sector and beyond.

Third, the Nigerian INOCs may find this study very useful and essential. The study aims to make useful suggestions and recommendations from the findings that emerge. In addition, the findings of the study may motivate and encourage the INOCs to improve their operational performance and efficiency by adopting state-of-the-art IS (if and when the need arises).

Fourth, indigenous investors and international oil companies (IOCs) may find it useful and relevant as well. The findings of the studies may also motivate and encourage indigenous investors and IOCs to understand the significance of partnership towards technical skill development as well as the deployment of state-of-the-art IS resources.

Finally, the general public may gain a better knowledge of the state of Nigerian INOCs in their upstream operations, particularly with regard to upstream IS. This may motivate them to assist the government in protecting the resources that are vandalised by the militants (Ogundiya, 2009; Ogundele, 2008; Scott, 2007).

1.7 Scope and limitation

Scope and limitation are the two elements that determine the border of the study as well as its limitations (Collins and Hussey, 2009). Considering Nigerian INOCs as the area of this study, the scope is limited to the upstream sector of Nigerian INOCs. In other words, the area of downstream will not be investigated in this study.

1.8 General outline of the thesis

This thesis is divided into ten chapters. The current chapter starts by giving the background as to what led to establishing the aim of this study. The aim, significance, objectives as well as the research questions of the study are also presented. In addition, the chapter outlines the theoretical framework as well as the methodology and methods adopted in the study. This is to simplify and guide the reader through the thesis. Furthermore, a concise description of the subsequent chapters is also provided.

Chapter two reviews and presents state-of-the-art upstream IS used by international oil companies so as to serve as a platform for identifying the gap that existed between them and their Nigerian INOCs counterparts. Other components of top-class IS, such

as state-of-the-art computer technology, technical skill, wireless technology, SCADA, multimedia resources and networking devices were presented.

Chapter three reviews and identifies the IS resources of developing countries. The chapter also discusses factors that limit the functions of IS in developing countries, ICT development, and challenges facing Nigerian INOCs, Nigeria and ICT infrastructure, software development as well as a general overview of INOCs. Furthermore, the chapter also discusses performance measurement in oil and gas companies as well as its relevance to the study.

Chapter four addresses barriers to the adoption of ICTs in developing countries. Similarly, constraints of ICT adoption in developing countries, top management role and obstacles affecting the management of oil companies' IS are also reviewed and presented as well as government policy, environmental factors and the theory of constraints.

Chapter five discusses the theoretical frameworks that have been reviewed, integrated and developed for the study. The chapter begins by reviewing the different types of theoretical frameworks and models by identifying their strengths and weaknesses. The chapter also presents an analysis of the data collected during interviews. The data analysed serves as the foundation as well as the background of the study. The analysis is conducted by developing and adapting an algorithm which has been followed sequentially. Conclusively, an integrated model for barriers to state-of-the-art IS adoption by INOCs of developing countries is developed after considering the peculiar situation of Nigeria and other similar African countries.

Chapter six presents the methodology and methods adopted by the study. The chapter gives a general review of the assumptions made which is relevant to the study and the methods employed in the research. The study has adopted a triangular approach by using two sets of interviews, questionnaires and secondary data. Statistical packages used in the analysis are also discussed and presented elaborately.

Chapter seven analyses the data collected through the questionnaire-survey method. Using descriptive statistics- mean, media and likert scale, the opinion and perception of respondents on each of the variables are critically analysed, interpreted and presented. Cross-tabulation analysis has also been computed among the various respondent groups so as to identify the level of their collective group agreement or otherwise. Mann-Whitney tests were also computed as a follow-up in order to

determine the significant differences that existed between the groups of stakeholders that participated in the questionnaire-survey.

Chapter eight analyses the data collected during follow-up interviews on the questionnaire findings. The chapter addresses the significant differences that existed between groups of stakeholders on the questionnaire findings and also serves as member validation. The findings have helped to make the opinions of the stakeholders very sound and strong.

Chapter nine presents the main findings and the original contributions to knowledge, and the summary of main major discoveries. In addition, the research questions of the study are answered and the aim and objectives are all addressed.

Chapter ten presents the summary and recommendation of the study. Furthermore, the major limitations of the study and some suggestions for possible future research on IS adoption by INOCs are also presented.

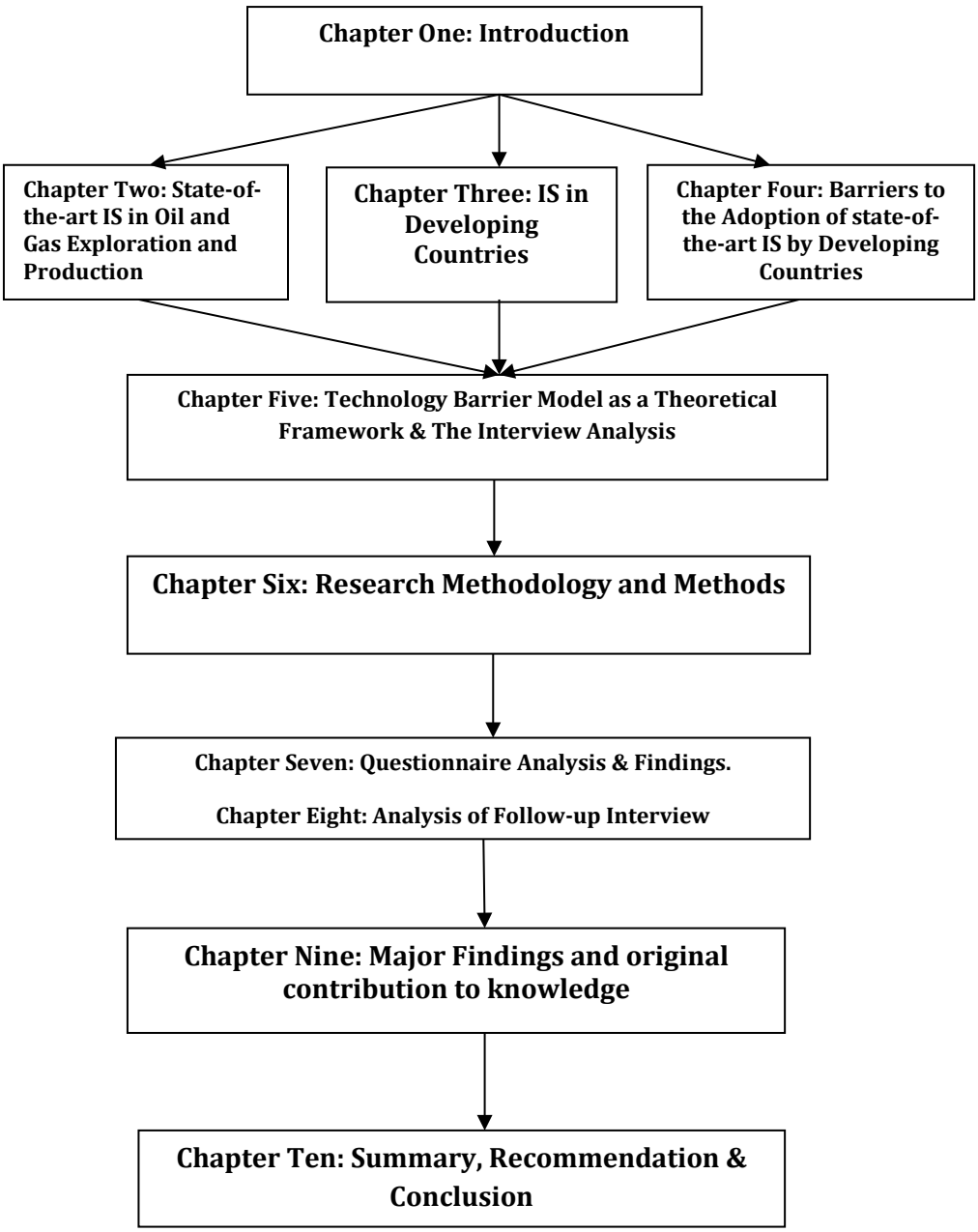


Figure 1.2: The chart of the thesis

CHAPTER TWO

State-of-the-Art Information Systems in Oil and Gas Exploration and Production

2.1 Introduction

This chapter reviews relevant literature relating to state-of-the-art upstream IS resources used by IOCs globally. The review is to provide an essential knowledge and a general insight into state-of-the-art IS used by world-class oil companies in the developed nations across the globe. These general insights could assist the Nigerian INOCs, independent oil companies of other developing nations and researchers to discover the significant barriers to state-of-the-art IS. The chapter also presents the importance and benefits of successful state-of-the-art IS adoption in order to address the first objective of the study (Yusuf, Gunasekaran & Abthorpe, 2004). They emphasised on the need of successful implementation of IS adoption.

Furthermore, the state-of-the-art IS resources reviewed by the chapter are in phases. These include world-class computers, computing facilities, multimedia tools, 3-D visualisation, wireless resources, upstream software, and the integration of SCADA into the state-of-the-art IS used in the oil and gas sector (Lenhard, 2004; Talib & Malkawi, 2011). However, all the ICT resources discussed have both state-of-the-art and inferior quality. In this chapter, only state-of-the-art IS resources have been reviewed.

The rest of the chapter is divided into relevant sections. Section 2.2 discusses the background of IS and its management in the oil and gas sector. Section 2.3 discusses computer technology in exploration and production. Section 2.4 discusses computing in upstream operations. This is followed by Section 2.5 which addresses state-of-the-art multimedia. Multimedia and collaborative engineering environment are addressed by Section 2.6 Furthermore, 3-D visualisation is discussed in Section 2.7 of the chapter. Section 2.8 discusses wireless application. Section 2.9 presents robotic technology. Section 2.10 discusses state-of-the-art software. SCADA and ICT infrastructure are addressed by Section 2.11. Similarly, Section 2.12 presents oil and

gas reserves and ICT engineering applications. Section 2.13 then discusses the background on measuring the performance of oil companies and the importance of performance and its measurement in the oil and gas sector, and the chapter is concluded by Section 2.14.

2.2 Background of IS, IT and IM and their application to oil and gas

Information Systems (IS), Information Technology (IT) and Information Management (IM) are overlapping disciplines that are related to each other (Detlor, 2010; Beynon-Davies, 2009). Furthermore, Beynon-Davies (2009) uses the word "informatics" as a centre that accommodates all three disciplines. In his previous research, Beynon-Davies (2007) considered IS as the central area of discussion when referring to "informatics", because "information systems" can accommodate the remaining disciplines. Much earlier, Kling and Allen (1996) used "organizational informatics" to be the locus of Information, IS and IT, and it can be used in various places of human organizational informatics (Beynon-Davies, 2002). The word "information" can be traced to a verb in the Latin "informare", meaning "to form an idea of", "to shape" or "to describe" (Beynon-Davies, 2009; Hobart & Schiffman, 1998).

Informatics as a discipline is related to ICT. This is because ICT infrastructure is a collection of tools used to assist in forming information systems (Bamiro, 2007). Information systems stand for systems of communication, due to the fact that it produces, stores, collects and disseminates information (Beynon-Davies, 2009; Bamiro, 2007).

Similarly, IT plays a significant and vital role in managing information in an organization (Detlor, 2010). Likewise, it should be remembered that ICT is the technical media through which information is stored, accessed, processed and used (Detlor, 2010; Bamiro, 2007).

Furthermore, IM is a broad term that has different definitions and meanings among various constituencies; it is being interchanged with management of IS, management of IT, management of information resources and management of ICT (Detlor, 2010; Choo, 2002). In line with this, IM can be defined as the management of the procedures and stages that create, arrange, store, distribute and use information.

The main aim of IM is to assist managers and companies to process, utilise and manage information diligently and successfully (Detlor, 2010). Prominent

information management experts and designers give it different definitions. Choo (2002) defines IM as the management field of processes that deals with acquiring, creating, organizing, distributing and using information. Similarly, Wilson (2003) defines IM as "the application of management principles to the acquisition, organization, control, dissemination and use of information relevant to the effective operation of organizations of all kinds". In addition, the US Government Accountability Office (2008) explains IM as "the planning, budgeting, manipulation and controlling of information throughout its life cycle." As this study argues, all the definitions discussed so far are closely related and convey almost the same meaning and they differ only in their choice of words to convey the message.

Detlor (2010) suggests that the description of information management functions and roles in an organization is not in total conformity with what the word stands for, thus it is better to be phrased as an alternative and replace it with, "information technology management" or "information systems management." Information systems management deals with controlling the development, innovation, creation and support of IS applications that accommodates business activities, management and their workflow. On the other hand, information technology management refers to the managing and controlling of hardware, software and peripheral devices used for E&P of oil and gas.

Furthermore, it is because of the essentiality of state-of-the-art IS that even schools and institutions are procuring it for the implementation of integrated educational IS (Bloch, Hedberg & Harper, 1994). They noted that they do that in order to enjoy innovations in educational technological advancement.

Inter-organisational IS are sub-information systems that are linked together to establish and/or form global information systems (GIS). Similarly, Inter-organisational Information systems are a collection of ICT resources- Hardware, protocol for data communication, human resource skills, network facilities and required software, that form an IS for an organisation (Haiwook, 2001). Meanwhile, the Inter-organisational IS has been implemented for the past 50 years which can also be divided into some phases that function as a single system (Shore, 2001). This could be relevant to this study towards the adoption of the state-of-the-art IS by Nigerian INOCs.

Furthermore, IS comprises of five primary and basic resources. These resources include: personnel which includes ICT experts and computer scientists; software which includes system, utility and application software; hardware which includes all the physical components of the IS; data which includes database and knowledge; and networks which include communication media and network facilities (Beynon-Davies, 2009; Ozigbo, 2008; Bamiro, 2007). As this study argues, these are the related components of IS to be addressed in the study.

2.3 Computer technology in oil and gas

In the oil and gas sector, upstream expenses account for a significant amount of E&P budgets ranging from 50% to 80% of the total expenditure (Okoye, 2004; Fisher & Kenny, 2000). The use of complex mathematical modelling for calculations in E&P started in around 1950, and it was the same decade that witnessed the emergence of digital computer systems for commercial purposes (Ozigbo, 2008; Okoye, 2004; Shapiro & Randall, 1985; Galle & Woods, 1960). According to Neal *et al.*, (2007) the pioneer outstanding performance of technological innovation in the oil E&P was the separation of oil and gas.

In addition, microcomputers and software applications allow programmes and packages primarily designed for drilling in exploration to be placed into the hands of engineers and geologists anywhere in the world (Hill et al., 2008; Shapiro & Randall, 1985). Consequently, MNOCs invested heavily in hardware, software and telecommunication facilities, when the experts were convinced beyond reasonable doubt that the enormous amount on the part of the companies could not be performed without the intervention of state-of-the-art ICT resources, networking facilities, software and relevant IS skill (Talib & Malkawi, 2011; Lenhard, 2004).

Furthermore, ICT resources and skills are necessary ingredients in managing huge resources of information, particularly during E&P (Gouvea, 2007; Fisher & Kenny, 2000). Without getting valid and authentic state-of-the-art IS resources, important business calculations and other relevant operations will become difficult or almost impossible to execute accurately (Arora et al., 2009; Hill et al., 2008; Heeks & Nicholson, 2004).

2.4 Computing in upstream operations

Computing performed through state-of-the-art IS adoption is the centre of virtually every process of E&P, and even recording of seismic signals and it has become

necessary for all stages of upstream operations (Anisi et al., 2010; Johnson, 2009; Evans, 2002). The sector of oil and gas discovery, exploration and production brings special and serious challenges in many areas of software development, computing and general information technology (Hill et al., 2008).

Interestingly, technological innovations in ICT and programming deal with the challenges of E&P and bring about all types of high performance computing possibilities that were once well beyond the reach of most companies in the oil and gas sector (Goodrich & Schultz, 2007; Johnson, 2009). Drilling experts and other technical personnel also agreed with the great advantage of computer simulation by state-of-the-art ICT resources, but they had differed about the kind of software required for work to be successful. Experts in the field usually run the various drilling optimisation programs used in drilling during E&P (Skourup & Pretlove, 2009; Johnson, 2009; Shapiro & Randall, 1985).

From what has been reviewed, it is no longer a debatable issue that state-of-the-art IS for computing is a compulsory technology for oil and gas companies (Goodrich & Schultz, 2007; Evans, 2002). In addition, IS resources for computing that are being used in practice today are mainly in the domains of exploration and production (Anisi et al., 2010; Hill et al., 2008; Lenhard, 2004). As this study argues, this investigation could help towards identifying the impediments (if any) of state-of-the-art IS adoption by Nigerian INOCs.

Consequently, the general concept and background of IS cannot be understood without making reference to Information Technology. Information Technology (IT) is a collection of devices that handle the process of inputting data and outputting information. The Information Systems (IS) is formed when such devices are assembled together, so that information can be shared and flow between people and organisations (Li & Womer, 2009; Haynes, 2001). However, IS cannot function without software because it serves as the life and the most essential component of the system. The combination of these two and other networking and peripheral devices is referred to as IT or ICT infrastructure (Li & Womer, 2009; Chen, 2004; Haynes, 2001).

Based on the definition of IS which applies to both the oil and gas sector, it is a combination of hardware, data, and Software- which include system, programming

and application software, wireless facilities, networking devices and technical skill (Hill et al., 2008; Shabtay & Steiner, 2007; Callaos & Callaos, 2002).

As an example of a multinational oil company, Texaco as an oil company had up to twelve eras of programming, ICT procurement, technical skill development and software deployment which covered more than five decades (Anisi et al., 2010; Hirschheim et al., 2003). These eras included deployment of ICT resources and computing facilities, creating computer department for services, networking and Database maintenance, software deployment and up to what they entitled "Transition to Acquisition". They completed the era through their merger with Chevron ICT in early 2002 (Atakpu, 2007; Hirschheim et al., 2003). Further, it has been confirmed that they will need more technological advancement in time, in order to maintain the modern challenges in the field (Li & Womer, 2009; Hirschheim et al., 2003).

All the ICT resources mentioned so far are found in MNOCs. This may be contrary to the situation of Nigerian INOCs with regards to state-of-the-art IS adoption (Ihua, 2009; Bamiro, 2007). However, this study argues that the significant barriers (if any) limiting the adoption of state-of-the-art ICT computing facilities in INOCs have not been identified, and this emphasises the importance of this study.

2.5 State-of-the-art multimedia in oil and gas E&P

In the early 1990s, the decade witnessed significant progress with the emergence of multimedia technology (Jieshu & Fude, 2008). Multimedia technology is a new ICT resource that brought about the integration of information, texts, software, video images, audio, colour pictures and animations, and the ability to process them intensively with computers and supporting facilities to produce a single file document as a combination (Cuifang, 2009; Jieshu & Fude, 2008).

Consequently, multimedia technology is a state-of-the-art modern technology device that is applicable to oil and gas E&P (Yang, et al., 2010). It has many more segments such as computer hardware, software, film, electronics, television and digital camera. Specifically, these texts, images, audio, 2-D, 3-D animations and visualisations are combined together in an integral form and produce a single audio visual document (Yang, et al., 2010).

It has been practically proven that state-of-the-art multimedia technology as it is today is applicable to all fields of human endeavour, including education, the oil and gas sector, cultivation and health and security (Cuifang, 2009). In line with this, Yang, *et al.*, (2010) critically confirmed that up-to-date multimedia technology is applicable to exploration, gathering, drilling and production of oil and gas. They also demonstrated its applicability to even the teaching of oil and gas exploration and storage. One argues why these state-of-the-art ICT resources if not available, may not affect the performance of Nigerian INOCs.

2.6 Multimedia and collaborative engineering environment in oil and gas

The ability to manipulate and visualise models in the computer system has entirely changed the method of working professionally (Santos et al., 2004; Dorn, 2002). However, with all the technological advancement witnessed so far, there may be urgent need to address more challenges during E&P in remote fields located in difficult environments (Cisco, 2011; Munro, 2007).

Santos et al., (2004) have proposed the development of state-of-the-art collaborative engineering environment to help in performing projects in the oil and gas sector. This will happen in the computer-field, by the integration of three advanced technologies of multimedia collaborative systems, workflow management system and collaborative virtual environment. This proposal, if executed will serve in executing tremendous works in the sector. Looking critically at this proposal highlighted earlier, it is a multimedia based approach that will assist in "Control" and "Execution" of some projects. This has been identified as one of the main contributions of state-of-the-art ICT resources in the oil and gas sector (Cisco, 2011; Munro, 2007).

2.7 The 3-D Visualisation in oil and gas E&P

The field of computer and ICT resources brought about many changes in the oil and gas sector. Similarly, as regards 3-D visualisation as a segment and product of multimedia, it has been proven and established by researchers that it significantly assists in reducing the risk of oil and gas searching, exploration and production (E&P), and it is a necessary tool for the oil and gas sector (Evans, 2002; Volz, 2002). Many state-of-the-art 3-D visualization software applications have been developed to assist the geoscientists and engineers in the process of E&P (Evan, 2002). Some of these software applications are: Igeoss structural geology software; Techlog wellbore solution software; and 3D propagator software (SIS, 2013; Evans, 2002; Volz, 2002).

Frohlich (2002) enunciated the fact that the oil and gas sector is a great challenge to the field of visualisation as on a daily basis, the demand for more advanced technology emerges. Visualisation technology is expanding in the oil and gas company, particularly in recent times with modern and state-of-the-art innovations in hardware, software and visual resources (Dorn, 2002). He emphasised that even more advanced resources could be needed as a result of emerging new challenges.

Multi-disciplinary asset teams utilise 3-D visualisation technology, enhanced computing and basin modelling to critically investigate and communicate the hydrocarbon system in the sub- surface (Munro, 2007; Burley, et al., 2000). They noted that they are generally applicable for attempts to reduce the exploration risk and increase performance, and this is ultimately part of the E&P sector (Burley, et al., 2000).

2.8 Wireless application in oil and gas E&P

The oil and gas sector is experiencing the emergence of wireless device as a technology that forms part of ICT resources in upstream operations. Two fundamental challenges took place in the process of E&P of oil and gas, these are: asset productivity; and efficiency of operation (Cisco, 2011; Munro, 2007). Initially, geologists and other experts in the field found it extremely difficult or almost impossible to see the current stage of the oil and react immediately with technical actions to increase the oil flow or significantly reduce downtime (Munro, 2007).

However with the new technology invented by Cisco, known as “First Mile Wireless”, this challenge has been reduced or eliminated, because it allows operators to integrate their operations by establishing the sense-and-respond capabilities that increase asset productivity (Cisco, 2011). Furthermore, the “First Mile Wireless” at the same time reduces the cost of operation and improves communication (Munro, 2007; Cisco, 2011). One argues that while all these state-of-the-art ICTs are available in multi-national oil companies, the situation may be different in the Nigerian INOCs and the barriers have not been identified academically.

Consequently, operational visibility has been improved and advanced by the invention of First Mile Wireless networks of Cisco (Cisco, 2011). This visibility includes the following: sending and receiving data without going there physically; data collection and transmission to exploration experts without going to remote locations; supporting the acquisition of data from the wellhead; transmitting data for

managerial decisions; maintaining physical security and alerting the experts to potential problems, and all these are achieved without being there in person (Munro, 2007).

Similarly, the oil and gas sector can use "First Mile Wireless" and manage multiple well operations concurrently and communicate with technicians in the field in real time as well as reducing the operational cost dramatically (Munro, 2007). However, there are some future challenges to be addressed by the Cisco, which include instant mobile interactions for extreme and critical remote areas and collaboration of real-time with the physical field.

In addition, Hill, *et al.*, (2008) identified some challenges in the modern oil field which require significant investment in the field of IS which will streamline their activities smoothly and successfully. These challenges include; extremely natural cold, hot or dangerous areas of E&P field and uninterrupted 24-hour flow of production process.

2.9 Robotic technology in oil and gas E&P

Robotic technology is an aspect of computing and ICT discipline that falls under artificial intelligence which requires hardware and software components in conjunction with wireless device to function effectively (Anisi et al., 2010; Goodrich & Schultz, 2007). They further stated that, its architecture comprises of control system, application server, remote user, robot controllers, computer system and wireless facilities. The main driving factor towards the invention of robots in oil and gas exploration and production (E&P) is to improve health, safety and environment (HSE), and at the same time to increase performance by improving access productivity and reducing operational costs (Anisi, et al., 2010). Robotic technology is an integral part of IS for upstream operations.

Additionally, the oil and gas sector faces a lot of challenges in modern times (Skourup & Pretlove, 2009). This is because of the fact that, in some countries, the easiest and most accessible fields have been exploited, leaving the most difficult and challenging reserves for E&P in the future. These difficult fields include, offshore, deepwater, deserts and other dangerous areas (Skourup & Pretlove, 2009; Goodrich & Schultz, 2007). This makes international oil companies (IOCs) pay more attention to maintaining, inspecting and controlling their discovered E&P systems remotely (Anisi *et al.,* 2010; Goodrich & Schultz, 2007). They emphasised that MNOCs give more attention to adopting state-of-the-art production system and its maintenance

from time to time. One argues that there is an urgent need to investigate and identify the significant barriers, if any that impede their adoption by INOCs.

Furthermore, robots serve as the organ of seeing and hearing as well as the hands of the operators to execute tasks from the control systems (Skourup & Pretlove, 2009). They further stated that this gives room for human personnel to keep physically away from dangerous and hazardous fields and relocate to a safer and more conducive environment and use their state-of-the-art ICT resources and manage the operation easily and successfully.

However, there are still some challenges attached to robotic technology with respect to upstream operations. Some of these challenges include, scheduling of different tasks concurrently and maintaining the location of high-level robots (Li & Womer, 2009; Shabtay & Steiner, 2007; and Chen, 2004), increasing safety, and maintaining the SCADA networks with certainty (Alcaraz-Tello, et al., 2008; Igure, et al., 2006; Byres & Lowe, 2004), and more advanced visualisation of the operation from the control room (Husoy & Skourup, 2006).

In light of the challenges highlighted so far, Anisi, *et al.,* (2010) predicted and forecasted even more challenges in the future in order to eliminate the dangers affecting health, safety and improved performance. They predicted that this can be tackled effectively with more innovations in the field. Studies conducted show that the complete automation of oil and gas devices and machines requires the provision of automation to more than one thousand different operations being performed today by the personnel, with the help of state-of-the-art ICTs and technical expertise (Blaer & Allen, 2009).

In addition, robotic technology plays a major role with its significant intervention in the field of engineering, data management, and computing in the sector of oil and gas E&P. This study argues that whilst MNOCs in developed nations are looking for more advancement in the sector, Nigerian INOCs and researchers are yet to critically investigate and identify the significant barriers (if any) to state-of-the-art IS adoption.

2.10 State-of-the-art software in upstream oil and gas operations

In this research, various types of software that serve as an integral component of state-of-the-art IS will be reviewed; those that are applicable to the oil exploration

process. In the developed countries, state-of-the-art software was developed and served as an integral part of state-of-the-art IS for E&P oil and gas reserves.

In addition, Ivanchenkov, *et al.,* (2000) have developed an algorithm, interface and procedure of a software design as a solution to the problem of prognostic tasks of oil E&P activities. This is as a result of the fact that, the field of software engineering experiences various stages of development in the oil and gas sector, with the sole aim of improving general performance efficiency, reducing risk as well as improving data management and analysis.

Furthermore, Schlumberger Information Solutions (SIS) produces oil and gas software and services to overcome the challenges of reservoir by enabling the creativity of geoscientists and engineers through innovative workflows and comprehensive global services (SIS, 2012). In line with this, here are some oil and gas software names that served as an integral component of world-class IS used in the oil and gas E&P. The list is displayed in Table 2.1.

Table 2.1: The list of upstream software and their functions

No	Software	Function
1	ECLIPSE 2012 Reservoir Engineering Software	*Excellent prediction of reservoir during E&P
2	GeoFrame Reservoir Characterization Software	*Description of subsurface during E&P *Handling multitasking functions
3	Igeoss Structural Geology Software	*Eliminates geological doubts *Control on 2D & 3D seismic interpretation *Execute complex computation
4	InnerLogix E&P Data Quality Management Software	*Allowing geologists to skip unnecessary steps in data analysis
5	INTERSECT Reservoir Simulation Software	*Very fast in running complex models with accuracy
6	Merak 2010 Software Release	*Provides data quality control *provides good management during E&P.
7	Ocean Software Development Framework	*Provides the most essential software development environment.
8	Production Surveillance, Analysis & Forecasting (OFR) Software	*Offer surveillance during E&P and detects challenges

9	PetroMod Petroleum Systems Modelling	*It increases the success of the exploration
10	Steady-State Multiphase Flow Simulation (PIPESIM)	*It improves the performance of simulation during E&P.
11	ProSource E&P Data Management Software	*It coordinates data processing
12	Techlog: Your Wellbore Solution Software	*Provides real time *Excellent visualisation
13	Malcon Interactive Suite Fluid Software	*Performing analytical chemistry data with precision, effectiveness & certainty
14	Petrel E&P software platform	*It increases performance of the reservoir
15	Studio E&P Knowledge environment software	*It gives access to difficult area
16	3D Propagator Software	*Excellent horizon tracker *It reduces risk *Its enhances user control
17	CRAM Software	*It increases speed *It provides target-oriented solutions

(Source: SIS, 2012 with major modification)

2.11 Integration of SCADA into upstream IS

ICT resources and the general concept of information systems (IS) have been going through many metamorphoses of technological advancement in the multinational oil sector of the developed countries of the world (Stig, Skramstad & Hagen, 2009; James, 1996). This study argues why rich-developing countries are not making a major contribution to this advancement.

Furthermore, in the oil and gas sector of developed nations, the collection of various world-class ICT resources give an advanced system entitled as "Process Management Systems" (Davison, Martinsons & Kock, 2004). In addition, the ICT resources used in the developed MNOCs or national oil companies of developed nations of the world comprise the most up-to-date networking devices, the most up-to-date maintenance systems, the most up-to-date production systems (usually enterprise resource planning systems), the most up-to-date telephone support systems, the most up-to-date video systems (usually closed-circuit television and VHF radio) and the most up-to-date radar system (Stig, Skramstad & Hagen, 2009; Hollnagel, Woods & Leveson, 2006).

In the past decades, “stand-alone process management systems” were used to control oil and gas production through traditional and stand-alone IS and separate Supervisory control and data acquisition (SCADA) systems (Stig, Skramstad & Hagen, 2009; Hollnagel, Woods & Leveson, 2006). However today, because of advancement in ICT, wireless and networking technology, real-time monitoring and production systems have been established whereby data is shared between systems so as to perform and execute vital operations in the oil and gas sector.

Similarly, state-of-the-art SCADA systems have advanced from previous stand-alone systems to commodity networked workstations that are always connected to the internet (Davison, Martinsons & Kock, 2004). This brings all-time dependency on the various systems put in place for E&P in developed companies and nations of the world. In these countries, SCADA systems are mostly integrated with Safety Instrumented Systems (SISs) in order to improve security, safety and resilience (Stig, Skramstad & Hagen, 2009).

Initially, SCADA was not part of IS resources (Johnson, Ask, & Roisti, 2008). They emphasised that technological advancement in the field of ICT has necessitated the integration of state-of-the-art ICT resources, SCADA, technical skill and corporate networks as well as internet. They said that, this state-of-the-art integration, in spite of its challenges, has resulted in “Process Control Systems” which gives a real-time online monitoring system. As this study argues, this could not be found in Nigerian INOCs notwithstanding the country’s abundant resources.

As a result of the integration of SCADA with ICT hardware, numerous challenges emerged including the need for advanced security systems, patches and effective security and state-of-the-art anti-virus solutions (Johnson, Ask, & Roisti, 2008). This study may also argue that the challenges manifested so far necessitated the need for the adoption of state-of-the-art IS by INOCs in Nigeria in order to improve performance by eliminating the risk and dangers attached to SCADA and ICT resources.

Furthermore, if the most up-to-date upstream IS were put in place, operational and efficiency performance would be enhanced and accident rates would be reduced to the minimum as a result of the real-time online monitoring systems (Johnson, Ask & Roisli, 2007). The authors argued that this allows technical experts to perform their activities and control their operation from the system room and manage their SCADA

system without necessarily risking their lives by physically attending the risky fields and areas (Johnson, Ask & Roisli, 2007). In order to achieve this, ICTs and SCADA systems should always be safe, resilient, secure and up-to-date in order to function efficiently and effectively during their operation (Stig, Skramstad & Hagen, 2009; James, 1996). However, one argues that while this has been achieved in developed countries, the situation could be very different with oil companies in developing countries, in which Nigerian INOCs are included

Furthermore, the precision and accuracy of information systems is essential to businesses and organisations, as its failure can cause great danger and a major loss of services or products (knight et al., 2004). Hence, IS reliability and dependability are a major concern to all stakeholders, particularly in the oil sector (Knight et al., 2004). It is therefore meaningful to suggest that the performance of organisations depends on the quality of IS deployed by these organisations.

2.12 Oil and gas reserves and ICT applications

The expression 'Information and Communication Technology' (ICT) was officially brought about in 1997 in order to accommodate telecommunication as an indispensable component of information technology (Bamiro, 2007; Schwalbe, 2002; Specials, 1997). The phrase was originally articulated in a report by Dennis Stevenson to the United Kingdom (UK) and intellectually advanced by the new National Curriculum document for the UK in the year 2000. The convergence of various technologies and applications is what brought about ICT, interlocking them will comprise three technological elements: these are computer hardware, computer software and telecommunications (Bamiro, 2007; Schwalbe, 2002). In the new modern approach, using the phrase "ICT" is more suitable and compatible in the computer world than "IT", for the former accommodates telephone networks, audio-visual and computer networks, however they both stand for each other (Bamiro, 2007; Okoye, 2004, Oyebisi et al., 2004; Alter, 2002). Similarly, this research prefers the use of "ICT" rather than "IT" because it is more comprehensive, compatible with this study and self-explanatory.

IOCs of developed nations have attained the up-to-date stage of the adoption of state-of-the-art ICT resources. This has been achieved over a period of time through investigations, feasibility studies and cost benefit analysis (Jieshu & Fude, 2008; Santos et al., 2004).

As of 2013, there are 49 indigenous oil companies and 28 marginal fields' operators at exploration, development and production stages of their upstream operations (Adeniyi, 2013; Allison-Madueke, 2013). As this study argues, there is a need for research into the technological advancement of the INOCs.

However, since the policy was introduced, these companies are yet to make a significant impact on Nigeria's oil production. For example, the Governor of Central Bank of Nigeria (CBN) Sanusi Lamido recently reported that "despite the emergence of a number of indigenous oil companies over the years, their collective output only represented one per cent of total production in the industry" (Sanusi, 2011 pp. 7). However, as this study argues, despite the poor production of INOCs, the assertion made by the Governor of CBN could be wrong due to the fact that it contradicted the record of indigenous production (Adeniyi, 2013; Allison-Madueke, 2013). Furthermore, the production of INOCs is within the range of 5%-11% of the total oil production (Adeniyi, 2013; Sanusi, 2011). This may suggest a gap between the policy expectations in terms of the performance of these companies and what they have been able to achieve so far.

Many reasons may have contributed to this poor performance. For example, it may well be due to the types of IS resources deployed in the exploration and production by these companies, as suggested earlier. It was also suggested earlier that there is a positive relationship between the type and quality of upstream IS deployed by, and the performance of, oil and gas companies. Perhaps, MNOCs deploy more sophisticated state-of-the-art IS in the exploration and production of oil and gas relative to their indigenous counterparts because they:

i. "specialize in managing complex, multifaceted and technically challenging ventures"; and
ii. mostly have superior access to finance (Kaiser and Pulsipher, 2006).

2.13 Background on measuring the performance of oil companies

Among the most essential activities of the sustainability of any company is the way performance assessment and impact are determined and measured (Davis et al., 2003; Tan, 1996). The impact of IS on the companies' performance has been of interest to both stakeholders and academic researchers for a long time (Davis et al., 2003; Tan, 1996; Banker et al., 1984).

Furthermore, stakeholders and experts in both public and private sectors are encouraged and urged to determine the value of their ICT resource investment and their performance through determining and measuring their success and failure rate (EDUCAUSE, 2004; Porter, 1998) because world-class ICT resources contribute fervently to organisations through enhancing their general performance and productivity and this is mostly achieved through reducing cost and increasing efficiency (Kassim, 2010).

In addition, the significant effect of ICT resources towards advancing organisation's performance, cost reduction, efficiency, productivity, profitability, precision and accuracy is variously entitled "ICT strategic advantage", "IT as competitive weapon", "IT-dependent strategy", "ICT business value" or "ICT strategic value" by different ICT wizards and researchers (Kassim, 2010; Oh & Pinsonneault, 2007; Piccoli & Ives, 2005; Melville et al., 2004).

However, ICT resources performance measures and periodic assessments were not widely spread, because the most common method used is "self-assessment", and only a few companies use full methodologies such as "the balanced scorecard" and "Malcolm baldridge"(Kassim & Underwood, 2010; Qing & Jing, 2005; EDUCAUSE, 2004). This situation is applicable to Nigerian INOCs, because they hardly adopt any methodology for measuring or determining their performance with all its importance and significance.

Furthermore, this situation brought about "IT business value (ITBV)" which is considered as the product of deploying state-of-the-art ICTs in the conduct and execution of works within engineering and technical aspects of the performance metrics including schedule, safety, cost, profitability and general stakeholders' satisfaction (Oh & Pinsonneault, 2007; Brynjolfsson, 1993).

2.13.1 Importance of performance measurement in a company

Measuring and determining of performance is an essential and fundamental building structure of the Total Quality Management (TQM) of a company or an industry (DTI, 2010; Kelvin, 2009) because the success rate or otherwise can be determined through genuine and accurate performance measurement (DTI, 2010). Consequently, because of the necessity to have world-class ICT resources in today's world, measuring it becomes all the more imperative for determining success rate (DTI, 2010; Steven, 2008).

Similarly, Anon (2010) stated that you can only try to manage what you can measure accurately, but if you cannot measure accurately, then it will not be manageable." Furthermore, Kelvin (2009) indicated that, you can know details about a company if you can control and measure what you are managing and express it statistically within a specific period of time. Moreover, Steven (2008) emphasised the fact that the performance of any oil company must be measured based on its objectives, which are mainly investors' value maximisation or national policy.

2.14 Conclusion

This chapter has reviewed the ICT resources in oil and gas E&P used by IOCs of developed nations. In addition, the oil and gas sector of developed nations has reached its advanced stage of technological advancement in computing in all their activities, including exploration and production activities.

This chapter has specifically reviewed the components of IS used by world-class oil and gas companies for upstream operations. This includes state-of-the-art computer and computing technology, multimedia, 3-D visualisation, wireless application, robotic technology, SCADA and the general concept of state-of-the-art IS.

The review of the relevant publications and subsequent discussions in this chapter vindicated a number of important issues and challenges. It is evident that there is major progress in technological advancement as regards the adoption of state-of-the-art IS by IOCs. However, no oil reserve can be discovered, explored and produced efficiently, effectively and safely without the full adoption of world-class IS.

Furthermore, this chapter has also reviewed and analysed the importance of determining and measuring performance as regards achieving and attaining Total Quality Management (TQM) in the oil and gas sector (DTI, 2010; Anon, 2010). This has been identified as a major step in the deployment, adoption and maintenance of state-of-the-art IS used by oil and gas companies.

The review has also established and revealed the strong link between the adoption of state-of-the-art ICT resources and the improving performance of the oil and gas E&P. Additionally, what has been reviewed so far is relevant to the identification and

interpretation of the significant barriers that may arise between IOCs on the one hand, and local oil companies of developing countries on the other.

The next chapter will review the relevant literature on ICT resources in the oil and gas sector of developing nations with emphasis on Nigeria. Specifically, the review will focus mainly on the level of progress of IS in developing nations, obstacles to its deployment and management, ICT in developing nations, and its challenges and prospects. At the end of the chapter, the journey so far towards the adoption of state-of-the-art ICT and the development of manpower will also be reviewed.

CHAPTER THREE

Information Systems in Developing Countries

3.1 Introduction

This chapter reviews relevant literature relating to IS used by developing nations particularly, in their E&P of oil and gas. The justification of the chapter is that, it could give an important and essential insight into the true and authentic situation of oil and gas in most developing nations, Nigeria inclusive. This essential insight could assist in addressing the second and third objectives of the study. In addition, it may also help us to compile an analysis of the IOCs and understand the significant barriers that exist in terms of upstream IS adoption and its utilisation. It may also help with the formulation of relevant research instruments to be applied in the subsequent stages of the study.

The situation and poor performance of Nigerian INOCs has been disturbing many Nigerians, particularly in the area of E&P of oil and gas. The total number of upstream INOCs in Nigeria is higher than multinational ones (Shosanya, 2013; Ozigbo, 2008). At time of writing, there are 49 indigenous, 28 marginal fields operators and 24 MNOCs operating in the country (Allison-Madueke, 2013; Adeniyi, 2013). With all these, very few resources are currently being found addressing ICT and technical skill related issues in Nigerian INOCs (Ihua, 2009; Bamiro, 2007; Baker, 2006). This may be largely due to the inefficient role they play in oil production in the country. However the country's oil and gas sector has been classified as Nigeria's mainstay because of its contribution of approximately 90% of export earnings and 85% of government revenue (Olujimi, 2011; Onadipe, 2010; Odulari, 2008; Atakpu, 2007).

The rest of the chapter has been divided into sections. Section 3.2 discusses the reasons why global IS may not function well in some developing Nations. Section 3.3 discusses ICT development and developing countries. Furthermore, Section 3.4 presents technological innovation in Nigerian INOCs. Section 3.5 discusses some of the challenges facing Nigerian INOCs. Section 3.6 focuses on the Nigerian industry and technology. Nigeria and ICT infrastructure are reviewed in Section 3.7. In addition, Nigeria and software development are discussed in Section 3.8. Then Section 3.9 addresses the challenges facing information systems' strategies. This is then followed by the Nigerian petroleum exploration and production companies in

Section 3.10. Similarly, Section 3.11 presents an overview of petroleum exploration and production companies in Nigeria. Section 3.12 addresses the effectiveness of information systems. Section 3.13 discusses the performance of National oil companies.

Furthermore, Section 3.15 reviews insourcing and outsourcing of information systems, while Section 3.16 addresses barriers to ICT adoption in developing countries. The chapter is concluded by Section 3.17 which sets out the conclusion.

3.2 Global IS and its impediment in some developing countries

Numerous debates and research have been conducted in the past few decades in order to examine the views of IS analysts pertaining its management and the factors affecting it (Swanson, 1998; Jiang, et al., 1996; Kumar & Bjourn-Andersen, 1990; Pinto & Prescott, 1990).

It has been confirmed and documented that legal, cultural, and socio-political differences influence the management of global information systems (Hafid, 2009; Shore, 1998; Glober, et al., 1994). With all the technological advancement in information technology and information systems, research accommodating global issues and the impact of information systems, as it affects oil companies in developing countries, is still not widely available, and factors relating to it in Nigerian INOCs is even worse and very scanty (Peterson, et al., 2002; Cash, et al., 1992). Furthermore, as this study argues, with all the importance of ICT resources in upstream and downstream operation there is a clear absence of even the stakeholders' relevant record in the field with respect to Nigerian INOCs.

There are many significant factors affecting the functions of IS in developing countries, ranging from cultural, socio-political, legal and economic factors (Alvarado, 2009) and this may be relevant to Nigerian INOCs.

3.2.1 Legal factors

Legal issues are among the barriers that impede the adoption of ICT resources in some developing countries (Peterson, et al., 2002; Abdul-Gader, 1997). These include religious teachings in some Arab countries, like Arab Gulf Countries (AGC). The challenges comprise the prohibition of pork meat, gambling and alcohol (Peterson, et al., 2002; Abdul-Gader, 1997). The negative implication this has on IS management includes difficulty in retaining some Muslim and non-Muslim IS professionals whose

expertise is essential (Abdul-Gader, 1997). According to him, weekends in some middle-eastern countries fall on Thursday and Friday, which makes it difficult to liaise and scrutinise oil companies and satellite operations. In all developed countries, weekends fall on Saturday and Sunday and this constraint affects the adoption of state-of-the-art IS as it negatively affects technical skill in some developing nations (Abdul-Gader, 1997). However, the weekend in Saudi Arabia was changed in 2013 to Friday and Saturday (Bn-AbdulAziz, 2013).

3.2.2 Cultural factors

Literature confirms that culture also has implications, which includes religion and the official language of communication (Hafid, 2009; Abdul-Gader, 1997). For instance, the language of communication in Arab countries and some African countries is Arabic, while global IS and supporting ICT resources are mostly designed in English (Hafid, 2009; Abdul-Gader, 1997). In line with this, Chadhar & Rahmati (2004) discovered that national culture has an influence on state-of-the-art IS adoption and stated that, IS initially failed in Saudi Arabia as a result of their natural culture but was successful in Australia (Kaweevisultrkul & Chun, 2007). Hafid (2009) pointed out that it is indeed extremely difficult for organisations to standardise IS in their subsidiaries which are located in different regions of a developing country having different cultures or religions. As this study argues, this could be applicable to Nigerian INOCs where northern and southern parts of the country differ significantly in terms of their respective culture and religion.

3.2.3 Socio-Political factors

These include conflict, crisis and ethnic differences that deal with instability, which is more important than the economic factor which also has an implication on IS management (Hafid, 2009; Wang, 1993). Furthermore, it is an indisputable fact that during crisis, disaster and violence, data and other ICT hardware that are in a subsidiary or Headquarters (HQ), particularly in developing countries, will definitely be affected, and so this makes the socio-political issue very important in IS management (Hafid, 2009; Wang, 1993).

3.2.4 Economic factors

Economic factors lead to scarcity of technical skill labour which has the consequence of high dependence on a foreign labour force (Hafid, 2009; Abdul Gader, 1997). They pointed out that the IS management implication is that of possible conflict between

indigenous and foreign staff on salary procedures based on citizenship. Currency value affects it as well, due to the effect of the exchange rate (Abdul Gader, 1997). He emphasised that, this has an implication on major hardware and software investment decisions.

3.3 ICT development and developing countries

Global software and hardware industries have been transformed into the largest growing industries globally (Fisher & Kenny: 2000). Boosting productivity, accuracy and saving time are the reasons why software has been analysed, designed and written (Talib & Malkawi, 2011). One may argue that the Federal Government of Nigeria has urged the INOCs to deploy local goods and services under "Local Content Policy" perhaps, without providing state-of-the-art ICT resources, training and world-class services.

In addition, software, hardware and networking devices are necessary ingredients when managing huge resources of information in any organisation (Fisher & Kenny: 2000). Invariably therefore, without getting state-of-the-art ICT infrastructure, computer operations and important business calculations and operations become difficult or almost impossible to execute (Arora, Drev & Forman, 2009).

Some underdeveloped countries recognise the real importance of ICT development and its utilization (Gouvea, 2007; Kambhampati, 2002). These countries comprise Brazil, India and Argentina, and currently they are among the countries that dominate the Software market in the world (Heeks & Nicholson, 2004; Talib & Malkawi, 2011). Countries such as India and Ireland are among the leading software exporters in the world (Kambhampati, 2002). For almost a decade, Brazil has been classified as the 7th biggest software producer and exporter in the world (Gouvea, 2007).

Furthermore, Government support in these developing countries assists the software industries and ICT companies, through establishing international partnership, in order to produce different kinds of world-class ICT resources which are demanded by indigenous companies and for exporting to other countries (Botelho, et al., 2005). One argues that this is the kind of incentive needed from the Nigerian government to encourage and sponsor computer scientists, software engineers, information technology professionals and system analysts to learn and develop different kinds of software for local consumption and exportation to other countries. As this study

argues, despite the number of developing countries, such as Brazil, India and Argentina that participated fully in software development for exportation, none of the Nigerian firms registered their presence in the exportation field seriously.

It has been confirmed that ICT is still poor in many developing countries, the effect of which has been to make the World Bank adopt internet and general ICT resources as one of the key strategies to promote the growth of small and medium enterprises (SMEs) in developing countries (UNESCAP, 1999). Similarly, (Okereke, 2008) noted that lack of awareness of the benefits and performance of modern technology is the main reason why developing countries are not making serious progress.

3.4 Technological innovation in Nigerian INOCs

Nigeria's population and its estimated 36.5 billion barrels of crude oil as well as its commitment to Africa's stability make it the largest and most influential country in Africa (Allison-Madueke, 2013; Atakpu, 2007; World Bank, 2006). Similarly, they observed that Nigeria's economy mainly depends on oil, which accounts for more than 90% of export revenues and also its contribution to gross domestic product is approximately about 41%.

Consequently, Ozigbo (2008) discussed the real need to deploy state-of-the-art ICTs to the Nigerian indigenous oil and gas sector in order to improve performance and general production, which is the backbone of our research in this project. It is emphasised that, for economic growth and social development, engaging in scientific and technological development is a compulsory factor and a necessary ingredient (World Bank, 2006).

In addition, as this study emphasised earlier, ICT does not necessarily mean hardware only, but it includes hardware, software, networking devices and mobile facilities. Nigeria's oil and gas industry needs the intervention of technological building capacity as this improves an organisation's ability to achieve its mission (Okoye, 2004).

In line with this, Ozigbo (2008) considers both Nigeria's indigenous oil and gas technological building capacity and the formulation of local content policy as to the utilisation of both the country's material and human resources and the exploration and production of hydrocarbon resources as two major challenges. Because of this, he advised the Petroleum Technology Development Fund (PTDF) to put more

emphasis on the area of state-of-the-art hardware and software deployment in Nigeria's indigenous oil and gas sector, and at the same time assist INOCs in ICT skill acquisition and implementation.

According to Energy Security (2006), China assists some of Nigeria's indigenous oil and gas companies in the area of exploration and production. However, the study did not identify and specify the names of the companies or the type of technical skill and expertise provided.

3.5 Challenges facing the Nigerian indigenous oil and gas sector

Due to the numerous challenges facing the Nigerian indigenous oil and gas sector, Iledare (2008) calls for its institutional restructuring, particularly in the area of technology, which includes state-of-the-art ICT infrastructure, supporting facilities and technical skill. This may hopefully increase the performance of the indigenous oil sector.

Akinyele (2001) identified too much dependency on imported technologies for exploration and production as the main factor delaying the progress of the Nigerian oil and gas sector. In support of this argument, Baker (2006) advocated the grooming of highly skilled indigenous experts to readdress foreign domination of the sector. He emphasised the need to consider it as an imperative to promote the sector.

Moreover, an amount estimated of approximately £6 billion is spent annually on importing hardware, software, seismic operation and engineering activities. This amount is alleged to be spent on servicing the industry and carrying its operations (Ihua, et al., 2009; Iledare, 2008). Unfortunately, despite spending this amount of money, only a limited amount is being spent within the country. The significant amount flies abroad, and indigenous companies benefit very little as the sum is almost insignificant to enable them to execute their operation efficiently in comparison with multinational oil companies, but the barriers to its adoption are not clearly identified and stated (Ihua et al., 2009). This amount is predicted and projected to reach £13 billion within the present decade if the trend continues without serious monitoring and evaluation (Business Day, 2008). As this study argues, corruption and misappropriation of funds could be the main reason for big spending without there being any significant change.

In line with this, many researchers identified this as a benefit and a reinforcement of the need for an open source software (OSS) because it reduces costs and results in less dependency on imported technical skill and technological resources (Bamiro, 2007; NACI, 2002). However this will still give room to customise software to suit the interest of the users (Anisi et al., 2010; Bamiro, 2007).

Chukwu (2002) and Akinyele (2001) discussed the problems facing the Nigerian oil and gas sector; they mentioned among others the inadequacy of state-of-the-art ICT infrastructure. Chukwudebe (2009) rated the application of Nigeria's ICT infrastructure and supporting facilities in all spheres of life as only 10% excluding airlines, banks and multinational companies. She emphasised that information must be considered as the fourth resource after labour, land and capital and if "Technology" is attached to it - "It refers to receiving information at the click of a button."

Initially, when addressing this issue of lack of development and too much dependency in the early 2000s, the Federal Government of Nigeria initiated what has been phrased as "Local Content (LC) Policy", with the main aim of enhancing and integrating indigenous oil companies' production (Ihua, et al., 2009). However, even the local content policy has been criticised as being a factor contributing to poor technological capacity and inadequate ICT resources (Aneke, 2002).

Furthermore, in the same line of argument, Oladele (2001) attributed the low quantity and quality of oil being produced by the indigenous oil companies in Nigeria, to poor training and poor managerial action. Aneke (2002) elaborated the point of low local content in Nigeria to low and poor technological capacity; inadequate infrastructure and lack of partnering between technically excellent foreign companies and indigenous ones.

However, this policy has been designed to promote and transform the indigenous companies through procuring indigenous facilities, infrastructure and human skill in order to ensure that a higher % of local indigenous companies partake seriously, actively and technically in oil production (Nwapa, 2007; Lawal, 2006). Recently, Sanusi (2011) emphasised the fact that the local oil companies produce approximately only 1% of the total oil being produced in the country. As this study argues, notwithstanding our disagreement with the production of only 1%, this clearly tells us the aim of the local content law has not been achieved.

3.6 Nigerian industry and technology

Modern industries in the world are technically classified under the concept of industrialisation and industrialised nations, which is also the product of technological and scientific advancement (Olujimi, 2011; Ukaegbu, 1991). Furthermore, Industrialisation is explained as the replacement of human energy with mechanical and electric power in production (Olujimi, 2011; Ozigbo; 2008; Ukaegbu, 1991).

In addressing the obstacles to Nigeria's industrialisation, many researchers have outlined problems such as: inferior software; old modern technology; inadequate and poor infrastructures; foreign dominance and lack of modern expertise (Ozigbo, 2008; Sullivan & Ikpeze, 1980; Adejugbe, 1979). Similarly, the metamorphosis of modern industry in advanced countries differs with its counterpart in an underdeveloped country like Nigeria, because modern industry depends on the adoption of sophisticated technological resources (Ozigbo, 2008; Adejugbe, 1979).

In addition to this, "Modern Technology" is a combination of world-class intellectual and state-of-the-art mechanical processes (Botelho et al., 2005; Wangwe, 2002; Steers, 1981). This is what characterised multinational oil companies, contrary to their indigenous counterparts in Nigeria as argued by this study. Talib and Malkawi (2011) and Turner (1980) documented some procedures adopted by multinational oil companies which assist them to dominate oil exploration. These strategies include: only strong oil companies can afford essential and modern oil exploration facilities; strong IOCs can bear the danger of oil exploration; and only big and strong companies have enough wherewithal for exploration, which includes state-of-the-art ICT resources (Fisher and Kenny: 2000; Ukaegbu, 1991; Tanzer, 1980). Meanwhile, this study argues that some indigenous oil companies such as Petronas of Malaysia and Saudi Aramco have attained a relative international standard.

Unfortunately, Nigerian INOCs have been described as having a lack of world-class skill and expertise for exploration and production (Nwapa, 2007; Ukaegbu, 1991). As a result, Idemudia (2007) emphasised the need for Nigerian INOCs to join the trend of globalisation. However, based on this evidence, INOCs may not reach the level of multinational counterparts, but with the adoption of state-of-the-art ICTs and technical skill, they may reduce the gap and make substantial progress in quality and quantity of oil being produced as this study argues.

3.7 Nigeria and ICT infrastructure

Nigeria as a country has started realising that ICT is the mainstay for its survival as a country. And it has confirmed its backwardness and that of indigenous companies in this field. As a result, in the year 2000, the Federal Government of Nigeria (FGN) enacted its "National Policy for Information Technology (NPIT)" with the sole aim of making Nigeria one of the key players in ICT in the next 15 years. The objectives include: to encourage the development of ICT infrastructure and maximise its utilisation nationwide; to improve national development through ICT; to provide solutions to challenges to the information age; to train and encourage its citizens economically and intellectually to partake in software development; to motivate the production of state-of-the-art indigenous ICT facilities; and empower the youth through developing their ICT skills (National IT Policy, 2000). Looking at the policy's objectives confirms that the country recognises its underdevelopment in ICT with respect to its indigenous companies, agencies, hospitals and educational institutions.

Furthermore, lack of awareness of the benefits of modern technology has been identified as a reason why developing countries are not making serious progress (Okereke, 2008; Lenhard, 2004, Talib & Malkawi, 2011). One may argue that this may be applicable to INOCs in Nigeria.

However, an abundance of oil and gas reserves and a large population puts Nigeria in a good place to become an influential country in Africa. Similarly, Nigeria's economy mainly depends on oil, which accounts for more than 90% of export revenues, and its contribution to gross domestic product is about 41% (Atakpu, 2007;World Bank, 2006). As this study argues, this necessitates a huge effort to improve and sustain the country's oil sector.

3.8 Nigeria and software development

Nigeria's software sector is an industry which has been disappointingly relegated and neglected in the country as examined by Soriyan and Heeks (2004). They emphasised that there are virtually 100 privately-owned software industries mostly around the South-West; and they were mostly small in size. Only 16% of Nigeria's software industries partake in local package development which is used in some industries, institutions and companies (Soriyan & Heeks, 2004). In addition, in order to motivate software production, Heeks (1999) designed five strategic positions for developing countries that can be occupied by software industries.

Additionally, the Computer Professionals Council of Nigeria CPCN (2011) discussed the problems facing the software industry in the country and agreed that; national security is undermined by an over-dependence on foreign software products; and the country has the expertise to manufacture software for exportation and provide job creation for thousands of youths and it will definitely boost the economy of the country. On the contrary, as this study argues, Nigerian ICT experts and computer scientists residing in the country may not have enough expertise for the production of state-of-the-art upstream software.

Furthermore, as a way out of Nigeria's software industry, CPCN (2011) advised that the private industries should invest in indigenous software. They observed that the government and its ministries must encourage and patronise local software industries and the country's youth must be intellectually trained and subsequently involved in an effort to promote this industry.

In addition, the CPCN (2011) addressed the challenges of oil and gas and ICT deployment during its 2011 Assembly. They outlined the lack of commitment from the Nigerian Content Development Board after more than two years of its establishment to develop local ICT industry and the fact that Nigeria depends on the IOCs and foreign contractors for about 95% of its functions and activities. Soriyan *et al.,* (2001), identified methodological development must be an understanding of the existing practices and problems in IS Development in Nigeria.

3.9 Challenges facing information systems' strategies

The study reviews and evaluates some challenges facing the management of different types of IS used by oil companies, and the critical issues affecting the strategy of IS of oil companies in Nigeria. Companies that deal with exploration and production are divided into two: multinational oil companies, which have international coverage; and the local oil companies, or indigenous; which are locally based (Adeniyi, 2013; Blackherald, 2011; Okorie, 2005).

Information systems strategists had faced the challenge of internationalization, in the last few decades, as has been observed by researchers and designers (Abdul-Gader, 1997; Cash, et al., 1992). In the past, research dealing with issues affecting IS and ICT globally was very scanty (Cash et al., 1992; McFarlan, McKennedy & Applegate, 1992). The challenge was higher when it came to IS global issues of multinational companies (MNCS) in developing countries such as Arab Gulf Countries (Abdul-

Gader, 1997). As this study argues, the challenge could be more significant in Nigerian INOCs.

Similarly, this brought about the Global Information System for MNCs, or globalising IS (Okorie, 2005; Abdul-Gader, 1997). They stated that, it is an attempt to find a direction for oil companies, with regards to IS professionals to perform their functions during exploration and production.

According to Abdul-Gader (1997), global Information Strategists outlined two challenges to these issues: (i) the challenges of global Information Systems operations; and (ii) the focus in which recommended solutions are being developed. In support of this argument, Badri (1992) and Awad (1985) enunciated that IS adoption is very essential and a vital resource for any organisation which must be analysed and managed with all seriousness. They emphasised that planning and control of IS and its supporting facilities have increasingly advanced in the past few decades, considering the amount of resources that are committed to it over a long period of time.

Experts in the field of systems analysis and design observed that, IS in the modern world depends on two things; these are "Technology" and "Environment" (Badri, 1992; Wetherbe, 1984). Because of this assertion, periodic assessment and maintenance of issues relating to IS adoption is essential (Wetherbe, 1984). Further, rapid advancement of IS in industries and companies in the United States of America (USA) during the past four decades has brought about the need to examine and evaluate the IS phenomena in other societies with different technological history and advancement (Porter, 1986).

Badri (1992) advanced the research by evaluating and examining IS in six member countries of the Gulf Cooperation Council (GCC) - Saudi Arabia, Kuwait, Qatar, Bahrain, Oman and the United Arab Emirates. In addition, differences between these countries and the USA were critically examined, investigated and analysed. In each and every organisation, research on critical issues of IS had been conducted. Further, during a conference in 1983, at the University of Minnesota, organisers and participants were requested to formulate critical issues in IS, and finally they reached a consensus on just how essential they are (Dickson, et al., 1984).

Furthermore, the critical issues relating to IS require better awareness and enlightenment, as a result of their impact on companies, institutions and

organisations (Brancheau & Wetherbe, 1987). The study on IS has been on-going over a period of time. Ball and Harris (1982) surveyed the Society of Information Management (SIM) members and requested their input on the importance of some issues concerning IS, including, "MIS long-range planning and integration, gauging MIS effectiveness, the impact of communications on IS, the developing role of the information resource manager, and decision support systems." Six years later after the research of Ball and Harris (1982), four issues relating to Information Systems were identified and analysed, these are "IS technology organisation issues, multinational IS issues, Organizational issues in IS development and planning issues in IS" (Cash, et al.,1988).

Similarly, Hartog and Herbert (1985) surveyed MIS managers of fortune 1000 companies throughout the USA. The issues they addressed included Software development and productivity. While Martin (1982) conducted a research in the form of question and answer format, in which he requested the Information Systems chief executives to write down what they perceived as critical issues in the field, which was coined as "Critical Success Factors" (CSF). The next round of the question and answer session was followed by summarising and returning it to the same officers for "Review and Change". All of this research was carried out because information is a vital resource which must be managed and administered critically (Awad, 1985).

An international perspective of comparative analysis which accommodates the Gulf Cooperation Council of six countries was conducted and finally recommended the need to prioritise Information Systems Management (Badri, 1992).

3.10 Nigeria's history of oil and gas in the colonial era

Hopkins (1976) advised Africans (what he called Africanists) to study imperial business as an important aspect of colonial rule as an extension of American and European business history and culture. Since then, many researchers have responded to this advice by publishing a substantial number of journal articles. Similarly, the area that remains not properly addressed is the history and origin of oil exploration and production in colonial Africa, Nigeria inclusive (Steyn, 2006).

In addition, Carland (1985) studied oil exploration in colonial Nigeria, restricting his area to the relationship that exists between Colonial Office and Nigeria Bitumen Corporation, from 1906 to 1914. In line with this, Njeze (1978) has given more emphasis on the Captain Edward Algernon Barnett's case which occurred in 1907

and the legislative power of oil production in 1907, 1914 and 1916, and subsequently dealt with other activities that are related to exploration ranging from 1906 to 1958.

Further, Steyn (2006) has contributed immensely to the history of oil and gas in Nigeria by analysing the exploration of oil in the colonial era between 1903 and 1958 when the pioneer shipment of the country's crude oil arrived in Rotterdam. Likewise he utilised the archival collection available at the British National Archives, the Nigerian National Archives and many other archives attached to the two countries or oil industries.

Meanwhile, despite the fact that Britain depended on importing oil for their consumption, the British government couldn't make any significant effort to explore or encourage the exploration of oil and gas in the country. Only a private British oil venture started making an effort to discover the potential area of exploration between 1903 and 1914 (Steyn, 2006).

Similarly, small oil companies lacked the resources, expertise and technological resources to start the exploration in the environment which was full of challenges. For instance, it took Shell/D'Arcy joint venture almost 15 years and millions of pounds before discovering a commercially exploitable amount in the country by 1956 (Steyn, 2006).

3.10.1 Background of oil exploration and bitumen in Nigeria's colonial era

During the colonial era in Nigeria and most African countries, some advanced countries have advanced immensely in the field of exploration of oil. Still, at that time, demand was much higher than supply because technological advancement and innovations had brought about new progress for crude oil and its products (Steyn, 2006). With the emergence of natural gas as the means of illumination, the market of kerosene reduced dramatically. Kerosene constituted almost 25% of all the crude oil products, while fuel oil and petroleum amounted to almost 64% by 1914. However, the former dropped dramatically in the subsequent decades (Steyn, 2006; Clark, 1958).

According to the American Association of Petroleum (2008), searching for oil in Nigeria started formally and officially by 1903 when two oil companies, "the Nigeria and West African Development Syndicate (Limited)" and "Nigeria Properties (Limited)" started their exploration for oil, coal and bitumen. The two companies

dominated a territory of 400m^2 in the Agbabu-Mulekangbo area in the Lekki Lagoon region of the Southern part of the country.

Steyn (2006) has enunciated that, exploration in the company witnessed a giant effort by a British businessman named, John Simon Bergheim when he became interested in oil exploration in colonial Nigeria in 1905. He emphasised that this happened at a time when the majority of British oil investors were mainly in America and Europe. He then later established the first oil company that would partake in exploration for crude oil and bitumen in the Southern part of Nigeria. In November 1905, the Nigeria Bitumen Corporation was established with the objective of acquiring and working with the concession of the "Nigeria and West African Development Syndicate" and "Nigeria Properties". This area of concession was expanded in November 1906 when the company purchased the concession of the Northern Nigeria Syndicate which was located in the Lekki Lagoon area, adjacent to the concessionary field of Nigeria Bitumen.

According to Njeze (1978), Nigeria Bitumen was a German company working in Nigeria. Furthermore, this claim or assertion was debunked by Steyn (2006), testifying that the company was a British-registered company and the West African Market of the stock exchange was the one managing its shares in London. Operations with Nigeria Bitumen started in 1906, which had a great negative effect on the local environment of Lekki Lagoon, because a substantial amount of land was evacuated and it caused serious water and air pollution. The site also served as the headquarters for their operations (Steyn, 2006).

3.10.2 The concept of contracts and licenses in the Nigerian oil and gas sector

In Nigeria, the only and earliest way of forming contracts between 1908 and 1969 was concessions (Olisa, 2001). And it was in the same year, 1969 that concessions were replaced with participation agreements through Joint Operating Agreement and Joint Venture as it was officially titled as an Isolated Case of Service Contract (Umar, 2005). It was introduced in July 1859 at Titusville, Pennsylvania, USA when Colonel Edwin Drake received the rights of mining for only 15 years with the possibility of renewal for the same years (Umar, 2005; Olisa, 2001).

Concession has been defined as the granting of exclusive mining rights to a concessionaire, mostly spanning a large expanse of a specific and allocated contract field or area under a long agreement of mostly not less than 20 years, although

sometimes it reaches 99 years (Olisa, 2001; Gidado, 1993). Similarly, the Concessionaire pays the oil country a substantial share of the project's economic gains and a small amount of land tax. The concessionaire takes responsibility for all the costs and the risks of exploring the field and controls or/and exercises the rights of the legitimate and legal owner of the exploitable minerals (Umar, 2005; Gidado, 1993). This is indeed one of the concepts that affect Nigerian INOCs.

Besides concession, there are two other petroleum arrangements in the Nigerian upstream oil and gas sector. These are joint ventures and production sharing contracts (Biobaku & co, 2008). They explained that joint ventures which are usually used between the International oil companies and the federal government of Nigeria whereby both parties contribute a proportional amount of funding for the exploration, production and development of oil, and the hydrocarbons produced from the parties' funding are being shared according to the proportion of their respective funding. Furthermore, production sharing contracts is a situation where NNPC employs the IOCs or local investors as contractors for the exploration and production operations on its behalf. (Biobaku & co, 2008; Umar, 2005; Gidado, 1993).

3.10.3 The historical background of the Nigerian oil and gas sector from 1956

History has enunciated and confirmed that oil and gas operations for commercial benefits started effectively in 1956 in the southern part of Nigeria (Ntido, 2011). He emphasised that it was then that oil was first discovered in commercial quantities in a place called Oloibiri, which is now located in the Bayelsa State in Nigeria. The village, Oloibiri, is about 95 kilometres west of Port Harcourt where exports started in 1958 two years later (PENGASSAN, 2012; Ntido, 2011). Shell D'Arcy started the commercial activities of oil and gas in the same year. From November 1938, the whole country was dominated by concession enabling Shell D'Arcy to continue their exploration for petroleum. This monopoly of Shell in the Country continued for almost two decades, until the country became a member of the Organization of Petroleum Exporting Countries (OPEC) in 1971. There and then the country started to take the overall dominance of its oil and gas resources, because this is the policy of OPEC Countries. Furthermore, it was the decade that witnessed the establishment of the National Oil Companies (NOCs) across OPEC Countries. In the other OPEC Member countries, the NOCs control the production operations. While in Nigeria, the Multinational Oil Companies (MNOCs) were approved and permitted to continue with the operations under Joint Operating Agreements (JOA), which clearly

established and indicated the role of respective stakeholders, which included the Government of Nigeria and the companies (Ntido, 2011; Pengassan, 2012).

Meanwhile, this span of time witnessed the establishment of the other MNOCs such as Gulf Oil and Texaco (now known as ChevronTexaco), Mobil (Now, ExxonMobil), Elf Petroleum (Now Total) and Agip, which came into existence after Shell, which had earlier dominated the industry. Today, these companies play a major role in oil production in Nigeria, with Shell alone producing almost 50% of total daily production in the industry, which is about 2.4 million barrels per day. Similarly, JOAs dominated the production of oil and gas in the country, accounting for approximately 90% of total production (Obasi, 2003).

3.11 Petroleum Exploration & Production companies in Nigeria

This section identifies the various indigenous petroleum and exploration (E&P) companies that are found in Nigeria. Similarly, the list accommodates only exploration and production indigenous oil and gas companies that partake in upstream operations.

Previously, the United Nations Environmental Programme UNEP (1997) stated that the oil and gas industry is technically categorised into two main sectors: "upstream"- which deals with the exploration and production of the industry; and "downstream"- which deals with refining and processing of crude oil and gas products as well as their distribution and marketing. Companies operating in the industry may be regarded as fully integrated, (i.e. have both upstream and downstream interests), or may concentrate on a particular sector, such as exploration and production, commonly known as an E&P company, or just on refining and marketing (a R&M company). Many large companies operate globally and are described as "multinationals" whilst other smaller companies concentrate in one country or continent, and are called indigenous, local or independent oil companies (Adeniyi, 2013; UNEP, 1997).

In addition, Adeniyi (2013) and UNEP (1997) stated that, in a global setting, exploration and production started fully around 1912 when experts were requested to discover and crush fields of Oklahoma in the United States of America (USA). However, the basic process remains unchanged, but with technological advancement in hardware, software and modern engineering, the accuracy and precision increased, because the new modern and sophisticated resources were developed for

that purpose. Owen (1975) pointed out that exploration and production technology has increased significantly since the first commercial oil well in the United States was drilled adjacent to an oil seep in 1859. Since then, many countries immediately followed the US in advancing their exploration technology including Nigeria. Consequently, since this study deals with INOCs in Nigeria, the names of the exploration and production companies and their ownership categories found in the country are listed and discussed in the next sub-sections.

3.11.1 Nigerian INOCs and marginal fields' operators and their ownership categories

There are many registered indigenous oil companies (INOCs) in Nigeria. As of 2013, there are 49 INOCs as well as 28 marginal fields' operators operating in Nigeria. However, they are both classified under indigenous oil companies. There is NPDC which is owned by the Federal Government of Nigeria. In contrast, the majority of them are owned by influential Nigerians who have cordial relations with the government and also indicated their interest in the art of exploration (Blackherald, 2012; Biobaku & co, 2008).

The Nigerian constitution provides that all mineral oils and natural gas belong to the Federation's government. The petroleum act provides three categories of licenses for upstream operations: i) oil mining lease (OML); ii) oil exploration licence (OEL); and iii) oil prospecting licence (Biobaku & Co, 2008). He emphasised that only Nigeria's citizens and companies incorporated in the country can be approved and granted an OML and OPL or be permitted to hold any interest in the license.

3.11.1.1 Differences of two types of indigenous oil companies and their production

There are two different types of indigenous oil companies in Nigeria (Adetoba, 2012; Offia, 2011). These are indigenous independent oil companies and marginal fields' operators. The indigenous independent oil companies are the major indigenous operators, while the latter are also called operators or minor operators (Adeniyi, 2013). As a result, oil prospecting licence (OPL) of oil blocks is granted to the major indigenous companies. The smaller operators are only granted with oil mining licence (OML). The differences between them can be summarised in Table 3.0.

Table 3.0: Differences between the two types of INOCs

	Indigenous oil companies	Marginal Field operators
1	Awarded with full oil blocks	Awarded with only maginal fields
2	They are the holders of oil prospecting licence (OPL) which has been described as the best for exploration and production	They are the holders of oil mining licence (OML) Which is the inferior in exploration and production.
3	They are allowed to have full scale production of up to 125, 828 bpd or more.	They are allowed to produce a maximum of 10,000 barrels per day.
4	Not long distance from existing production facilities.	Long distance from existing production facilities.
5	They are full-fledge companies.	They are not full-fledge companies, but are termed as companies or operators.

(Adetoba, 2012; Offia, 2011 with a modification)

Unfortunately, according to Adeniyi (2013), all the two types of INOCs perform below expectations considering their total number as well as the target that had been set by the Federal Government of Nigeria (FGN). For example, in 2012, 2.48 million barrels per day (mbpd) were produced (Allison-Madueke, 2013; Shosanya, 2013). They observed that, out of this, the collective production by all the type of INOCs totalled only 276, 040 bpd, which is approximately 11% of the total oil production in the country. Furthermore, the major production was achieved by the IOCs, like Shell. Additionally, Shell Production Development Company (SPDC) produced 605, 539 bpd, while Mobil Producing Nigeria Unlimited (Exxon Mobil) produced 528, 000 bpd. Then Chevron Nigeria produced 489, 999 bpd, while Total Elf produced 400, 134 bpd. In addition, Agip produced 98, 287 bpd, and finally Addax produced 90, 489 bpd. As this study argues, the significant production of the IOCs could be as a result of many factors, including the state-of-the-art IS deployed and adopted for exploration and production operations.

In comparison, INOCs led by the exploration and production arm of NNPC of the Nigerian government, i.e. Nigerian Petroleum Development Company (NPDC), produced only 125, 828 bpd in 2012, followed by Seplat Petroleum which produced 40, 033 bpd, while Pan Ocean produced 7, 387 bpd and all the remaining local oil companies produced 102, 797 bpd. Similarly, the only significant production came from the NPDC, Seplat Petroleum and Pan Ocean (Shosanya, 2013; Adeniyi, 2013).

Table 3.1: The List of Indigenous Oil Companies

No	Name of Company	Year of Award	Licence
1	Alfred James Petroleum	1991	OPL 302
2	Alfren Global Resources		
3	Allied Energy Resources Nigeria Ltd	2001	OPL 120 & 121
4	Amni International Petroleum	1998 & 1999	OPL 112 & 117
5	Ashbert	2005	OPL 325
6	Atlas Petroleum Int. Nigeria Ltd	1996	OPL 109
7	Cavendish Petroleum Nig Ltd	1996	OPL 110
8	Cleanwater Consortium	2007	OPL 289
9	Consolidated Oil	1993, 1998 & 2006	OPL 103, 458 & 136
10	Continental Oil & Gas Limited	1998	OPL 59
11	Centrica/CCC/All Bright Consortium	2005 & 2006	OPL 276 & 283
12	Dajo Oil Limited	2004	OPL 320
13	Dubril Oil Co Nigeria	1987	OPL 96
14	Emerald Energy Resources	2001	OPL 141
15	Enageed Resources Limited	2007	OPL 274
16	Ekcrest E&P Limited	2012	OPL 40
17	Express Petroleum	1995	OPL 108 & 1995
18	Famfo Oil Limited	1993	OPL 216

19	First Hydrocarbon	2011	OPL 26
20	Gas Transmission & Power Ltd	2005	OPL 905
21	Global Energy Company Limited	2005	OPL 2010
22	Malabu		OPL 245
23	MoniPulo	1999,2008 & 2009	OPL 114, 239, 234 & 231
24	Neconde	2011	OPL 26
25	Niger Delta Western	2012	OPL 34
26	NorthEast Petroleum	1991	OPL 215, 840 & 902
27	New Nigeria Development Company		OPL 733, 809, 810 & 722
28	Oando	2005, 2006	OPL 278, 236
29	Optimum petroleum	1992	OPL 310
30	Oil and Gas Limited	2003, 2004	OPL 249 & 140
31	Oranto Petroleum Limited	2002	OPL 320
32	Orient Energy		OPL 915, 916
33	Oriental Energy Resources	1999	OPL 115
34	Pan Ocean	1976, 2007	OPL 98, 275
35	Peak Petroleum	2001	OPL 122
36	Sahara Energy Exploration	2005, 2006	OPL 284, 228, 332
37	Soglas Nigeria Limited	1991	OPL 226
38	South Atlantic (SAPETRO)	1998	OPL 264, 130
39	Starcrest, Cross River Energy & NPDC	2011	OPL 242

40	Seplat	2010	OPL 4, 38, 41
41	Starcrest		OPL 291
42	Summit Oil Nigeria Limited	1990	OPL 205, 206
43	Sunlink Petroleum	1993	OPL 238, 311
44	Tenoil Petroleum Energy Services	2007	OPL 208,
45	Transcorp	2011	OPL 281
46	Crownwell Petroleum Ltd	1993	OPL 305, 306
47	Oil World	2007	OPL 241
48	Yinka Folawiyo Petroleum Company	1998	OPL 113
49	Zebbra Energy Limited	2004	OPL 248

(Adeniyi, 2013; Blackherald, 2011).

Table 3.2: The List of Marginal Field Operators in Nigeria

S/NO	Name of Company	Year of Award	Licence
1	All Grace Energy		Ubima (OML 46)
2	Associated Oil & Dansaki Petroleum		Tom Shot Bank (OML 14)
3	Bayelsa Oil Company		Atala (OML 46)
4	Bicta Energy		Ogedeh (OML 90)
5	Brittania U-Nigeria		Ajapa (OML 90)
6	Chorus Energy		Amoji (OML 56)
7	Del Sigma		KE (OML 55)
8	Energia Limited & Oando Production Devt Company		Ebendo/Obodeti (OML 56)
9	Euraftic Energy Limited		Dawes Inland (OML 55)
10	Excel Exploration & Production	2003	Eremor (OML 46)

11	Frontier Oil Limited	2003	Uquo (OML 13)
12	Green Energy & African Oil Ltd		Otakikpo
13	Independent Energy Limited	2003	Ofa (OML 55)
14	Midwestern Oil & Gas Suntrust Oil		Umsadege (OML 56)
15	Millennium Oil and Gas	2003	Oza (OML 11)
16	Movideo Exploration & Production	2003	Ekeh (OML 88)
17	Network Exploration & Production	2003	Qua Iboe (OML 13)
18	Niger Delta Company	1999	Ogbele (OML 54)
19	Oriental Energy	2006, 2007	Owok (OML 67)
20	Pillar Oil Company	2003	Umusati/Igbuku (OML 56)
21	Prime Petroleum Ltd & Suffort Petroleum	2003	Asaramaroru (OML 11)
22	Sahara Energy & African Oil Ltd	2003	Tsekelewe (OML 40)
23	Sogenal Ltd	2003	Akepo (OML 90)
24	Goland Petroleum Development	2003	Oriri (OML 46)
25	Universal Energy	2003	Stubb Creek Field (OML 13/14)
26	Waltersmith Petroleum & Morris Petroleum		Ibigwe (OML 16)
27	Platform Petroleum Limited		Egboma (OML 38)
28	Guarantee Petroleum & Owena Oil	2003	Ororo (OML 95)

(Adeniyi, 2013; Adetoba, 2012; Offia, 2011; Blackherald, 2011)

3.11.1.2 Oil production of oil companies in Nigeria

According to a report by Adeniyi (2013), out of the 31 marginal oil fields awarded by the Federal Government of Nigeria in 2003 to local operators, only 8 of them are producing as of 2012. Furthermore, the data indicated that the marginal fields operated by Nigerian INOCs produced only a 1.8% share of Nigeria's total production, while approximately 93% is produced by IOCs and the remaining 5.2% is produced by the 49 major indigenous independent oil companies. However, as this study argues, based on the available data, the individual percentage fluctuates by increasing or decreasing from time to time without any significant change.

Many researchers have acknowledged the delay of some oil companies in procuring world-class upstream ICT hardware over the last few decades and there is urgent need to intensify efforts towards that (Cassian, 2007; Dorn, 2002). Perhaps, and this study argues, it may be aptly applicable to Nigerian INOCs.

3.12 Effectiveness of information systems

Different resources of IS are being adopted in the discovery, exploration and production of oil and gas reserves. However, the different resources are somehow similar in the operation process, but this research gives more emphasis on the stages of E&P as they affect Nigeria.

This section focuses more on the effectiveness of IS, particularly as regards exploration and production of oil and gas reserves; because over 50 IS experts have confirmed the ranking of information systems software and the effectiveness of its supporting facilities as the fifth most important IS issue (Delone & Mclean, 1992).

3.12.1 Information systems strategy

IS strategy is fundamental to IS research and practice. The main purpose of adopting IS strategy is to attain an effective and efficient delivery of information that organisations require when conducting their activities (Pollack, 2010; Chan & Reich, 2007; Melville et al., 2004; Ward & Peppard, 2002). Similarly, this study argues that, literature and personal contacts reveal otherwise with respect to Nigerian indigenous oil companies (INOCs).

Over the years, many international organisations have made an effort in the direction of IS strategy (Ward & Peppard, 2002; Chan & Reich, 2007). However, the concept of IS strategy is not well understood by various researchers (Pollack, 2010; Melville et al, 2004). IS strategy is explained as "an organisational perspective on the investment in, deployment, use, and management of information systems" (Chen et al., 2010 pp. 9).

In addition, the IS of an organisation comprises of information and technology infrastructure, application systems, data and personnel that technically manipulate information and telecommunication resources to deliver information and communications services in an organisation (Chen et al., 2010; Davis, 2000). In other words, management of the organisational function in charge of the designing,

planning, developing, implementation and operation of the system and the rendering of services can also be referred to as IS (Chen, et al., 2010).

It is essential to note that the concept of IS comprises both the human activities and the technical components within the organisation, and explains the process of managing the organisational informational system's life cycle (Avgerou & McGrath, 2007). As a result, spending on IS adoption and maintenance represents a substantial amount of an organisation's annual budgets (Cone, 2005).

It is because of the paramount importance of IS that its strategy becomes a primary responsibility for technical experts and management in any organisation. As a result, IS alignment continues to be a huge challenge to IS managers and other organisational executives (Luftman & Kempaiah, 2008; Armstrong & Sambamurthy, 1999; Chan et al., 1997; Brancheau et al., 1996; Earl, 1993). Due to overwhelming evidence about the importance of IS to organisations, understanding its strategic value has tremendously drawn the attention and interest of IS researchers who have established various investigations in this area for more than three decades (Luftman et al., 2006; McGee et al., 2005; Galliers, 1993). After their research, three streams of closely related areas have subsequently emerged. These are "alignment between IS strategy and business strategy", "strategic information systems planning" and "competitive use of IS or using IS for competitive advantage" (Chan & Reich, 2007; Piccoli & Ives, 2005; Hulland, 2004; Melville et al., 2004; Ward & Peppard, 2002; Galliers, 1991). In fact, they all centred on the key concept of IS strategy (Luftman & Kempaiah, 2008; Piccoli & Ives, 2005; Melville et al, 2004).

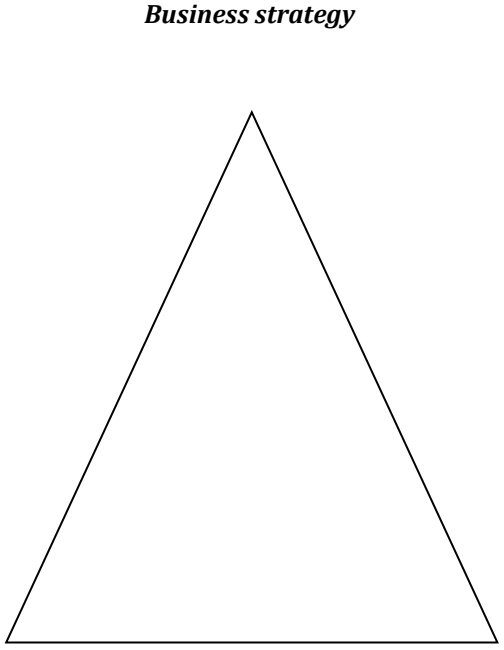
Notwithstanding this position and the importance of IS strategy in practice and research, review of relevant literature expounds that the concept of IS strategy is a term that is mostly used but not fully understood among the three streams explained earlier (Chen, 2010). Some examples suggest that it is not clear whether IS strategy is an independent strategy within an organisation (Henderson & Venkatraman, 1999), or if it should be defined through its relation to business strategy (Chan et al., 1997). Consequently, some researchers argued that, IS strategy is a project which is planned by management in advance (Chan et al., 1997) while other researchers believe that IS strategy can emerge just as a pattern (Ciborra, 2004). Some researchers argue that, IS strategy can both emerge without planning or be planned in advance (Benner & Tushman, 2003). One argues that, looking at the concept of IS and its diversification,

it could be concluded that all these areas and perspectives have been included in the field of IS strategy.

Today, IS serves as an integral part of many organisations in their transformations (Pollack, 2010; Melville et al, 2004). They emphasised that, success mostly occurs when organisational planning and IS are integrated together, and this can be achieved when general and technical managers of an organisation perform their functions collaboratively. The strategic IS planning is articulated to ensure that technology activities are technically joined together with the needs and strategies of an organisation (Pollack, 2010; Luftman et al., 2006). IS strategy should always support and push an organisation's business strategy. (Galliers, 2004; Ciborra, 2004).

3.12.2 Information systems strategy triangle

IS strategy triangle is a framework that assists an organisation to clarify the importance and necessity of IS (Pearson & Saunders, 2010; Pollack, 2010). They argued that, the signal conveyed by the IS strategy triangle is that all the three main elements of the triangle are business, organisational and IS strategies which work together and complement each other harmoniously.



The information Systems Strategy Triangle partially adapted from (Pearson & Saunders, 2010).

The three main elements of the triangle are as follows:

i. Business strategy which accommodates the mission of the organisation as well as the set of related actions that fulfil the purpose, objectives and goals and expound how to achieve their vision;
ii. Organisational strategy which accommodates people, structure, work processes, plans and hiring practices that motivate and assist with the achievement of business goals; and
iii. IS strategy is the platform that an organisation employs in providing useful information services (Pearson & Saunders, 2010; Pollack, 2010).

Strategic IS planning was initially the function of systems professionals, but it has now been completely changed by becoming a general challenge to top managers, systems professionals, business unit managers and even external stakeholders, such as alliance partners (Pollack, 2010; Ruohonen, 1996). They elaborated that the planning of state-of-the-art IS strategy is a complete partnership between those with technical expertise and skills. They IS triangular strategy has been cafefully chosen to be adopted in this study of local oil companies as suggested by other researchers (Pollack, 2010).

3.12.2.1 Justification for the use of triangular strategy model

Triangular strategy model has been used in this study because of its compatibility and suitability (Pearlson & Saunders, 2010; Porter, 1985). The areas that the study examined, and subsequently accepted the suitability of the model to this research are: the business mission of the Nigerian INOCs; the scope of their production; and their geographical location and limit.

Furthermore, with regard to the mission of Nigerian INOCs, they are established with the primary aim of engaging in commercial activities in order to generate monetary resources for the owners (Hartley *et al.,* Victor, 2007). Similarly, triangular strategy model gives more emphasis to business strategy, because organisational strategy and the IS strategy are always working towards the achievement of business strategy (Pearlson & Saunders, 2010; Porter, 1985). As a result, business strategy of the model is a well-defined mission and vision in which a business tries to move forward and how it strategies to move forward. One may

argue, there is need for this effort in the Nigerian INOCs so as to achieve their vision and mission of generating profit.

In addition, triangular strategy has also been chosen because of the recommendation of other researchers (Pearlson and Saunders, 2010; Porter, 1985). The researchers stated the suitability of information strategy triangular to national/local oil and gas sector.

The scope of the companies is another issue that has been taken into consideration (Shosanya, 2013). There are other models that are available for oil companies. For example, IS value chain model, IS shareholder value model and IS unlimited resources model and IS corporate model (Pearlson and Saunders, 2010; Porters). However, most of the models mentioned, are more suitable to international companies. In the constrast, Nigerian INOCs are currently and mostly operating within Nigeria only (Adeniyi, 2013). Hence the use of triangular strategy model in this study.

3.13 On performance of National oil companies

Relevant literature addressing the performance of national, independent or local oil companies is limited indeed. However, they control over 79% of global oil reserves and account for over 72% of total production (Adeniyi, 2013; Victor, 2007; World Bank, 2006). However, they described the National oil companies with low performance, because they explore and produce oil far less than International oil companies (IOCs). However, most of the oil and gas reserves under national or independent oil companies controlled are considered as "dead", very few of them like Saudi Aramco, ADNOC and KPC perform effectively and efficiently.

In addition, according to Hartley *et al.,* (2007) and Victor (2007) different missions made the evaluation of national oil companies' performance very difficult. Their missions include: "commercial purpose;" and "national purpose." They noted that this makes their goals differ to a certain extent. They emphasised their assertion that, non-profit directives which the government issues to the national oil companies have a serious negative impact, which includes providing infrastructure for public use, creating unnecessary employment opportunities and political gesture.

3.13.1 Determining performance based on market capitalisation

Market value or market capitalisation is directly proportional to companies' performance, while performance is a product of many functions which include the type of ICT resources deployed by a company (Victor, 2007; World Bank, 2006). Market value or market capitalisation of oil and gas companies is determined and calculated mathematically by multiplying the number of outstanding shares of a given company by the present or current market price of one commodity share (Victor, 2007; World Bank, 2006). Similarly, it is directly related to the financial performance of a company, its production and reserves.

In the oil and gas sector, market capitalisation of companies that hold bigger reserves is higher, with an exception of Russian companies (Victor, 2007) because Russian oil industries' performance is greatly affected by political factors rather than excellent managerial decisions and efforts, and this keeps inventors and partners looking for economic gains away from them (Hartley & Medlock, 2007; Victor, 2007). Additionally, most indigenous and national oil companies are making enormous efforts to increase their performance through making their market capitalisation higher by deploying the state-of-the-art ICT resources and engaging exceptional professionals in different sectors of oil and gas exploration and production (Hartley & Medlock, 2007; Victor, 2007).

However, market capitalisation has been described as an imperfect indicator for measuring performance in many independent and indigenous oil companies (Nwokeji, 2007). This is due to the fact that the shares of many NOCs, particularly in the Middle East are not publicly and openly traded and marketed, and in some cases their reserves are overestimated (Victor, 2007).

3.13.2 Reserves and oil production between MNOCs and INOCs

Relevant literature suggests that, MNOCs and IOCs are two different names that mean the same thing when describing the oil companies that operate globally or internationally. The names refer to the non-state-owned oil and gas companies that operate all over the world. While national and (INOCs), local oil companies (LOCs) and independent oil companies (INDOCs) are related and almost the same to some extent as this study argues. They are the same in the sense that they operate within a national context, but they sometimes differ in ownership. All National oil Companies (NOCs) are owned by the government, while Local/Indigenous/independent Oil

Companies (LOCs/INOCs) are mostly owned by individual citizens of a country that engage in the art of exploration and production within their country. Based on this background, we can arguably say that all NOCs are LOCs, while not all LOCs are NOCs. However, our study accommodates both of them as INOCs.

Consequently, over 79% of the proven oil and gas companies in the world are owned by NOCs/INOCs (Victor, 2007). In 2007, the 10 largest and/or biggest upstream companies measured by reserves were all NOCs, and the largest IOCs by reserves was number 12 in the hierarchy, and this was ExxonMobil (Victor, 2007). However, in the same year, Nwokeji (2007) stated that, approximately 77% of proven oil and gas reserves are under the control of NOCs. Furthermore, some years back in 2004, oil reserves worldwide showed that NOCs controlled approximately 75%; Major IOCs (BP, ExxonMobil, Total, Royal Dutch Shell and Chevron) controlled 4% while other IOCs controlled 21% (BP, 2007; Energy intelligence Top 100, 2006). This indicates that NOCs/INOCs and their various governments in different countries mostly control the production of oil and gas resources upstream, and still their percentage is increasing considering the trend of events. Similarly, because of the interference of various governments with political agendas and local interests, this tends to have negative effects on the managerial decisions and investment in NOCs. Today, NOCs/INOCs are described as having poor staffing, poor performance and inefficient investment (Victor, 2007). As this study argues, there is a need to investigate the significant barriers to the adoption of the state-of-the-art Information systems of the local oil companies in developing nations, Nigeria included.

3.13.3 Difficulties in determining the performance of oil companies

This study is not unaware of the difficulties that arise in determining and/or measuring the importance of individual factors and their obstacles that affect oil companies, particularly the indigenous ones. Some researchers consider the measurement of individual factors as impossible, but collectively, it is indeed possible to measure and assess the general level of general performance (Steven, 2008; Victor, 2007). They identified “national mission”, “so-called aggregation problem” and “lack of transparency” as the greatest challenges which led to these difficulties in measuring the performance of INOCs.

Furthermore, specific performance measurement comprises of “efficiency performance measure”, “operational performance measure” and “financial

performance measure" that are used in assessing the performance of multinational and indigenous oil companies (Steven, 2008). However, performance is measured based on the objectives set by the stakeholders, which includes maximizing the value of their shares, national missions and strategic decisions as referred to by Saudi Aramco strategy (Marcel, 2006; McPherson, 2003; Van der Linde, 2000).

3.13.4 Measuring performance

As stated earlier superficially, Steven (2008) argued about the impossibility of measuring the performance of individual factors in any scientific and objective way in oil companies, but collectively is very possible. However, this study looks into investigating the significant barriers that affect the performance by limiting the adoption of the state-of-the-art IS by the Nigerian INOCs. Steven (2008) emphasised that, measuring performance is always required from oil companies periodically and this would assist in improving their performance. One may argue that periodic measurement of performance could motivate the INOCs to investigate their limitations; including state-of-the-art IS and address them accordingly.

3.13.5 Measuring performance using an aggregate measure

Using an aggregate measure in an oil company depends largely on the "reputation" of that company (Steven, 2008). Similarly, oil companies' reputational issues incline towards public perception of their history on various issues, starting from human rights integrity, technological advancement, customer satisfaction, environmental health, safety, managerial decisions and style (Steven, 2008). However, he noted that, it is extremely difficult to measure performance using "reputation", but not impossible.

Consequently, Delphi Method is a method of measuring "reputation" (Steven, 2008; Nield, 2007). They stated that, it comprises a step-by-step approach of consulting and seeking the response of substantial number of experts to indicate their subjective views on the company's performance measure on a recommended scale, then determining the average of their view and/or opinion gives a consensus view in a normal distribution curve (Steven, 2008; Nield, 2007). In addition, Nield (2007) conducted research on NOCs of five developing countries and the result achieved is presented in the Table 3.4.

Table 3.3: General Performance measure for Oil Companies

Measure	Description
Commercial Performance	Investments return, profit gained & commercial opportunities
Production	Amount produced & how it is being maintained considering the constraints.
Reserves Replacement	How reserves are being replaced.
Downstream investment	Dealing with the challenges of refinery & creating means of resource monetisation.
Partnership	Success of contract terms in attracting partners and new innovations towards partnering.
Technology	How state-of-the-art technologies are being deployed, Research & Development, and expertise on their usage.
Overseas investment	As a commercial company how competitive with the (other) overseas' companies.
Independence	What is the commercial level of their independence and freedom
Environment	Health & safety of their environment
Human Resources	Quantity & Quality of staff, training, recruitment

(Source: Steven, 2008 with great modification)

Table 3.4: Results of performance measurements

Measure	Saudi Aramco	ADNOC	Sonatrach	NIOC	KPC
Commercial Performance	9	7	8	5	8
Production	9	8	6	5	6
Reserves Replacement	7	7	4	4	4
Downstream investment	8	7	4	5	5
Partnership	7	8	5	5	3
Technology	9	8	6	4	2
Overseas investment	8	6	8	6	8
Independence	8	7	7	3	4
Environment	6	8	7	5	3

Human Resources	9	7	8	4	2
Total	80	73	63	46	45

(Source: Middle East Economic Digest, 2007)

Note: Scores for elements explained, ranging from 10-1, 10 being the highest

3.14 Insourcing and outsourcing of IS

Taking the decision to insource- i.e. in-house IS adoption and management, or IS outsource- to buy from external sources, has been a difficult task for decision makers with expertise in ICT resources (Baldwin, Irani & Love, 2001; Yang & Huang, 2000). Different risks and complexity have been considered as the fundamental and central reasons for this difficulty in decision making (Marcolin & McClellan, 1998; Cronk & Sharp, 1995).

Similarly in the field of IS, outsourcing concerns many stakeholders, because of its risks, dimensions and challenges (Yang & Huang, 2000). Yet with all these potential risks, IS outsourcing is presently moving through a phase of unstoppable limits (Gonzalez, Gasco & Llopis, 2009; Takahashi & Sayer, 2007).

Since the beginning of the 1990s, there has been a serious challenge as regards outsourcing (Currie, 2000; Quinn, 1999). This is due to the fact that, companies had prepared to outsource at that time in order to avoid the (Y2K) challenge of the millennium as a result of computer compatibility or crashing in moving from one millennium to another (Currie, 2000; Quinn, 1999; Duncan, 1998).

3.14.1 Merits and demerits of outsourcing

Researchers on the benefits or otherwise of the outsourcing of IS are always in debate about the best option to be adopted in an organisation (Paisittanand &Olson, 2006; Harland, et al., 2005). However, reading between the lines, will easily show that the benefits or otherwise always depend on the resources, size, field and the gravity of challenges facing the organisation that requires the IS adoption (Yang *et al.*, 2007; Paisittanand & Olson, 2006; Harland, et al., 2005).

3.14.2 Merits of outsourcing IS adoption

According to some researchers, outsourcing IS has some benefits (Quinn, 1999; Lacity & Willcocks, 1998). According to them, these benefits include cost reduction,

accessing new technology, enjoying better services, having an alternative to ICT staff and allowing staff to focus mainly on their field without interruption as a result of ICT management.

However, the defendants of this argument consider outsourcing to have the advantage that if the organisation cannot have enough resources to deploy the technology through in-house adoption (Quinn, 1999; Lacity & Willcocks, 1998). If an efficient contractor is employed for the deployment and management of new technology, effective management could be established in their place. As this study argues, the complex nature of exploration and production could not easily be performed by the IS analysts without upstream knowledge.

3.14.3 Reasons for outsourcing IS

Quite a few authors have critically analysed the potential reasons leading organisations to outsource their IS (Poisittanand and Olson, 2006). These reasons can be summarised as: dedicating time to the organisation's strategic issues and allowing the outsourcing time to fulfil the technical requirement outlined in the contract during outsourcing (Alner, 2001); flexibility based on the legitimate interest of the clients (Yang, et al., 2007); assessing alternatives to the in-house IS staff has been another reason (Gonzalez, Gasko & Llops, 2005); and imitation of the fashion of other companies that have succeeded relatively through outsourcing based on their perception (Smith, Mitra & Narasimhan, 1998).

3.14.4 Risks and demerits of outsourcing

Outsourcing has a catalogue of risks associated with it, with the client and with the provider as well (Jiang & Qureshi, 2006). These risks and demerits can be outlined and summarised as: staff expertise of the provider based on the client's technical knowledge (Tafti, 2005; Fowler & Jeffs, 1998); negligence by the provider which causes havoc and trauma to so many clients (Jiang & Quraishi, 2006; Clark, Zmud & McCray, 1995); overdependence on the provider (Tafti, 2005; Clack, Zmud & McCray, 1995); inability of the providers to deploy and adopt new state-of-the-art technologies (Glass, 1996); unclear and undetermined cost-benefit analysis (Jiang & Qureshi, 2006; Clark, Zmud & McCray, 1995); lack of IS security guarantee (Alter, 2001), difficulty of switching to the in-house deployment of IS (Fowler & Jeffs, 1998); creating client's staff problems and suspicions against their employer (Yang, et al.,

2007); and staff opposition to the decision as a result of the anticipated negative impact on them (Gonzalez, Gasko & Llopis, 2005).

3.15 Barriers to ICT adoption in SMEs of developing countries

The emergence of the ICT has advanced small- and medium-sized enterprises (SMEs) to strongly and effectively compete in local and international markets (Kafurubandara and Lawson, 2006; Schmid, Stanoevska-Slabeva & Tschammer, 2001). They noted that, ICT and internet play a major role in promoting SMEs in many advanced nations in the world.

It has been observed that, the developed nations have successfully developed most of their SMEs through e-transformation of their business activities (Zhang & Aikman, 2007). However, the situation is different with the developing countries (Knol & Stoeken, 2001; Chau and Turner, 2001).

Undoubtedly, ICTs have been identified as fundamental components of improving socio-economic development of nations globally (Ekekwe, 2009; Basant, et al., 2006). There are factors that impede or limit the adoption of ICT resources in developing countries (Kapurunbandara & Lawson, 2007). They noted that, these factors affect the adoption of ICT by small-sized enterprises, medium-sized enterprises and large scale industries in these countries. ICT adoption constraint is one of the most pressing current developmental issues and challenges facing developing countries (Iheduru, 2011; Kim, 2011).

3.15.1 Categories of SMEs

SMEs are very important to the advancement of both developed and developing countries (Lawrence & Tar, 2010; Chau and Turner 2001). They also play a significant role in developing and sustaining the economy of many countries.

Looking at the number employees in Nigerian INOCs, they could be accommodated within the category of at least, medium-sized enterprise (Shosanya, 2013). However, countries employ and adopt different parameters to categorise and also define SMEs. The parameters range from capital investment, number of employees, size of the business to amount of turnover (Huff & Yoong, 2000). However, as this study argues, the categorisation of SMEs using the number of employee may be very relevant to the investigation of this study with regard to both marginal fields' operators and the indigenous independent oil companies in Nigerian. For example:

Table 3.4.1: Categories of SMEs

Category	Number of employess
Medium-sized Enterprise	Mostly more than 200 employees, but less than 300
Small Enterprise	Mostly between 10 and 49 employess
Micro Enterprise	Mostly less than 10 employees

(Source: Gamage, 2003; European Union; 2003 with major modification)

3.15.2 Classisfication of barriers to ICT adoption in SMEs

Barriers can be defined as an obstacle or fence that substantially prevents access or movement (Cambridge, 2013; Gillingham & Sweeney, 2012). In line with this, some developing countries started investing heavily in ICT with the sole aim of overcoming barriers and catapulting their countries to an ICT-advanced level, even if they cannot reach the level of industrialisation (PTAC et al., 2005).

In addition, there are barriers that impede that adoption of ICT in SMEs. Researchers investigating the barriers to the adoption have categoried them into different categories. For example, Chau and Turner (2001) discovered and categorised the impediments into three categories: costs and return on investment; characteristics of the firm; and characteristics of managers and owners.

Furthermore, Chau and Turner (2001) and OECD (1998) noted that managers and/or owners always play a significant role in making a decision in SMEs. In addition, it has been found that owners' and managers' lack of knowledge of modern ICT, lack of human skills, lack of resources, security issues, mistrust of the ICT experts, lack of guarantee in short term returns and lack of dynamism are the barrier factors to ICT adoption (Knol & Stoeken, 2001; Chau and Turner, 2001). As this study argued, the barriers to ICT adoption could be relevant to the constraints to the adoption of state-of-the-art IS by Nigerian INOCs.

Developing countries have the potential to attain sustainable SMEs development by establishing economic-based systems upon state-of-the-art ICT infrastructure (UNDP, 2004). Furthermore, according to Basant, et al., (2006) and UNDP (2004), a lack of the latest ICT adoption in developing countries is very clear, and also there is a large variation in ICT adoption across and within developing countries and their sectors. They observed that, this variation is usually traced to various significant barriers:

such as skill shortages; cost of resources; government policies; inadequate telecommunications facilities; and services.

However, there are obstacles that limit the deployment and adoption of state-of-the-art ICT resources by industries and companies in developing countries (Gillingham & Sweeney, 2012; PTAC et al., 2005). However in developed countries, these challenges have been addressed significantly and the general impediment is no more in existence (PTAC et al., 2005). We may argue why some rich-underdeveloped countries, Nigeria inclusive, are not making any enormous effort towards identifying and eradicating these significant barriers towards technological advancement.

3.15.3 External and internal barriers to ICT adoption in SMEs

Barriers to ICT adoption in SMEs, particularly in developing countries, can be broadly classified into two. These are external and internal barriers (Kafurubandara and Lawson, 2006; Chau and Turner, 2001). Their meaning and explanation will be presentated next.

3.15.2.1 External barriers to ICT adoption in SMEs

These are the barriers that can only be addressed and eliminated directly by an external body, like govenrment. In other words, external barriers cannot be eliminated or resolved by the SMEs directly. They have no absolute power over them. These barriers include, government policies, cultural issues, national infrastructure and instability within the country (Kafurubandara and Lawson, 2007; Chau and Turner, 2001).

3.15.2.2 Internal barriers to ICT adoption in SMEs

These are the barriers that SMEs have alsolute power and control over them. As a result, they have the ability to address them. These include poor managerial attitude, insufficient resources, lack of skill development and lack of awareness or knowledge of the state-of-the-art technology (Kafurubandara and Lawson, 2006; Chau and Turner, 2001). As this study argued, the classificantion of SMEs' barriers into external and internal barriers could be applicable to Nigerian INOCs considering their size, location and level of their awareness. The barriers to ICT adoption in SMEs are significantly the same in banking system and e-commerce. This study argues that, some of the barriers could be the same to the obstacles that impede the adoption of the state-of-the-art IS by Nigerian INOCs.

3.15.3 Digital divides between developed and developing countries

Digital divide has been defined as the unequal access to ICT resources (Cayla, Cohen & Guigon, 2005). Similarly, this divide explains the disparity in the diffusion of ICT between developed and developing countries. Apart from a digital divide between countries, analysts also enunciated that the unequal access to ICT resources within a single country between organisations or individuals is also entitled "Domestic Digital Divide" (Sciadas, 2002).

Braun (2003) said that the geographical location of a country or region of a country has an impact on the adoption of ICT. In support of this argument, Khan (2000) also observed that it is important for countries to understand their local needs and conditions if they are to solve their barrier problems. He emphasised that, Africa must critically understand and recognise the value of local knowledge and meaningful policies while embarking on ICT development projects.

Consequently, the Parliamentary Office of Science and Technology (2006) reported that Organisation for Economic Co-operation Development (OECD) countries have the highest and most up-to-date access to ICT resources, followed by South Asia. The report portrays African countries excluding South Africa as the worst in ICT, Nigeria inclusive.

Furthermore, since state-of-the-art ICT officially became more commercially available in the early 1990s, it has been adopted more rapidly in developed countries, and diffused to all their sectors, but generally slowly in developing countries of the world (Achimugu et al., 2009; Chiemeke and Longe, 2007). However, some are slightly better than others (Achimugu et al., 2009). They emphasised that, some of the developing countries that have made progress in ICT adoption and diffusion in most of their sectors are Brazil, Estonia, Chile and Malaysia.

Consequently, the United Nations has outlined four major indicators and signs that indicate complete and total information technology diffusion in a given country as:

i. availability of modern ICT infrastructure and access;
ii. use of ICT by businesses;
iii. ICT sector and trade in ICT goods; and
iv. unlimited access and use of ICT by individuals, organisations and government (Chiemeke and Longe, 2007).

3.16 Conclusion

The review of this chapter relating to the issues of IS and other ICT resources of developing countries in their respective oil and gas sectors is now concluded. The chapter has given more emphasis on Nigerian INOCs as the main case of study. Its accomplishment in this chapter sets out some basic elements of the study towards understanding the significant barriers to the adoption of state-of-the-art IS.

The chapter reviewed the cultural, socio-political and economic factors as obstacles to the deployment and management of IS in developing countries. Further, an in-depth review of ICT development, technological innovation, software development, IS strategies, insourcing, outsourcing and measuring performance and some significant barriers have been discussed extensively and intensively.

Furthermore, the review and its analysis revealed a number of important and significant issues. It is evident that there is no previous research or published journal on the issue with respect to the oil and gas sector. In addition, significant barriers to ICT adoption in SMEs and local companies have been identified as regards the design and development of instrument for data collection. The review also identified the merits and demerits of insourcing and outsourcing of IS with respect to companies. The relevance of both- insourcing and outsourcing has been discussed with respect to Nigerian INOCs. The existing gap in the adoption of IS used by Multinational oil companies (MNOCs) on the one hand and their indigenous counterparts in developing nations on the other, has also been identified. In addition, the issue of digital divide as an important component of the study has been discussed.

The next chapter will review the literature relevant on the significant barriers to the adoption of state-of-the-art IS by developing countries. Specifically, the review will focus mainly on internal barriers, external barriers as well as environmental factors impeding or limiting the adoption of state-of-the-art IS by developing countries.

CHAPTER FOUR

Barriers to the adoption of state-of-the-art IS by Developing Countries

4.1 Introduction

This chapter reviews the significant barriers that limit the adoption of state-of-the-art IS by different sectors in developing countries, Nigeria inclusive. The chapter may help to address the third, fourth and fifth objectives of this study. Many researchers have conducted studies on the barriers to ICT adoption by companies and enterprises in the developing nations, like Sri Lanka. However, the barriers have not been investigated in Nigerian INOCs. These barriers can either be internal or external (Lal, 2007; Kapurunbandara & Lawson, 2006). They noted that, internal barriers are the obstacles that can be addressed by the management of an organisation while external barriers are the obstacles to be addressed by an external body or government.

Furthermore, Tarafdar & Vaidya (2006) and Ginsberg & Venkatramen (1992) discovered that managers show different attitudes towards ICT adoption, depending on its perceived usefulness in their operation and general activities. Apulu and Latham (2009) agreed with this observation and outlined four general aspects that influence organisations in the direction of ICT adoption: the role of top management in organisational leadership; availability of resources; effects of organisational culture; and level of ICT network penetration.

Recently, Mehrtens, Cragg and Mills (2011) noted that not all organisations are motivated towards ICT deployment and adoption. The argument has been supported by Shim and Jones (2001) that the extent of ICT adoption depends on managerial motivation towards its adoption. Hence, Tarafdar and Vaidya (2006) recommended that it is essential for the management of various organisations that they are motivated and educated about the fundamental factors behind adopting the latest technology and its value to the organisational development and advancement. However, as this study argues, all these issues were not investigated in Nigerian INOCs.

The rest of the chapter has been divided into sections. Section 4.2 discusses the barriers to IS adoption in independent oil companies of developing countries. Section 4.3 discusses the barrier factors in adopting IS. The obstacles affecting the

management of IS in oil companies are then presented in Section 4.4. Furthermore, Section 4.5 presents government policy. Section 3.6 discusses environmental factors. Section 4.7 focuses on the theory of constraints. The chapter is concluded by Section 4.8.

4.2 Barriers to IS adoption in other developing countries

These are barriers that impede or limit the adoption of IS (Iheduru, 2011; Lal, 2007; Kapurunbandara et al., 2006). In their analysis, they argued that, lack of proper partnership to meet funding and capacity challenges, are major barriers impeding their adoption and diffusion.

However, based on the investigation of this study, there is absence of specific research on ICT and general concept of IS in Nigerian INOCs. As a result, the study depends mainly on making personal contacts with the experts in the field through various media and instruments.

So many industrialised countries identified their challenges and have adopted suitable ICT resources and solved their problems amicably. Even Canada as an industrialised nation had for a long time identified its upstream technology challenges leading to a useful deployment of technologies (PTAC et al., 2005). Their achievements in Canada include remote data monitoring, online real-time communication and implementation of 3-D seismic capability (PTAC et al., 2005).

4.2.1 Problems of ICT adoption in developing countries

There are many problems associated with ICT adoption in developing countries as investigated by Okot-uma (1992) and Kunda & Brooks (2000). They discovered that the problems of deploying ICT resources in developing countries can be classified into three generic classes, namely, contextual, operational and strategic problems.

Contextual problems are due to incompatibility of models designed for developed countries and adopted by developing countries (Kunda & Brooks, 2000). They stated that, these problems are in terms of differences and discrepancies in context, semantic discrepancies in the wording and understanding of phenomena as well as references to different concepts of rationality and different values. They also observed that, operational problems comprise technical, economic challenges, poor and unskilled personnel. Furthermore, strategic problems comprise both local and national policies and laws.

Mehrtens, Cragg and Mills (2011) argue that not all organisations are naturally inclined towards ICT adoption. In support of this argument, Shim and Jones (2001) enunciated that sometimes, the extent of ICT adoption depends on organisational attitude towards ICT resources and their deployment. Hence, Tarafdar and Vaidya (2006) recommended that it is important for the organisations to be educated about the fundamental factors behind adopting technology and its value to the organisation's advancement.

Furthermore, Ginsberg and Venkatramen (1992) emphasised that different organisations and/or managers show different attitudes towards ICT, depending on its perceived usefulness in their operation and general activities. Apulu and Latham (2009) agreed with this observation and outlined four general aspects that influence organisations toward ICT adoption: they include the role of top management in organisational leadership; availability of resources; effects of organisational culture; and the level of ICT network penetration.

The attitude of top management plays a vital and significant role towards ICT adoption in an organisation (Beatty et al., 2001; Crook & Kumar, 1998). An enthusiastic approach on the part of top managers can lead to ICT adoption (Beatty et al., 2001; Crook & Kumar, 1998; Premkumar & Ramamurthy, 1995; Grover, 1993). Similarly, Yap, Soh and Raman (1992) and later, Cerpa and Verner (1998) confirmed that the involvement of management is significant towards ICT adoption success.

In addition, the effect of organisational culture has also been significant to ICT adoption (Harindranath, Dyerson & Barnes, 2008; Tarafdar & Vaidya, 2006). Their investigations also revealed that technical expertise and experience towards ICT performance influence the company's willingness and ability to engage in ICT matters. According to them, there are two aspects of organisational culture, which can influence ICT adoption: firstly, managers and/or owners' experience with ICT; and secondly, cultures that motivate state-of-the-art ICT resources deployment.

Availability of resources also affects ICT adoption (Harindranath, Dyerson & Barnes, 2008; Tarafdar & Vaidya, 2006). According to them, the availability of resources that motivates the adoption of ICT resources includes cost, software and skill (Arendt, 2008). Furthermore, Andrade and Urqahart (2009) stated that organisations which are prepared to adopt modern ICT resources must overcome resources and scale economic challenges.

Furthermore, Akpan-Obong (2007) has identified three potholes to Nigeria's information superhighway: these are the telecommunication landscape, technology dependency and electricity constraints. However, according to his research, these potholes affect the country as a whole. This study argues that, Nigerian INOCs were not given any preference in all the investigations conducted so far, as this limitation emphasises the need for this study.

ICT network penetration has seriously grown around the world, especially in developed countries (Andrade & Urquhart, 2009; Tarafdar & Vaidya, 2006). Different reasons indicate this notable growth, such as computer initiatives, mobile tools and ICT projects at the organisational and individual level (Andrade & Urquhart, 2009). However, this study argues that, developing countries are suffering from erratic internet signal and poor infrastructure.

4.3 Internal and external barriers in information systems adoption

Barriers concerning, the adoption of state-of-the-art IS and other ICT resources in the oil and gas sector in developing countries have two categories as addressed previously in Chapter 3 with regard to SMEs (Lal, 2007; Kapurunbandara & Lawson, 2006). Furthermore, these are internal and external barriers (Lal, 2007; Kapurunbandara & Lawson, 2006). As this study argues, this classification of barriers could apply to Nigerian INOCs as the obstacles that limit the adoption of state-of-the-art IS for E&P operations.

4.3.1 Internal barriers to ICT adoption

Internal barriers are the factors that can be resolved by the organisation itself because they exist within the organisation and can be resolved by the organisation's management or staff (Kapurunbandara & Lawson, 2006). These internal factors include ICT infrastructure (Anwar & Shamim, 2011; Kapurunbandara & Lawson, 2006); technical sophistications (Anwar & Shamim, 2011; Anoa, 2002; Longe & Chiemeke, 2006); cost of resources (Ekekwe, 2009); lack of skilled human resources (Anwar & Shamim, 2011; Apulu & Latham, 2009); lack of timely and reliable systems for communication (Akkeren & Cavaye, 1999); and lack of most up-to-date software (Kunda & Brooks, 2000); and application problems (Apulu & Latham, 2009); internal corruption and lack of software renewal (Bingimlas, 2009).

These internal barriers could be further classified into individual (owner/manager) barriers, organisational barriers and cost and return on investment (Chiemeke &

Longe, 2007; Ahiokwo, 2002; Akkeren & Cavaye, 1999). Poor condition or limited availability of ICT infrastructures have been considered to be barriers impeding ICT diffusion in developing countries (Achimugu, et al., 2009; Kunda & Brooks, 2000). They argued that, modernising existing infrastructure as well as deploying the most up-to-date ICT infrastructure in developing countries is the key issue. In addition, they pointed out the challenges of sustainable wired and wireless networks, cost, inconsistency of policies and political instability.

4.3.2 External barriers to ICT adoption

External barriers are the impeding factors that need to be addressed either by government intervention or other external collaborators (Kapurunbandara & Lawson, 2006; Bingi, Mir & Khamalah, 2000). These external factors include external corruption, insecurity, cultural barriers; social activity and lack of developed legal and regulatory systems (Anwar & Shamim, 2011; Amaraegbu, 2011; Ogundele, 2008; Obayelu, 2007; Ribadu, 2006).

4.4 Obstacles to the management of oil companies' IS

Hafid (2009) enunciated that it is extremely difficult in major organizations to globalise and standardise IS in their subsidiaries that are located in different regions and countries with different cultures due to existing barriers. Meanwhile, cross-cultural writers confirmed that it is impossible to take existing models and theories and implement them on environments with different cultures (Hafid, 2009; Trompenaars, 1993; Tayeb, 1994; Hofstede, 1994).

There are still some factors that are contributing to the difficulty of implementing local and global IS, which include differences in the development factors considered to be the most reliable by IS designers and programmers in both developed and underdeveloped countries (Peterson, et al., 2002; Katz & Townsend, 2000; Kedia & Bhagat, 1988).

Some researchers indicate that the US, Japan and Korea are among the countries that are seriously involved in the development of global IS (Peterson et al., 2002). These countries consider national and cultural differences to affect the successful IS implementation. The three countries were selected because of their diverse cultural differences to prove the impact of culture on information systems, which was finally proved and vindicated (Peterson et al., 2002).

In line with this, various studies have been conducted to find the variables that will differentiate between successful and unsuccessful IS projects (Aladwani, 2000). They highlighted 18 factors that are responsible for either success or failure of global IS (Aladwani, 2000; Pinto & Slevin 1997; Ewusi-Mensah, 1997).

However, in Nigeria, the failure of major activities associated with drilling, well invention and production could be associated with lack of expertise and poor technological maintenance (Nwosu, 2006). This study argues that, there is no empirical research conducted to ascertain and confirm the obstacles to IS management in Nigerian INOCs.

4.4.1 Trans border data flow problem

Technological innovation makes trans-border data flow (TBDF) the easiest and cheapest way of transferring data (Milrad & Chong, 2010; Kuner, 2010; Wang, 1993). However, some factors like privacy, culture and national rules oppose its smooth implementation. TBDF is considered as the flowing of digitalised data across political boundaries for storing, processing, retrieving and analysing data across international borders (Milrad & Chong, 2010; Wang, 1993).

Technological advancement in computer and ICT makes TBDF become economically and technically a way of executing global data communication, but legal, political and economic barrier factors work in the opposite direction (Kuner, 2010; Wang, 1993; Samharya & Phatak 1990). Multinational companies (MNC) are always in loggerhead with government policies and regulations due to the laid down economics and sovereignty reasons which are not the same among nations (Kuner, 2010; Wang, 1993; Guynes, et al., 1990; Samharya & Phatak 1990). This may affect some Nigerian INOCs, because they recently started expanding their exploration and production activities to neighbouring African countries. This study argues that no research has ever been conducted in Nigeria to ascertain whether TBDF as a government policy affects Nigerian INOCs in their technological advancement or not.

4.4.2 TBDF problems and issues

As a policy, while some countries like India and Brazil restrict data/information flowing into their various countries, the US supports free flow and general access to information (Hafid, 2009; Wang, 1993). Supporters of free flow defend their argument by saying that their stand benefits all countries, while critics say; free flow

helps and benefits only the countries that already dominate the information market (Kuner, 2010; Wang, 1993; Guynes, et al., 1990). However, Hafid (2009) pointed out that, countries that support the restriction of TBDF outlined privacy, economic issues, sovereignty and culture as their strong idea for the restriction and/or regulations.

4.4.3 Privacy issues

The protection of their interest and rights is the strongest motivation for the regulations. The strong manipulation of computers to store and retrieve data brings concern about the probability of abusing information by those who control it. Over the last three and four decades, there was a serious trend among countries towards passing restrictive laws to protect privacy (Milrad & Chong, 2010; Kuner, 2010; Palmer and Dukes, 1986). These laws and regulations were based on the Privacy Act enacted and documented in the USA (Milrad & Chong, 2010; Palvia & Sarawat, 1992).

This protection of data policy differs from one nation to another, based on their reflection on socio-political and socio-cultural variations. They differ even in defining the word "person"; some consider it to accommodate both natural and legal persons, like the definition of European countries, which includes even the data of corporations (Kuner, 2010; Wang, 1993, Buss, 1984 & Chadran, 1987). Variations in privacy regulations among countries have brought difficulties for MNCs in managing TBDF. In 1991, the European Commission (EC) made a gigantic effort to make data protection laws uniform, in order to make it easier to transfer data among nations in unified Europe (Wang, 1993; Betts, 1991). In line with this argument, recently ARAMCO as indigenous oil company of Saudi Arabia experienced an ugly attack on their cyber world that affected 30,000 workstations for exploration and production (Bn-AbdulAziz, 2013).

4.4.4 Economic issues

Many countries consider that processing information outside their country/border will create or increase unemployment for their citizens and increase employment opportunities for other countries. This makes some countries (Like Canada, Brazil and Germany) enact laws that necessitate the pre-processing of some data within their country before they allow it to pass their borders (Milrad & Chong, 2010; Wang, 1993; Chandran, Phatak & Sambhara 1992; Bett, 1991). This study argues that, there is indeed a very serious challenge of unemployment but there is no law in that direction.

Economic issues include the protection of domestic industries, and this makes some countries (like Venezuela, Brazil and West Germany) legalise the use of indigenous hardware, software and communicating equipment to transmit data across international borders (Kuner, 2010; Carper, 1992; Wang 1993). This makes MNCs depend on local equipment, which is purchased at a high cost (Kuner, 2010; Wang 1993; Carper, 1992; Guynes, Guynes and Thorn, 1990).

4.4.5 Sovereignty

Too much reliance on international networks for data flow may expose countries to difficulties with regards to political problems. Countries feel if their vital data are accessed or kept in other nations, they may lose it as a result of war or other international conflicts and disasters. This also helps developed nations to know more about underdeveloped nations more than themselves, particularly the countries that occupy the security council of the United Nations because of their power in taking decisions and executions as well as expertise in computing (Milrad & Chong, 2010; Wang, 1993; Guynes, Guynes & Thorn, 1990).

4.4.6 Global business strategy

Different global business strategies exist for multinational companies, based on their compatibility and aims. However, some types of strategies are more independent than others. To have a clear perception of global IS, the understanding of multinationals' global business strategy becomes an obligation (Mohdzaher, Mohdzain & Ward, 2007; Wang, 1993).

Most often global business strategies analyse the relationship between the corporate Headquarters (HQ) and the different subsidiaries that are related to it, but which are separated by an international border (Mohdzaher, Mohdzain & Ward, 2007; Wang, 1993; Barlett, 1989). There are different types of global business strategies, but three are more prominent and relevant to this research, these are; multinational, global and transnational.

4.4.7 Multinational business strategy

In the MNCs that are following and adopting this kind of strategy, most of the transactions are processed within each subsidiary unit, and their link with the HQ is negligible. In this strategy, the subsidiary retains its autonomy. And this is the one that is very much relevant to multinational oil companies, because they always adopt

Multinational strategy (Kuner, 2010; Aladwani, 2000; Wang, 1993, Barlett & Ghoshal, 1989).

4.4.8 Global business strategy

In the global application, the MNCs adopting this strategy link international subsidiaries through a powerful controller from the HQ. In this strategy, the autonomy of the subsidiary is negligible indeed, and the HQ requires an amount of information in order to function as the controller (Alvarado, 2009; Wang, 1993; Alavi & Young; 1992).

4.4.9 Transnational business strategy

The MNC adopting this strategy tries to maintain the local function of each subsidiary unit and at the same time pursues global integration and innovative diffusion (Aladwani, 2000; Wang, 1993). The researchers argue that there is a form of inter-independence between the HQ and the subsidiaries.

4.4.10 Global information systems

It is generally confirmed that the development of any form of IS strategy is based on the MNCs global business strategy; a choice must be made from among them in order to adopt even one of them (Wang 1993; King & Seith, 1992). Different researchers adopted different types of IS strategy. Three major IS strategies are mostly adopted by researchers: Decentralized IS strategy, Centralized IS strategy and integrated and distributed IS strategy (Hafid, 2009).

4.5 Government policy

Since the discovery of oil and gas in commercial quantities by Shell Corporation in 1957, the Nigerian Oil and gas sector has developed and become a giant player in the oil and gas market globally (Ihua, Ajayi & Eloji, 2009; Atakpu, 2007). As a result of attaining this prestigious position, Ministry, companies, agencies, boards and parastatal have been established and policies have been formulated by previous and current Nigerian governments in order to sustain and promote this sector (NNPC, 2006; Odulari, 2008).

In spite of this positive development, the contribution of the Nigerian oil sector to the Gross Domestic Product (GDP) has been insufficient. The sector accounted for only 38%-41% of the national GDP (World Bank, 2006; Agusto, 2002). This has been

identified as being a direct consequence of the inactive indigenous participation in the sector, given that over 80% of the goods, human and services required for projects are imported from foreign nations. This situation affects Nigeria negatively by increasing the unemployment rate to approximately 41.8% (Vanguard, 2011). This has also been confirmed by the Minister of Youth and Social Development as the highest rate in the whole world as of 2011 (Vanguard, 2011).

Consequently, in support of this argument, for over 30 years, the Nigerian upstream oil and gas sector dealing with discovery, exploration, drilling, and production has been significantly dominated by major multinational oil companies with very large numbers of expatriate experts being imported into the country to carry out technical services (Ihua, Ajayi & Eloji, 2009; Atakpu, 2007). This has been anticipated to be the primary reason for unemployment, lack of technical skilled labour, lack of capacity building, lack of indigenous workforce and lack of sustainability of national economic development (Ihua, Ajayi & Eloji, 2009; Oladele, 2001). As this study argues, there is no evidence to indicate that Nigerian experts could manage the sector efficiently without the support of the expatriates.

In recognition of this great challenge, the Federal Government of Nigeria (FGN) had made some efforts in the past to domesticate a substantial portion of economic derivatives from the oil and gas sector by motivating the growth, development and deliberate deployment of indigenous human and material resources in the sector (NNPC, 2006; Ogbodo, 2008). This effort brought about the formulation of some government-friendly policies; the establishment of the Division of National Content Policy under the Nigerian National Petroleum Corporation (NNPC) to look after Nigerian Content Policy; and the articulation of the Nigerian Association of Indigenous Petroleum Exploration Companies. Some critics have remained nervous about some of these formulations without indicating any specific challenge or solution to the perceived problem (Ihua, Ajayi & Eloji, 2009).

4.5.1 Local Content Development Policy

Local content development is a policy for Nigeria's Federal government to advance and develop local capacity in the oil and gas sector to enable substantial indigenous participation (Ihua, Ajayi & Eloji, 2009; NNPC, 2006). They emphasised that, it has taken precedence and power over any policy that might had been formulated before its emergence. It is considered to be an effort towards the utilisation of indigenous

human and material resources in the exploration of the hydrocarbon resources in the country. The policy is to ensure that a substantial percentage of locally-produced services, goods, personnel and resources rendered to the sector are increased in order to generate more economic empowerment and development.

The local content development policy is explained and documented as:

> *"the quantum of composite value added or created in the Nigerian economy through the utilisation of human and material resources for the provision of goods and services to the petroleum industry within acceptable quality, health, safety and environmental standards in order to stimulate the development of indigenous capabilities" (NNPC, 2005; NNPC 2006).*

The main vision and mission for local content policy as stated by NNPC (2006) is to transform the oil sector to become a state-of-the-art socio-economic engine for national development and job creation. As a result, the greater proportion of works and services are encouraged to be performed indigenously by citizens of the country (Ozigbo, 2008).

4.5.2 New dimension of the local Content Development Act

The President of Nigeria, Dr Goodluck Jonathan renewed government effort on the policy on 22nd April of 2011 with some modifications. Under the new Act, the use of indigenous human and material resources for the provision of goods and services to the petroleum sector "within acceptable quality, health, safety and environment standards" are made in order to enhance the development of indigenous capabilities (Adeniyi, 2013).

4.5.3 Main components of the local content Act

i) The Nigeria Content Monitoring Board
ii) Submission of the Nigeria Content Plan
iii) Consideration of Nigerian Content in Bid Evaluation
iv) Research, Development & Technology Transfer Obligations
v) Employment/Training
vi) Expatriate Quota
vii) Utilisation of indigenous Insurance, Financial and Legal Services
viii) Penalties (NNPC, 2006; NNPC, 2005).

Consequently, local Content Policy has been efficient and successful in some oil producing countries, such as Norway and Brazil, but such achievement can be doubted in Nigeria because of divergent views so far (Ogbodo, 2008; Obasi, 2003).

The aim of developing National/indigenous oil companies in Nigeria to an advanced stage has not yet been achieved due to undetermined challenges, but other developing countries that did not restrict their indigenous oil companies (INOCs) to their local content have indeed advanced, such as Malaysia NOC (Petronas), Venezuela NOC (PdVSA) and Saudi Aramco (Iledare, 2008). This study argues that, in all the observations put forward about these policies, none of them seek the opinion of Nigerian INOCs about the impact of these policies on their performance.

Furthermore, other stakeholders in either IS or Nigerian oil and gas sector or even both, such as Nigerian Computer Society (NCS), Information and Communication Technology (ITAN), Internet Services Providers of Nigeria (ISPN), Computer Professionals Council (CPN), Nigerian Communication Commission (NCC), Association of Telecom Operators in Nigeria (ATCON), the National Information Technology Development Agency (NITDA) and Association of Licensed Telecom Operators of Nigeria (ALTCON) have complained about the difficulty of achieving local content policy with the current indigenous human resources without the intervention of Nigerians in Diaspora (The Nation, 2012). As a result, they emphasised the need for capacity development, through developing a reliable, efficient and improved workforce if Nigeria really needs to achieve its local content objectives. Similarly, during a joint-conference between the National Association of Computer and Software Companies of India (NASSCOM) and the Information Technology Association of Nigeria that allowed cross-fertilization of knowledge and invaluable ideas, they unanimously agreed that Nigeria must learn some lessons from India (The Nation, 2012). They noted that, India's achievement can be attributed to its citizens in Diaspora after receiving their independence from Britain. They remained in Great Britain and assisted in transferring ICT knowledge and technology to India in order to develop the country's ICT industry, and As a result, India has intellectually been transformed into one of the leading and best ICT's countries in the world (The Nation, 2012). They stated that, if Nigerians in Diaspora fail to return and contribute their quota towards impacting state-of-the-art ICT skills and knowledge, then we have to acquire the knowledge from other countries that are superior in that field, and that will definitely assist in promoting the growth and development of local content agenda. However, they made all these observations without discussing the situation of IS in Nigerian INOCs. As a result, this makes this study an essential academic endeavour.

4.5.4 Source of technological capacity building for Nigerian INOCs

The main source of the country's indigenous technological capacity building as stated in the policy is through the proposed services of the National Engineering and Technical Company Limited (NETCO) (NNPC, 2006). The company was officially established in 1989 to develop technology through sufficient involvement in all aspects of oil and gas engineering and all other sectors of the country (NETCO, 2012).

Similarly, NETCO was established with the sole aim of producing state-of-the-art technology (NNPC, 2006). NETCO'S main objective is to fulfil the strategic vision of NNPC for developing indigenous engineering capacity which may assist the citizens to analyse, design and implement resources for the country's oil and gas sector (NNPC, 2006).

In the last decade, NETCO has performed and executed many significant projects and services leading to the award of the prestigious international standard organisation (ISO) 9001 Quality Certification effective from April 18, 2000, which is the first to be achieved by any indigenous engineering company (NNPC, 2006). However, since then for more than a decade, nothing has been noticed or identified as an effort of NETCO, even by the oil and gas sector. Except that, the NETCO announced its willingness to go into alliance or partnership with international engineering firms to execute projects in the oil and gas sector (NNPC, 2006). However, this study might argue that NETCO, may not be competent enough technologically and otherwise to produce state-of-the-art ICT resources for indigenous oil companies (INOCs) that will enhance their performance.

4.5.5 Government incentives

The main government incentive is formulated under "consideration of government bid evaluation" (NNPC, 2006). The Act states that, when evaluating bids for projects, all project promoters and operators shall consider the Nigerian content and the one having the highest amount of local content will be considered, provided the Nigerian content in the selected bid is at least 5% higher than its nearest competitor.

Some researchers indicate lack of compliance to this policy of motivation by government agencies towards motivating indigenous participation (Ihua, Ajayi & Eloji, 2009; Oladele, 2001). However, this research may still argue that even if this incentive is considered judiciously, it may not be a success if the material and human resources produced are sub-standard and not of state-of-the-art quality.

4.6 Environmental factors

Environmental factors are among the constraints that impede the progress, development and industrialisation of many developing countries (Ribadu, 2012; Chiluwa, 2011). Further, there is a lack of accountability, justice and stability in most developing countries, Nigeria inclusive (Ribadu, 2012; Obayelu, 2007). These environmental factors are mainly corruption and insecurity in the Nigerian context.

4.6.1 Misappropriation of funds and general corrupt practices

Corruption can be defined as an effort to acquire wealth through illegitimate and illegal means for personal gain at public expense; or misuse of public power for private benefits (Agbu, 2001). Corruption and fraud are not evils that are around today, but are as old as the history of the world (Lipset & Lenz, 2000).

Corruption is one of the factors that always impede the development of African countries (Ribadu, 2012; Obayelu, 2007). In Nigeria, corruption is one of the most dangerous unresolved problems (Sachs, 2007; Ayobolu, 2006). Unfortunately, the country has also been described as one of the leading countries in the world which has shamefully excelled in perpetrating corrupt practices and fraud (Ribadu, 2012). It remains a long-term economic and political challenge for Nigeria (Sachs, 2007). Unfortunately, corrupt practices and fraud are in every sector of the country, with its civil service having been described as the engine of corruption (Uwuagiaren, 2012; Ribadu, 2012; Chiluwa, 2012). Workers in the government and private sectors mostly depend on fraud to become rich far above their salaries and general monetary entitlements (Ribadu, 2012).

As a result of this endemic corruption, many organisations in the private sectors have collapsed, government officials imprisoned and many projects have been abandoned (Ribadu, 2012; Obayelu, 2011). Similarly, many indigenous writers have revealed that corruption is the greatest threat to the country's democracy, industrialisation and socio-economic development (Uwuagiaren, 2012; Ayobolu, 2006). Experts have canvassed that the case of Nigeria is tragic because of its natural and human resources, and undoubtedly, it has an excellent prospect of truly becoming the giant of Africa (Uwuagiaren, 2012; Ribadu, 2012). They emphasised that, corruption is the impeding factor of Nigeria's development from independence to date.

Unfortunately, corruption has been considered as the cankerworm that has already eaten deep into the fabric of the country and impeded growth and development in all

sectors (Ribadu, 2012). And it has also been considered as the main reason behind the country's difficulties in developing very fast with all its abundant resources (ICPC, 2006). This is evident, because Transparency International index (TI) has a consistent and constant rating in Nigeria as one of the top three most corrupt nations in the whole world (Ribadu, 2006; ICPC, 2006).

Furthermore, corruption creates a bad national image, trifles economic development, and reduces economic efficiency and loss of revenue (Obayele, 2011). Similarly, endemic corruption reduces both local and foreign investment leading to a substantial reduction in foreign direct investment (Obayelu, 2011). This study argues that no research investigated the effect of corruption on IS resources used by Nigerian INOCs.

Because of its general implications and household popularity, there are different phrases and vocabularies being used by Nigerians and the media to describe corruption in the country (Obayelu, 2011). Some of these are embezzlement, bribery, unfair advantages, financial malpractices, extortion, dash, brown envelopes, mobilisation fees, gratification, undocumented extra payments, softening the ground, sub-payments, revised estimates, over-invoicing, payoffs, collusion, tribute culture, customary gift-giving, "let's keep our secret, secret", padded customary, tips, deal, benefits of office, blessings of office, 50% rule, 10% rule (bribe surcharge) and nepotism (Obayelu, 2011).

Similarly, some researchers emphasised the presence of endemic corruption in Nigeria's government and its oil sector (Hadi, 1999). Although private companies are less corrupt than public sectors (Amadi, 2004). Corruption has become more glaring and manifest as if it had been officially legalised in the country (Gire, 1999). As Goodling (2007) noted "since 1996, Nigeria was labelled the most corrupt nation three times: 1996, 1997, and 2000: and placed in the bottom five four more times: fourth from the bottom in 1998 and second in 1999, 2001, 2002 and 2003". We may still argue that, there is a need to empirically investigate whether corruption is a significant barrier to state-of-the-art ICT adoption by Nigerian INOCs or not.

4.6.2 Security challenges and instability

Security is a basic condition of safety from deprivation and harm, which is applicable to human beings, animals and inanimate objects, while insecurity is the condition of harm and deprivation that can be dangerous and harmful to human beings and other

creatures (Amaraegbu, 2011; Ogundele, 2008). Insecurity is one of the most recent challenges affecting the socio-economic development of Nigeria in general. Although, two regions of the country are more affected with severe security challenges, these are North-East region and South-South region (Ogundiya, 2009; Ogundele, 2008).

Consequently, the Niger Delta region where proven oil fields are completely located in South-South has been seriously under security challenge for over two decades (Amaraegbu, 2011; Ogundele, 2008). Security challenges worsened with the proliferation of many ethnic militia groups (Chiluwa, 2011). Niger Delta constitutes the tributaries that run from the Niger River, through its land and ends up in the Atlantic Ocean. The two cities of Port Harcourt and Warri are home to major oil fields owned by Multinational and indigenous oil companies.

The Niger Delta conflict which began in the 1990s and gradually escalated into a multinational resistance in the last decade, has received environmental, political, economic, strategic and developmental dimensions and implications (Amaraegbu, 2011; Ogundele, 2008). In these conflicts, thousands of civilians have been killed in the crossfire between the military-backed oil companies and tribal gangs, as well as militants. Most popular was the assassination of Ken Saro-Wiwa who had been the Ogoni social activist, followed by the subsequent rioting and alleged annihilation of Odi town by Nigerian military forces and shell company (Okorie, 2007).

Many groups have been formed by the Niger Delta youths fighting in the Nigerian state and some oil companies under the pretext of protecting the oil fields of their region, and for the benefit of their region alone (Ogundiya, 2009; Scot, 2007). They always claim that, the oil sites do not belong to the Nigerian government, but to their region only. Many writers (Ogundiya, 2009; Ogundele, 2008; Scott, 2007; Cohen, 2008; Dagne, 2006) have used different terms to describe these youth groups and associations, such as rebels, criminals, ethnic militia, terrorists, freedom fighters, militants, fundamentalists, insurgents, revolutionaries and political agitators.

In economic terms, millions of British pounds (£) have been lost to youth restiveness, pipeline destruction, disruption of production, attacks on oil sites, perforation of pipelines, stealing of equipment in water bodies, siphoning of export crude oil to regional black markets, hostage-taking, assaults and bombings of oil installations (Ogundiya, 2009; Mamdami, 2004). The political and economic messages of these groups to the Nigerian state are as simple as, the current fiscal federalism or amnesty

program is not the best option for their region (Ogundiya, 2009; Mamdami, 2004; Heng, 2002). However, there is no study that indicates any relationship between the current security challenges and ICT adoption by the Nigerian INOCs. We may argue that, empirical investigation has not been conducted so as to verify if insecurity of Niger-Delta affects the adoption of the state-of-the-art ICT resources in any way or not.

In addition, Achimugu et al., (2009) agreed that the security issue is one of the major challenges facing ICT adoption in developing countries. He outlined the challenges as:

i. the cost of full connection and maintenance;
ii. security issues;
iii. the difficulty of sustaining wired and wireless networks;
iv. inconsistency of policy;
v. political instability; and
vi. a lack of effective coordination.

However, they emphasised the individual adoption of ICT resources in their research. Other researchers highlighted that they are more applicable to organisational adoption (Anwar & Shamim, 2011; Bingimlas, 2009).

4.7 The theory of constraints

This study deals with identifying the constraints that brought about some barriers to the adoption of state-of-the-art IS in the developing countries of the world with more emphasis on Nigeria. In addressing similar challenges, the theory of constraints (TOC) was developed by Goldratt in the 1980s (Goldratt & Cox, 1986). TOC has received wide acceptance by many researchers (Ronen, 2005; Mabin & Balderstone, 2003). Interestingly, many studies, documentaries and reports indicated that TOC has assisted many organisations with tremendous performance improvement in operation and output result (Mabin & Balderstone, 2003; Gupta, 2003).

The general concept of TOC is the constraint that prevents the organisation from achieving its objectives (Goldratt & Cox, 1986). Goldratt (1991) outlined a five-step algorithm for increasing the system's performance and general efficiency. Similarly, Ronen & Spector (1992) integrated the TOC process by adding two steps to the algorithm developed by Goldratt. Step 1-2 are the ones integrated by Ronen and Spector (1992), while step 3-7 are the ones initially developed by Goldratt (1991).

4.7.1 An algorithm for the theory of constraint

An algorithm has been developed by Goldratt (1986) for the theory of constraints. The algorithm has been integrated and stated as a being a step towards solving some of the problems of IS as opined by Ronen and Spector (1992). Furthermore, this theory could be applicable to developing countries towards identifying the barriers and general obstacles to technology adoption (Goldratt & Cox, 1986). This study argues that, designing and adopting an algorithm will be very applicable to the interview-survey adopted in the data collection, subsequent analysis and presentation of the data.

The seven-step algorithm comprises of:

i. outlining the system's objectives and/or goals;
ii. global Performance Measurement Determination;
iii. identifying the system's constraints;
iv. deciding how to exploit the system's constraints;
v. subordinating the system to the constraint;
vi. integrating the system's constraint; and
vii. if the constraint has been demarcated in the previous steps, return back to step 3. Don't allow inertia to become the system's constraint.

Dynamic expert system implementation which has been developed according to the theory of constraints approach at the Ashdod Refinery, was technically analysed, and as a result the system had generated over 3 million USD of extra profits during the first two years of its implementation and operation (Rosolio, Ronen & Geri, 2008).

Furthermore, the theory of constraints can be applied to many situations, because it has a general approach which is applicable to the situations (Geri & Geri, 2011; Mabin & Balderstone, 2003). TOC has been successfully adopted and used in health services (Ronen, Pliskin, & Pass, 2006); software implementation (Ioannou & Papadoyiannis, 2004); education (Goldratt & Weiss, 2005); and various manufacturing settings, such as automotive, aerospace and electronics (Ronen, Pliskin & Pass, 2006).

In addition, TOC thinking processes have been used in the adoption of Inter-organisational systems, and served as the instrument to analyse complex settings (Geri & Ahituv, 2008). Similarly, TOC has assisted in bringing cooperation among competing organisations that have the same Inter-organisational systems in common

(Geri, 2009). As this study argues, developing and adopting an algorithm is suitable for data analysis of its interview.

4.8 Conclusion

This is the last of the chapters that have been designed to review the relevant literature on IS adoption in developing countries. The aim of reviewing the relevant literature has been achieved, because the gap between multinational and indigenous oil companies has been identified accordingly.

The chapter has also reviewed the relevant literature on ICT resources in enterprises and companies of developing nations. Specifically, the review focused mainly on the stage of IS of developing nations, obstacles to its deployment and management, ICT obstacles, constraints and/or barriers towards state-of-the-art ICT adoption and manpower development have all been reviewed.

The chapter has also reviewed and identified internal barriers, such as cost, skill and managerial attitude that limit the adoption of state-of-the-art ICT resources. In addition, external barriers, such as government policy, incentives as well as environmental factors, such as corruption and insecurity have also been reviewed and adopted.

The next chapter of the thesis will focus on model/theoretical framework and interview analysis. Many models and theoretical frameworks will be studied critically and modified for the purpose of this study. The interview will be conducted in order to fill the gap of lack of sufficient relevant literature on upstream IS in Nigerian INOCs.

CHAPTER FIVE

Barrier to Technology Adoption Model and the Analysis of foundation Interview

5.1 Introduction

For more than five decades, studies have attempted to construct an exact theory and model capable of technically and methodologically unifying the many available branches of the scientific enterprises, like information technology, communication technology, analogue technology and digital design (Rajagopal, 2002; Venkatraman, 1989). However, publishing these efforts did not start seriously until the 1980s by leading journals in information systems (Tornatzky & Klein, 1982; Bailey & Pearson 1983; Doll & Torkzadch, 1988; Ives. et al., 1983; Davis, 1989). Similarly, this study attempts to review the relevant models/frameworks that are related to information technology.

As a result, there are many studies dealing with theoretical framework, model and instrumental development measuring the opinions and/or perceptions of organisations and individuals towards innovative ICT adoption or its barriers (see for example: Kapurubandara & Lawson, 2007; Moore & Benbasat, 1991). Furthermore, the field of technology barrier, adoption, diffusion and acceptance have been an area of research since the early period of technological advancement in computer to date (Kim, 2011; Rogers, 2003). Earlier, Moore and Benbasat (1991) argued that there had been inconclusive and contradictory outcomes, due to the lack of authentic theoretical foundations for such research and insufficient measurement of constructs. This limitation had led to the development of their innovation diffusion theory model.

Subsequently, technology barrier models were critically reviewed by this study. And in the process, their strengths and weaknesses were identified and analysed. In the final analysis, a new model was developed, piloted and adapted as an integration of the previous ones.

This chapter has been categorised into relevant sections. Section 5.2 discusses the general background of models' development. Section 5.3 discusses theoretical foundations in ICT research. Section 5.4 addresses innovation diffusion theory.

Section 5.5 discusses research models. Section 5.6 presents some barriers to ICT adoption for evaluation in model design and also discusses the frameworks of barriers impeding the adoption of ICT in developing countries, while Section 5.7 analyses the data collected during the first set of interview. Further, Section 5.8 proposes an integrated barrier model to state-of-the-art IS by Nigerian INOCs. In addition, technology transfer was discussed in Section 5.9. The chapter is completed with Section 5.10 as a conclusion.

5.2 Background of models' development

There are many theoretical models developed as part of technology related issues (Venkatesh & Davis, 2000; Chau, 1996; Davis, 1989). Most of them presented the general topics and frameworks only relating to the adoption, diffusion or infusion of ICT into an organisational context (Abdulwahab & Dahalin, 2010; Venkatesh & Davis, 2000). These models capture efforts at adopting general socio-psychological models to the ICT discipline. Among the prominent models are "Technological Adoption Model" (TAM) designed by Davis (1989), which was an integration of "Theory of Reasoned Action" designed and developed by Azjen and Fishbein (1975). Similarly, Moore and Benbasat (1991) also developed "Diffusion of Innovation" which was technically based on Roger's "Diffusion of Innovation Model" which started back in 1963. In addition, it was later reviewed and adopted in 1983 and re-integrated in 1995. Furthermore, there was also the "Theory of Planned Behaviour" designed and developed by Taylor and Todd (1995) which was an integration of "The Theory of Planned Behaviour" by Cooper and Zmud (1990) and "Task-Technology Fit" was developed by Goodhue and Thompson (1995). All these models were mainly developed to address the adoption and acceptance of ICT resources, but they either slightly or generally differ in their theoretical structure, design, itemisation, construct or approach.

Recently, the "Unified Theory of Acceptance and Use of Technology Model" (UTAUT) was developed which is an improved TAM Model (Chiemeke & Ewwiekpaefe, 2011). They opined that when potential adaptors are presented with latest technology resources, a number of factors influence them about the time and the procedure of adopting them. As this study argues, the issues raised by Chiemeke & Ewwiekpaefe (2011) are related to enablers and barriers to technology adoption.

Measuring adopters' perceptions of the technology has been adopted and entitled by many researchers in the field of ICT innovation and adoption as a "Classic Issue", and this is because of its paramount value (Venkatesh et al., 2003; Moore & Benbasat, 1991). Therefore, this study is dealing with determining significant barriers to state-of-the-art IS adoption; the "Classic Issue" could be suitable and applicable to it.

Furthermore, classic issue has also been one of the problems facing IS managers as a result of the rapid pace of technological advancement showing no signs of changing or slowing while some constraints leave other countries behind (Chin & Marcolin, 2001). As this study argues, this argument made this empirical investigation of significant barriers to state-of-the-art IS adoption by Nigerian INOCs an essential one.

In addition, Ashraf, Swatman and Hanisch (2011) have developed what they call "extended framework" that demonstrates that ICT resources, if fully adopted, can lead to development. However, they further argue, that this development can only be achieved if constraints are addressed and eliminated. Arguably, this fits the aim of this study, which was to see to the improvement of the use of IS in the Nigerian oil and gas industry, via investigating the significant barriers to the adoption of the state-of-the-art IS by the indigenous oil sector.

5.2.1 The perception of using innovative ICT resources

Researchers confirmed that, perception of using Innovative ICT resources is more important than perceptions of the Innovative technology itself (Venkatesh et al., 2003; Moore & Benbasat, 1991). According to researchers, innovation diffusion research suggests that the most essential innovation characteristics are; perceived compatibility, perceived relative advantage, perceived cost and perceived complexity. As this study argues, the perception of stakeholders in Nigerian INOCs on managerial attitude may assist towards identifying the significant barriers to the adoption of state-of-the-art IS.

5.3 Theoretical foundations in ICT research

Innovation diffusion theory approach has been reviewed in this study. This is because of its high level of reliability and validity that have been confirmed by many prominent researchers (Kim, 2011; Rai, 2003; Rajagopal, 2002; Moore & Benbasat, 1991). Further, its compatibility to ICT adoption and diffusion is second to none, because of the fact that, it has been primarily designed and constructed in order to accommodate this aspect of ICT adoption research and has been applied in many

studies which give a reliable and excellent result (Rajagopal, 2002; Premkumar, Ramamurthy & Nilajanta, 1994; Moore & Benbasat, 1991).

In addition, as discussed in this chapter, Section 5.5, the idea of "Task-Technology Fit" was also reviewed. The two components of "task" and "technology" are relevant to our study of IS adoption in the oil and gas sector, particularly in developing countries, Nigeria inclusive.

5.4 Innovation diffusion theory

Innovation diffusion theory explains and enunciates the method by which an innovation is transmitted through certain channels over a period of time among the members of a community, organisation or social system (Henry, 2008; Rogers, 2003). This study adopted a significant idea of barriers to innovation diffusion theory, as it deals with state-of-the-art innovative IS resources in the oil and gas sector.

Peterson (1985) explains this diffusion process by identifying four essential elements; these are "Innovation" (means object, practice or idea that is perceived to be latest or up-to-date); the "channels of communication" (accommodate the means or medium by which information is technically transferred or transmitted within the system); the "social system" (means the community of organisations and/or individuals that are probably potential adopters of the innovative technology); and "time" (means the speed or acceleration by which members of social system adopt the innovative ICT facility). One may argue that, innovation in this context comprises state-of-the-art upstream IS for complete real-time online monitoring while the channel of communication is through the internet and staff training which takes place from time to time. Finally, social system entails INOCs in Nigeria.

There are two streams that accommodate research on diffusion theory in ICT: these are (i) research on innovation diffusion processes (Rajagopal, 2002; Brancheau and Wetherbe, 1990) and (ii) research on the attributes of innovations (Rajagopal, 2002; Moore & Benbasat, 1991). Similarly, one may argue that there is a need to identify the constraints and significant barriers to state-of-the-art IS diffusion in Nigerian INOCs.

However, this research is more related to the first stream, which deals with the obstacles to the innovation diffusion process. However, the second stream has also been accommodated in the study as it relates to the performance of IS. Regarding the second stream, there are five characteristics of an innovation which directly affects

the diffusion of ICT innovation and its adoption, as stated by Rogers (1983). These are:

i) relative advantage; (ii) compatibility; (iii) complexity; (iv) observability and (v) trialability (Kim, 2011; Moore & Benbasat, 1991; Tornatzky & Klein, 1982). Furthermore, after critical analysis, Moore and Benbasat (1991) added to these three characteristics with; visibility, trialability and image.

Similarly, among the most outstanding studies on adoption of technology and its supporting components, which becomes a reference point for many researchers, is that of Rogers (1983), which has been excellently integrated by Moore and Benbasat (1991). In this research, they identified the impact of these eight characteristics of IS adoption by empirically determining and measuring users' perceptions of adopting an ICT innovation. In this outstanding research, the relative advantage is explained as the degree to which an IS innovation is considered as better than precursor, existing technology or legacy. Compatibility means the degree to which an ICT innovation is consistent with needs, existing values and past experiences of potential adopters. Complexity means the difficulty introduced by innovative IS as a result of using it. Observability means the simplicity of observing the result or final output of the ICT innovation. Trialability means the series of experiments that could be performed with the innovative IS before its total adoption. In line with this, this study seeks the opinion of experts in order to identify the factors that are significant barriers to state-of-the-art IS adoption by management of INOCs in Nigeria.

One of the most outstanding features outlined by Moore and Benbasat (1991) is its applicability to a wide variety of technological innovations, and particularly innovative ICT. Furthermore, innovation diffusion theory has been empirically applied and successfully implemented into various contexts and fields of knowledge in an attempt to vindicate innovative ICT diffusion and elimination of constraints that impede their adoption (Kim, 2011; Rai, 2003). The application areas include, computer-aided software engineering implementation (Rai, 2003), Mobile system for ticketing services (Mallat et al., 2009), Analysis, design and implementation of integrated enterprise resource planning systems (Rajagopal, 2002); and interchanging the electronic data system (Premkumar, Ramamurthy & Nilajanta, 1994). These are some of the systems whose diffusion in so many areas and countries has been determined using innovation diffusion theory. This study argues that, the situation is not the same in INOCs of most developing countries, Nigeria inclusive.

5.4.1 The diffusion approach in hardware and software resources

In the context of innovative ICT resources, the diffusion theory has been applied in relevant hardware and software applications and simulations. These studies include perception of adopters on the latest software practices in developed nations and their constraints, which were carried out by Zmud (1983). In line with this, Brancheau and Wetherbe (1990) conducted research on spread sheet software. Similarly, Nilakanta and Scamell (1990) conducted research on the innovation and diffusion of database design tools and techniques. And in the same year, Gurbaxaci (1990) conducted similar research on BITNET.

5.4.2 Diffusion of ICT outsourcing

In recent decades, some organisations have adopted and handed over the management of ICT resources and its general infrastructure to external organisations. This modern approach has been entitled "Diffusion of ICT Outsourcing". These modern approaches include "IT networks joint -ownership" like, industry-wide electronic data interchange, and code-development of application software", such as multi-company consortium (Loh & Venkatraman, 1992).

Outsourcing is divided into two, based on the extent of its adoption; these are Outsourcing of all ICT infrastructures, and Outsourcing of only significant components of the users' ICT infrastructure. Diffusion of ICT outsourcing means the extent of the transfer of technical management of IS by an organisation to an external ICT organisation. One may argue that outsourcing is adopted by some Nigerian INOCs but its efficiency has not been confirmed.

5.5 Research model

As it has been earlier discussed superficially in Section 5.4 of this chapter, the rapid acceleration of adoption processes is established when users are able to transfer knowledge of the precursor system or legacy system to the latest up-to-date innovative system (Gregan-Paxton, 1997). As this study argues, this will not be difficult in the oil and gas sector, because of the quality of the user-friendly resources as well as their similarities with the legacy system.

Furthermore, innovative technology can be adopted within a short period of time if the facility is compatible with old technology being used, and is less complex, and as a result reduces cognitive efforts for executing a task and leads to higher operational

and efficient performance (Ratchford, 2001). Similarly, a "fit" between the old system and the proposed innovative system motivates users to easily and ceremoniously adopt the innovative system (Dennis, Wixom & Vandenberg, 2001; Goodhue & Thompson, 1995). As a result, this study emphasises the need for an assessment of ICT resources for E&P before their adoption and subsequent update of their products from time to time.

In addition, the task-technology fit literature gives and establishes an efficient and fabulous conceptual framework to explain this old-innovative system fit or precursor-innovative system fit, and subsequently presents an excellent background for adopting hybrid integrated systems. Similarly, it is of great importance to state the difference in the adoption of individual and organisational information systems. The organisational information system is usually adopted through a process entitled "acquisition-and-evaluation model approach", while individual information system is normally adopted through an "evaluation-and-acquisition model" (Kim, 2011; Ratchford, 2001). As this study argues that, "acquisition-and-evaluation model" will be more compatible with indigenous oil companies because it deals with organisational IS in the context of the oil and gas industry.

The procurement of organisational IS by the organisation starts with a decision to adopt, confirmed by executives and decision makers, with recommendations from their technical experts and trusted end-users (Rai, 2003; Ratchford, 2001). In line with this technical observation, this study accepts only the input of technical experts and trusted end users during data collection, as they are in the best position to give their opinion and views on ICT resources in oil and gas.

5.6 Background of barriers to ICT adoption for model design

There are barriers to ICT adoption in developing countries (Lal, 2007; Kapurubandara & Lawson, 2007). They emphasised that, these barriers are classified into internal and external barriers. Internal barriers are the constraints that can be eliminated by the organisation, while external barriers can only be eliminated by a foreign body outside the organisation. This foreign body is mostly the country's government. As this study argues, considering the factors that impede the adoption of state-of-the-art IS, the classification of barriers into internal and external barriers is more applicable and suitable to this research.

However, these barriers are also classified into organisational factors, technological factors and environmental factors (Kunda & Brooks, 2000). Organisational and technological factors are constraints that mostly deal with internal barriers, while environmental factors mostly deal with external barriers.

Interestingly, frameworks for accessing barriers to ICT adoption in developing countries have been developed by researchers. However, Kurnia and Johnson (2000) noted that, these frameworks mostly look like just a general framework using the technology, external environment and the capabilities of the organisation. Similarly, Tornatzky and Fleischer's (1990) model emerged earlier, and Kurnia and Johnson's (2000) looks like its duplication. In addition, Scupola (2002) on Tomatzky and Fleischer's model emphasised that, external environments which include government intervention, competitive pressure, buyers and suppliers are indeed the most critical and influential factors affecting the adoption of ICT, internet and other resources.

Moreover, some researchers observed that, government support is very influential for ICT adoption (Scupola, 2003; OECD, 2000). They noted that, this government support includes financial supports, developmental support and tax breaks. Due to the exorbitant price of ICT innovative resources, information systems outsourcing is becoming an influential factor and suitable for many sectors that are financially handicapped or not interested in adopting through in-sourcing.

Furthermore, weak organisations adopt modern and efficient IS through outsourcing, because of difficulties in overcoming barriers to adopt in-house ICT procurement as explained earlier. One may argue that some Nigerian INOCs seem to employ outsourcing of IS and other exploration and production activities because of their weakness in overcoming barriers where they exist.

5.6.1 Framework of barriers to E-commerce & ICT adoption in developing countries

As discussed in Chapter 4 Section 4.2 and Section 4.8 of this study, so many significant factors have hindered the adoption of ICT resources in developing countries, Nigeria inclusive. Significant barriers vary widely among countries (Lawrence & Tar, 2010). Furthermore, some theoretical frameworks have been developed by researchers in order to assess the barriers impeding the adoption of ICT infrastructure and e-commerce in developing countries (Lawrence & Tar, 2010; Kapurubandara, 2007).

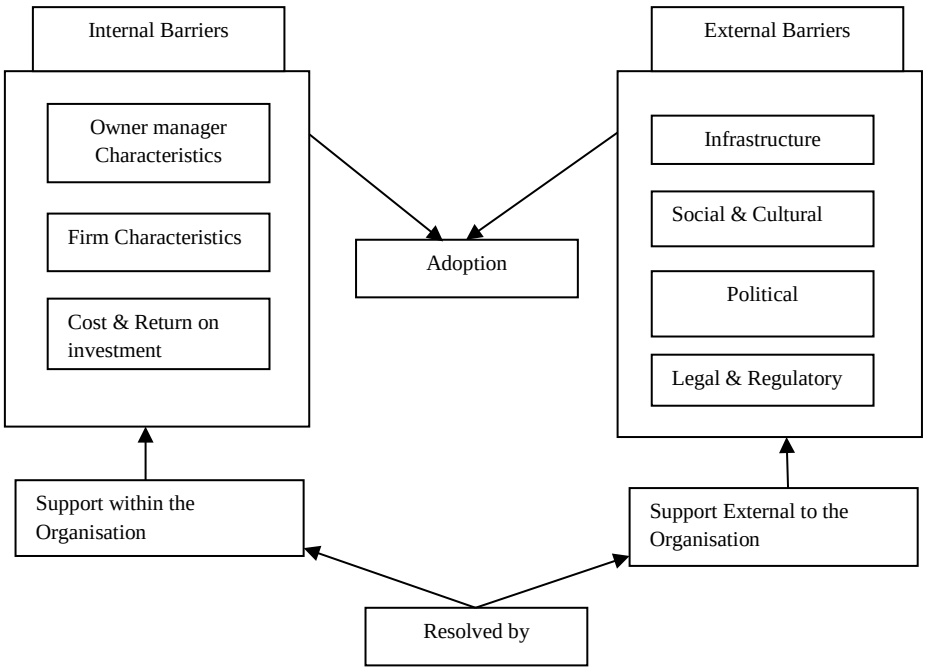
In line with this, two relevant frameworks were identified and analysed towards the development of a model for this study. These frameworks were analysed based on their compatibility with developing countries in general and the oil and gas sector more specifically.

5.6.2 Review of "framework for barriers" to ICT adoption in developing countries

An intensive review of framework barrier developed by Lawrence and Tar (2010) has indicated some strengths and weaknesses when applying it to some developing nations. As this study argues, the greatest weakness discovered by this study is the lack of addressing and capturing environmental factors extensively as a significant barrier to ICT resources and e-commerce adoption in developing countries. In addition, the issue of maintenance was not addressed by the framework and it is a very significant factor that impedes the sustenance of e-commerce and state-of-the-art IS by local oil companies. Similarly, managerial attitude, such as interest, knowledge, dynamism, ability and ICT-oriented culture were not critically addressed and considered as barriers to ICT adoption.

5.6.3 Barriers to adoption model

A critical review of "barriers to adoption model" by this study has identified it as a good model in terms of some selected developing countries, such as Sri Lanka where the model was tested (Kapurubandara & Lawson, 2007). However, this study argues that, the model has some weaknesses in terms of addressing external barriers to ICT adoption in developing countries. Some of the significant barriers that impede ICT and e-commerce adoption in developing countries include government incentives and environmental factors, such as corruption and security challenges. In addition, other internal barriers, such as maintenance attitude, renewal of licenses and training and retraining of technical staff are not addressed by the model. The "Barriers to adoption Model" is presented in Figure 5.1.



(Source: Kapurubandara & Lawson, 2007)

Figure 5.1: Barriers to adoption model

Interestingly, in spite of the weaknesses identified in the model, it also has good attributes and features that, if modified, integrated or extended, could be applicable to many or almost all of the developing countries as this study strongly argued. As a result, a significant idea of the model can be adopted towards developing a new model for indigenous/local/independent oil companies of developing countries. However, because of lack of relevant literature with regard to ICT in Nigerian INOCs and also the peculiar situation of most African countries, another interview was conducted in order to develop a new model and also identify significant barriers to state-of-the-art IS by Nigerian INOCs. The barriers can be used in quantitative aspect of the study to validate the findings. The analysis of the interview is presented in the next sections of this chapter.

5.7 Analysis and Presentation of Interview Findings

5.7.1 Introduction

This section analyses and presents the data collected through interview surveys. To accomplish this, the section is divided into four sub-sections. The next Sub-ection 5.7.2 following this introduction presents an overview of interview analysis. Sub-

section 5.7.3 discusses and presents interview analysis of significant assertions. And Sub-section 5.7.4 concludes the analysis of the interview.

5.7.2 An overview of interview analysis

Interview analysis and subsequent findings, are the major target of conducting the interview-survey. To accomplish the aim of analysing the interview as well as attaining valid and reliable findings, certain methods and procedures must be adopted and followed sequentially. These methods and procedures comprise generating, coding and interpreting data with the aim of attaining meaningful information with respect to the research questions and objectives of the study (Stephen, 2009; Grbich, 2007; Miles & Huberman, 1994). Generally, these steps of the procedure include but are not limited to data writing, data display, data reduction, data interpretation and generating its conclusion (Stephen, 2009; Miles and Huberman, 1994).

The interviewees who participated in the study were assured in the process of organising and conducting the interview that their identity will not be disclosed and only the data received from them will be analysed and utilised. Therefore, the study will analyse the data that has been collected after transcription with confidentiality (See Appendix A for interview schedule).

The six senior personnel interviewed comprises of the engineering manager, general manager, computer scientist, exploration and production engineer, senior geologist and information systems analyst are represented and coded for confidential purposes with acronym as IP01, IP02, IP03, IP04, IP05 and IP06 respectively. Their responses were transcribed and will be analysed and discussed elaborately in this chapter.

In line with the above argument, the study has adopted its proposed algorithm after minor corrections and amendments during its pilot study. The algorithm is presented in Chapter 6, Section 6.5.1.8 of this thesis.

5.7.3 Interview analysis of significant assertions

The “qualitative content analysis” was used as a way of understanding the reality on the ground with respect to state-of-the-art IS adoption by Nigerian INOCs. Consequently, seven variables were identified to form the basis of the interviews and the subsequent analysis. These are:

i. knowledge of the state of IS in the upstream sector of the Nigerian oil and gas industry;
ii. in-house state-of-the-art upstream IS in Nigerian INOCs;
iii. state-of-the-art upstream software and licenses' renewal;
iv. state-of-the-art hardware adoption by the Nigerian INOCs;
v. state-of-the-art online monitoring systems by the Nigerian INOCs;
vi. barriers to state-of-the-art upstream IS adoption by the Nigerian INOCs; and
vii. solutions to the significant barriers that limit the adoption of state-of-the-art IS adoption.

5.7.3.1 Knowledge of upstream IS in Nigerian INOCs

The general response received from the interviewees indicated their in-depth knowledge with the current state of upstream IS used by Nigerian INOCs and its usage for exploration and production. Furthermore, all the six interviewees- IP01, IP02, IP03, IP04, IP05 and IP06 stated that, they have knowledge of the current state of the upstream IS. Their responses are displayed in Table 5.1.

Table 5.1: Interviewees' role and knowledge of upstream IS in Nigerian INOCs

Interview Participant	Findings on the knowledge of IS	Quotations	Role in Oil & Gas Sector.
IP01	Knowledgeable	"Yes, I am very much familiar with and have a good knowledge of upstream IS because of my background as an engineer who has been working in the Nigerian oil sector for almost 25 years. This research is timely and important to the sector."	Engineering Manager.
IP02	Knowledgeable	"Yes I really am very familiar with it and knowledgeable."	General Manager.
IP03	Knowledgeable	"I have been in the oil sector for more than two decades. I am sure that I can speak authoritatively about the sector. And I personally appreciate your study as it will be essential to the indigenous sector."	Computer Scientist.
IP04	Knowledgeable	"Yes"	Exploration and Production Engineer.
IP05	Knowledgeable	"Yes"	Senior Geologist.

IP06	Knowledgeable	"Yes (MIS)"	Information Systems analyst.

(Source: Author generated)

From Table 5.1, the interviewees emphasised that, they have spent many years in the sector ranging from 20 years to 25 years as stated by IP01 and IP03. Further, based on their general knowledge with the state of upstream IS in the Nigerian INOCs, IP01 and IP03 noted that, this research is timely and essential to the indigenous oil sector.

As a result of their confirmation with the general knowledge of IS in Nigerian INOCs, the study considers it as a step forward towards generating valid data. It is indeed a reality that interviewing those that have no first-hand information may mislead the study.

5.7.3.2 In-house adoption of state-of-the-art upstream IS

As outlined by relevant literature in Sub-section 3.15.4 of Chapter 3 of this thesis, outsourcing of state-of-the-art IS seems to be insufficient and ineffective in other sectors. However, this analysis considers the responses of interviewees with respect to the effectiveness or otherwise of outsourcing by Nigerian INOCs.

The general response of the interviewees also indicated that, the quality and adequacy of the IS used for exploration and production through in-house adoption were not of the state-of-the-art standard.

Table 5.2: Availability of adequate in-house State-of-the-art upstream IS by Nigerian INOCs

Interview Participants	Findings on the availability of adequate state-of-the-art Upstream IS	Quotations
IP01	Not available.	"Before I answer your question, I need to categorise Nigerian indigenous oil companies into two: there are functioning and non-functioning oil companies. Functioning oil companies partake in the exploration and production of oil and gas, but they mostly depend on outsourcing their E&P activities. Even in these circumstances, they don't get world-class information systems for E&P activities in comparison with international oil companies"
IP02	Not available	"Generalisation in answering questions is sometimes misleading. However, the very few indigenous oil companies I work with or interact with directly don't have state of the art Upstream IS. There may be some that have, but I am not aware of them. They sometimes depend on outsourcing which is not effective"

IP03	Not available.	"Some of the oil companies are not at all serious. They have all the economic power to be up-to-date, but unfortunately they are not… They have everything financially to set the pace for others to follow, sadly, they don't. Our local oil companies do not purchase in-house state-of-the-art information systems"
IP04	Not available.	"No, Nigerian indigenous oil companies don't have it."
IP05	Not available.	"No, they don't have it."
IP06	Some few may have it.	"A few do have some systems but they are not adequate"

(Source: Author generated)

From Table 5.2, almost all the six interviewees outlined the inefficiency of outsourcing with regard to Nigerian INOCs and unavailability or inadequate in-house deployment of state-of-the-art IS. Furthermore, four out of the six personnel interviewed stated clearly that, standard in-house state-of-the-art IS was not available in Nigerian INOCs. However, one of them said in-house adoption of the state-of-the-art IS "Not available in almost all", while the remaining one interviewee said that, few do have some in-house IS, but not adequate and world-class upstream IS.

The four interviewees indicated that, in-house adoption of the state-of-the-art IS was not available in the Nigerian INOCs based on the current situation of the sector. A major view expressed by the interviewees as summarised and indicated by interviewee IP02 was that:

> *"Generalisation in answering questions is sometimes misleading. However, the very few indigenous oil companies I work with or interact with directly don't have state-of-the-art Upstream IS. There may be some that have, but I am not aware of them (IP02).*

The interviewee IP02, as stated above, indicated the unavailability of state-of-the-art IS in INOCs based on his knowledge of the sector. However, he also admitted there might be some that have in-house state-of-the-art IS, but he is not aware of them. He indicated that generalisation in answering a question that affects 49 INOCs requires precautions in order to avoid misleading answer. As a result, he answered the question based on his experience and knowledge. However, the interviewee IP03, IP04 and IP05 stated the following with regard to the availability of in-house adoption of the state-of-the-art IS by Nigerian INOCs. IP03 noted that:

> *"Some of the oil companies are not serious at all. They have all the economic power to be up-to-date, but unfortunately they are not... They have everything financially to set the pace for others to follow, sadly, they don't.*

Our local oil companies do not purchase adequate in-house state-of-the-art information systems (IP03).

Similarly, IP04 also stated that:

"No, Nigerian indigenous oil companies don't have it (IP04)

While IP05 stated his view by indicating the unavailability of in-house adoption of the state-of-the-art IS by Nigerian INOCs. He noted that:

"No, they don't have it (IP05)

However, IP01 categorised the Nigerian INOCs into two: functioning oil companies; and non-functioning ones. He explained that, functioning oil companies depend mostly on outsourcing their exploration and production operations and only a few of them adopted IS through in-house deployment. The major opinion of the interviewee IP01 is presented below.

"I need to categorise Nigerian INOCs into two: there are functioning and non-functioning oil companies. Functioning oil companies partake in the exploration and production of oil and gas, but they mostly depend on outsourcing their E&P activities. Even in these circumstances, they don't get world-class IS for E&P activities compared to international oil companies (IP01).

The perception of the IP01 in spite of categorising the oil companies into two has indicated that, they do not have adequate state-of-the-art IS for exploration. This view has been the same with the view of the three interviewees discussed earlier. The interviewee IP01 put the absence of state-of-the-art IS adoption down to many factors, which includes reliance on outsourcing of E&P activities.

Consequently, the interviewee IP06 was the only stakeholder among the interview respondents, who had no clear view on the issue. He only stated that, some Nigerian INOCs have some systems but did not mention state-of-the-art IS adoption. He responded that:

"A few local oil companies here in Nigeria do have systems, but they are not adequate (IP06)".

In the final analysis, considering all the views stated by all the six interviewees, one could deduce that, most of the Nigerian INOCs, if not all, did not procure in-house state-of-the-art IS for exploration and production of oil. In addition, outsourcing that some depend on is unreliable in the INOCs, as stated by three interviewees. Similarly,

their assertions are consistent with the conclusion of literature of other sectors regarding the issue (see please Chapter 3, Sections 3.14.1 and 3.14.4 of this thesis).

5.7.3.3 State-of-the-art upstream software and licenses' renewal by INOCs

The study sought the opinion of the six interviewees on the availability or otherwise of state-of-the-art upstream software and as well as licenses' renewal timely and appropriately. The six interviewees almost share the same argument with regard to the availability of state-of-the-art upstream software and appropriate licenses' renewal. However, their arguments were very similar to each other.

Table 5.3: State-of-the-art upstream software and Licenses' Renewal by Nigerian INOCs

Interview Participant	Findings on the availability of the state-of-the-art software and timely licenses renewal	Relevant Quotations
IP01	State-of-the-art software not available in most of them.	"They don't have it. The very few that try E&P hardly ever renew their software licenses, due to the high cost of renewal. To be fair, I know only of two local oil companies here in Nigeria who try to do so, but they are below average if you compare them with independent oil companies in other developed countries. To be frank with you, I am not completely happy with the status of our local oil companies with respect to ICT procurement and development."
IP02	State-of-the-art software not available in most of them.	"There are different companies that design and produce software, such as schlumberger, BMI, Halliburton and the rest. Their software applications are good, but some of them are more efficient and sophisticated in terms of quality. I know that most local companies go for low quality among the latest. You know that the software we (indigenous oil companies) use is not designed and produced in Nigeria. It is foreign, at least. However, I am assuring it is not the best by international standards. Renewing software licenses I am sure some of us do, but I cannot guarantee whether this is done timely and appropriately."
IP03	State-of-the-art software not available in most of them.	"I can confirm that only two of them are up-to-date, and most of them are somehow below average. Even these two require more effort and investment to be more productive. Most of them are no longer interested in the exploration of oil. They are owned by politicians and this is where all of their interest lies."
IP04	State-of-the-art software not available.	"No, they don't have it"
IP05	State-of-the-art software not available.	"Majority No. those that do have it, renew their licences timely and appropriately"
IP06	Not available in most of them.	"Only a few, the private ones, and license renewal depends on the availability of mega contracts."

(Source: Author generated)

Five interviewees out of the six were in agreement that, state-of-the-art software for E&P was not adopted in the majority of Nigerian INOCs as well. However, only one

interviewee stated that, all INOCs don't have state-of-the-art software and licenses' renewal completely. The five interviewees also stated that, the state-of-the-art software and licenses' renewal can also be not timely.

Furthermore, the major arguments that emerged from the five stakeholders interviewed seem to indicate the availability of state-of-the-art upstream software in only a few of the INOCs of Nigeria, which are mostly not adequate and sufficient. Similarly, their major arguments are presented here:

> *"They don't have it. And even those that try E&P hardly renew their software licenses, due to the high cost of renewal. To be fair, I know only two local oil companies here in Nigeria who try to do so, but they are below average if you compare them with independent oil companies in other developed countries… (IP01).*

> *"I know that most local companies go for low quality among the best. You know that the software we (indigenous oil companies) use is not designed and produced in Nigeria… As for renewing software licenses, I am sure some of us do, but I am not sure if this is done timely and appropriately (IP02).*

> *"I can confirm that only two of them are up-to-date, but most of them are somehow below average. Even these two require more effort and investment to be more productive. (IP03).*

> *"Majority No. those that do have, renew their licences timely and appropriately (IP05).*

> *"Only a few, the private ones, and license renewal depends on the availability of mega contracts (IP06)."*

The arguments of the five stakeholders presented seems to indicate that, very few INOCs in Nigeria procure state-of-the-art upstream software and maintain the renewal of their licenses. Moreover, even in that situation the software and renewal of licenses seems to be insufficient, inadequate and not timely as well.

Consequently, only one interviewee indicated the complete unavailability of state-of-the-art upstream software and absence of licenses' renewal appropriately. He opined that: *"No, they don't have it (IP04).*

In the final analysis, the most popular argument that emerged, indicated that, only a few, approximately two, INOCs in Nigeria procure state-of-the-art upstream software

and renew their licenses. However, it seems that, they were neither sufficient nor adequate. The study will extensively discuss the significant barriers that limit the adoption of state-of-the-art IS by Nigerian INOCs in Chapter 8 of this thesis.

5.7.3.4 State-of-the-art upstream hardware by INOCs

The study sought the opinion of the six interviewees on the availability or otherwise of state-of-the-art upstream hardware by Nigerian INOCs. The six interviewees did share the same argument with regard to the availability of state-of-the-art hardware for E&P. Their arguments were mostly the same in meaning but differed in words.

Table 5.4: State-of-the-art Hardware in Nigerian INOCs

Research Participant	Findings on the state-of-the-art Hardware in INOCs	Relevant Quotations
IP01	State-of-the-art hardware not available in most of them.	"If you mean computer hardware I know many have it. Even individuals have computers in their homes. However are they the latest kind/type? Are they networked efficiently? Are they enough in terms of quality and quantity for upstream operation? Certainly not! However some very few are better than others. Most of their computers are not for E&P operation, but for managerial activities."
IP02	State-of-the-art hardware not available in most of them.	"They mostly don't have it. Due to negligence, they mostly depend on outsourcing for most of their activities through international consultants of E&P and this is very inefficient. Most of the consultants have expertise in information technology, but are very inefficient in the field of exploration. Outsourcing in Nigeria is due to laziness."
IP03	State-of-the-art hardware not available in most of them.	"They have computers, because they are relatively cheap. They don't have excellent SCADA and latest 3-D capabilities. Go and visit multi-national oil companies and compare them with our local oil companies and you will be confused. As I said before, some local companies are relatively good, but they are still below standard. Today, the latest technology is necessary for effective E&P."
IP04	State-of-the-art hardware not available.	"No"
IP05	State-of-the-art hardware not available.	"Majority No"
IP06	Not available in most of them	"Not adequate in INOCs in Nigeria."

(Source: Author generated)

From the Table 5.4, the collective argument indicated unavailability of adequate world-class hardware for E&P in Nigerian INOCs. However, they stated that, these hardware gadgets were available, but seemed to be inadequate and insufficient. The summary of their major arguments are presented here. IP01 stated that:

Certainly not! However some very few are better than others. Most of their computers are not for E&P operation, but for managerial activities (IP01).

The above opinion seems to express inefficient hardware for E&P operation. In addition, another interviewee observed inefficient state-of-the-art upstream hardware and stated outsourcing as one of the obstacles that limits in-house adoption. The interviewee IP02 stated:

"They mostly don't have. Because of negligence, they mostly depend on outsourcing for most of their activities through international consultants of E&P and this is very inefficient. Most of the consultants have expertise of information technology, but are inefficient in the field of exploration. Outsourcing in Nigeria is due to laziness (IP02).

In support of this argument, another interviewee among the stakeholders noted that, some INOCs were relatively good compared to others. However, in spite of this, they suffered from inadequate state-of-the-art SCADA systems and world-class 3-D capabilities. Further, the interviewee IP03 stated that:

"They have computers, because they are relatively cheap. They don't have excellent SCADA and latest 3-D capabilities. Go and visit multi-national oil companies and compare them with our local oil companies and you will be confused. As I said before, some local companies are relatively good, but they are still below standard. Today, the latest technology is necessary for effective E&P (IP03).

Furthermore, the remaining three interviewees responded briefly by "No", the second one said "Majority No" and the last one among them said "Not adequate".

Similarly, their arguments enunciated that, the majority of INOCs did not procure state-of-the-art upstream hardware. Additionally, even a few local oil companies that adopt the state-of-the-art upstream hardware were not sufficient and adequate for their exploration and production.

5.7.3.5 State-of-the-art online monitoring systems

State-of-the-art online monitoring systems has been an essential component of state-of-the-art IS. Similarly, real-time online monitoring systems are inevitable to improve and maintain performance during E&P of oil and gas as in Chapter 2 Section 2.10 of this thesis.

Unfortunately, the arguments of all the six stakeholders who participated during the interview-survey have confirmed that state-of-the-art online monitoring systems for

E&P was not available in the Nigerian INOCs meaning that all six interviewees shared the same opinion.

Table 5.5: State-of-the-art online monitoring systems in Nigerian INOCs

Interview Participant	Findings on state-of-the-art online monitoring systems	Relevant Quotations
IP01	State-of-the-art online monitoring systems not available.	"They don't have state-of-the-art online monitoring systems."
IP02	State-of-the-art online monitoring systems not available.	"The ones I know usually have stand-alone systems not online monitoring systems."
IP03	State-of-the-art online monitoring systems not available.	"I assure you they don't have it ...I know we have a few indigenous oil companies that perform above average, but I know they will not be more than five % of our local oil companies."
IP04	State-of-the-art online monitoring systems not available.	"No"
IP05	State-of-the-art online monitoring systems not available.	"No"
IP06	State-of-the-art online monitoring systems not available.	"No"

(Source: Author generated)

During their responses in the process of the interview, the interviewees IP01, IP02 and IP03 have stated their assertions with lengthy explanations compared to the rest. Their major arguments in answering the interview questions are captured and presented as:

> *"They don't have state-of-the-art online monitoring systems (IP01).*

However, the second interviewee responded based on his experience. As a result, he answered the interviewer by saying:

> *"The ones I know usually have stand-alone systems not online monitoring systems (IP02)".*

The third interviewee IP03 responded by assuring us it was unavailable. He said:

> *"I assure you they don't have state-of-the-art online monitoring systems ... I know we have a few indigenous oil companies that perform above average (IP03)".*

The above three arguments have represented the general responses of the engineering manager, general manager and computer scientist respectively.

Moreover, the remaining three interviewees responded by saying only one word, i.e. “No” without making any explanation.

In the final analysis, all the six interviewees were in agreement on the unavailability of state-of-the-art real-time online monitoring systems in Nigerian INOCs. It is hereby submitted that state-of-the-art monitoring systems and supporting hardware were not deployed and adopted by INOCs. This might lend support for this study, and further scrutiny with the view to examining the need to go further and discover the significant barriers and obstacles that impede the adoption of this state-of-the-art real-time online monitoring system that improves performance.

Undoubtedly, this indicates a clear disparity and gap as regards online monitoring systems between IOCs and Nigerian INOCs. Relevant literature of other countries suggests that, the state-of-the-art SCADA and real-time online monitoring systems have advanced from previous stand-alone systems to community networked workstations that are always connected to the internet (Stig, Skramstad & Hagen, 2009; Davison, Martinsons & Kock, 2004). Therefore, its adoption could assist INOCs towards improving their performances.

5.7.3.6 Significant barriers to state-of-the-art upstream IS adoption

There are many significant barriers that limit the adoption of ICT infrastructure and skill development in developing countries as reviewed in Chapter 3, Section 3.2 as well as Chapter 4, Sections 4.2, 4.3 and 4.4 of this thesis. However, as this study observed the significant barriers that impede or limit the adoption of state-of-the-art IS by Nigerian INOCs have not been investigated and recorded in any available document.

In line with this, the opinions of six interviewees were sought on the significant impediments or obstacles that limit the adoption of state-of-the-art ICT resources as well as world-class skill and expertise.

Table 5.6: Significant Barriers to state-of-the-art IS adoption by Nigerian INOCs

Interview Participant	Findings of Significant Barriers	Relevant Quotations
IP01	Corruption. Lack of knowledge. Managerial attitude.	"Corruption is the biggest barrier. There may be other reasons, like insecurity, lack of managerial knowledge or managerial attitude. However corruption should definitely come first".
IP02	Lack of interest. Insecurity.	"Mismanagement of funds and insecurity in the country. I think lack of interest or insecurity in the country".
IP03	Environmental issues. Outsourcing of ICT. Managerial attitude. Lack of gov't motivation.	"There are barriers, like environmental challenges, managerial attitude, outsourcing of ICT resources and the cost of state-of-the-art ICT resources and the lack of government motivation".
IP04	Funding. Management perception. Outsourcing of technology	"Funding in general, outsourcing of technology and Management perception on the importance of IT in E&P biz". "Mismanagement of funds as well as lack of security of lives and property …"
IP05	Inadequate skill development. Managerial attitude. Cost of resources.	"Organisational capacity in terms of staff skills and expertise, learning and growth is weak. "Financial crimes and lack of security and safety. "International processes in terms of process bottlenecks, proper delineation between wants and needs by management is most often absent. "Even though the Nigerian content law considerably helps in building these companies' capital base, funding is still a major issue for some companies.
IP06	Poor managerial attitude.	"Corrupt practices, poor bureaucracy, and poor attitude to efficiency by the management and lack of security. For the government-owned indigenous companies, the feeling of 'not my company' by the employees.

(Source: Author generated)

The significant barriers mentioned by the interviewees as in Table 5.6 can be discussed and presented here.

5.7.3.6.1 Environmental factors

Environmental challenges have been identified as major obstacles to state-of-the-art IS adoption by all the interviewees who participated in the study. The six interviewees mentioned the environmental factors with different names that could be summarised as "corruption" and "insecurity". The interviewees did share the same opinion with regard to this challenge.

Furthermore, all the six interviewees participated in the study mentioned some significant barriers to the adoption of state-of-the-art IS by Nigerian INOCs. All of

them emphasised “corruption” and “insecurity” with different words meaning almost the same thing. Their major arguments can be summarised and presented here as:

Interviewee IP01 noted that: “Corruption is the biggest barrier. There may be other reasons, like insecurity…. However, corruption should definitely come first (IP01).” Similarly, the interviewee IP02 stated corruption using the word “mismanagement of funds and insecurity in the country”. He said: “I think lack of interest, mismanagement of funds.” In addition, the interviewee IP03 used the phrase “environmental challenges” that technically accommodates both corruption and insecurity. He responded to the question on significant barriers to state-of-the-art IS adoption by Nigerian INOCs with the following words while indicating corruption and insecurity. The interviewee IP03 opined that:

> *“There are many barriers, like environmental challenges… lack of government motivation” (IP03).*

Further, the interviewee IP04 also opined that:

> *“Mismanagement of funds as well as lack of security of lives and property …”*

Corruption and insecurity are among the major constraints that limit the adoption of state-of-the-art IS used by Nigerian INOCs. Moreover, the interviewee IP05 also indicated that the environmental factors with the words “financial crimes” and “lack of safety and stability”. Finally, the last interviewee IP06 also confirmed the environmental factors with the following words:

> *“Corrupt practices, bureaucracy, poor attitude to efficiency and lack of security… (IP06).”*

Unfortunately, as stated earlier superficially, from the above analysis, all the six interviewees have indicated that corrupt practices and insecurity were among the major significant barriers that limit the adoption of state-of-the-art IS used by Nigerian INOCs. Similarly, in spite of the lack of relevant literature on ICT adoption by Nigerian INOCs, literature on corruption and insecurity on Nigeria is in abundance. Interestingly, the assertions of the six interviewees are consistent with the relevant literatures available. However, the literature was not specifically on INOCs but on the Nigerian government and its agencies.

The literature suggests that, corruption is one of the factors that always impede the development of African countries generally (Ribadu, 2012; Obayelu, 2007). In Nigeria, corruption is one of the most dangerous problems (Sachs, 2007; Ayobolu, 2006). Unfortunately, the country has been described as one of the leading nations in the world that has shamefully excelled in perpetrating corrupt practices and fraud (Ribadu, 2012). It remains a long-term economic and political challenge for Nigeria (Ribadu, 2012; Scott, 2007). Workers in the government and private sectors mostly depend on fraud to become rich far above their salaries and general monetary entitlements (Ribadu, 2012; Sachs, 2007). This has been elaborately addressed in Chapter 4 Section 4.6.1 of this thesis.

Consequently, the relevant literature also suggests that, many groups have been formed by the Niger-Delta youths fighting Nigerian state and some oil companies under the pretext of protecting the oil fields of their region, and for the benefit of their region alone (Ogundiya, 2009; Scot, 2007). They claimed that, the oil sites do not belong to the Nigerian government, but to their region only. Many writers (Ogundiya, 2009; Ogundele, 2008; Cohen, 2008; Scott, 2007; Dagne, 2006) have used different names to describe these youth groups and associations, such as rebels, criminals, ethnic militia, terrorists, freedom fighters, militants, fundamentalists, insurgents, revolutionaries and political agitators.

5.7.3.6.2 Managerial attitude

Management plays a significant role in ICT adoption in developing countries. The relevant literature suggests that managerial dynamism, interest and knowledge are very significant in technological adoption in organisations.

Similarly, all the six interviewees who participated in this survey have mentioned managerial attitude as a constraint to the adoption of the state-of-the-art IS by Nigerian INOCs. They also emphasised that, the perception of management as well as their knowledge of the importance of state-of-the-art IS play a significant role towards its adoption or otherwise.

The major views of the all six experts IP01, IP02, IP03, IP04, IP05 and IP06 who participated in this interview survey can be summarised and presented as lack of managerial knowledge, interest, dynamism, ability and willingness. Interviewee IP01 noted that, lack of managerial knowledge or managerial attitude. Thereafter, interviewee IP02 also indicated that, lack of interest or mismanagement of funds

among the significant barriers that limit the adoption of state-of-the-art IS by Nigerian INOCs. Further, interviewee IP03 enunciated the significant barrier as "managerial attitude", while IP04 expounded "funding in general, outsourcing of technology and management perception on the importance of IT in E&P business." Similarly, interviewee IP05, highlighted the managerial barrier as "lack of proper delineation between wants and needs by management is most often absent". Finally, the last interviewee IP06 outlined the managerial attitude as "poor bureaucracy and poor attitude to efficiency by the management".

Moreover, three interviewees specifically commented on managerial attitude by giving more emphasis on outsourcing as one of the significant barriers that always limits the technological advancement of INOCs particularly, in the area of E&P activities. Interviewee IP03, IP04 and IP05 opined that managerial interest in outsourcing some E&P operations made the oil companies more dependent on other consulting or servicing companies than making an enormous effort towards in-house deployment and adoption.

The major assertions outlined by the six interviewees are consistent with the relevant literature of other sectors in developing nations as reviewed in Chapter 4 Section 4.4 of the thesis. This has justified that the managerial attitude can be a strong obstacle to the adoption of state-of-the-art IS.

In the final analysis, all the chosen stakeholders who participated in this interview highlighted managerial attitude as a significant obstacle that can limit the adoption of state-of-the-art IS by Nigerian INOCs. They mostly used synonymous words that all indicated the same meaning with poor managerial attitude.

5.7.3.6.3 Cost of ICT infrastructure and skill development

The cost of ICT infrastructure and human skill development have been discovered as significant barriers to IS adoption in developing nations as discussed in Chapter 4, Sections 4.3.1 and 4.3.2 of this thesis. Further, some of the interviewees who participated in the survey confirmed that, the cost of ICT infrastructure and human skill development were major barriers to the adoption.

Three out of six interviewees who participated in the research have supported the argument that cost of state-of-the-art IS was a significant constraint to the adoption of state-of-the-art IS by Nigerian INOCs. The remaining three interviewees did not

mention cost of ICT among the factors that limit the adoption. The interviewees IP03, IP04 and IP05 mentioned the cost of ICT resources or inadequate human skill and expertise as major obstacles to state-of-the-art IS adoption by INOCs in Nigeria.

The three interviewees that considered cost of resources as a significant barrier indicated their arguments with different words that could mean the same. Interviewee IP03 noted that, "there are barriers… like cost of state-of-the-art ICT resources", while interviewee IP04 mentioned "funding" as a significant barrier and that could accommodate cost of resources as well as skill development. However, the interviewee IP05 emphasised more on inadequate staff skills and funding as significant barriers. He noted that:

> *"Organisational capacity in terms of staff skills and expertise, while learning and growth are weak… funding is still a major issue for some companies (IP05)."*

In the final analysis, at least three interviewees seem to observe and indicate that cost of ICT resources and human skill were among the significant barriers that limit the adoption of the state-of-the-art IS by Nigerian INOCs. And this was in agreement with the findings of the relevant literature that has been reviewed. However, the other three interviewees that did not mention cost may be as a result of considering other barriers as more serious than cost. One point that is very important to observe is that, the interviewees that did not mention "cost" mostly placed more emphasis on "corruption" as a significant barrier; they opined that corruption was the major obstacle that consumes the resources allocated for funding.

5.7.3.6.4 Government policy and motivation

Government policy and government motivation are among the major impediments that impede the adoption of ICT in many developing countries as in Chapter 4 Section 4.4.10 of this thesis. Similarly, some of the stakeholders that were interviewed seem to agree with the findings of other researchers in other sectors as indicated in the literature.

With regard to government policy or law as well as government support or motivation three interviews had different responses that seem to be contradictory to each other. However, the remaining three interviewees did not mention anything about government with regards to their views on significant barrier.

Among all the six interviewees, only one of them mentioned government motivation as a significant barrier. On the contrary, the second interviewee seems to consider government policy as a positive step towards the advancement of the INOCs. And the last interviewee opined that the poor attitude of oil workers in the government oil companies could be a significant barrier. However, based on the opinion of the last interviewee, the study argues that, poor attitude of oil workers in the government owned oil companies could be as a result of lack of government motivation and support.

Interviewee IP03, who indicated government motivation as a barrier stated that, "lack of government motivation" was a significant barrier. Interviewee IP05, who looked at the government policy as a significant enabler not a significant barrier, stated that:

> *"Even though the Nigerian content law considerably helps to build these companies capital base, funding is still a major issue for some companies (IP03)."*

As highlighted earlier, only one interviewee blamed the oil workers for the failure of their companies as a result of their poor attitude and lack of commitment. He observed that, "for the government owned indigenous companies the feeling of not my company by the employees" could be the significant barrier.

5.7.3.6 Some solutions to significant barriers

The study requested the six interviewees to identify some solutions and recommendations that may alleviate the significant barriers discussed in the previous section of this chapter. The solutions presented here are their views due to their experience and knowledge in the INOCs of Nigeria.

All the six interviewees recommended some proposals that may reduce or eliminate the constraints that impede or limit the adoption of state-of-the-art IS by INOCs. Similarly, it seems the interviewees differed but not significantly in various solutions proposed for the oil companies.

Table 5.7: Some solutions to the significant barriers of Upstream IS adoption

Interview Participant	Findings on Solutions to significant barriers	Quotations
IP01	Fighting corruption. Proper management of funds. Enlightenment on the importance of latest ICT for E&P.	"Let's fight corruption in Nigeria. I am sure all the problems will end there. Look at how people generate illegal money in this country through the oil sector. We always read it in the newspapers. To this day, nobody has ever been punished. Many wealthy Nigerians try to get oil blocks not for exploration but for corrupt practices". There is an urgent need that the management of oil companies should be enlightened on the importance of having the latest ICT facilities for E&P
IP02	Improving Government policy. Measurement of performance. Fighting financial crimes. Improving security.	"I think revoking their licenses if they are not active and making serious development will go a long way in motivating them to be world-class indigenous oil companies". We can also remove the barriers by addressing financial crimes and improving stability in the region."
IP03	Educating the stakeholders. Improving managerial knowledge. Lack of performance measurement. Fighting corrupt practices.	"Educating the stakeholders will solve these challenges". In addition to measuring performance. We should also fight financial crimes and instability in Nigeria" However, as long as corrupt practices are being perpetrated and lives and properties are not protected, then it will be difficult to achieve any meaningful advancement
IP04	Enlightenment on the need of ICT. Skill development. Improving ICT infrastructure.	"Awareness Workshops etc on the importance of IT in Research & Development and overall effectiveness and efficiency of the Oil & Gas sector"
IP05	Improving managerial attitude. Improving security.	"Improved organisational capacity and internal processes as well as addressing insecurity in the country."
IP06	Managerial integrity. Fighting financial crime.	"When accountability, transparency, efficiency and competition are considered, controlling factors in the indigenous oil and gas companies in Nigeria"

(Source: Author generated)

5.7.3.6.1 Environmental challenges

As in Table 5.7, five out of six interviewees proposed a solution to both- corrupt practices and insecurity or at least one of them. Three of the interviewees recommended the need to eliminate the challenges of both corruption and insecurity, while the remaining two recommended the need to address one of them without mentioning the other. However, one of the interviewees did not mention anything in that regard.

Interviewee IP01 responded to the interviewer by saying:

"Let's fight corruption and improve our security situations in Nigeria. I am sure all the problems will end there. Look at how people generate illegal money in this country through the oil sector. We always read it in the newspapers. To this day, nobody has ever been punished."

Similarly, interviewee IP02 proposed and emphasised the need to, "address financial crimes and improve stability in the region." In addition, interviewee IP03 also recommended the urgent need of addressing financial crimes and instability in Nigeria, and emphasised that it will be difficult to attain any technological advancement in a situation of corrupt practices and insecurity as they predominantly exist in Nigeria. He said that:

"However, as long as corrupt practices are being perpetrated and lives and properties are not protected, then it will be difficult to achieve any meaningful advancement (IP03)."

Furthermore, interviewee IP05, advised on the need to improve the security situation of the country without mentioning anything pertaining to corruption. He opined that "Improved organisational capacity and internal processes as well as addressing insecurity in the country." On the other way round, interviewee IP06 proposed the need of accountability and transparency among others as a solution to the endemic corruption that engulfs Nigeria and its oil sector. As a solution to corrupt practices, the interviewee stated that:

"When accountability, transparency, efficiency and competition are considered, these are controlling factors in the INOCs in Nigeria."

5.7.3.6.2 Managerial challenges

Managerial challenges were among the major obstacles that limit the adoption of ICT infrastructure in developing countries (Kapurunbandara & Lawson, 2007). The six interviewees of this study also agreed with the findings of the literature of other sectors. As a result, they proposed some solutions to the managerial challenges.

Five out of six interviewees discussed the need to identify material challenges as well as the urgent need to address them. Interviewee IP01 stated that: "management of oil companies should be enlighten on the importance of latest ICT facilities for E&P." Further, interviewee IP03 highlighted the urgent need to educate relevant decision makers on the essentiality of world-class ICT as well as measurement of performance from time to time in order to understand the success and failure that could occur. Interviewee IP03 noted that, "educating the stakeholders will solve these challenges.

There is also a need to measure performance periodically." Specifically, interviewee IP04 was more direct in his proposed solution to the challenges. He opined that:

> *"Awareness workshops on the importance of IT in research and development and overall effectiveness and efficiency of the oil and gas sector (IP04)."*

In line with this proposal, interviewee IP05 stated that: "improved organisational capacity and internal processes…." Interestingly, the last interviewee IP06 proposed a solution that could solve the challenge of poor managerial attitude, as he proposed that:

> *"Managerial expertise and integrity should be given priority during the appointment of skilled workers and those in managerial posts."*

Only one interviewee among the six interviewees that did not propose any solution to managerial challenges as discussed. However, all the five interviewees seemed to offer proposals that could improve managerial attitude.

5.7.3.6.3 Sufficient funding

Two of the six interviewees indicated the need to provide sufficient funding to cater for the cost of state-of-the-art ICT resources and provide world-class skill, development, training and relevant expertise. The remaining four interviewees did not propose anything with regard to funding as a solution to the major obstacles that limit the adoption of state-of-the-art IS by Nigerian INOCs.

Interviewee IP04 stated that there is a need for sufficient funding. He stated that*:*

> *"… Good and enough funding for the oil companies towards latest ICT resources and E&P skill acquisition."*

In addition, interviewee IP05 proposed the same solution as he noted that:

> *"There is urgent need for funding the companies by their owners."*

Moreover, it seems that if sufficient funding is provided and monitored its utilisation judiciously with transparency and accountability, the deployment of state-of-the-art IS and provision of E&P skill and training could be achieved easily. This study argues that, if sufficient funds are provided, the proposed technological advancement and skill development could hardly be achieved without accountability.

5.7.4 Conclusion of interview analysis

The empirical investigation of this interview survey was able to discover the availability or otherwise of state-of-the-art IS used by INOCs. In the process of analysing the interview, the study has discovered the unavailability or inadequate state-of-the-art upstream software, hardware, real-time online monitoring systems and significant barriers to the adoption of state-of-the-art IS. The survey also identified some critical areas and proposed solutions.

Additionally, significant barriers and obstacles were discovered by the study. These significant barriers include the cost of some, not all, state-of-the-art ICT resources, quality and quantity of skill development, poor managerial attitude and their inadequate knowledge of ICT performance and usage, over reliance on outsourcing technology, government policy, corruption and insecurity.

This empirical investigation served as the background for designing questionnaire tool for the next data collection. The gap that existed between world-class multinational oil companies (MNOCs) and Nigerian INOCs as well as the significant barriers that created this ugly gap have been identified and discovered generally. Moreover, the questionnaire will address issues in more specific terms as all the components of state-of-the-art IS will be separated and surveyed. In addition, managerial attitude, some government policies, government incentives, corruption and insecurity as significant barriers will be analysed more elaborately.

In the final analysis, the platform of designing the model and the next tool for data collection has been identified and established. In addition, the gap that separates world-class oil companies and their Nigerian counterparts has been undoubtedly explained and analysed academically. This chapter is more of a general analysis. The more specific analysis will be conducted elaborately through seeking the opinions and/or perceptions of stakeholders in the next chapter of questionnaire-survey analysis. The next chapter that follows is Chapter 8 which presents the analysis of the questionnaire findings.

5.8 Developing an integrated model for INOCs of developing countries

After rigorous review of ICT adoption, acceptance, diffusion and barrier models, this study adopts a significant idea from Kapurubandara and Lawson's model (2007) and the findings of the interview as in Section 5.7, develops a new model that could be

used in assessing and identifying the barriers to state-of-the-art IS adoption by indigenous/local/independent oil companies of developing countries.

The model has been developed as a result of reviewing available literatures, the result of two exploratory pilot studies and interviews with the relevant stakeholders in the oil industries as well as a subsequent survey. This study spent a whole year in the process of identifying barriers to state-of-the-art IS by reviewing relevant internal and external barriers of other sectors or other countries.

The classification of barriers into internal and external barriers is more relevant and suitable to this study as observed and discussed in Section 5.6 of this thesis. These barriers are carefully and critically selected through reviewing the literature of other sectors that are similar to oil and gas. In addition, in the course of conducting the study, many relevant oil and gas stakeholders were consulted and questioned. Similarly, interviews were organised and conducted with the aim of identifying the significant obstacles, if any, to the adoption of state-of-the-art IS by Nigerian INOCs as in Section 5.7 of this chapter. As a result, the main items outlined for model development of significant barriers to state-of-the-art IS can be summarised here. This was achieved after identifying relevant issues that are peculiar to oil and gas sector of developing nations. This includes issues like maintenance, training and retraining of technical skills, regular and timely update of software and environmental factors. The significant barriers are presented as:

5.8.1 Internal barriers for model development

5.8.1.1 Cost

i) Cost of purchasing state-of-the-art ICT resources

ii) Cost of renewal of licenses

iii) Cost of maintenance

5.8.1.2 Skill

i) Quality of skill development

ii) Quantity of skill development

iii) Access to relevant training

5.8.1.3 Managerial attitude

i) Managerial dynamism

ii) Managerial ICT-oriented culture

iii) Governance structure

5.8.2 External barriers for model development

5.8.2.1 Government policy

i) The policy objectives of local content policy

ii) Utilisation of indigenous human resources

iii) Utilisation of indigenous material resources

5.8.2.2 Government incentives/support

i) Incentives towards state-of-the-art ICT adoption

ii) Import waiver

iii) Motivation towards international partnership

5.8.2.3 Environmental factors

i) General corruption

ii) Misappropriation of funds

iii) General insecurity

iv) Security of lives and property of IS experts.

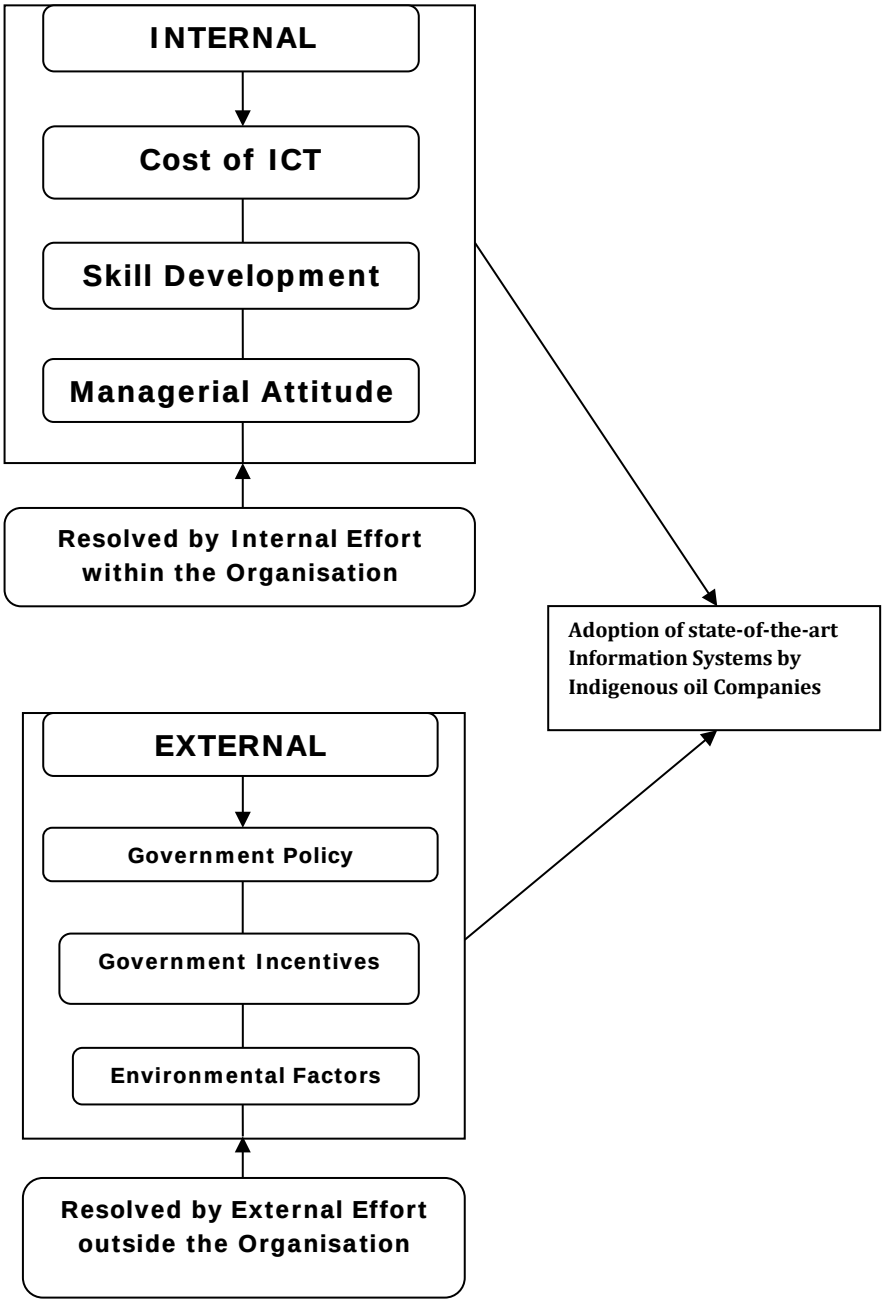
The above significant barriers were identified by relevant literature and initial interviews as obstacles to the adoption of ICT resources. This study could confirm them as significant barriers or otherwise to state-of-the-art IS adoption by Nigerian INOCs. A record of significant barriers to state-of-the-art ICT adoption is presented in Table 5.8.

Table 5.8: Significant barriers to state-of-the-art ICT adoption by INOCs in developing countries

Dimensions	Category	Major Elements
Internal Barriers	ICT, IS, Skill	
Cost		State-of-the-art of ICT hardware, software, online monitoring facilities, SCADA, 3-D seismic capability and telephone support system
Cost of purchasing state-of-the-art ICT resources		
Cost of renewal of licenses and ICT resources		
Cost of maintenance		
Skill	Human Development	Quality and quantity of skill, technical expertise, access to training programme
Quality of skill		
Quantity of skill		
Access to relevant training		
Managerial attitude	Human Development	Managerial interest, knowledge, dynamism, age bracket, ability, willingness, ICT-oriented culture and proper governance
Managerial willingness		
Managerial dynamism		
Managerial ICT-oriented culture		
Governance structure		
External Factors		
Governance policy	Law & Policy	Policy objective, utilisation of indigenous human and material resources, and international partnership
The policy objectives of local content law		
Utilisation of indigenous human resources		
Utilisation of indigenous material resources		

Government Incentives/Support	Motivation	Government incentives, import duty waiver and motivation
Incentives towards ICT adoption		
Import waiver		
Incentives/motivation towards international partnership		
Environmental Factors	Hazard	Corruption, misuse of funds and insecurity to lives and property
Corruption		
Insecurity		

(Source: Author designed from Interview finding of Section 5.7)



5.2 State-of-the-art technology barrier model

5.9 Technology transfer

The previous section was about technology barrier model development. The purpose of this section is to review technology transfer, which is the way that Nigerian INOCs could adopt state-of-the-art IS as their multinational oil counterparts have it for all their upstream operations.

Technology transfer has been explained as the process of transfer or movement of information, expertise and technical sophistication among cooperate technical functions with the sole aim of achieving innovative products and services that meet organisational goals (Mojaveri, Nosratabi & Farzad, 2011; Henry, 2008). Furthermore, technology transfer has been considered as an important component of growth and development in developing countries (Fagerberg, 1994; Blomstro & Zeeman, 1994). This study argues that, technology transfer is definitely required in the adoption of state-of-the-art IS by Nigerian INOCs compared to multinational counterparts in the country.

It is an indisputable fact that, the growth and industrialisation of developing countries depends on the extent of their technology transfer from the developed and industrialised countries/companies, and their ability and wherewithal to diffuse and adopt the technology (Mojaveri, Nosratabi & Farzad, 2011; Henry, 2008). One may argue that in spite of Nigeria's resources, the level of technology transfer, particularly with respect to state-of-the-art ICT resources, is below average, and there is urgent need to adapt state-of-the-art technology transfer by Nigeria and its organisations in order to attain growth and development.

This study identifies the significant barriers that limit state-of-the-art technology transfer by Nigerian INOCs as in Section 5.9 of this chapter. Additionally, it has been confirmed that, is impossible to effectively transfer technology without addressing barrier-related factors that mostly impeded its adoption (Henry, 2008; Blomstro & Zeeman, 1994).

5.10 Conclusion

This chapter has reviewed and discussed different types of frameworks/models for ICT adoption, diffusion, transfer and their respective barriers. All the most important frameworks developed in the field have been reviewed and discussed according to their relevance to this study.

Consequently, diffusion of ICT outsourcing and its influence was also discussed in the chapter as a result of its relevance to the study. In addition, task-technology fit as a concept that has been adopted by IS analysts in determining performance of technology was also discussed and analysed accordingly. Furthermore, significant barriers to state-of-the-art IS adoption by INOCs as well as relevant organisations have been identified and presented in the chapter.

CHAPTER SIX

Research Methodology and Methods

6.1 Introduction

This chapter addresses the methodology and method adopted in the conduct of the study. The argument that emerged from the relevant literature indicated that over the past three or more decades, there have been debates, discussions and publications over the choice of research methodology and its approaches (for example, see: Collins & Hussey, 2009; Carter & Little 2007; Duranti, 2006; Hamilton et al, 2006; Mason, 2006; Yanchar et al., 2005; Ritchie & Lewis, 2003; Robson, 2002; Boswell & Brown 1999; Maffie, 1999; Fischer 1998; Lin, 1998; Hughes & Sharrock, 1997). Similarly, this study acknowledges the existence of divergent views between various schools of thought in philosophical research, IS inclusive (Saunders et al., 2011; Neuman, 2005; Denzin & Lincoln, 2005; Collins & Hussey, 2003).

The sequence of the chapter has been divided into relevant sections. Section 6.2 discusses the philosophical assumptions of the study. Section 6.3 addresses general methodology. Section 6.4 discusses mixed-method. Section 6.5 discusses the method of data collection used in the study. Section 6.6 explains the pilot study conducted. Section 6.7 presents the population and sample of the questionnaire survey. And finally, the chapter is concluded by Section 6.8.

6.2 Philosophical Assumptions

Behind any research there must be philosophical assumptions, including the research of this kind (Russo & Stolterman, 2000; Wynekoop & Russo, 1995). Researchers hold their assumptions based on certain characteristics, which include education, environment, experience and emotion (Chua, 1986; Hopper & Powell, 1985). Similarly, it is advisable to understand the assumptions of philosophical research. And it is indeed necessary to understand the importance of these assumptions in social science; hence it is inevitable to have a clear focus of their meanings, definitions and scopes (Carter & Little, 2007; Duranti, 2006; Mahmud, 1997).

In research, “Paradigm” is an umbrella that accommodates both “theoretical” and “philosophical” assumptions. However, Collis and Hussey (2003) hold a different

view, in which they define paradigm as *"the progress of scientific practice based on people's philosophies and assumptions about the world and the nature of knowledge"*. In addition, some researchers expound a demonstration of paradigm, as a mental medium through which researchers analyse the social world (Bailey, 2008; Robson, 2002).

Furthermore, various researchers examining a single phenomenon from different paradigms will easily come out with different results and recommendations. For instance, if two researchers view a tree from different angles, one as an elevation while the other as depletion, it will definitely have different results, because the former views it while standing on a ground level while the latter views it from the top of an upstairs building (Saunders et al., 2011).

Social scientists view their research with an assumption about the nature of the social world and the procedure in which it is followed to be investigated, these are ontological assumptions, epistemological assumptions, human nature and methodology (Ritchie & Lewis, 2003; Burrell & Morgan, 1994). As stated earlier, there is a gap between various philosophical research schools of thought; the most common among them is between the "Positivist" and the "Interpretivist" philosophical position.

In line with the suggestion put forward by Read and Marsh (2002) that, a researcher should make a decision and adopt the most suitable method that will suit him in his research. This study intends to follow "pragmatic approach" as its paradigm and mixed-methods. The mixed-methods, which is a combination of both qualitative and quantitative methodologies approach, grants the researcher a platform to deal with research questions arising. As stated earlier, considering the characteristic of the study as well as the data collected and the process it was collected (interviews and questionnaires), this study has adopted a pragmatic approach. In addition, pragmatism is an approach that, "works within both positivist (quantitative) and interpretivist (qualitative) positions. It applies as a practical approach of integrating different perspectives to help collect and interpret data" (Saunders et al., 2009, p. 598). The view was also supported by Morgan (2007).

6.2.1 The Burrell and Morgan framework

Burrell and Morgan (1994) documented a classical analysis of the philosophical assumptions that support and strengthen different methods of enquiry. They finally

confirmed their views as, the careful selection of approach lies mainly upon assumptions connected to ontology, epistemology, human nature and methodology as well. Some researchers hold similar opinions, but different in their description. In line with this, Ryan, Scapens and Theobald (2002 pg. 35), opined that *"the assumptions which the researcher holds regarding the nature of the phenomena's reality (ontology), will affect the way in which knowledge can be gained about that phenomenon (epistemology), and this is turn affects the process through which the research can be conducted (methodology)".*

A diagram was designed and developed by Burrell and Morgan (1994) to illustrate four paradigms. The diagram has been displayed in Table 6.1.

Table 6.1: Row and Column diagram for assumptions analysis about the nature of research on the Subjective-Objective Dimension Approach to Social Sciences

The Subjective Approach		**The Objective Approach**
Nominalism	**Ontology**	**Realism**
Anti-Positivism	**Epistemology**	**Positivism**
Voluntarism	**Human Nature**	**Determinism**
Ideographic	**Methodology**	**Nomothetic**

Source: Burrell and Morgan (1994)

In the field of social science, the nature of the social world and the method of their investigation are followed and approached by assumptions (Burrell & Morgan, 1994). To start with ontological assumptions, under this paradigm, social scientists are more interested, concerned and inclined towards the nature of the reality of the phenomena under investigation. Similarly, "Nominalism" predicts and assumes that social reality exists in the human imagination in the individual consciousness (Ryan, Scapens & Theobald, 2002; Burrell & Morgan, 1994). In the same line, how "Realism" views the world differs from that of Nominalism.

Consequently, epistemological assumptions are always inclined and concerned with the general knowledge's study and what he has accepted as a "valid knowledge" (Collis & Hussey, 2003). According to the view of objectivists and positivists, knowledge must fulfil two conditions before being considered and classified as valid

knowledge. These conditions are; it must be measurable and observable (Ryan, Scapens & Theobald, 2002; Burrell & Morgan, 1994).

6.2.2 Situating the research in its proper assumptions and research methods

Having discussed the different theoretical assumptions and research methods that are adopted in research and their suitability to different disciplines, triangulation was the method selected and adopted to answer the research questions. Triangulation is the method that involves more than one method to gather data, such as observations, questionnaires, documents and interviews (Yusuf et al., 2012b; Collis and Hursey, 2009; Denzin, 2006; Coghlan, 2002). In this study, interviews, questionnaires and secondary data are used. The detailed explanation will be presented in Section 6.4 of this chapter.

The next step is to technically discuss this thesis within its assumptions and research methods intensively. Thus, the next two sub-chapters will be dedicated to these issues.

6.3 Methodology and methods

A researcher should make a choice, decide upon and select the most appropriate methods that interest him in a particular research. It is in line with this that we select "pragmatic approach." Similarly, considering the research query, "mixed method"-combination of qualitative and quantitative Methodology was carefully selected and adopted in conducting the research. The reason is that the qualitative methodology approach allows and guides the researcher to handle and deal extensively with all components of the research questions emerging from the significant barriers (if any) to state-of-the-art IS adoption in INOCs of Nigeria (Read and Marsh, 2002).

Flexibility has been considered and is believed to be the primary and most essential difference between qualitative and quantitative methodology (Berg, 2011). Qualitative method is considered as a range of techniques comprising of focus group interviews, individual interviews and the rest of applicable techniques, that are employed in understanding the practice of key informants and their experiences and to locate them legitimately and authentically in their context (Devine, 2002).

However, Spencer *et al* (2003) argued that qualitative research gives a comprehensive and in-depth understanding of people's perspectives, experiences and their historical background in the context of their personal settings and

circumstances. It allows a critical analysis of data that is usually rich, comprehensive and complex. As a result, two sets of qualitative research were conducted in this study in order to understand people's perspectives and experience on the barriers to the adoption of adequate state-of-the-art IS by the Nigerian INOCs.

On the other hand, quantitative research gives more emphasis to the analysis of the casual relationship between variables and their measurements, not the processes being adopted in the research (Denzin & Lincoln, 2005). Quantitative method centres mainly on measurement, sampling and design issues. The main purpose and wisdom of quantitative research is to discover "how many" and "what kind", as it was rightly put by (Brannen, 1992 pg. 33) when he said: *"discover how many and what kind of people in the general or parent population have a particular characteristic which has been found to exist in the sample population."*

6.3.1 Reliability and validity

Terrell (2012) noted that, mixed-methods are neither less nor more valid and reliable than specific approaches to every research. As such all the established rules and regulations for establishing validity and reliability in standard quantitative and qualitative research must be strictly identified and obeyed when the two methods are combined (Terrell, 2012; Bazeley, 2006). Many qualitative researchers have divergent views about reliability and validity (Koro-Ljungberg, 2008; Aitman et al., 2006; Ritchie & Lewis, 2003; Golafshani, 2003). Although in research their importance cannot be over-emphasised due to their impact (Patton, 2002). These two factors- reliability and validity are very essential to any qualitative researcher, particularly during design, analysis, implementation and judging its quality as well (Golafshani, 2003).

Consequently, Kirk and Miller (1988 pp. 136) defined these two terms as *"reliability is the extent to which measurement procedure yields the same answer however and whenever it is carried out; validity is the extent to which it gives the correct answer. These concepts apply equally well to qualitative observations."*

Seale (1999) uses three words- dependability, truthfulness and consistency to refer to "reliability". Similarly, in qualitative research, reliability refers to selecting and using acceptable research methods by the research experts as legal and legitimate procedures of collecting, analysing and judging the quality of the result (Collingridge & Gantt, 2008; Clont, 1992).

In qualitative study "Dependability" has been used by some researchers in place of reliability (Neuman, 2006). Fulfilment and meaningfulness in the descriptions of data are the quality of reliability in qualitative methods (Collingridge & Gantt, 2008).

Similarly, Neuman (2006) defined validity as *"truthful' based on 'authenticity' of giving a fair, honest, and balanced account of social life from the point of someone who lives it every day".* The applicability of the concept of reliability has been challenged and criticised by many researchers in the field of social sciences (Golafshani, 2003; Cresswell & Miller, 2000).

However, it is believed to be appropriate and applicable to this study, having a science background and ICT orientation, and it also deals with determining performance and the significant barriers that limit the adoption of state-of-the-art upstream IS. In qualitative research, *"measuring what one purports to measure means selecting an appropriate method for a given question and applying that methods in a coherent, justifiable, and rigorous manner"* (Collingridge & Gantt, 2008 pp. 391).

In addition, for the purpose of this study, the definition of validity by Neuman (2006) and earlier, Ritchie and Lewis (2003) is more appropriate and more applicable to this study because in their attempt to define validity, they nicely referred to it using the following words "truthful", "authentic", "precision" and "correctness", and these are necessary ingredients in determining both the performance and significant barriers to state-of-the-art IS used by the oil and gas sector, and they are indeed suitable, appropriate and applicable to the study.

6.3.2 Comparative analysis between qualitative and quantitative paradigms

There are some similarities of approach between qualitative and quantitative paradigms in terms of their collection tools and differences in terms of the quality of their data and samplings. Additionally, both of them have tools for their data collection. The tools are presented in Sections 6.3.2.1 and 6.3.2.2 of this chapter.

6.3.2.1 Qualitative paradigm uses open-ended/semi-structured

The qualitative paradigm has been identified as using an open-ended/semi-structure of:

i. questionnaire;
ii. interview;
iii. document analysis;

iv. observation;
v. video recording; and
vi. image analysis

6.3.2.2 Quantitative paradigm uses closed-ended/structured

i. questionnaire;
ii. interview;
iii. document Analysis;
iv. official statistics; and
v. systematic observation

The greatest difference between qualitative and quantitative tools is that, qualitative paradigm uses "Open-ended/Semi Structures" in all the tools mentioned earlier, while quantitative paradigm uses "Closed-Ended/Structured tools". There are some similarities between qualitative and quantitative paradigms, but methods of data collection can be classified under open- or close-ended. However their placement in a qualitative or quantitative paradigm is mostly based on assumptions about how the data is used.

Furthermore, data generated from open-ended measures are mostly grouped into codes and themes, while data generated from close-ended methods are mostly quantified. However, researchers confirmed that, the coding data generated from open-ended methods can still be quantifiable, but close-ended data does not need to be quantified before being used in any study.

6.3.2.3 Sampling of qualitative and quantitative paradigm

Sampling of qualitative paradigm depends mainly on:

i. small sample size;
ii. non-representative generalisations; and
iii. single or small scale case study. Furthermore, the sampling of quantitative paradigm depends mainly on:
iv. large sample size;
v. representative generalisation; and
vi. multiple cases.

6.3.2.4 Data produced by qualitative and quantitative paradigm

Qualitative Paradigm produces data in:

i. word; ii) audio; and iii) image.

Furthermore, quantitative paradigm produces data in: i) numerical format.

The data associated with or produced by the two paradigms is the most overwhelming difference between them. Quantitative is mainly associated with numbers, while qualitative is mainly associated with word, audio and image.

6.3.2.5 Method of analysis by qualitative and quantitative paradigm

Qualitative paradigm uses the following during analysis:

i. coding;
ii. matrixes; and
iii. narrative analysis.

However, quantitative paradigm uses the following during analysis:

i. descriptive (counting);
ii. statistical modelling; and
iii. hypothesis testing.

In the final analysis, this study is the combination of both and it used all the qualitative and quantitative paradigms, because it uses semi-structured and structured interviews as well as a closed-ended questionnaire. In addition, in sampling, the study uses small sample size interviews and large scale size questionnaires. Further, data is produced in numerical and data format. This confirms that, the study employs both qualitative and quantitative methods known as "mixed-methods" which is to be discussed elaborately in Section 6.4 of this chapter.

6.4 Mixed-Methods

Mixed-methods study is a combination of two methods- these are the qualitative and quantitative approach. Mixed-methods research is also called Multi-methodology, compatibility thesis or pragmatist paradigm (John, 2004). This new concept of mixed-methods has academically emerged from the paradigm arguments and debates between qualitative and quantitative researchers and their approaches in order to serve as a global mode of inquiry (Johnson & Christensen, 2007). Furthermore, Tashakkoki and Teddlie (2008), defined mixed-methods studies as a

"studies that are products of the pragmatists paradigm and that combine the qualitative and quantitative approaches within different phases of the research process".

In addition, quantitative method deals with "if" in research, while qualitative method deals with "why" and/or "how" (Johnson & Christensen, 2007). Mixed-methods accommodate both "if" and "why" and/or "how" in research approach.

6.4.1 The emergence of mixed-methods approach

The emergence of this concept was due to an intellectual pleading as a result of what they called "a truce" between the supporters of the two major paradigms from the 1980s to the 1990s (Terrell, 2012; Caracelli & Greene, 1997). They confirmed that, leading researchers and authors agreed that qualitative and quantitative research methodologies are very much compatible to each other, and they can be integrated together. Subsequently, this brought about this new approach- "mixed method" which has been considered now as "trendy approach" or "latest approach". Furthermore, the researchers of mixed methods claimed that they brought about the benefit of qualitative and quantitative approaches together. As a result, they argued that their approach has more valid results (Bazeley, 2006; Caracelli & Greene, 1997).

Consequently, as a result of this integration, many researchers believe that closed-ended questionnaires and open-ended opinions can be combined under "mixed-methods". This is one of the reasons why this research adopts mixed-methods approach. Terrell (2012) emphasised that, mixed methods approach is very much applicable and suitable to the fields of psychology, IS, library and information science, and political science.

6.4.2 Meaning of mixed-methods expression

Tashakkoki and Teddlie (1998) argued that this term or phrase "Mixed-Model" is academically more appropriate than "Mixed-Method" for research that accommodates different approaches and applies at any or all of the stages involved through the research, because "mixing" extends beyond just the methods used in the research (Caracelli & Greene, 1997). However, as this study argues, the difference in the expression is nothing to worry about since the meaning of both terms conveys the same message.

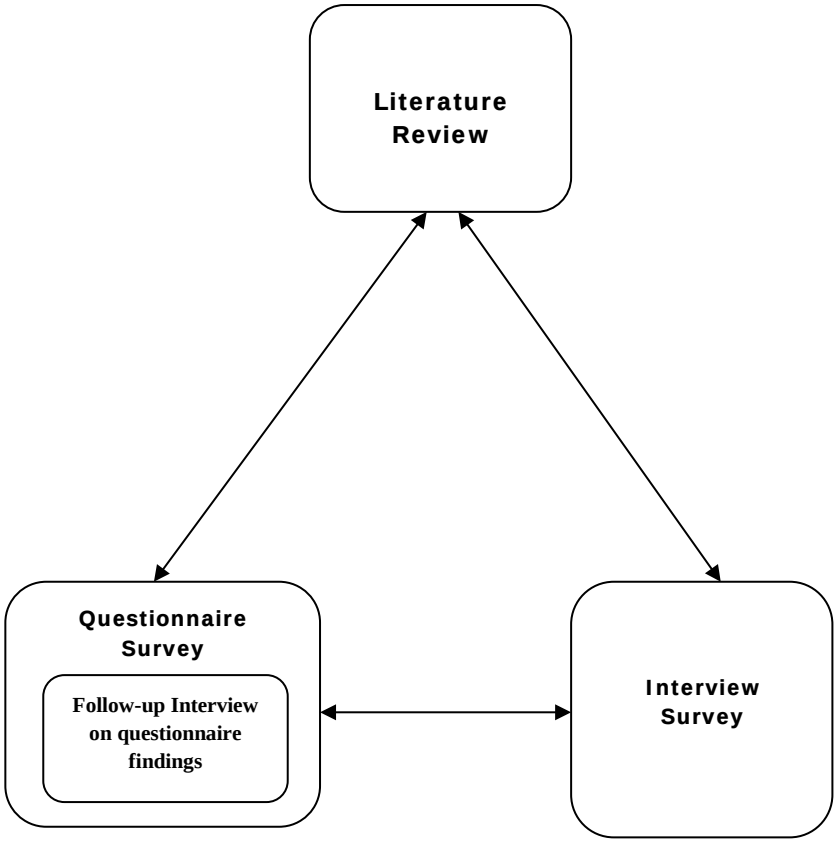
6.4.3 Type of multi-methods approach for the study

Four factors always determine the type of multi-method approach to be adopted. These four factors are: i) theoretical perspective- either "implicit" which is based on a theory indirectly or "explicit" which is based on a theory directly; ii) strategic priority- which includes "equal priority", or "quantitative priority" or "qualitative priority"; iii) general sequence of data collection implementation- which accommodates "no sequence implementation", "qualitative first" or quantitative first; and iv) point of data integration- which includes at "data collection point", "during data analysis" or at "data interpretation" or "with some combination".

Consequently, all these four factors of multi-method have been adapted in this study. These include theoretical perspectives, strategic priority, and general sequence of data collection with qualitative first and point of data integration which is during data interpretation.

6.5 Method of data collection used in the study

Different research methods are employed by different research methodologies. Similarly, research methods can easily be defined as the procedure of collecting and analysing data by employing different means and tools (Smith, Osborn & Smith J, 2003; Collis & Hussey, 2003; Creswell & Miller, 2000). In support of this argument, considering the nature of the literature so far gathered, three main research tools/methods were proposed and employed for data collection. These include secondary sources, interviews and questionnaires (see for example: Hvelplund, 2008; Midnutt & Gautesen, 2007; Vachon & Menz, 2006). These three main research tools have their advantages and disadvantages, but in order to reduce the disadvantage, the study applied them in the right position during data collection. Furthermore, the next subsequent sections will review an interview and a questionnaire. The three methods of data collection used in the study are triangulated and demonstrated in Figure 6.1.



6.1: Triangular approach of the study

The study started by reviewing the relevant literatures which are presented in Chapter 2, 3 and 4. Furthermore, as a result of the lack of specific and clear-cut literature, the study begins by conducting an interview with the relevant stakeholders in order to resolve significant issues with respect to the availability of state-of-the-art IS in Nigerian INOCs as well as the significant barriers, if any, to the adoption of world-class IS. The interview is presented in Chapter 5, Section 5.7 of this thesis. In addition, the questionnaire-survey was developed from the relevant literatures and the interviews conducted earlier. The result of the questionnaire-survey is presented in Chapter 7 of this thesis. Finally, as a result of some significant issues aroused from the questionnaire-survey, another follow-up interview was conducted. This follow-up interview is dependent on the questionnaire-survey. The

result of the follow-up interview is presented in Chapter 8 of this thesis. More details and an explanation of the tools will be presented subsequently.

The secondary data as well as the qualitative and the qualitative methods were integrated and triangulated accordingly. The secondary data were used in the process of generating qualitative data. The data generated through the literature review was used in qualitative research of Chapter 5, Section 5.7. Similarly, the data gathered from the literature review and the qualitative approach of Section 5.7 and Chapter 8 were fully integrated and triangulated with the qualitative data of Chapter 7 of this thesis.

Furthermore, in the search for the secondary data, as well as the gathering of the qualitative and the qualitative data, the significant barriers to the adoption of state-of-the-art IS by the Nigerian INOCs were fully investigated and discovered. In the end, the result of the findings is in Chapter 9 of this thesis.

6.5.1 Interview

Both positivist and phenomenological methodologies are associated with interviews as a method of data collection. Furthermore, an interview has been defined as a method of data collection, in which selected participants and respondents are confronted with some selected questions to find out critically what they think, feel or do (Collis & Hussey, 2003). Additionally, this interview can have many formats like, face-to-face, screen-to-screen and voice-to-voice (Smith, Osborn & Smith J, 2003; Oates, 2008; Collis & Hussey, 2003). In addition, the interview is most appropriate for examining a complex and very sensitive area, and it can be applied to any type of population, but it is indeed time-consuming and it also consumes large amount of resources, particularly, if the respondents are scattered and far away from each other (Robson, 2002).

Further, interviews can academically be divided into structured or unstructured (Smith, Osborn & Smith J, 2003; Sekaran, 1992) or even sub-divided into exploratory or standardised (Oppenheim, 2000). In explaining the different types of interview, structured interview is employed in situations in which the interviewer has enough knowledge of what information is required and needed (Collis & Hussey, 2003; Smith, Osborn & Smith J, 2003). Thus, in these kinds of situations, the interviewer has prepared a predetermined list of questions that will be presented to the interviewees, one after the other.

On the other hand, an unstructured interview is the situation in which the interviewer does not enter into the venue of the interview with planned and organised questions that will be presented to the respondent sequentially (Oates, 2008; Sekaran, 1992). While semi-structured is the combination of both (Collis & Hussey, 2003; Smith, Osborn & Smith J, 2003). As this study argues, the structured interview is more appropriate to the follow-up interviews of Chapter 8 of this thesis, because most of the questions to be asked, if not all, are well known.

Data collection through interviews allows researchers and system analysts to benefit from the deep and critical investigation of the situation on the ground. However, the combination of these two forms of interview produces and establishes semi-structured interviews which are also suitable and applicable to this study as in Chapter 5, Section 5.7 of this thesis and this is due to the fact that it articulates and produces the advantages of both, structured and unstructured interviews. The semi-structured interview, allows the researcher to ask important questions that are not originally in the designed schedule, but are still essential to the research and relevant as well (Neuman, 2006). Further, the respondents can be drawn back to the study area if they go astray or talk out of context.

Consequently, interviewing as a method of data collection has advantages. These advantages include:

i. excellent response rate, as the interviewer captures and records responses during interview;
ii. high degree of flexibility, as the questions will be technically adjusted to suit any situation that may arise or change; and
iii. relatively easy handling and administration, because data collection through interviews does not require the respondents to read, write or handle complex documents or advance questionnaires (Smith, Osborn & Smith J, 2003; Collis & Hussey, 2003).

However, sometimes some issues, if not managed properly, may affect this method of data collection, such as: poor memory or low level of understanding among the interviewees which can easily render instant responses unreliable; if the presented questions are not technically and literally good, that may bring misunderstanding and confusion among the interviewees; transcription of interview data can be time consuming, difficult and boring as well; and there is a challenge pertaining recording

of responses due to some policies and laws in some places in the world (Smith, Osborn & Smith J, 2003).

Similarly, as a result of geographical constraints as well as the official engagement of some oil and gas experts, the data collected by interview were conducted in two phases; face-to-face interviews and telephone interviews (see Appendix A for the interview schedule).

6.5.1.1 Qualitative content analysis

Qualitative analysis of content is one of the most employed analytical tools in qualitative research (Hsieh and Shannon, 2005; Patton, 2002). The qualitative content analysis has been defined as "any qualitative data reduction and sense-making effort that makes a volume of qualitative material and attempts to identify core consistencies and meanings" (Patton 2002, p.453).

The analysis is by far beyond interview words or presenting the content objectively from a transcribed interview, but it helps analysts to critically understand social reality subjectively in a scientific manner (Zhang and Wildemuth, 2006). Because of its usefulness and compatibility, it has been adopted in the conduct of this study's interviews and their analysis. As a result, all the sets of interviews conducted in Chapter 5, Section 5.7 and Chapter 8 were carefully analysed by data reduction and meaningful efforts as explained in Section 6.7.7 of this thesis. In addition, the volumes of data were taken so as to identify consistencies in the responses and figure out meanings from the information. In summary, this is what qualitative content analysis stands for.

6.5.1.2 The process of qualitative content analysis

There are approximately eight stages of qualitative content analysis (Zhang and Wildemuth, 2006). Furthermore, they have all been used in the process of collecting data through interviews in this study as well as subsequent analysis and findings. The process of the analysis and its stages are as follows:

i. data preparation;
ii. unit of analysis definition;
iii. categories development and a scheme of coding;
iv. testing coding stages on a sample unit of the text;

v. coding of all the text to be used in the analysis;

vi. assessment of the consistency of the analysis;

vii. drawing of conclusions from the coded data; and

viii. reporting of findings (Zhang and Wildemuth, 2006; Patton, 2002; Bradley, 1993; Weber, 1990; Tesch, 1990).

6.5.1.3 The population and sample of the interview

The interview was conducted after an in-depth review of the relevant literature on IS in the oil and gas sector. The review of the literature discovered a lack of research pertaining to Nigerian INOCs. However, relevant literature in other developing countries was reviewed and partially adopted in the Nigerian context subject to its agreement or disagreement with the analysis of the interviews and questionnaire survey of the study. Furthermore, due to these reasons, the study started by conducting an interview with some selected senior stakeholders in the Nigerian oil and gas sector and other relevant institutions.

A limited number of samples were considered, because qualitative research is performed with a small sample size, particularly if more than one method is used as stated by many researchers (Hsieh and Shannon, 2005; Patton, 2002). In addition, the interviews were not the main tool for data collection. The first set of interviews served as the foundation of the study, while the second sets served as a follow-up on the questionnaire findings.

Furthermore, before selecting the stakeholders to be interviewed, the researcher attended a forum of experts in the oil and gas sector. This was to familiarise the researcher with the most relevant stakeholders to be contacted. In addition, after establishing contact with them, criteria were set for the condition of selecting the interviewee. Every interviewee must fulfil some conditions before being approached with the request. These conditions included technical knowledge of the state of IS in the Nigerian oil and gas sector; in-depth experience in the sector; senior staff or decision maker in the sector or any other agency that is involved in oil and gas operations; and must be of proven integrity in words and actions.

In order to achieve this aim, some selected officers in the sector were contacted. They subsequently recommended the most suitable experts to be interviewed. After a critical review of the proposed names by making other contacts, seven senior officers

were selected and contacted for the interview. Subsequently, six of them accepted the offer while one of them rejected. Finally, one senior officer was interviewed from every group of stakeholders identified by the study.

Moreover, the wisdom behind interviewing them was to serve as the basic and general foundation of the study as a result of a lack of any written record and/or research on the situation of IS in the Nigerian oil and gas sector. This has been achieved, as most of the significant barriers mentioned were similar to other developing countries. The items identified from the interviews conducted serve as the general background to the questionnaire design and the questions asked.

6.5.1.4 Selection of stakeholders and the respondents' rate

This study has dedicated ample time to making contacts, attending gatherings of Nigerian INOCs and other relevant institutions with the aim of identifying relevant stakeholders and knowledgeable staff in the field of study. This has assisted tremendously in getting contacts with the relevant stakeholders and their constituency as a step towards analysing the problem in hand. Initially, seven stakeholders were selected based on their expertise, role, experience and integrity. Six of them accepted it and indicated their willingness to participate in the study, while one of them turned down the request as stated earlier.

In addition, this study has adopted a triangular approach whereby it depends on interviews, questionnaire surveys and relevant secondary data of Nigeria and other developing countries for its analysis and establishing subsequent findings. The interview has been the first primary method of data collection and it has served as the foundation of analysing and identifying gaps, significant barriers, designing questionnaires, and finding some useful recommendations to overcome the major barriers to state-of-the-art IS adoption.

During the conduct of the first set of interviews, six senior personnel from the Nigerian indigenous oil and gas sector and other stakeholders were interviewed one after the other as reported in Chapter 6 Sections 6.5.1.3 and 6.5.1.4 of this thesis. This has been achieved through studying their roles, integrity and identifying their in-depth knowledge and experience in the oil and gas sector. These stakeholders selected for interview were senior officials that have been recommended by their colleagues and other researchers as very suitable and competent to speak authoritatively on Nigerian INOCs. Their roles are engineering manager, general

manager, computer scientist, exploration and production engineer, senior geologist and information systems analyst.

In addition, the stakeholders as research participants responded to the seven questions presented to them during the conduct of the study. In addition, they also highlighted other important issues that were not in the interview schedule. Interestingly, they have answered all the questions clearly and intellectually but with conciseness and precision. The questions covered knowledge on the current state of upstream information systems, ICT skill, managerial attitude, availability of ICT resources, significant barriers and constraints to the adoption of state-of-the-art IS and recommendations to the challenges.

6.5.1.5 Data checking and analysis approach

As elaborately discussed in Chapter 6 Section 6.3.1.6 of this thesis, the study has spent a month in transcribing the interviews one after the other. After transcribing the data, the written interview was sent to the relevant respondents so as to agree or disagree with what they initially stated during the conduct of the interview. This is also called "member checking" or "member validation" (Bryman, 2010). He stated that, the checking or validation has been explained as a procedure in which data or information is submitted by a researcher to those who were the source of the data. This can be after transcription or after findings or after both (Bryman, 2010). The crucial issue or wisdom for the exercise is to have an agreement between the researcher on the one hand, and the respondents on the other.

Furthermore, during the checking of this study, after indicating minor observations by the interviewees, they unanimously accepted and agreed with the information. This has established a unanimous and collective agreement between the researcher on the one hand, and the respondents on the other.

6.5.1.6 Justification for the interview questions asked

Seven questions were presented to every research respondent during the first sets of the interview of Chapter 5, Section 5.7. These questions were carefully and technically selected to cover all areas of the study. The first question confirmed the familiarity and knowledge of the research respondents with the situation of IS in the Nigerian oil and gas sector. This has been asked in order to avoid interviewing irrelevant respondents who would mislead the study.

Consequently, question 2 has been asked about the availability or otherwise of state-of-the-art IS in the indigenous sector. Additionally, question, 3, 4 and 5 has been asked according to the various components of IS and other supporting resources. This is due to the fact that, the information systems has been interlocked into some interrelated components, such as hardware, software packages, online monitoring systems and skill availability.

Question 6 was asked on the significant barriers, if any, to state-of-the-art IS adoption by Nigerian INOCs. And finally, the last question was asked as a result of answering question 6 in the affirmative, on the way out from this situation of inadequate state-of-the-art IS in the indigenous oil sector. (See Appendix A for details).

Another justification for the questions asked was, the questions were nominated, reviewed and adapted after rigorous contacts with the supervisory team of the study, experts in multinational and INOCs and reviews of relevant publications on the subject matter. Similarly, the aim of the interview was to serve as a strong background for developing a questionnaire which is the main tool for data collection of this study.

6.5.1.7 Face-to-face interviews

Face-to-face interview is the first stage of data collection adopted by this study. Major stakeholders which included Managers and other technical experts of exploration and production operations in INOCs of Nigeria were selected and interviewed in the cause of data collection. This was absolutely necessary because of the absence of academic literature or any reliable document that dealt with the situation of INOCs in Nigeria with respect to ICT resources as discussed in the previous section of this chapter. As a result, an interview was conducted in order to confirm whether INOCs deployed state-of-the-art IS or not. This phase of data collection involved significant monetary resources and planning for travelling, but the data generated was extremely beneficial and resourceful, as it served as the first stage of the study upon which the remaining stages and phases have been built. The researcher was able to conduct the interview as a semi-structured one. In addition, four senior personnel were interviewed through this method of data collection.

6.5.1.8 Telephone interview

The second phase of data collection through interview was conducted through telephone. This is as a result of the fact that, some stakeholders who were chosen to

be interviewed were difficult to be found face-to-face. As a result, appointments were not fulfilled due to their tight schedule and their dependency on their companies' schedule. Subsequently, one of the technical experts to be interviewed is a Nigerian in Diaspora. Therefore a telephone interview was employed and adapted for respondents who were not available for face-to-face interviews during the first phase of the study. A face-to-face interview schedule was adopted and used in telephone interview. The data collected at this phase of interview approach was also very beneficial and resourceful. The principal reason for this success was as a result of the integrity of the respondents as well as their interest in the study. Having attended conferences and seminars in the oil and gas area afforded the study an opportunity to be familiar with the some senior managers and technical experts some of whom served as interviewees and respondents in the questionnaires in this research.

In addition, the finding of previous researchers emphasises this argument. According to Berg (2011, pp. 21) the importance of initial contacts "allow the subjects to ask questions and raise any concerns they might have about the study or their anticipation. It will also provide an opportunity for the investigator to gain some sense of the individual and to begin developing a kind of relationship and rapport as well as an opportunity to convince the individual to participate in the study if the individual is resistant."

Moreover, critics of telephone interview were replied about their misconception by many researchers (for example, see: Holt, 2010; Carr & Worth, 2001). And they stated that data collected through telephone interviews proved to be valuable and extremely productive (Holt, 2010; Sturges & Hanrahan, 2004; Carr & Worth, 2001).The interview conducted was also a semi-structured one. Similarly, semi-structured interview combines structured interview, because of its efficiency in data collection, knowledge and familiarity with the questions to be asked as well as the recommendations of the technical experts.

6.5.1.9 Recording and data transcription

Qualitative research encourages recording, because it is extremely difficult or almost impossible to recall the responses of the respondents during the interview. As a result of this, Bryman (2008) emphasised that, the recording of interviews is very important for generating valid data. Consequently, recording allows the researcher to avoid writing and concentrate on the interview and present the questions to the

respondents attentively. In line with this, as earlier stated that this study recorded the interview conducted, and the data recorded were transcribed verbatim in order to maintain its spirit and richness. The researcher transcribed all the recorded data verbatim in spite of its time consuming and difficulty. This has been done as a result of the recommendation of many researchers on its importance and essentiality (Bryman, 2008; Barbour, 2008; Punch, 2005; Richards, 2005; Ritchie & Lewis, 2003). Interestingly, the study was able to generate resourceful and rich primary data which serve as the main foundation of the research and its analysis.

Importantly, as a result of responses generated from interview, a questionnaire was developed for subsequent data collection and analysis. The research followed a triangular approach, starting from secondary data to interview to questionnaire and finally to a follow-up interview on questionnaire findings.

6.5.1.10 Coding of data and its analysis

A significant amount of time has been spent in writing the interview. After the data transcription, the written interview was sent to the interviewees so as to agree or disagree with what they initially stated during the conduct of the interview. Furthermore, after indicating minor observations, they collectively, but differently agreed with the information. This established an agreement between the study on one the hand, and the interviewees on the other.

The study had intended to adopt Nvivo for the analysis. As a result, the study motivated the attendance of training on Nvivo and other relevant academic forums on data analysis. However, in the process of learning, it was realised that Nvivo has been designed for managing huge data which is contrary to the amount of this study's interview-survey data. In contrast, because of the huge data for questionnaire-surveys and the difficulty of managing numerical data, Statistical Packages for Social Sciences (SPPSS) software has been adopted for its analysis. Furthermore, as explained in Section 6.5.1.1 of this chapter, the study has adopted qualitative content analysis in analysing all the data collected during all the two sets of interviews conducted.

Furthermore, the study has developed, designed and adapted an algorithm towards achieving its objectives as proposed by many previous researchers (Goldratt & Weiss; 2005; Mabin & Balderstone, 2003; Gupta, 1992; Ronen & Spector 1992;

Goldratt & Cox, 1986). In addition, the algorithm has been piloted which established its efficiency before its final application.

The steps of the algorithm developed by the study for the purpose of simplifying the adoption of qualitative content analysis are:

i. data transcription and proofreading;
ii. itemisation of variables;
iii. designing of database;
iv. data coding;
v. analysis and discussion;
vi. finding; and
vii. conclusion

The algorithm has been used in line with qualitative content analysis discussed in this chapter, Sections 6.5.1.2 and 6.5.1.3. The designed flow-chart for the algorithm is displayed in Figure 6.2.

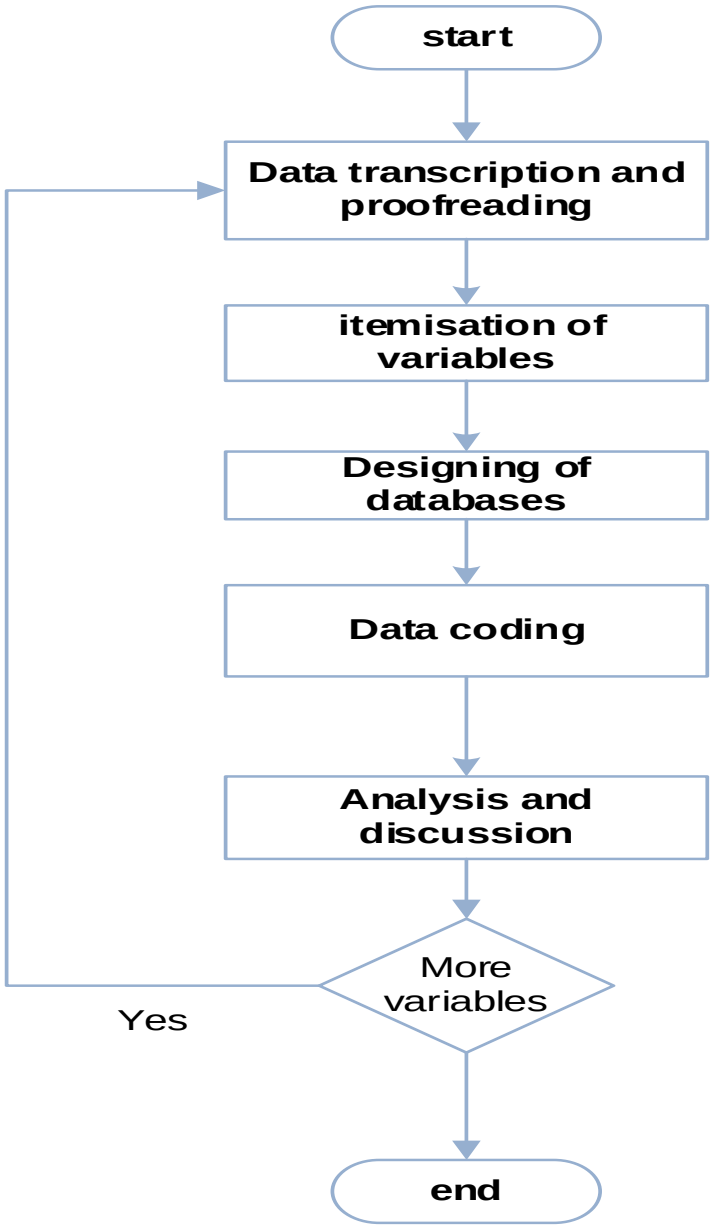


Figure 6.2: Flow-Chart of the developed algorithm for the study

6.5.2 Questionnaire

A questionnaire can be defined as a list of carefully selected structured questions, which have been chosen after critical testing, with the intention of generating reliable and genuine responses from relevant respondents (Oates, 2008; Collis & Hussey, 2003). This method of data collection is mainly and technically associated with positivistic and phenomenological methodologies (Sekaran, 1992). Furthermore, the

main objective of a questionnaire is to critically find out what the selected groups of respondents think, feel or do. This method of data collection is more essential and efficient when the researcher knows "how to measure the variables of interest" and "what is required" are known (Sekaran, 1992).

There are two different types of questionnaire; these are open-ended and closed-ended questions. Open-ended question is a situation where each and every respondent can present his opinion in his own words; while closed-ended question is determined by choosing an alternative from a given number of predetermined alternatives (Collis & Hussey, 2003). Further, multiple-choice question, classification questions, questions using the rating scale and sensitive questions were advanced by some researchers in questionnaire design and implementation (Collis & Hussey, 2003).

In a situation where respondents are requested to answer closed-ended questions and select one of the multiple answers from a category, this is referred to as "multi-choice questions". "Classification questions" try to find out more about the respondent's biography, like his age, specialisation, academic qualifications and occupation. "Rating scale" tries to identify the respondent's opinion and answers factual questions, like presenting numerical value to the respondent's view/opinion by the researcher. Any question that sounds embarrassing, scaring and threatening to the respondents are classified under "sensitive questions" (Collis & Hussey, 2003).

A questionnaire has some advantages, which makes it reliable to be used in this study. Collis and Hussey (2009) and Sekaran (1992) outlined some of them, which include:

i. it is straight forward;
ii. protection of data quality;
iii. it is relatively cheap;
iv. it is relatively bias-free;
v. the respondents have enough time to consult other parties before filling it in;
vi. influence of the researcher is very limited; and
vii. confidentiality and anonymity of the respondents are protected.

Subsequently, personally administering and mailing are the two main methods of questionnaire distribution and retrieval. This opinion has been expounded by

Sekaran (1992), but sometimes ambiguities, a lack of seriousness on the part of respondents and misunderstanding survey questions may arise (Sekaran, 1992). While in secondary sources, data is easily generated, but it may be difficult to confirm its validity and reliability (Collis & Hussey, 2003).

6.5.2.1 Questionnaire design

Effective questionnaires can only be produced by a researcher, when some guidelines and principles are followed during its design process (Oates, 2008; Smith, Osborn & Smith J, 2003; Collis & Hussey, 2003; Creswell & Miller, 2000). Some areas that a researcher needs to focus his view on are categorisation of variables, wording of designed questions and the general appearance of the questionnaire (Smith, Osborn & Smith J, 2003; Sekaran, 1992). This study has analysed all the guidelines and principles during the design of its questionnaire (see: Appendix D).

Furthermore, Oppenheim (2000) and Sekaran (1992) suggested certain fundamental principles which should be respected and adopted in the design of a questionnaire. These include, but are not restricted to, sequence, wording, and categorisation, type, scaling of the questions, scope, itemisation and the scope of the pilot study. In support of this argument, Sekaran (1992) emphasised that wording of the questionnaire should be selected and adopted precisely, concisely and carefully so as to avoid leading questions, technical jargons, ambiguous questions, double-barrelled questions, loaded questions and dependent questions. He further, opined and recommended that, the length of the questions should be formulated to a minimum length that is simple, short and concise.

In line with the recommendations of other researchers, this has been adapted and used by this study in the process of designing its questionnaire. Similarly, with the aim of producing an outstanding questionnaire, rewriting the questions, screening them, careful selection of wording, sequencing, scaling the questions and categorising them covered a period of ten months before completion. The questionnaire begins each section by providing a concise and precise literature so as to guide the respondents towards answering the subsequent questions. Furthermore, the respondents answered all the questions clearly without seeking further clarification from the researcher on the questions asked or the procedure followed.

6.5.2.2 Questionnaire administration

As discussed in Section 6.3 of this chapter, the two main methods of questionnaire distribution and its administration are the personally (or physically) administered questionnaire and the mailed questionnaire. The personally administered method was carefully selected for the survey of the study's questionnaire. The personally administered method was chosen for seven reasons: (i) unreliability of Nigeria's postal system; (ii) the pages of the questionnaire and supporting documents were relatively bulky; (iii) personal contact offers a great opportunity for further discussion on the topic of the study; (iv) it allows the researcher to clarify some misunderstanding that might arrive; (v) it allows the researcher to replace a questionnaire completed wrongly by the respondent if he requires; (vi) it allows the researcher to retrieve the completed questionnaire within a reasonable period of time; and (vii) and it allows the researcher to keep the confidentiality of the respondents better.

6.5.2.3 Justification of questionnaire questions asked

The questionnaire designed for this study comprises of two preliminary parts and five sections. The first preliminary part is the title of the survey which is derived from the topic of the study. The second part which is of two parts, presents an assurance to the respondents that their responses will be kept confidential and their identity will not be disclosed, and the meaning of abbreviations used in the questionnaire.

Consequently, the five sections of the questionnaire followed the preliminary pages. The first section is in two parts, designed to gather general information from the respondents about their working place among the various companies, associations and institutions that formed the stakeholders' corporation as well as their various roles in the corporation(s) or place of duty. The second was designed so as to assess the impact of the cost of state-of-the-art IS as a significant barrier to its adoption by Nigerian INOCs or not. The third was designed to assess skill development in the indigenous oil sector. The fourth was on managerial attitude. The fifth was designed to generate data on government policy in the oil sector. The sixth was formulated so as to gather data on government incentives. The seventh was designed in order to assess the impact of environmental factors on the adoption of state-of-the-art information systems by Nigerian INOCs. Finally, the last section was designed to seek the respondent's permission by providing their telephone number and/or e-mail to be contacted in the future if the need arises.

6.6 Pilot study

The study had employed a pilot approach before the main data analysis. A pilot study is a step towards preparing for the major study, in which a trial was conducted or small-scale version is performed in order to prove the validity of the tool (Polit, 2013; Aitman et al., 2006). Additionally, conducting a pilot study is very essential because of the fact that, it allows a researcher to identify strengths, deficiencies and weaknesses of his tool during design, and this can be addressed and corrected before spending resources, which include time, money, energy and skill in the process of data collection with an invalid tool that has not been authenticated (Oates, 2008; Aitman et al., 2006).

Furthermore, a pilot study allows this study to identify more appropriate and more relevant stakeholders to be interviewed and/or served with questionnaires to respond. Consequently, during the pilot study, the first draft of the questionnaire was circulated to some senior staff in the oil industry, other relevant stakeholders and experts, to get their positive and negative observations on the questionnaire's structure, format and wording. Further, the comments received were revised, updated and corrected and a final copy of the questionnaire was produced. The data was collected; its reliability, validity, interpretation and analysis will be the next step in the research process (Polit, 2013).

In this study, the pilot studies were conducted in three stages. The first stage was conducted at the Robert Gordon University. Two staff and five doctoral candidates reviewed the questionnaire and commented on its content, wording and general layout. Furthermore, the questionnaire was reviewed after receipt of their comments and recommendations. This has been achieved through the invaluable comments and observations of my supervisor team.

The second pilot study was conducted among the various oil and gas senior staff working with oil companies in Aberdeen and other parts of the United Kingdom. Five experts were recommended and later contacted in Aberdeen to indicate their observations and suggestions on the proposed questionnaire. After the first pilot study, the revised questionnaire was reviewed once again after receiving their technical opinions and observations.

The final pilot study was conducted in Nigeria. Two people from NNPC, INOCs, educational institutions, NCS/ITAN, PENGASSAN and NETCO's group of respondents

were identified and contacted on the pilot study due to their: (i) knowledge and experience in the Nigerian INOCs; (ii) knowledge and experience on the state of IS used by the indigenous oil companies; (iii) their integrity and commitment to the sector; and (iv) their responsibilities, roles and functions as major stakeholders in the oil and gas sector.

6.7 The population and sample of the questionnaire survey

Sekaran (1992) described the population of any study as "the entire group of people, events, or things of interest that the researcher wishes to investigate". This is as a result of the fact that, the size of any population under consideration in many studies makes it impossible to survey the whole population (Lawal, 2006; Collis Hussey, 2003).

The total population of the questionnaire-survey of this study was defined to include respondents from six groups which include Nigerian National Petroleum Corporation (NNPC) which is owned by Nigerian Federal Government (NFG) and serve as the national oil company that participated in exploration and production; Indigenous Oil Companies (INOCs) mostly owned by the citizens of the country and also participated in exploration and production; Petroleum and Natural Gas Senior Staff Association of Nigeria (PENGASSAN) which is an independent association as well as a pressure group of senior staff working in the oil and gas sector; National Engineering and Technical Company Limited (NETCO) owned by the Federal Government as a subsidiary of NNPC which has the responsibility of producing technology and services of indigenous oil sectors; educational institutions (that deal with ICT in oil and gas sector) which comprises researchers and activists as members of Academic Staff Union of Universities (ASUU) from higher academic institutions dealing with oil and gas, but with special interest in ICT; Nigerian Computer Society (NCS) and its sister organisation- Information Technology Association of Nigeria (ITAN) as an umbrella that accommodates computing and ICT experts in the country and also work with the INOCs . All these were selected and adapted for the study after rigorous investigation and contacts.

There were five reasons for the selection, identification and categorisation of these research respondents. Each of the respondent population was recognised and confirmed to be at least one or more of the following: (i) active participants in computing and ICT in the oil and gas sector, particularly relating to its upstream

operations; (ii) acting as managers and/or decision makers in either ICT or oil and gas sector; (iii) their functions and responsibilities are directly related to ICT in oil and gas sector; (iv) having direct knowledge of the sector as a result of academic interest and; (vi) rendering consultancy services to the sector. In addition, these respondent populations were nominated and contacted either as a result of their role, knowledge and experience, or by the possibility of the study's impact on them as stakeholders in the sector.

The population used in this study are: (i) general and engineering managers in the Nigerian oil and gas sector; (ii) engineers and maintenance technicians; (iii) computer scientists, software engineers, programmers and information systems experts and analysts; (iv) exploration and production technologists; and (v) others, which include researchers, business strategists, project experts and process engineers.

Consequently, this population has been selected in order to compute the respondents' views among the stakeholders according to their workplace. Sometimes differences occur as a result of workplace. Stakeholders from NNPC which is owned by Nigeria's government have expertise in the field of study and they are mostly loyal to their employer- the Federal Government of Nigeria. Stakeholders from INOCs and NCS/ITAN were mostly independent in their opinion as private companies and independent societies usually and openly agree or disagree with the government because of their independent position. In addition, stakeholders from PENGASSAN and educational institutions are mostly activists and pressure groups. Stakeholders from educational institutions are mostly members of Academic Staff Union of Universities (ASUU) and they mostly go to extreme positions in their opinions and perspectives. Fortunately, this helps in checking bias and assessing unnecessary selfish interests.

Furthermore, all these have been considered as organisations of stakeholders in the oil and gas sector. Similarly, they have some experts of upstream IS who mostly deal with the Nigerian INOCs. However, according to the demand of each and every component of the questionnaire, other stakeholders could be more knowledgeable than others. However, all of them are relevant.

The NNPC and its subsidiaries such as National Petroleum Investment and Management Services (NAPIMS) and Nigerian Petroleum Development Company

(NPDC) served as the upstream arm of the national oil company that oversees the nation's investment in joint venture companies, exploration, service contract companies and production sharing companies. Sixty (60) respondents were selected in the population frame for this category of potential respondents from the NNPC and its subsidiaries. This number was selected because of the high population of the corporation and its relevance to the study. Furthermore, the respondents are strategically important, as their organisations are the exploration and production arm of the NNPC and they also serve as an intermediary between the INOCs on the one hand, and the Federal Government of Nigeria on the other. The performance of the oil and gas activities is related to the NNPC through its arm, NAPIMS.

The indigenous oil operators are a collection of forty-nine (49) active and non-active INOCs as well as twenty-eight (28) marginal fields' operators. They have few relevant respondents compared to NNPC as a result of their dependency on consultancy services from other bodies for some of their activities. Forty (40) senior staff and experts of the Nigerian INOCs were included in the population frame for this category of potential respondents as some of them may be contacted through their association, PENGASSAN.

The Petroleum and National Gas Senior Staff Association of Nigeria (PENGASSAN) is an association that has experts of IS in the oil sector and a pressure group was included in the population frame of the study. As the name implies, it is an organ that accommodates senior staff from NNPC, INOCs, oil and gas servicing companies, independent marketers as well as individual experts in the oil and sector. Twenty-five (25) stakeholders were selected from the association. This number has been selected, because some of them may be contacted under NNPC, INOCs or any other group because of their dual functions.

The National Engineering and Technical Company Limited (NETCO) as a Federal Government owned company is shouldered with the responsibility of producing state-of-the-art technology and services for the oil and gas sector and was also selected as part of the population frame of the study. The NETCO is also a subsidiary of NNPC. Twenty- five (25) stakeholders were also included in the study. This number was determined as a result of their limitation in terms of staff strength who have input and relevance to the study.

Few educational institutions that offer courses on petroleum resources in which their staff specialised in computing and ICT were included, such as the Federal University of Technology Yola (FUTY), Abubakar Tafawa-Balewa University Bauchi (ATBU) as well as the Federal University of Petroleum resources, Delta State. Out of them, only twenty-five experts were selected as a result of the fact that few people have expertise in the study area.

The Computer Association of Nigeria/Information Technology Association of Nigeria as the associations of experts in computing and ICT were included as part of the population frame of the study. Twenty-five experts were selected based on their area of expertise as well as their workplace. The population has been determined considering that, some of them may be contacted through NNPC or educational institutions as a result of their dual functions or membership. Furthermore, limiting the majority of them in the area of expertise and place of assignment is another factor that has been considered.

As stated earlier in this section, the majority of researchers are unable to survey the whole population of their study, instead they mostly settle for what is called "a sample" as described by Sekaran (1992). He noted and explained a sample as a suitable representative subset of the whole population. He emphasised that a sample should always represent some, but not all elements of the population of the study. In very exceptional and rare situations that a sample will be the exact replica of the whole population from which it is drawn. Therefore, the sample should be selected in a way that makes it probable to be representative of the population it is expected to characterise (Sekaran, 1992). Furthermore a representative sample if critically and carefully selected participants will precisely and accurately reflect the whole population and the data generated could represent the whole data to be collected from the population.

Interestingly, the selected sample for this study is very adequate to critically survey the significant barriers (if any) to the adoption of state-of-the-art IS by Nigerian INOCs because, two hundred (200) questionnaires were very adequate as a sample compared to the number of stakeholders that are knowledgeable in upstream IS in the oil and gas sector.

6.7.1 Coding and data processing of the questionnaire-survey

Selected codes were assigned to each variable to ease and facilitate the keying of responses directly into the computer application software packages. After receiving the questionnaire, a number was given to each one in order to identify and recognise the category of each respondent during analysis.

The questionnaires were all administered one after the other using the number given to them. This started with their workplace, followed by their role and/or expertise, and subsequently the main body of the questionnaire which comprises the cost of ICT resources up to environmental factors as significant barriers, or otherwise, to state-of-the-art IS by Nigerian INOCs were all processed.

6.7.2 Analysis of questionnaire & selection of stakeholders

The design of the questionnaire has been an important component of this study and is still part of its analysis. As a result, necessary attention has been given to all its components in an attempt to produce a world-class questionnaire with precision and accuracy. This had been monitored in line with the procedure for analysis that had been adapted in Chapter 6 Section 6.5 of this thesis.

The researcher had been requested by his supervisors to review all the items that had been identified as barriers to the adoption of state-of-the-art IS and all other ICT infrastructure and placed in the context of Nigerian INOCs. This had been done carefully, but efficiently for a long period of time.

A period of ten months had been spent in the course of producing the questionnaire-survey tool. However, it had been conducted concurrently with other components of the study.

During the design of the questionnaire, the different items that had been confirmed as barriers in other developing countries have been divided into relevant sections and reconciled with Nigerian INOCs. However, another important component that had not been addressed in other countries and very relevant has been added to this study. Most importantly, among them were environmental factors such as corruption and insecurity as identified from the interview survey that had been conducted prior to this investigation as in Chapter 5, Section 5.7 of this thesis.

6.7.3 Selection of workplace and its analysis

Efforts had been made to select various groups according to their workplaces. Various companies that have been active and/or in the true picture of exploration and production activities by Nigerian INOCs had been identified and adopted for getting relevant data. This study believes that without identifying relevant and appropriate institutions, associations and companies receiving valid data could not be achieved, and as a result, the data collected would mislead the study.

As explained earlier, six groups of stakeholders or workplaces which include Nigerian National Petroleum Corporation (NNPC), Indigenous Oil Companies (INOCs), Petroleum and Natural Gas Senior Staff Association of Nigeria (PENGASSAN), National Engineering and Technical Company Limited (NETCO), Educational institutions (that deal with ICT in the oil and gas sector), Nigerian Computer Society (NCS) and its sister organisation- Information Technology Association of Nigeria (ITAN) were selected after rigorous investigation and contact.

Interestingly, this has been selected in order to compute the respondents' views among the stakeholders according to their workplaces. Sometimes differences occur as a result of different workplaces. Stakeholders from NNPC which is owned by the Nigerian government have expertise in the field of study and they represent the Federal Government of Nigeria in the sector. Stakeholders from INOCs and NCS/ITAN also have expertise and were mostly independent in their opinion as private companies and independent societies. In addition, stakeholders from PENGASSAN and educational institutions also have expertise of IS in INOCs and are mostly activists and pressure groups. Stakeholders from educational institutions are mostly members of Academic Staff Union of Universities (ASUU) and they mostly state their opinions on any matter without fear. Fortunately, this helps in checking bias and assessing unnecessary selfish interests (Bryman, 2010).

Furthermore, all these have been considered as groups of stakeholders of upstream IS in the oil and gas sector. Similarly, all the groups of chosen stakeholders were experts of IS.

6.7.4 Selection of stakeholders within the organisations

Stakeholders' selection within the organisations had been achieved after careful assessment of their roles within the organisation(s) and their direct contact with upstream operations or their management. The selection has been achieved through

reviewing their functions and roles, contacting prominent stakeholders in the sector and attending local relevant conferences that were attended by oil and gas stakeholders.

General Managers, engineering managers, upstream engineers, maintenance technicians, computer scientists, ICT analysts and upstream technologists are actively in the oil and gas sector. The following are direct stakeholders by virtue of their positions or academic roles they have been playing with respect to Nigerian INOCs.

6.7.5 Limitation of the questionnaire

All questionnaires may have their limitations at any time, and particularly after a period of time from its design and development. No matter how intellectually and carefully the statements and questions were articulated, designed and formulated, a few ambiguities may exist (Oppenheim, 2000; Sekaran, 1992). However, beside praises, commendations and admiration, no respondent had indicated any negative observations on the questionnaire in general. However, the study itself had an observation on it after the data collection. On the top of section B of the questionnaire, as the study may observe, instead of writing "cost of state-of-the-art ICT resources" the study wrote "cost of resources" only. However, in a real sense, the content of the section really guided the respondents to understand it without seeking any clarification during data collection.

Furthermore, in this study, an effort has been made to make the questions as brief as possible, but without hiding any useful information from the respondents.

6.7.6 SPSS Tools

This research used objective statistical tools based on SPSS to analyse the significant barriers and constraints that limit the adoption of state-of-the-art IS by Nigerian INOCs. However, there are other statistical packages, but the selection of the SPSS was made for three reasons: i) it has the provision of all the applications to be used in the analysis of the questionnaire survey of this study; ii) it is very powerful for data analysis that has statistical procedures (Pallant, 2005); and iii) it is universally acceptable for quantitative researchers that require statistical packages for their analysis.

The study has made an attempt to expose how significant barriers impede the performance of INOCs by limiting the adoption of state-of-the-art engineering

applications with ICT tools (networking, real-time and integrated database) to improve workflow, reduce cost and simplify the overall business process.

This study has selected survey research as a suitable methodology that enables the attainment of research objectives. As a pragmatic approach, this methodology collected both primary and secondary data from a sample, which will be analysed statistically and generalise the result on the entire population. Specifically, analytical survey methodology was conducted to ascertain whether there is a relationship between two or more variables of the framework selected (Collis & Hussey, 2009). This could be between INOCs and the existence of significant barriers that limit the adoption of state-of-the-art IS or not.

Consequently, the survey method is also employed because it helps critically towards generating an in-depth knowledge of the "reality" of the situation with respect to the significant barriers to state-of-the-art upstream IS in the Nigerian INOCs. This is possible through reaching relevant stakeholders and understanding their views, in order to come out with a standard and comprehensive basis that will facilitate a clear picture of the issues associated with exploration in the indigenous oil and gas sector.

Similarly, questionnaires were distributed hand-to-hand and some very few key stakeholders were e-mailed after receiving their consent. As explained earlier, the key stakeholders interviewed were found in the Nigerian oil sector and other relevant institutions, which include, NNPC, INOCs, NETCO, NCS/ITAN, academics and PENGASSAN formed the target population of this research.

Furthermore, their technical views and understanding were sought on various issues surrounding the significant barriers to state-of-the-art IS adoption by Nigerian INOC.

6.7. 7 Methods of data analysis used in the questionnaire

Data analysis is defined by Bodgen and Bilken (1982) as the way of systematically arranging the data you have gathered to increase your knowledge of them and to guide you to present what you have identified and discovered to others.

Furthermore, Miles and Huberman (1994) explained that, data analysis comprises of three activities. These are: i) data reduction; ii) data display, meaning to organise the data to allow making of meaningful conclusions; and iii) drawing of conclusion and verification. They noted that, these activities are interrelated.

Data reduction is also called data condensation as articulated by Tesch (1990). He and Miles and Huberman (1994) defined it as the process of identifying, nominating, simplifying, and converting raw data throughout the process of the analysis. As a result, it is advisable to reduce the amount of data in order to make it more concise and understandable (Berg, 2004; Tesch, 1990).

Data display is also defined as a systematic assembly of information that permits conclusion drawing and action (Berg, 2004; Tesch, 1990). Data display is regarded as the organisation of the collected data that will allow the drawing of a meaningful and useful conclusion (Berg, 2004).

Conclusion drawing is explained as drawing a useful meaning from the data, and establishing evidence from a logical chain. These three stages are used during data administration of the questionnaire of this study, coding and subsequent analysis as well as presentation of the final result.

Furthermore, all the three stages can be achieved by either parametric or non-parametric statistical tests. Parametric statistics make an assumption that data are drawn from a set of probability distribution and the parameters of the distribution are interfered with in the process (Geisser and Johnson, 2006). On the other hand, the statistics that depend not on the type of the probability distribution from which data were drawn are referred to as non-parametric statistics (Geisser and Johnson, 2006).

Table 6.2: Some prominent statistical tests for analysis

Non-Parametric test	Parametric test	Aim of the test
Mann-Whitney U test; Wilcoxon rank-sum test	t test for independent samples	Compare two independent samples
Kruskal-Wallis analysis of variance by ranks	One way analysis of variance (F test)	Compare three or more groups

(Dallal, 2001 with modification)

From Table 6.2, Mann-Whitney and t-test are two tests used for comparing the means of two independent groups of stakeholders under non-parametric and parametric respectively. The Mann-Whitney test makes it a condition that two independent

groups of stakeholders arise from the same population and have the same distribution as well as being homogenous to one another. The Mann-Whitney test has been described as one of the strongest and most powerful non-parametric tests (Dallal, 2001; Landers, 1982). These are among the reasons why Mann-Whitney tests were used in the analysis of questionnaire in this study. The Mann-Whitney test has been testing all six groups of stakeholders one after the other. Under each variable 15 computational tests were computed sequentially in order to check whether any significant differences had existed or not.

6.7.8 Missing value analysis

Missing values refer to questions with no answer or data without meaning (Croninger & Douglas, 2005; Allison, 2002). This might be due to participants not understanding the statement or refusing to indicate their perceptions due to some reasons known to them. The threat to the reliability and validity of a study is the challenge that is posed by missing values. However, mean estimation technique is designed in order to handle the threat of a missing value (Croninger & Douglas, 2005; Allison, 2002).

Surprisingly, in the questionnaire survey of this study, no missing value has been identified. The study has reviewed the entire returned questionnaires one after the other up to three times without tracing any missing value. This could be as result of many reasons: i) careful selection of responsible stakeholders for the questionnaire survey; ii) simplicity of the questionnaire; and iii) interest of the stakeholders with regard to the study.

6. 7.9 Follow-up interviews on questionnaire findings and member checking

This section addresses the issue of follow-up interviews that were conducted. After the completion of questionnaire survey analysis, significant differences existed between some groups of stakeholders. INOCs differed significantly 15 times with educational institutions. In addition, NNPC differed significantly 14 times with educational institutions. And finally, INOCs also differed significantly 10 times with PENGASSAN. However, most of the significant differences occurred in their collective agreement or collective disagreement. For example, one group of stakeholders strongly agreed whilst another group agreed only. In order to understand the reasons for the significant differences between various groups of stakeholders and their

implications to INOCs' progress and development, other interviews were arranged and conducted as a follow-up interview.

Twelve stakeholders were selected for the interview and they all agreed to be interviewed. The first six stakeholders were the initial interviewees during the first set of interviews that were conducted prior to the questionnaire survey. These were the engineering manager, general manager, computer scientist, E&P engineer, senior geologist and information systems analyst. Two stakeholders were interviewed from each group of six stakeholders. This also serves as "member checking" of the original interviews conducted as well as the questionnaire findings. Member checking or member validation is a procedure where a data or information is submitted for an investigation to the stakeholders who were the primary sources of those data or information (Bryman, 2010). He emphasised that the checking is mostly associated with qualitative research. Further the wisdom behind the checking is mostly to have an agreement between the researcher and the respondents. The exercise has been conducted in this follow-up interview. The result established an agreement between the researcher and the interviewees.

Similarly, all the twelve stakeholders were selected through the same process of investigation, and a critical review of their expertise as well as their integrity. This has been discussed elaborately in this chapter, Section 6.5.1.3.

6.7.10 Justification of follow-up interview questions

Five questions were presented to every research interviewee as a structured interview. These questions were carefully selected to cover all the areas of the significant differences. The first question was asked purposely in order to avoid any bias. The first question requested the interview respondents to select the groups of stakeholders that they perceived could differ on their opinion or view on the significant barriers to the adoption of state-of-the-art IS by Nigerian INOCs.

Question 2 had been asked on the significant differences that occurred between four groups of stakeholders. These are NNPC and INOCs on the one hand, educational institutions and PENGASSAN on the other.

Consequently, question 3 asked whether the significant differences that occurred in question 2 can be a significant barrier to the adoption of the state-of-the-art IS by Nigerian INOCs.

Furthermore, question 4 asked on the best way to resolve the significant differences that existed between the various groups of stakeholders. And finally, the last question asked for their recommendations to the INOCs on the adoption of the state-of-the-art IS.

Another justification for the five questions asked was, the questions were critically reviewed after making contact with the supervisory team of the study. All the comments and suggestions pointed by the team were reviewed and implemented. In addition, the aim of the interview was to resolve the significant differences that existed between the various groups of the stakeholders as well as serves as "member validation".

Furthermore, all the stakeholders were interviewed face-to-face. The details and the procedure for conducting the interview were as discussed in this chapter, Section 6.5.1.5. However, some stakeholders that participated in telephone interview during the first set of interviews met face-to-face during this stage of follow-up interviews.

6.8 Conclusion

The chapter has discussed the methodology and method adapted in this study. Similarly, the chapter has also addressed the philosophical assumptions that are compatible with the study as well as the relevance of the "Burrell and Morgan frameworks". The study has been situated in its proper assumptions. In addition, methodology and methods as well as relevant issues such as reliability and validity were also reviewed and integrated within the context of our study. The issue of reliability and validity is very important to generate genuine and valid data.

Furthermore, qualitative and quantitative methods of data collection as well as their integration to "mixed-method" were also discussed and analysed according to the direction of this study. Additionally, the methods of data collection that have been addressed extensively include interviews and questionnaire-surveys. These two methods were selected in the process of data collection after considering their compatibility with our studies as well as careful application in their best situations according to their suitability.

The population of the sample has also been determined and selected for both interviews and questionnaire-survey according to the general population of the respondents as well as the availability of relevant stakeholders to be contacted.

The justifications for the questions asked during interviews and questionnaire-survey was also discussed, explained and analysed in the chapter. Further, after rigorous review of tools designed for data collection, the tools were subjected to a pilot study through sending our proposed tools to experts for their comments and observations which has also been discussed elaborately in this chapter.

Finally, the suitability of using SPSS according to data collection during questionnaire-survey was also presented. And the chapter will be followed with Chapter 7 that presents and analyses quantitative data collected for the study .

CHAPTER SEVEN

Analysis and Presentation of Questionnaire Findings

7.1 Introduction

The aim of this chapter is to analyse and report the data collected in the questionnaire survey. In order to accomplish this, the chapter is categorised into five sections. Section 7.2 presents analyses of the respondents' rate of the questionnaire survey. Section 7.3 addresses Analysis of data validity and corrections. Section 7.4 displays the demographic information of research participants participated in the study. And finally Section 7.5 presents and discusses significant findings of the questionnaire. The chapter is concluded by Section 7.6.

7.2 Questionnaire-based survey responses

Walonick (2004) stated that questionnaire-based survey responses differ from one questionnaire to another and mostly within the range of 10% to almost 90%. Furthermore, he strongly emphasised that, excellent questionnaires generate a high response rate. This study as stated in Chapter 6 Section 6.7, has administered a total of 200 questionnaires to 6 groups of stakeholders and 142 questionnaires were successfully returned (see Table 7.2). Further, 2 questionnaires were excluded from the research as invalid, because they were not completed according to the guidelines presented to the respondents. As a result, the 140 valid questionnaires constituted 70% of the total questionnaires that were administered.

Table 7.1: The rate of Questionnaires distributed and retrieved

Groups of Respondents	Distributed	Retrieved	Excluded	Used
Nigerian National Petroleum Corporation (NNPC).	60	42	2	40
Indigenous Oil Companies (INOCs).	40	35	0	35
Petroleum & Natural Gas Senior Staff Association of Nigeria (PENGASSAN).	25	19	0	19
National Engineering & Technical Company Limited (NETCO).	25	17	0	17
Educational Institutions (with special interest in ICT).	25	15	0	15
Nigerian Computer Society & Information Technology Association of Nigeria.	25	14	0	14
Total	**200**	**142**	**2**	**140**

Furthermore, many reasons might have contributed to the high response rate of the questionnaire-based survey in this research. The first reason may be the value and prestige of an excellent introductory letter from my supervisory team which has been signed by Professor Alex Russell (see Appendix B). The letter has been written on the Robert Gordon University's letter head. My supervisory team has stated not only the academic contribution of the study, but its significance to the economy of Nigeria as a country. Furthermore, many respondents indicated their keen interest in the study as a result of their concern and commitment to the progress of Nigerian INOCs. This motivated them to give maximum support to the study.

The concise and precise design of the questionnaire will be another reason. All the sections of the questionnaire started with a concise literature that summarises what the section addresses as suggested by the stakeholders during pilot study. This has assisted the respondents to get the direction of each section and answer the questions accordingly. In addition, the questionnaire was accompanied by a cover letter from the researcher, in addition to the one from the supervisory team. The cover letter which indicates among other things: the aim of the study; a guarantee of confidentiality; and procedure for answering the survey questions.

Furthermore, respondents were given enough time to respond to the questions. Some respondents were allowed sufficient time to contact their colleagues (if there was a need) before responding to some technical questions. Six weeks of frequent follow-ups through official visits, e-mails and phone calls motivated the respondents to answer the questions in the questionnaires and return them to the researcher.

Consequently, some senior staff assisted the researcher by encouraging their fellow respondents to complete their questionnaires and return them on time. With the help of these senior officers, the questionnaires were distributed to the appropriate experts and consequently retrieved at the right time.

7.3 Checking of Data and its correction

In order to analyse the data, the first step taken was to confirm the validity of the data by checking its precision and accuracy. This was done by checking data coding and its entry by going through all the completed questionnaires and checking them against their SPSS files. Before data entry, all the completed questionnaires were numbered serially and cross-checked one after the other against their corresponding SPSS files.

In addition, about 3 cases were identified in which the data had been entered wrongly. The completed questionnaires were crosschecked over and over against their corresponding data on the computer. Errors were identified and corrected accordingly. In questionnaire with serial no 27 under Section D, in the first statement "strongly agree" was initially and mistakenly entered instead of "strongly disagree". Similarly, in questionnaire with serial no 71 under Section F, the corresponding entry of statement "c" was mistakenly entered as neutral instead of "disagree". Finally, in the questionnaire with serial no 125 under Section G, in the second statement, the choice was mistakenly entered as "strongly agree" instead of "agree". These were the 3 cases that were initially entered wrongly and subsequently corrected during data checking.

7.3.1 Demographic information of questionnaire participants and questions

Demographic characteristics of questionnaire respondents were surveyed in two stages, namely: workplace and role in the company. These characteristics were perceived to be relevant to the research. However, critical analysis of the fact from the survey indicates that workplace (groups) and role in the company have significant value in the analysis towards resolving some divergent opinions. In

addition, cross-tabulation analysis has been employed towards understanding the response of various groups of stakeholders. The cross-tabulation is described as being essential in order to determine the responses of the participants and their relationship between various independent groups of stakeholders (Fink & Koseloff, 1985). Further, in ICT technical questions, responses of technical experts of upstream and ICT were sought for more clarification and analysed accordingly.

Table 7.2: Demographic characteristics of the workplace

Workplace	**Frequency**	**Percentage**
Nigerian National Petroleum Corporation (NNPC).	42	30%
Indigenous Oil Companies (INOCs).	35	25%
Petroleum & Natural Gas Senior Staff Association of Nigeria (PENGASSAN).	19	13%
National Engineering & Technical Company Limited (NETCO).	17	11.9%
Educational Institutions (with Special interest in ICT).	15	10.1%
Nigerian Computer Society & Information Technology Association of Nigeria (NCS/ITAN).	14	10%
Total	**140**	**100%**

Table 7.3: Stakeholders' role and expertise

Occupation	**Frequency**	**Percentage**
General/Engineering Manager	15	10.71%
Exploration & Production Engineer	47	33.58%
Computing/IT Professional	42	30%
Exploration & Production Technologist	14	10%
Other Stakeholders	22	15.71%
Total	**140**	**100%**

Table 7.4: Statistics of questions

Statement	Number of Questions	Percentage
Cost of Resources	9	23.7%
Skill	5	13.1%
Managerial Attitude	8	21.2%
Government Policy	5	13.1%
Government Incentives	5	13.1%
Environmental Factors	6	15.8%
Total	38	100%

7.4 Reliability and validity analysis

Reliability and validity analysis are very important in research, particularly a quantitative one. As a result, Forza (2002) noted that, without determining the reliability and validity of a collected data, the effects of measurement errors that can occur on theoretical relationships are impossible to be detected.

Furthermore, the reliability and validity of a primary data collected using questionnaire are easily assessed and confirmed (Saunders, et al., 2009; Forza, 2002). They stated that, the assessment and confirmation can only be achieved if a good explanation of the instrument used for data collection is given during its design and pilot programme.

7.4.1 Reliability analysis of the study

The quantitative data collected for this study adapted scaled responses using likert scale. Therefore, it is highly recommended to compute and determine the reliability of the scale (Tracey et al., 2005). Prior to that, the data has been confirmed to be free of random effects, as a result, reliability tests were computed and determined as a measure of the internal consistency of the questionnaire tool developed for the study. Reliability is a process that confirms that data collection techniques will produce consistent findings if repeated (Saunders et al., 2009). In other words, the test is to verify if two or more research participants or the same participant observing the same event more than once, can achieve or observe the same opinion (Sekaran and Bougie, 2013). The primary aim of the test is to ensure error free result through obtaining consistent measurement

in various times and across various items of the research tool or instrument (Pallant, 2010).

The test is employed in this study to assess "internal consistency of measures". In addition, internal consistency of measures can be defined as "the degree to which the items that make up the scale are measuring the same underlying attribute" (Pallant, 2010). In other words, it means to evaluate whether the items and subsets of items in the measuring instruments are correlated. Further, internal consistency can be determined through split-half reliability and inter-item reliability tests. And this will be subsequently addressed in the next sections.

7.4.2 Cronbach's alpha for significant construct

It has been stated by many researchers that, the most accepted and commonly used statistic in measuring internal consistency is cronbach's alpha coefficient alpha (Sekaran & Bougie, 2013; Pallant, 2010; Flynn et al., 1990). In addition, cronbach's alpha for significant construct is a reliability coefficient that shows how well the items in a given set are positively and correctly correlated to one another (Sekaran & Bougie, 2009). The test using cronbach's alpha ranges from 0 to 1. There are different levels of reliability depending on the nature and purpose of the scale (Pallant, 2010). In general, reliabilities of more than 0.80 are very good. Further, the reliabilities of 0.70 are acceptable, while reliabilities of less than 0.60 are poor. In addition, Swafford et al., (2006) opined that, Cronbach's alpha at 0.70 and above are typically accepted to confirm reliability of a construct. However, in peculiar situations, 0.6 cronbach's alpha is acceptable (Forza, 2002). Pallant (2010) indicated that, if the number of items in an instrument is small, Cronbach's alpha value may be small.

Furthermore, in this study, reliability tests using cronbach's alpha coefficient for significant constructs were computed and determined. The tests were conducted for the main sections of the questionnaire instrument- which comprises of the entire questionnaire, demographic information, cost of ICT resources, skills, managerial attitude, government policy, government incentives and environmental factors. The "internal consistency reliability" of the measures used in this study can be considered as good for the entire questionnaire and environmental factors. In addition, the test indicated that the result is acceptable for the demographic information, cost of ICT resources and managerial attitude. The result of the test is displayed in Table 7.4.1.

Table 7.4.1: Cronbach's alpha coefficient reliability test for significant construct

Focus of the Tests	Cronbach's Alpha	Items
The entire questionnaire	.855	51
Demographic information	.765	2
Variables of Cost of ICT resources	.767	9
Variables of skills	.656	5
Variables of managerial attitude	.777	8
Variables of environmental factors	.879	6

The Table 7.4.1 shows that, the Cronbach's alpha for the entire questionnaire of 51 items is .855, while environmental factors of 6 items have Cronbach's alpha of .879. In addition, the demographic information of 2 items has Cronbach's alpha .765, cost of ICT resources with 9 items has Cronbach's alpha .767 and managerial attitude with 8 items has Cronbach's alpha .777. In the contrast, skills have .656. This result shows that the questionnaire instrument of this study is reasonably reliable.

7.4.3 Non-Response bias using two-wave analysis for validity test

Validity of an instrument is the extent to which the instrument correctly measures what it has been designed to measure (Robson, 2011; Sekaran & Bougie, 2009; Saunders et al., 2009). The main concern of validity is about the authenticity of the cause-and-effect relationships (i.e internal validity) and their generalizability to the external environment (i.e external validity) (Sekaran & Bougie, 2013).

Furthermore, in this study, validity was integrated in a number of ways. Firstly, the questionnaire was developed after intensive review of relevant literature. Secondly, a conceptual model was adopted. Thirdly, all completed questionnaires were numbered and scrutinised prior to analysis. This helps in establishing a sound construct validity.

In addition, two-wave analysis was employed to investigate the validity of the questionnaire. The completed and returned questionnaires were divided into two groups according to the time of their arrival.

The wisdom behind two-wave analysis is that, the first group of respondents which returned their questionnaire early indicated those who are interested and willing to

participate in the study. In addition, the second group who returned late comprised those who are non-responding respondents.

The two-wave analysis was conducted between the two groups of respondents. The result is displayed in Table 7.4.2 of this study. The attributes measured in the analysis were demographic information, cost of ICT resources, skills development, managerial attitude, government policy, government incentives and environmental challenges. As in Table 7.4.2, for all the attributes analysed and measured in this study, the two tailed significance values are all greater than 0.1. This has proved that there is no significant difference between mean values of the both waves.

Table 7.4.2: Non-Response bias using two-wave analysis

Variables	**1st Wave**	**2nd Wave**	**2 tail sig.**	**Df**	**Levene's test**
Category of company	2.79	2.97	.758 .693	25 33	.326
Role in the company	2.69	2.52	.877 .774	25 33	.770
Cost of resources	2.99	2.89	.558 .569	25 33	.766
Skill development	4.21	4.23	.748 .777	25 33	.515
Managerial attitude	2.58	2.79	.539 .565	25 33	.413
Government policy	2.91	2.99	.687 .520	25 33	.546
Government incentives	2.87	2.89	.538 .811	25 33	.878
Environmental factors	2.19	2.15	.855 .515	25 33	.349

Note: Levene's Test: Two variances are not significantly different if the significance level is greater than .05.

df: degree of freedom.

Furthermore, based on the first and second wave means, two tailed significance and the Levene's T-test as in Table 7.4.2, the questionnaire tool is proved and established to have a high level of validity. It indicated there is no significant difference between the early respondents and late respondents, since the Levene's T-test of all is greater than .05 as in Table 7.4.2.

7.5 Significant findings of the study

The 6 sub-questions developed for the study as in Chapter 1, Section 1.3 are answered in this section. The previous section has computed and analysed a: i) reliability test; ii) crombah alpha for significant constructs; and iii) non-response bias test using two-wave analysis.

Subsequently, descriptive analysis of the frequency distribution of the respondents' opinions was discussed extensively in subsequent sections of this chapter. These are mean, median and cross-tabulation. The data collected through questionnaires were coded based on a 5 points likert scale in the following format: strongly disagree (1); disagree (2); neutral (3); agree (4) and strongly agree (5). In addition, overall perceptions of the respondents in relation to each of the 38 variables were adopted in the process of the study.

Mann-Whitney tests were also conducted so as to determine if any significant differences existed between the various groups of stakeholders. This is done for Mann-Whitney at 5% ($p< or =0.05$) of significance difference as recommended, adopted and applied by other researchers (Stigler, 2008). The resultant differences were discussed, analysed using cross-tabulation analysis and compared mean where necessary.

7.5.1 Cost of ICT resources

This section has addressed the first sub-question of the study. The sub-question which is to be analysed and answered using the responses to nine variables relating to section B of the research instrument, is restated as follows:

- ✓ **Q_1. Is the cost of ICT resources a significant barrier that impedes the adoption of state-of-the-art ICT by Nigerian INOCs?**

Furthermore, cost of software, IS, training, maintenance and hardware resources have all been identified as barriers to ICT and IS adoption in South Korea and Sri Lanka (see: Kafurubandara & Lawson, 2006; Lee & Kim, 2004; MIC 2002; Locke & Cave, 2002). Further, stakeholders' opinion was sought in order to clarify their opinion with respect to the cost of state-of-the-art ICT resources as a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

The result of the descriptive frequencies relating to cost of state-of-the-art upstream ICT systems is displayed in Table 7.5.

Table 7.5: Descriptive frequencies relating to cost of state-of-the-art upstream ICT as a significant barrier to its adoption by Nigerian INOCs

Statement	Median	Mean	SD	D	N	A	SA
Cost of state-of-the-art ICT infrastructure.	2.00	2.81	4 (2.8%)	76 (53.9%)	12 (8.5%)	39 (27.7%)	9 (6.4%)
Cost of purchasing new state-of-the-art E&P software licenses.	2.82	2.00	3 (2.1%)	77 (55%)	9 (6.4%)	44 (31.4)	7 (5%)
Cost of state-of-the-art E&P software licenses.	2.00	2.79	3 (2.1%)	69 (49.3%)	25 (17.9%)	40 (28.6%)	3 (2.1%)
Cost of state-of-the-art hardware resources.	2.00	2.87	4 (2.9%)	68 (48.6%)	14 (10%)	50 (35.7%)	4 (2.9%)
Cost of state-of-the-art online monitoring systems.	4.00	4.00	2 (1.4%)	50 (35.7%)	13 (9.3%)	65 (46.4%)	10 (7.1%)
Cost of maintenance of state-of-the-art online monitoring systems.	3.50	3.18	3 (21%)	48 (34.3%)	19 (13.6%)	61 (43.6%)	9 (6.4%)
Cost of state-of-the-art SCADA systems.	4.00	3.44	2 (1.4%)	32 (22.9%)	10 (7.1%)	94 (67.1%)	2 (1.4%)
Cost of state-of-the-art telephone support systems	2.00	2.46	10 (7.1%)	77 (55.0%)	33 (23.6%)	19 (13.6%)	1 (1.4%)
Cost of state-of-the-art 3-D seismic capability	4.00	3.38	4 (2.9%)	35 (25.0%)	17 (12.1%)	72 (51.4)	12 (8.6%)

Note: i) SD= Strongly Disagree; D= Disagree; N= Neutral; A= Agree; SA=Strongly Agree,

ii) All figures in brackets are % of relevant responses.

Table 7.5 shows percentages and frequencies of the respondents' opinions on the cost of state-of-the-art ICT infrastructure as a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. A total of 140 valid responses for each of the nine variables were recorded.

7.5.1.1 Cost of state-of-the-art ICT infrastructure

This statement inquired into the respondents' opinions on cost of state-of-the-art infrastructure. The respondents' opinions were sought in order to clarify whether the cost of state-of-the-art ICT infrastructure was a significant barrier to state-of-the-art IS adoption by Nigerian INOCs or not.

From Table 7.5, it can be confirmed that the respondents did not share the same 2opinion. However, 80 (56.7%) of the respondents disagreed that the cost of state-of-the-art ICT infrastructure was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. In contrast, 48 (36.2%) agreed that it was a significant barrier and the remaining 12 (8.5%) remained neutral. Similarly, a mean score of 2.81 and a median value of 2.0 confirmed that the respondents disagreed with the cost of state-of-the-art ICT infrastructure as being a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. While 80 (56.7%) of the respondents disagreed, however, a significant percentage agreed that, it was a significant barrier to the adoption of state-of-the-art IS.

In spite of their disagreement that cost of state-of-the-art IS infrastructure was a significant barrier, different groups differed in the level of their disagreement which requires clarification and further analysis. As a result, cross-tabulation analysis was conducted which indicated, NNPC (42.5%), INOCs (40%), PENGASSAN (84.2%), NETCO (70.6%), educational institutions (86.7%) and NSC/ITAN (57.1%) all disagreed with the cost of state-of-the-art ICT infrastructure as a significant barrier to the adoption of state-of-the-art IS. The PENGASSAN, NETCO and educational institutions are all above (70%) in their agreement.

Consequently, this is inconsistent and incompatible with the findings that emerged from relevant literature of other sectors in the process of the study. Section 4.3.1 of Chapter 4 discovered cost as a barrier. According to Irefin, Abdul-Azeez and Tijjani (2012) and Adam (2003) cost was discovered as the most potent factor in the adoption of ICT by SMEs in Nigeria".

Given these divergent opinions, Mann-Whitney tests were computed to determine the significant difference, if any, among the groups of stakeholders. The result is displayed in Table 7.6.

Table 7.6: Mann-Whitney tests for cost of state-of-the-art ICT infrastructure in Nigerian INOCs

Statement: Cost of state-of-the-art ICT infrastructure						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC			0.01		.008	
INOCs			.002	.010	.001	
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

ii) NNPC= Nigerian National Petroleum Corporation; INOCs= Indigenous oil companies; PENGASSAN= Petroleum & Natural Gas Senior Staff Association of Nigeria; NETCO=National Engineering and Technical Company Limited; NCS/ITAN= Nigerian Computer Society/Information Technology Association of Nigeria.

From Table 7.6, only 5 significant differences emerged between the various groups of stakeholders. NNPC differed significantly with two groups, while INOCs differed significantly with three groups in spite of their collective agreement with the statement that the cost of state-of-the-art ICT infrastructure not a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

In spite of the significant difference, the popular and collective opinion of 80(56.7%) indicated that the cost of state-of-the-art ICT was not a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.1.2 Cost of purchasing new state-of-the-art E&P software licenses

This statement sought the perception of stakeholders on whether the cost of purchasing new state-of-the-art upstream software licenses was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not. From Table 7.5, the respondents did not share the same opinion. However, the majority of them constituting 80 (57.2%) disagreed that cost of state-of-the-art E&P software licenses was a significant barrier. In addition, 51 (36.4%) agreed that it was a significant barrier, while 9 (6.4%) were neutral. In line with that, a mean score of 2.82 as well as a median value of 2.00 were calculated and both supported that, cost-of-the-art software licenses was not a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Furthermore, a cross-tabulation analysis among the groups of stakeholders was conducted. In this analysis, all the collective stakeholders disagreed with cost of state-of-the-art software licenses as being a significant barrier to its adoption, but their % differed. For example, PENGASSAN (84.2%), educational institutions (86.7%) and NETCO (70.6%) significantly disagreed.

Furthermore, Mann-Whitney tests were conducted to check any significant differences between the stakeholders. The result is displayed in Table 7.7.

Table 7.7: Mann-Whitney tests for purchasing state-of-the-art software licenses

Statement: Cost of state-of-the-art software licenses						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC			.033		.015	
INOCs			.003	.050	.001	
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

In the final analysis, based on the result of the analysis, (56.7%) of the stakeholders disagreed with the cost of purchasing new state-of-the-art software licenses as being a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.1.3 Cost of renewing state-of-the-art E&P software licenses

The opinion of stakeholders has been sought with respect to the cost of renewing state-of-the-art upstream software licenses. The statement sought to clarify whether the cost of renewing state-of-the-art upstream software licenses is a significant barrier to its adoption or not.

It has been shown in Table 7.5, that the stakeholders' responses to this statement did not share the same opinion. However, the majority of them were of the opinion that the cost of renewing state-of-the-art upstream software licenses was not a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. Similarly, this can be established from the mean score of respondents as 2.87 and median of 2.00 which were both within the range of disagreement that the cost of renewing state-of-the-art software licenses was not a significant barrier to adopting state-of-the-art IS. From Table 7.5, It can be seen that 72 (51.4%) disagreed that the cost of renewing state-of-

the-art software licenses was not a significant constraint to the adoption of state-of-the-art IS. In contrast, 43 (38.7%) agreed, while (10%) were neutral or undecided.

The most popular view that emerged from this analysis indicated that the cost of renewing state-of-the-art software license was not a significant barrier to IS adoption by Nigerian INOCs. However, as explained earlier, there was a significant difference between stakeholders in the level of agreement or disagreement. The percentage of disagreement of opinion of stakeholders according to their place of work indicated that, NNPC (57.5%), INOCs (51%), PENGASSAN (57.9%), NETCO (58.8%) and educational institutions (80%) all disagreed that the cost of renewing state-of-the-art software license was a significant barrier to the adoption of the state-of-the-art IS.

In addition, a Mann-Whitney test was conducted among the independent groups of stakeholder. The result is displayed in Table 7.8 of this section.

Table 7.8: Mann-Whitney tests for cost of renewing of state-of-the-art software licenses

Statement: Cost of renewing state-of-the-art software licenses						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC					.036	
INOCs				.006	.001	
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN					.046	

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

The significant difference is more glaring between the NNPC, INOCs and NCS/ITAN on the one hand and educational institutions and NETCO on the other. As a result of this significant difference discovered by this study and its incompatibility with the relevant literature reviewed, compare mean was also determined in of the general mean of INOCs and NCS/ITAN were 3.11 and 3.00 respectively. This gave a collective opinion of neutrality. However, NNPC, PENGASSAN, NETCO and educational institutions gave an opinion of disagreement that the cost of renewing state-of-the-art software licenses was a significant barrier to state-of-the-art IS adoption by INOCs. As a result of their disagreement with a portion of literature reviewed by the study, the research also used compare mean to check whether there is a category of

stakeholders that agreed with the cost of renewing state-of-the-art software licenses as being a significant barrier. The result is displayed in Table 7.9.

Table 7.9: Compare Mean for stakeholders on cost of renewing state-of-the-art software licenses in Nigerian indigenous oil companies

Place of Work	Mean	N	Median
NNPC	2.90	40	3.00
INOCs	3.11	35	3.00
PENGASSAN	2.84	19	2.00
NETCO	2.76	17	2.00
Educational Institution	2.27	15	2.00
NCS & ITAN	3.00	14	3.00
Total	2.87	140	2.00

Note: Compare mean and median of stakeholders according to their various groups.

As in Table 7.9, this finding is not consistent with the empirical investigation conducted in other countries because, cost of all ICT resources and their maintenance were considered among the major barriers to the adoption of ICT by enterprises in developing countries, Nigeria inclusive (see Irefin, Abdul-Azeez & Tijjani, 2012; Harindranath, Dyerson & Barnes, 2008). However, the researchers have agreed that, large companies that possess adequate monetary resources and competent staff are most likely to adopt ICT resources.

In the final analysis, the cost of renewing state-of-the-art software licenses was not a significant barrier to IS adoption by Nigerian INOCs.

7.5.1.4 Cost of state-of-the-art IS hardware

This statement sought the opinion of stakeholders on whether the cost of state-of-the-art hardware was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not. Moreover from the Table 7.5, the respondents also did not share the same opinion.

However, the majority of the respondents which constituted 72 (51.5%) were of the opinion that the cost of state-of-the-art hardware was not a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. In contrast, 54 (38.6%) were of the

opinion that cost was a significant barrier while 14 (10%) remained neutral. A mean score of 2.00 and a median of value 2.87 also confirmed their disagreement. Therefore, the collective opinion was that, the cost of state-of-the-art hardware was not a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Consequently, in spite of the fact that, (51.5%) were in disagreement that cost of state-of-the-art hardware was a significant barrier; there was a significant difference of responses between the independent groups of stakeholders. A significant percentage of (38.6%) were in agreement. As a result, a cross-tabulation analysis was conducted in order to clarify the percentage response rate of the stakeholders according to their various groups. NNPC (55.0%), INOCs (58.6%) and NCS&ITAN (52.9%), PENGASSAN (78.9%), educational institutions (80%) and NETCO (64.7%) all disagreed with the cost of state-of-the-art IS hardware as being a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

This study's finding is inconsistent and incompatible with findings that emerged from the literature. Relevant literature of other developing countries and some developed countries identified the cost of technology as being a major barrier to ICT adoption by industries or SMEs. Further, as reviewed in Chapter 4 Section 4.3.1, Harindranath, Dyerson and Barnes (2008) and Adam (2003) discovered that the cost of technology is a key factor that limits the adoption of ICT in small firms in southeast England SMEs.

Furthermore, a significant difference has been checked among the groups of stakeholders using the Mann-Whitney test. The result is displayed in Table 7.10.

Table 7.10: Mann-Whitney tests for cost of state-of-the-art hardware

Statement: Cost of state-of-the-art hardware						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC					.036	
INOCs						
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

The result has shown that, only two groups of stakeholders differed significantly. As a result of their disagreement with cost of state-of-the-art hardware which was contrary to the argument of literature, we employed compare mean in order to check whether there is a category of stakeholders that agreed with the cost of state-of-the-art hardware resources as being a significant barrier or not. See Table 7.11 below as an evidence of compare mean between various groups of stakeholders.

Table 7.11: Compare Mean for stakeholders on cost of state-of-the-art hardware

Place of Work	Mean	N	Median
NNPC	2.95	40	3.00
INOCs	3.20	35	3.00
PENGASSAN	2.42	19	2.00
NETCO	2.47	17	2.00
Educational Institutions	2.27	15	2.00
NCS & ITAN	2.79	14	3.00
Total	2.79	140	2.00

Compare mean indicated that the individual mean of the groups of stakeholders, was in disagreement that the cost of state-of-the-art hardware resources was a significant barrier except for the groups of stakeholders who remained neutral.

In the final analysis, a general percentage of (51.5%) were in disagreement that cost of state-of-the-art hardware resources was a significant barrier.

7.5.1.5 Cost of state-of-the-art online monitoring systems

This statement has inquired into the respondents' opinions on the cost of state-of-the-art online monitoring systems. The respondents' opinions were sought in order to clarify whether the cost of state-of-the-art online monitoring systems was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

Furthermore, relevant literature in Chapter 4 Section 4.3.1 discovered that the cost of resources has been a significant barrier to the adoption of expensive IS resources, such as state-of-the-art online monitoring systems (Ekekwe, 2009). This is consistent

with the finding of this study, a median value of 4.00 signified that cost of state-of-the-art online monitoring systems was a significant barrier, while in contrast a mean score of 3.22 signified a neutral or undecided opinion. In addition, cross-tabulation analysis was computed in order to establish a stronger position on the matter, the percentage of agreement of stakeholders according to their places of work was determined as NNPC (50%), INOCs (54.3%), PENGASSAN (63%), educational institutions (80%), NETCO (35.3%) and NCS/ITAN (42.9%). Based on this percentage, NNPC, INOCs, PENGASSAN and educational institutions were in agreement that, the cost of state-of-the-art online monitoring systems was a significant barrier. While only NETCO and NCS/ITAN differed.

Similarly, the Mann-Whitney test was also conducted among the groups of stakeholders. The result is displayed in Table 7.12.

Table 7.12: Mann-Whitney test for cost of state-of-the-art online monitoring systems in Nigerian INOCs

Statement: Cost of state-of-the-art online monitoring systems in Nigerian INOCs						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC						
INOCs						
PENGASSAN						
NETCO					.020	
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

As in Table 7.12, only one significant difference occurred between NETCO and educational institutions. In addition, the opinion of stakeholders from educational institutions was in accordance with the stakeholders of NNPC, INOCs and PENGASSAN.

Conclusively, the majority agreed with the cost of online monitoring systems as being a significant barrier to the adoption of state-of-the-art IS by INOCs in Nigeria.

7.5.1.6 Cost of maintenance of state-of-the-art online monitoring systems

As discussed in Chapter 4 Section 4.3 of this thesis, that cost of managing world-class IS for exploration and production used by developed countries has been very expensive (Okoye, 2004; Fisher & Kenny, 2000). As a result, multinational oil companies invested heavily in relevant state-of-the-art ICT resources that provide real-time online monitoring systems for upstream operations (Talib & Malkawi, 2011; Lenhard, 2004).

Consequently, our respondents in this study did not share the same opinion on whether the cost of maintenance of state-of-the-art online monitoring systems was a significant barrier to the adoption of state-of-the-art upstream IS or not. However, the majority of them indicated that the cost of state-of-the-art IS was a significant barrier. Among the respondents, 70 (50%) were in agreement, 15 (36.4%) were in disagreement while 19 (13.6%) remained neutral or undecided. However, a mean score of 3.18 and a median value of 3.50 indicated a mixed reaction which supported neutrality or undecided opinion.

As a result of this significant difference of mixed opinion, a cross-tabulation among the stakeholders according to their places of work was computed. The result indicated that, PENGASSAN (73.7%), educational institutions (80%) and NCS/ITAN (50%) agreed with the cost of maintenance of state-of-the-art online monitoring system as being a significant barrier. while many of them remained neutral. In contrast, NNPC (42.5%), INOCs (40%) and NETCO (35.3%) were in disagreement.

Furthermore, the Mann-Whitney test was conducted in order to identify the significant differences between the various groups of stakeholders. The result has shown that stakeholders from higher institutions differed with the stakeholders of NNPC, INOCs and NETCO significantly.

Table 7.13: Mann-Whitney tests for cost of maintenance of state-of-the-art online monitoring system in Nigerian INOCs

Statement: Cost of maintenance of state-of-the-art online monitoring systems						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC					.005	
INOCs					.009	
PENGASSAN						
NETCO					.008	
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

As in Table 7.13, it has been confirmed that significant differences existed between the respondents of NNPC, INOCs and NETCO on the one hand and the respondents of educational institutions on the other.

In the final analysis, the general percentage of their responses confirmed that, the cost of maintenance of the state-of-the-art online monitoring systems was a significant barrier. The finding has been consistent with the relevant literature.

7.5.1.7 Cost of state-of-the-art SCADA systems

Stakeholders' opinions were sought on whether cost of state-of-the-art supervisory control and data acquisition (SCADA) systems was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or otherwise. The general opinion of the stakeholders indicated that, the cost of state-of-the-art SCADA was a significant constraint on the adoption of state-of-the-art IS by Nigerian INOCs. The respondents' opinions indicated that, 96 (68.5%) were in agreement, 34 (24.3%) were in disagreement while 10 (7.1%) were neutral. The respondents were decided by median value of 4.00 and undecided or neutral by mean score of 3.44.

Furthermore, this finding is in agreement with the literature of other developing and some developed countries that discovered that the cost of technology is a significant barrier to its adoption by organisations and individuals. Similarly, prior literature suggests that, many researchers have stated that, all the components of ICT resources were significant obstacles to its adoption (see for example: Lee & Kim, 2004; MIC 2002; Locke & Cave, 2002).

In order to further resolve the issue, the stakeholders' opinions were sought according to their various independent groups. This was achieved through cross-tabulation analysis. The stakeholders according to their various places of work were in agreement based on percentage. NNPC (52.5%), INOCs (77.1%), PENGASSAN (78.9%), NETCO (88.2%), educational institutions (60%) and NCS/ITAN (64.3%) were all in agreement that the cost of SCADA was a significant barrier to the adoption of state-of-the-art IS by INOCs of Nigeria.

The Mann-Whitney test was conducted in order to check significant differences. Similarly, the result has indicated a significant difference between NETCO and NNPC stakeholders as displayed in Table 7.14.

Table 7.14: Mann-Whitney test for cost of state-of-the-art SCADA systems in Nigerian INOCs

Statement: Cost of state-of-the-art SCADA systems in Nigerian INOCs						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC				.023		
INOCs						
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

As in Table 7.14, the Mann-Whitney test has shown that only one significant difference existed between two groups of stakeholders- NNPC and NETCO. While stakeholders from NNPC (52.5%) were moderate in their agreement that the cost of state-of-the-art SCADA was a significant barrier to the adoption of state-of-the-art IS, NETCO (88.2%) has shown an extreme agreement.

In the final analysis, 96(68.5%) of the stakeholders confirmed that, the cost of state-of-the-art SCADA was a significant constraint to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.1.8 Cost of state-of-the-art telephone support systems

Stakeholders' opinion was sought on whether the cost of state-of-the-art telephone support systems was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or otherwise. The result indicated, the stakeholders did not share the

same opinion on the issue, but majority of them were of the opinion that the cost of state-of-the-art telephone support systems was not a significant barrier.

Descriptive statistics vindicated that, the general opinion of stakeholders' responses disagreed that the cost of state-of-the-art telephone support systems was not a significant barrier to state-of-the-art IS. The general percentage of stakeholders' opinion indicated that 87 (62.1%) disagreed. In contrast, 20 (15.3%) agreed that the cost of state-of-the-art telephone systems was a significant barrier, while 33 (23.6%) were neutral or undecided. In addition, a mean score of 2.46 and a median value of 2.00 confirmed their disagreement that the cost of state-of-the-art telephone systems was a significant barrier to the adoption of state-of-the-art IS by INOCs.

Furthermore, this is inconsistent with some parts of the literature review that, the cost of communication facilities have all been identified as being barriers to ICT adoption in South Korea, Sri Lanka and other developing countries (See for example, Lee & Kim, 2004; MIC 2002; Locke & Cave, 2002). The result of collective percentage has established that the cost of state-of-the-art telephone support system was not a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Consequently, cross-tabulation was also conducted among the independent groups of stakeholders. The NNPC (60%), INOCs (57.1%), PENGASSAN (84.2%), NETCO (64.7%), educational institutions (66.7%) and NCS/ITAN (52.8%) all disagreed with the cost of state-of-the-art telephone support system as being a significant barrier.

In the final analysis, the majority disagreed that the cost of state-of-the-art telephone support systems was a significant barrier to the adoption of state-of-the-art IS.

7.5.1.9 Cost of state-of-the-art 3-D seismic capability

This statement inquired into the respondents' opinions on cost of state-of-the-art 3-D seismic capability. The respondents' opinions were sought in order to identify whether the cost of state-of-the-art 3-D seismic capability was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCS or not. The collective opinion of stakeholders has indicated their agreement that the cost of state-of-the-art 3D seismic capability was a significant barrier to the adoption of state-of-the-art IS.

Descriptive statistics of the respondents' opinions was computed in order to determine the percentage of agreement, disagreement, neutrality, mean score and median value. The result indicated that the cost of state-of-the-art 3-D seismic

capability was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. The percentage of stakeholders' opinion has shown that 84 (60%) agreed, and 39 (27.9%) disagreed while 17 (12.1%) were neutral. Similarly, median value (4.00) supported their agreement. In contrast, (3.34) mean scores supported a neutral position or undecided opinion.

This opinion is consistent with the relevant literature review of other developing countries because reviewed literature reveals that the cost of ICT resources and the technical sophistication of managing state-of-the-art ICT resources have been significant barriers to its adoption in developing countries by enterprises (see for example: Anwar & Shamim, 2011; Ekekwe, 2009; Longe & Chiemeke, 2006; Anoa, 2002). Consequently, the 3-D seismic capability is a state-of-the-art modern technology device that is applicable to oil and gas exploration and production, it has many more segments, like hardware, software and film. 2-D, 3-D animations and visualisation are combined together in integral form and produce a single audio visual document (Yang, et al., 2010).

Cross-tabulation analysis of stakeholders' groups was computed to determine the percentage of agreement. This has shown that, NNPC (50%), INOCs (57.1%), PENGASAN (78.9%), educational institutions (93.3%) and NCS/ITAN (71.4%) all agreed with the cost of state-of-the-art 3-D seismic capability as being a significant barrier.

The Mann-Whitney test was conducted among the groups of stakeholders. The result is displayed in table 7.15.

Table 7.15: Mann-Whitney tests for cost of state-of-the-art 3-D seismic capability in Nigerian INOCs

Statement: Cost of state-of-the-art 3-D seismic capability						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC					.038	
INOCs						
PENGASSAN						
NETCO			.029		.002	
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

The significant difference occurred between the stakeholders' from PENGASSAN and educational institutions on the one hand, and the stakeholders of NNPC and NETCO on the other.

In the final analysis, the general opinion of stakeholders has indicated their agreement that the cost of state-of-the-art 3D seismic capability was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.1.10 Answering research sub-question with regard to cost of all state-of-the-art ICT resources

From the general finding with regard to all the statements of variables (A-J) in this section, it appeared that the questionnaire-survey participants did not agree that the cost of all state-of-the-art ICT resources were significant barriers to state-of-the-art IS adoption by Nigerian INOCs. As a result there was a mixed-reaction regarding the answering of the sub-question. However, the popular view that emerged confirmed the cost of state-of-the-art online monitoring systems and its maintenance, cost of SCADA systems and the cost of state-of-the-art 3-D seismic capability were all significant barriers to the adoption of the state-of-the-art IS by Nigerian INOCs. And these findings have clearly answered the sub-question $\mathbf{Q_1}$ of the study.

7.5.2 ICT Skill

This section has addressed the second sub-question of the study. The sub-question which is to be analysed and answered using the responses to five variables relating to section C of the research instrument, is restated as follows:

$Q_{2.}$ Is inadequate technical skill a significant barrier that limits the adoption of state-of-the-art IS by Nigerian INOCs?

Prior to that, literature suggests that, a shortage of appropriate training programmes and inadequate relevant expertise have all been identified as barriers to ICT adoption in developing countries, including Sri Lanka, South Korea, Pakistan, Iran and Malaysia (see for example: MIC, 2002; Locke & Cave, 2002; Abell & Lim, 1996). Stakeholders' opinions were sought in order to clarify whether the quality and quantity of technical skill development, inadequate technical expertise and inadequate access to upstream training programmes were significant barriers to the adoption of state-of-the-art IS by Nigerian INOCs or not.

Table 7.16: Descriptive frequencies relating to ICT Skill and expertise in Nigerian INOCs

Statement	Median	Mean	SD	D	N	A	SA
Quality of skill development.	4.00	3.88	2 (1.4%)	14 (10%)	8 (5.7%)	91 (65%)	25 (17.9%)
Quantity of skill development.	4.00	3.85	1 (0.7%)	11 (7.9%)	17 (12.1%)	90 (64.3%)	21 (15%)
Inadequate technical expertise.	4.00	3.93	1 (0.7%)	16 (11.4%)	1 (0.7%)	96 (68.6%)	26 (18.6%)
Inadequate relevant expertise.	4.00	3.91	1 (0.7%)	16 (11.4%)	5 (3.6%)	91 (65%)	27 (19.3%)
Inadequate access to exploration and production training programme.	4.00	3.88	4 (2.9%)	9 (6.4%)	14 (10%)	84 (60%)	28 (20%)

Note: SD= Strongly Disagree; D= Disagree; N= Neutral; A= Agree; SA= Strongly Agree.

ii) All figures in brackets are % of relevant responses.

Table 7.16 presents the mean, median and percentage of agreement, disagreement and neutrality on state-of-the-art ICT skill as being a significant barrier to the adoption of state-of-the-art IS. A total of 140 respondents for each of the five variables were recorded.

7.5.2.1 Quality of skill development

The opinion of stakeholders has been sought with respect to quality of ICT skill development in Nigerian INOCs. The statement sought to clarify whether quality of ICT skill development was a significant barrier to the adoption of state-of-the-art IS or not.

From Table 7.16, the collective opinion of respondents agreed that quality of ICT skill development was a significant barrier to the adoption of state-of-the-art IS. Furthermore, 116 (82.95) all agreed. In contrast, 8 (5.7%) remained neutral and only 16 (11.4%) disagreed. In addition, a median score of 4.00 supports their agreement and a mean score of 3.88 indicated a neutral or undecided opinion.

Similarly, cross-tabulation analysis was conducted among the groups of stakeholders. After the analysis, it was established that the most popular opinion of all the groups of stakeholders according to their workplaces indicated that, they were in agreement

that quality of skill development was a strong barrier to state-of-the-art IS. NNPC 31 (77.5%), INOCs 29 (82.8%), PENGASSAN 17 (89.5), educational institutions 15 (100%) and NCS/ITAN 12 (85.7%) were in agreement that quality of ICT skill development was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

This opinion is consistent with the relevant literature with respect to the quality of skill development and expertise as a strong obstacle to the adoption of state-of-the-art IS as discussed in Chapter 4 Section 4.3.1 of this study. Empirically, Lawrence and Tar (2010) and Harindranath, Dyerson and Barnes (2008) have discovered that quality of ICT skill and expertise was among the significant barriers to its adoption by many enterprises in developing nations.

The Mann-Whitney test was conducted among the various groups of stakeholders. After the test, only one significant difference was discovered between two groups as in Table 7.17.

Table 7.17: Mann-Whitney test for Quality of skill development in Nigerian INOCs

Statement: Quality of skill development						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC						
INOCs						
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN					.049	

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

Furthermore, NCS/ITAN (100%) significantly differed with stakeholders of educational institutions (85.7%) in their agreement. However, the result has indicated that all the groups of stakeholders agreed with the quality of ICT skill development as a significant obstacle.

In the final analysis, the most popular opinion was that, quality of skill development was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.2.2 Quantity of skill development

This statement sought the opinion of stakeholders on the quantity of ICT skill development. The statement requested the opinion of stakeholders on whether the quantity of skill development was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not. Moreover from Table 7.5.2, the respondents did not share the same opinion. However, the majority of them constituting 111 (79.3%) agreed that quality of ICT skill development was a significant barrier. In contrast, 12 (8.6%) disagreed that it was a significant barrier, while 17 (12.1%) were neutral. In contrast, a mean score of 3.85 indicated a neutral position or undecided can be rounded up statistically as an agreement. Similarly, a median score of 4.00 affirmed that, the stakeholders were of the opinion that the quantity of ICT skill development was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

The finding is consistent with the empirical investigations of other countries in which quantity of skill development or insufficient knowledge has been discovered as a significant barrier to the adoption of ICT resources as reviewed in Chapter 3 Section 3.9 of the study. Antlovâ (2009) has identified that insufficient skill development has been an individual barrier that impedes the adoption of ICT hardware by most enterprises.

Cross-tabulation analysis was conducted in order to discover the opinion of various stakeholders according to their workplaces. The common opinion of stakeholders vindicated their agreement with quantity of skill development as a significant barrier. NNPC 28 (70%), INOCs 27 (77.2%), PENGASSAN 18 (94.7%), NETCO 12 (70.5%), educational institutions 15 (100%) and NCS/ITAN 11 (78.6%) were all in agreement that quantity of skill development was a significant barrier.

Furthermore, the Mann-Whitney test was conducted among the various groups of stakeholders. In line with this, only one significant difference has been identified between two groups of stakeholders as in Table 7.18.

Table 7.18: Mann-Whitney test for Quantity of skill development in Nigerian INOCs

Statement: Quantity of skill development in Nigerian INOCs						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC						
INOCs						
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN					.026	

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

The significant difference existed between NCS/ITAN and educational institutions. However, the majority of respondents from all the groups of stakeholders agreed that quantity of ICT skill was a significant barrier.

In the final analysis, the most popular opinion was that, quantity of skill development was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.2.3 Inadequate technical expertise

This statement inquired into the respondents' opinions on inadequate technical expertise in Nigerian INOCs. The respondents' opinions were sought in order to clarify whether the inadequate technical expertise was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

From Table 7.16, it can be confirmed that the respondents did not share the same opinion. However, the most popular opinion of the stakeholders confirmed the agreement of the majority with inadequate technical expertise being a significant barrier to state-of-the-art IS. Subsequently, 122 (87.2%) of the respondents agreed that the inadequate technical expertise was a significant barrier. In contrast, only 17 (12.1%) disagreed, while 1 (0.7%) was neutral. A median score 4.00 indicated an agreement, while a median score 3.93 has shown a neutral position which can rounded-up statistically as agreement.

Incidentally, inadequate technical expertise has been mentioned in the literature as a significant obstacle that impedes the adoption of ICT infrastructure. In an empirical survey conducted on the factors affecting and/or impeding the adoption of ICT in

southeast England, lack of internal ICT expertise has been a factor that inhibits the widespread adoption and subsequent use of ICT by SMEs (see for example: Harindranath, Dyerson & Barnes, 2008).

Furthermore, cross-tabulation analysis vindicated that the most popular opinion of stakeholders was that inadequate technical expertise was a significant barrier to the adoption of state-of-the-art IS. As explained, NNPC 33 (82.5%), INOCs 27 (77.2%), PENGASSAN 19 (100%), NETCO 15 (88.2%), educational institutions 15 (88.2%) and NCS/ITAN 13 (92.8%) were all in agreement that inadequate technical expertise was a significant barrier to the adoption of world-class IS by Nigerian INOCs.

The Mann-Whitney test was also conducted amongst all the groups of stakeholders. However, the result has shown that, there was no significant difference amongst the groups of stakeholders. And this has justified their agreement without any discrepancy.

In the final analysis, the most popular opinion was that, inadequate technical expertise was a significant obstacle to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.2.4 Inadequate relevant expertise

The opinion of stakeholders has been sought with respect to inadequate relevant expertise. The statement sought to clarify whether inadequate relevant expertise was a significant barrier to the adoption of state-of-the-art IS or not. Subsequently, the most popular opinion of respondents confirmed their agreement that inadequate relevant expertise was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Descriptive analysis has indicated the agreement of stakeholders that inadequate relevant expertise was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. Furthermore, 118 (84.3%) were in agreement, while 26 (12.1%) disagreed and 5 (3.6%) remained neutral. In line with this, a median score of 4.00 and a mean value of 3.91 indicated their agreement and slight disagreement respectively which can be rounded as agreement.

The finding of this study agreed with the previous findings discovered by other researchers in the literature on inadequate relevant expertise as being a significant barrier to ICT adoption. Antlovâ (2009) and Harindranath, Dyerson and Barnes

(2008) outlined that, lack of relevant internal ICT expertise is a strong barrier that impedes the adoption of ICT resources. This study argued that, lack of relevant expertise affects smaller organisations and companies worse than the bigger ones as discovered by other researchers (see for example: Antlovâ, 2009; Locke & Cave, 2002).

Cross-tabulation analysis was conducted across various groups of stakeholders. The percentage of the analysis vindicated the opinion of descriptive analysis of agreement as the most popular opinion. NNPC 23 (82.5%), INOCs 26 (74.3%), PENGASSAN 17 (89.2%), educational institutions 15 (100%) and NCS/ITAN 12 (85.6%) were in agreement that inadequate relevant expertise was a significant barrier.

Furthermore, the Mann-Whitney test was also conducted among the independent groups of stakeholders. The result has shown only one significant difference between PENGASSAN and educational institutions as in Table 7.20.

Table 7.20: Mann-Whitney test for inadequate relevant expertise in Nigerian INOCs

Statement: Inadequate relevant expertise						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC						
INOCs						
PENGASSAN					.022	
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

Furthermore, PENGASSAN being an association of senior staff in the oil and gas sector is in a good position to know the extent of inadequate relevant expertise. In addition, their view was the same as other stakeholders from NNPC, INOCs, NETCO and NCS/ITAN.

In the final analysis, the general opinion of stakeholders confirmed their agreement that inadequate relevant expertise was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.2.5 Inadequate access to E&P training programme

This statement sought the opinion of stakeholders on whether inadequate access to the E&P training programme was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not. Moreover from Table 7.5.2, the respondents also did not share a single opinion. However, the majority of them were of the opinion that inadequate access to upstream training programme was a strong barrier to state-of-the-art IS by Nigerian INOCs.

Similarly, the majority of the respondents, which constitutes (80.7%), were of the opinion that inadequate access to E&P training programme was a significant barrier to the adoption of state-of-the-art IS. In contrast, 13 (9.3%) disagreed, while 14 (10%) were neutral or undecided on the issue. A median score of 4.00 has also indicated their agreement, while a mean score of 3.88 enunciated a neutral position that can be an agreement after rounding the figure statistically.

This finding is consistent with the literature of Chapter 4 Section 4.3, in which inadequate skill, expertise and access to training was a significant obstacle to ICT adoption for many organisations and enterprises (see for example: Pavic et al., 2007; Wymer and Regan, 2005).

For the sake of more clarification and to establish a strong opinion of individual groups, cross-tabulation analysis was conducted. The general opinion of various groups of stakeholders vindicated the earlier opinion established, that is the agreement of the respondents.

NNPC 23 (82.5%), INOCs 26 (74.1%), PENGASSAN 17 (89.5%), NETCO 15 (88.2%), educational institutions 15 (100%) and NCS/ITAN 12 (85.7%) were all in agreement that, inadequate access to E&P training programme was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Mann-Whitney tests were conducted to check any significant difference among the groups of stakeholders. After the test, only one significant difference was identified between the stakeholders of PENGASSAN and the educational institutions as in Table 7.21.

Table 7.21: Mann-Whitney test for inadequate relevant expertise in Nigerian indigenous oil companies

Statement: inadequate relevant expertise						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC						
INOCs						
PENGASSAN					.032	
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

Furthermore, PENGASSAN being an association of senior staff in the oil and gas sector was in a good position to know the extent of inadequate relevant expertise. In addition, PENGASSAN'S stakeholders' opinion was in closest range to that of other stakeholders from NNPC, INOCs, NETCO and NCS/ITAN.

In the final analysis, the general opinion of all stakeholders according to the strong percentage confirmed their agreement that inadequate access to the E&P training programme was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.2.6 Answering research sub-question with regards to technical skill

From the general findings with regards to all the statements of the variables (A-E) in this section, it appeared that the questionnaire-survey participants did agree that technical skill was a significant barrier to state-of-the-art IS adoption by Nigerian INOCs. Therefore, the sub-question $\mathbf{Q_2}$ is fully answered by the findings of all the variables A, B, C, D and E which represent quality of skill development, quantity of skill development, inadequate technical expertise, inadequate relevant expertise and inadequate access to E&P training programmes respectively.

7.5.3 Managerial Attitude

This section has addressed the third sub-question of the study. The sub-question which is to be analysed and answered using the responses to eight variables relating to section D of the research instrument, is restated as follows:

$Q_{3.}$ Is managerial attitude a significant barrier that limits the adoption of state-of-the-art IS by Nigerian INOCs?

Prior studies of other countries suggest that, the attitude of top management has played a vital and significant role towards ICT adoption in some organisations of other developing countries, including Brazilian, Malaysian and Saudi Arabian industries (see for example: Beatty et al., 2001; Grover, 1993; Yap et al., 1992). The authors also identified managerial interest, knowledge, dynamism, age and culture as some of the barriers to ICT adoption in organisations and industries.

In this study, respondents were requested to indicate the extent of their agreement on whether the following statements relating to managerial attitude are significant barriers to state-of-the-art IS adoption by Nigerian INOCs or not. This section of the thesis has been published by this study in an international conference as well as in international journal of Macrotheme review. (See Appendices as in F, G and H)

Table 7.22: Descriptive frequencies relating to managerial attitude as a significant barrier to the adoption of state-of-the-art IS

Statement	Median	Mean	SD	D	N	A	SA
Managerial Interest is significant to ICT adoption.	4.00	4.28	1 (0.7%)	4 (2.9%)	4 (2.9%)	76 (54.3%)	55 (39.3%)
Managerial knowledge is significant to ICT adoption.	4.00	4.09	0 (0%)	9 (6.4%)	6 (4.3%)	88 (62.9%)	37 (26.4)
Managerial dynamism is significant to ICT adoption.	4.00	4.14	0 (0%)	7 (5.0%)	3 (2.1%)	94 (67.1%)	36 (25.7%)
Managerial age bracket is significant to ICT adoption.	4.00	3.91	0 (0%)	13 (9.3%)	15 (10.7%)	84 (60%)	28 (20%)
Managerial ability towards establishing international partnerships.	4.00	3.59	0 (0%)	25 (17.9 %)	27 (19.3%)	68 (48.6%)	20 (14.3%)
Managerial willingness towards establishing international partnerships.	4.00	3.64	0 (0%)	25 (17.9 %)	19 (13.6%)	78 (55.7%)	18 (12.9%)
Managerial ICT-oriented culture is significant to ICT adoption.	4.00	4.11	0 (0%)	5 (3.6%)	5 (3.6%)	99 (70.7%)	31 (22.1%)

Lack of proper governance structure is significant to ICT adoption.	4.00	3.89	1 (0.7%)	10 (7.1%)	14 (10.0%)	94 (67.1%)	21 (15.0%)

(Source: Ibrahim, 2013 as part of this PhD study).

Note: i) SD= Strongly Disagree; D= Disagree; N= Neutral; A= Agree; SA= Strongly Agree.

ii) All figures in brackets are % of relevant responses.

Table 7.22 presents the descriptive statistics on variables of managerial attitude as a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not. A total of 140 respondents for each of the 8 variables were recorded.

7.5.3.1 Managerial interest

The opinion of stakeholders has been sought with respect to the managerial interest in Nigerian INOCs. The statement sought to clarify whether managerial interest was a significant barrier to the adoption of state-of-the-art IS or not.

A very good percentage significantly agreed that managerial interest was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. Descriptive statistics indicated that, 131 (93.6%) agreed that managerial interest was a significant barrier to the adoption of state-of-the-art IS. In contrast, only 5 (3.6%) disagreed, while 4 (2.9%) remained neutral.

Furthermore, these respondents' opinions indicated that, managerial interest has a significant impact on the adoption of state-of-the-art IS by Nigerian INOCs. In addition, cross-tabulation analysis was also conducted among the groups of stakeholders. The result affirmed their agreement that managerial interest was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. NNPC 37 (92.5%), INOCs 33 (94.3%), PENGASSAN 17 (89.5%), NETCO 16 (94.1%), educational institutions 15 (100%) and NCS/ITAN 13 (92.8%) all agreed that managerial interest was a significant constraint on the adoption of state-of the-art IS by Nigerian INOCs.

Similarly, this study's finding confirmed the literature of other sectors that discovered managerial interest as being a major factor that impedes the adoption of ICT resources. As in Chapter 4 Section 4.2, the large amount of empirical investigations conducted have examined and outlined managerial interest as a significant factor that plays a critical role in ICT adoption or otherwise in developing countries, Nigeria inclusive (see for example: Irefin, Abdul-Azeez & Tijjani, 2008; Mabert et al., 2006; Cerpa & Verner, 1998).

In the final analysis, the general opinions of stakeholders confirmed their agreement that managerial interest was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.3.2 Managerial knowledge

This statement sought the opinion of stakeholders on whether managerial knowledge was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not. The general opinion confirmed the agreement of various stakeholders that managerial knowledge was a significant barrier.

Subsequently, the stakeholders were of the opinion that, managerial knowledge about importance, essentiality and performance of state-of-the-art IS was a significant barrier to its adoption by Nigerian INOCs. Descriptive statistics have shown that 125 (89.3%) agreed that managerial knowledge was a significant barrier, only 9 (6.4%) disagreed, while 6 (4.3%) were neutral. In addition, central tendencies were determined, which indicated a mean score of 4.09 and a median value of 4.00. Both mean and median scores have confirmed their agreement that managerial knowledge was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Prior studies established that, knowledge of top management about the essentiality and performance of adopting state-of-the-art ICT resources has a significant value. The literature as discussed in Chapter 4, Section 4.2.1 that has discovered managerial knowledge as being a major obstacle to ICT adoption (Dutta et al., 2003; Beatty et al., 2001).

Similarly, cross-tabulation analysis confirmed the agreement of all the groups of stakeholders that managerial knowledge was a significant constraint to the adoption of state-of-the-art IS. The analysis shows that, NNPC 35 (87.5%), INOCs 31 (88.5), PENGASSAN 17 (89.5%), NETCO 15 (82.3%), educational institutions 15 (100%) and NCS/ITAN 13 (92.8%) all agreed with managerial knowledge as being a significant barrier.

The Mann-Whitney test was conducted among the groups of stakeholders in spite of their collective agreement. The result of the test is displayed in Table 7.23.

Table 7:23: Mann-Whitney tests on Managerial knowledge

Statement: Managerial knowledge as a significant barrier						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC			0.004			.044
INOCs			.037			
PENGASSAN						
NETCO						
Educational Institutions					.047	
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

The result has indicated three significant differences, but all of them were in the same range between "strongly agree" and "agree". The analysis presented so far, has supported the argument of literature that, managerial knowledge was a significant constraint to the adoption of world-class ICT resources.

In the final analysis, the most popular opinion was that, managerial knowledge was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.3.3 Managerial dynamism

This statement inquired into the respondents' opinions on managerial dynamism as a significant barrier to the adoption of state-of-the-art IS. The respondents' opinions were sought in order to clarify whether managerial dynamism was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

Descriptive statistics showed that, respondents' opinions agreed that managerial dynamism was a significant barrier to state-of-the-art IS adoption by Nigerian INOCs. Furthermore, 130 (92.8%) agreed that managerial dynamism was a significant barrier, only 7 (5.0%) disagreed, while 3 (2.2%) remained neutral or undecided in their opinion. In support of this argument, a mean score of 4.14 and a median value of 4.00 were determined after computing the respondents' views. The results have confirmed that, managerial dynamism was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Undoubtedly, literature has indicated that managerial dynamism has been a significant barrier to ICT adoption in developing countries. Mehrtens, Cragg and Mills (2011) argue that not all organisations are naturally inclined towards ICT adoption.

In support of this argument, Shim and Jones (2001) enunciated that sometimes, the extent of ICT adoption depends on the process adopted by managers towards ICT resources and their deployment. Hence, Tarafdar and Vaidya (2006) recommended that it is important for the organisations to be educated about the process and the fundamental factors behind adopting technology and its value to organisational advancement. The finding of this study is in agreement with the literature discussed so far that managerial dynamism is a significant barrier to the adoption of ICT resources.

Cross-tabulation analysis was conducted among the groups of stakeholders. The result has shown the agreement of the six groups of stakeholders. NNPC 36 (90%), INOCs 31 (88.5%), PENGASSAN 19 (100%), NETCO 15 (100%), educational institutions 15 (100%) and NCS/ITAN 14 (100%) all agreed that, managerial dynamism was a significant barrier to state-of-the-art IS adoption.

Mann-Whitney tests were conducted across all the groups of stakeholders. The result is displayed in Table 7.24.

Table 7:24: Mann-Whitney tests for managerial dynamism

Statement: Managerial knowledge as a significant barrier						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC			.026			
INOCs						
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

The significant difference between NNPC and PENGASSAN could be as a result of the different roles they play in the oil and gas sector. Stakeholders from PENGASSAN (100%) all agreed that managerial dynamism was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. This can be as a result of their position as a pressure group. The finding is consistent with the relevant literature as in Chapter 4 Section 4.2 of the thesis.

In the final analysis, the general opinion of the stakeholders in the oil and gas sector indicated their agreement that managerial dynamism was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.3.4 Managerial age bracket

This statement sought the opinion of stakeholders on whether managerial age bracket was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not. Moreover from the Table 7.21, the respondents did not share the same opinion. However, a majority of them constituting 112 (80%) agreed that managerial age bracket was a significant barrier to the adoption of state-of-the-art by Nigerian INOCs, while only 13 (9.3%) disagreed and 15 (10.7%) remained neutral in their opinion or undecided. A median value of 4.00 has confirmed their agreement, while a mean score of 3.91 has shown an undecided opinion that can be rounded up statistically as an agreement.

Furthermore, cross-tabulation analysis was conducted amongst the groups of stakeholders based on their workplaces. The results have indicated their agreement with managerial age bracket as being a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. The stakeholders from NNPC 36 (90%), INOCs 31 (88.5%), PENGASSAN 19 (100%), NETCO 15 (88.2%), educational institutions 15 (100%) and NCS/ITAN 14 (100%) were all in agreement that, managerial age bracket was a significant barrier to the adoption of state-of-the-art IS. Then Mann-Whitney tests were computed among the groups of stakeholders according to their workplaces. The result has been displayed in Table 7.25.

Table 7.25: Mann-Whitney tests for managerial age bracket

Statement: Managerial age bracket as a significant barrier						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC			.026			
INOCs						
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

From Table 7.25, the result has confirmed the difference between two groups of stakeholders. These are NNPC and PENGASSAN as 90% and 100% respectively agreed with managerial age bracket as a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. This is consistent and compatible with relevant literature of other developing countries.

Similarly, relevant literature discovered that the managerial-age bracket was a significant barrier to ICT adoption in developing countries. Hence, Tarafdar and Vaidya (2006) recommended that it is important for the organisations to be educated and up- dated about the process and the fundamental factors behind adopting technology and its value to organisational advancement. They emphasised that, mostly young officers within the range of 25-45 years are more inclined towards ICT adoption than older officers. Young officers in urban cities of developing countries are more of ICT-friendly users.

In the final analysis, the general opinion of the stakeholders in the oil and gas sector indicated their agreement that managerial age bracket was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.3.5 Managerial ability to establish international partnerships

The stakeholders' opinion has been sought with regard to managerial ability to establish international partnership. The statement sought to clarify whether managerial inability to establish international partnerships was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Subsequently, the most popular opinion of respondents confirmed their agreement that managerial inability to establish international partnerships was a significant barrier to the adoption of state-of-the-art IS by INOCs.

Descriptive statistics expounded the agreement of respondents that managerial inability to establish international partnerships was a significant barrier. 88 (62.9%) were in agreement, while 25 (19.9%) and a substantial 27 (19.3%) remained neutral. A median value of 4.00 has also confirmed the agreement of stakeholders. However, a mean score of 3.59 indicated a neutral position or undecided opinion by the stakeholders which can be rounded-up as agreement.

Cross-tabulation analysis amongst the groups of stakeholders was also conducted. The result indicated that, stakeholders from NNPC 23(57.5%), INOCs 26 (74.3%),

PENGASSAN 7 (36.8%), NETCO 10 (58.8%), educational institutions 12 (80%) and NCS/ITAN 10 (71.4%) agreed that managerial inability to establish international partnerships was a significant barrier. From the result, only PENGASSAN differed with other stakeholders from the oil and gas sector. Stakeholders from PENGASSAN disagreed that, managerial ability was a significant barrier, but they complained that corruption and unwillingness were the significant barriers (see David-West, 2012). The managers had the ability, but they were unwilling to adopt state-of-the-art IS as a result of corruption and bad attitude.

Mann-Whitney tests were also conducted among the groups of stakeholders according to their workplaces. The results have enunciated four significant differences between groups of stakeholders as displayed in Table 7.26.

Table 7.26: Mann-Whitney tests for managerial ability to establish international partnerships

Statement: Managerial ability towards international partnership						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC						
INOCs						
PENGASSAN		.001		.015	.017	.003
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

The result has indicated that PENGASSAN's stakeholders differed with four different groups- INOCs, NETCO, NCS/ITAN and educational institutions. As explained earlier, stakeholders from PENGASSAN believed that managerial ability was not the significant barrier, but rather corruption and unwillingness. The leadership of PENGASSAN mostly criticised the government on corruption and unwillingness not inability as in Chapter 4 of this thesis.

In the final analysis, the general opinion and perception of the stakeholders in the oil and gas sector stated their agreement that managerial ability towards establishing

international partnership was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.3.6 Managerial unwillingness to establish international partnerships

This statement sought the opinion of stakeholders on whether managerial unwillingness to establish international partnerships was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not. Moreover from Table 7.5.3, the respondents also did not share a single opinion. However, a majority of them were of the opinion that managerial willingness was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Furthermore, descriptive statistics indicated that, the general opinion of stakeholders agreed that managerial willingness was a significant barrier to adoption of state-of-the-art IS by Nigerian INOCs. The general opinion of the stakeholders indicated that, 96 (68.6%) agreed that, while 25 (17.9%) disagreed and 19 (13.6%) remained neutral or undecided. Similarly, a median value of 4.00 supported their agreement and a mean score of 3.64 indicated a neutral position or undecided opinion.

A cross-tabulation analysis has confirmed their general agreement according to their workplaces. Stakeholders from NNPC 27 (67.5%), INOCs 30 (85.8%), PENGASSAN 17 (89.5%), NETCO 9 (52.9%), educational institutions 12 (80%) and NCS/ITAN 11 (78.5%) all indicated their agreement that, managerial willingness was a strong barrier to state-of-the-art IS adoption by Nigerian INOCs. Similarly, the Mann-Whitney tests expounded the absence of any significant difference among the groups of stakeholders.

In the final analysis, the general opinion of the stakeholders in the oil and gas sector indicated their agreement that managerial willingness to establish international partnerships was a significant barrier to the adoption of state-of-the-art IS by INOCs.

7.5.3.7 Managerial ICT-oriented culture

This statement inquired into the respondents' opinions on managerial ICT-oriented culture. The respondents' opinions were sought in order to clarify whether the managerial ICT-oriented culture was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not. The respondents did not share the same opinion, but the general opinion of stakeholders indicated their agreement that managerial

attitude was a significant barrier to the adoption of state-of-the-art IS by local oil companies in Nigeria.

From Table 7.24, descriptive statistics indicated that, 130 (92.8%) were in agreement that managerial ICT-oriented culture was a significant barrier to the adoption of state-of-the-art IS by INOCs of Nigeria. While those who disagreed and those who are neutral are both 5 (3.6%). Similarly, mean score and median value confirmed their agreement with 4.11 and 4.00 respectively.

The stakeholders' opinions according to their workplaces confirmed their general agreement that, managerial ICT-oriented culture was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. NNPC 37 (92.5%), INOCs 23 (91.4%), PENGASSAN 18 (94.7%), educational institutions 15 (100%) and NCS/ITAN 12 (85.7%) were all in agreement that managerial ICT-oriented culture was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Furthermore, Mann-Whitney tests were also conducted among the groups of stakeholders. Similarly, the result has indicated the existence of significant differences between NNPC and INOCs on the one hand, then PENGASSAN and NCS/ITAN on the other as displayed in Table 7.27.

Table 7.27: Mann-Whitney tests for managerial ICT-oriented culture

Statement: Managerial ICT-oriented culture as a significant barrier						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC			.018			.018
INOCs			.017			.018
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

NNPC and INOCs differed significantly with PENGASSAN and NCS/ITAN. This is consistent with literature as in Chapter 4 Section 4.4 of this thesis. Because of the fact that, the (PENGASSAN) sometimes differ with the NNPC and other government executives on oil sector. For example, the PENGASSAN on 29/09/2012 blamed the government of Nigeria and noted that:

"if it had listened to them about their daily complaints in the oil and gas sector, the on-going fuel scarcity and crisis in Nigeria would have been completely avoided" (Eddy, 2012 p.10).

In contrast, speaking on the incident, Acting Group General Manager of NNPC replied that:

"The NNPC had taken measures working round the clock to end the crisis".

In the final analysis, the general opinion of the stakeholders confirmed the relevant literature as in Chapter 4 Section 4.4 of this thesis which indicated their agreement that managerial ICT-oriented culture was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.3.8 Lack of proper governance structure

This statement inquired into the respondents' opinions on lack of proper governance structure by Nigerian INOCs. The respondents' opinions were sought, based on their expertise, in order to clarify whether the lack of proper governance structure was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

From Table 7.24, it can be confirmed that the respondents did not share the same opinion. However, the most popular opinion of the stakeholders indicated their agreement that lack of proper governance structure was a significant barrier to state-of-the-art IS adoption by Nigerian INOCs. Subsequently, 115 (82.1%) of the respondents agreed that inadequate technical expertise was a significant barrier, while only 11 (7.8%) disagreed and the remaining 14 (10%) remained neutral. A median score of 4.00 indicated an agreement, while a median score of 3.89 has shown a neutral position which can be rounded-up as agreement.

Cross-tabulation analysis was conducted among the groups of stakeholders. And in the final analysis, their agreement established that, lack of proper governance structure was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. NNPC 29 (72.5%), INOCs 28 (80%), PENGASSAN 17 (89.5%), NETCO 13 (76.5%), educational institutions 15 (100%) and 13 (92.9%) all agreed that lack of proper governance structure implementation was a significant barrier.

Furthermore, Mann-Whitney tests were conducted among all the groups of stakeholders. The results indicated absence of any significant difference. As a result,

respondents' opinions confirmed that, lack of proper governance structure was a major constraint to the adoption of top-class IS by Nigerian INOCs.

In the final analysis, the general opinion of stakeholders in the oil and gas sector indicated their agreement that lack of proper governance structure was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs as in Chapter 4 Section 4.4.6 of this thesis.

7.5.3.9 Answering research sub-question with regards to managerial attitude

From the general findings with regards to all the statements of the variables (A-H) in this section, it appeared that the questionnaire-survey participants did agree that all the variables with regards to managerial attitude were significant barriers to state-of-the-art IS adoption by Nigerian INOCs. Therefore, the sub-question $\mathbf{Q_3}$ is fully answered by the findings of variables A, B, C, D, E, F, G and H which represent managerial interest, managerial knowledge, managerial dynamism, managerial age-bracket, managerial ability, managerial willingness, managerial ICT-oriented and lack of proper governance structure respectively.

7.5.4 Government Policy

This section has addressed the fourth research sub-question of the study. The sub-question which is to be analysed and answered using the responses to five variables relating to section E of the research instrument, is restated as follows:

Q_4. Is government policy a significant barrier that limits the adoption of state-of-the-art IS by Nigerian INOCs?

Furthermore, literature suggests that, local content development is the strongest policy of Nigeria's government to manufacture local content capacity in the oil and gas sector to enable indigenous participation (Ihua, Ajayi & Eloji, 2009; NNPC, 2005). In addition, they stated that, it has taken precedence and function over any policy that had been formulated before its emergence. It has been recognised as an effort towards the utilisation of indigenous human and material resources in the exploration of the hydrocarbon resources in the country. The policy objective is to ensure that a substantial percentage of locally-produced services, goods, personnel and resources rendered to the oil and gas sector are increased in order to generate more economic empowerment, employment and general development.

The main objective for local content policy as stated by NNPC (2005) is to transform the oil and gas sector to become state-of-the-art socio-economic engine for national development, empowerment and job creation. As a result, the greater proportion of works and services are urged to be performed indigenously by citizens of Nigeria (Ozigbo, 2008).

Further, stakeholders' opinions were sought in order to indicate their opinion on whether government policy with respect to the utilisation of indigenous human and material resources and directing NETCO to produce state-of-the-art indigenous technology for oil and gas sector were significant barriers to the adoption of state-of-the-art IS by Nigerian INOCs or not. The descriptive frequencies of the respondents are displayed in Table 7.28.

Table 7.28: Descriptive frequencies relating to government policy on upstream IS

Statement	Median	Mean	SD	D	N	A	SA
The policy objective of local content.	3.00	2.96	10 (7.1%)	53 (37.9%)	21 (15%)	44 (31.4%)	12 (8.6%)
Utilisation of indigenous human resources by INOCs.	3.00	3.11	11 (7.9%)	37 (26.4%)	22 (15.7%)	65 (46.4%)	5 (3.6%)
Utilisation of indigenous material resources by INOCs.	4.00	3.26	5 (3.6%)	37 (26.4%)	19 (13.6%)	74 (52.9%)	5 (3.6%)
Directive to NETCO to produce state-of-the-art indigenous technology.	4.00	3.49	2 (1.4%)	29 (20.7%)	22 (15.7%)	72 (51.4%)	15 (10.7%)
NETCO's inability to attract international partnerships.	4.00	3.49	2 (1.4%)	29 (20.7%)	22 (15.4%)	72 (51.4%)	15 (10.7%)

Note: i) SD= Strongly Disagree; D= Disagree; N= Neutral, A= Agree; SA= Strongly Agree, ii) All figures in brackets are percentages of relevant responses.

Table 7.24 displays the mean, median and percentages of agreement, disagreement and neutrality on government policy as a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. A total of 140 respondents for each of the five variables were recorded.

7.5.4.1 The policy objective of local content

The opinion of stakeholders has been sought with respect to the policy objective of local content law. The statement sought to clarify whether the main policy objective of local content was a significant barrier to the adoption of state-of-the-art IS or not.

It has been shown in Table 7.28; the stakeholders did not share the same opinion. However, majority of them were of the opinion that, the policy objective of local content law was not a significant barrier to the adoption of state-of-the-art IS by Nigeria INOCs. Similarly, this can be established from the mean score of respondents as 2.96 and median of 3.00 which were within the range of disagreement and neutrality respectively. Both of them indicated that, the policy objective of local content was not a significant barrier to adopting state-of-the-art IS by Nigerian INOCs. In addition, from Table 7.28, descriptive statistics also indicated that, 63 (45%) disagreed that the policy objective of local content law was not a constraint to adoption of the state-of-the-art IS. In contrast, 56 (40%) agreed, while 21 (15%) were neutral or undecided. However, based on the descriptive statistics presented so far, the respondents were undecided in their opinion with respect to the policy objectives of local content law. This is due to the fact that, a substantial percentage of 45% disagreed, while another percentage of 40% agreed. Though, a simple majority disagreed that the policy objective of local content law was not a significant barrier.

Consequently, in an attempt to resolve the undecided opinion of groups of stakeholders, four groups of stakeholders out of six were of the opinion that the policy objective of local content law was not a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. NNPC 19 (47%), INOCs 16 (45.7%), NETCO 10 (58.8%) and educational institutions 11 (73.3%) were all in disagreement. In addition, NNPC 7 (17.5%) and INOCs 6 (17.1%) were neutral or undecided. However, stakeholders from PENGASSAN 12 (63.2%) and NCS/ITAN 11 (78.6%) all agreed that the policy objective of local content law was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Furthermore, the opinion of agreement and disagreement of both stakeholders can be right. Those who agreed with the objective of local content policy as a significant barrier, such as PENGASSAN and NCS/ITAN based on their perception as a result of the inability and incapability of indigenous companies to produce the state-of-the-art IS to be used by Nigerian INOCs as reviewed in Chapter 3 Sections 3.7 and 3.8 of this

thesis. In contrast, those who disagreed with the policy objective of local content as a significant barrier, such as NNPC, INOCs and NETCO, did not consider the policy itself as a significant barrier, because it had been productive and reliable in other countries, like India as reviewed in Chapter 3 Section 3.3 of this thesis. Similarly, the local content policy has been relatively efficient and successful in some oil producing countries, such as Norway and Brazil, but this has not been achieved in Nigeria (Ogbodo, 2008; Obasi, 2003).

The advocate of local content policy emphasised that, the policy was not a problem, but the only challenge was the incapability of indigenous technological companies to manufacture the state-of-the-art IS. This great difference of perception between the two divergent groups of stakeholders arises as a result of different dimensions in looking at the issue as in Section 3.3 and 3.7 of Chapter 3 of this thesis.

Mann-Whitney tests were conducted among the groups of stakeholders to check significant differences. The result is displayed in Table 7.29.

Table 7.29: Mann-Whitney tests for the policy objective of local content

Statement: Policy objective of local content law						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC						.013
INOCs						.024
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

Similarly, NNPC, INOCs, PENGASSAN and NETCO differed significantly with other stakeholders on the one hand, and NCS/ITAN and educational institutions on the other. This can be as a result of differences in the role they play in the oil and gas sector as in Chapter 6 Section 6.7 of this study. In addition, NNPC, INOCs and PENGASSAN mostly deal with the purchasing, managing and maintenance of exploration and production in the oil and gas sector directly and physically. In spite of the divergent views, facts have supported that Nigeria's local content policy was not an obstacle to the adoption of world-class ICT resources and human development. This has been consistent with the relevant literature of other

developing countries as in Chapter 4 Sections 4.4.1, 4.4.2, 4.4.3, 4.4.4 and 4.4.5 of this thesis.

In the final analysis, the general opinion of the stakeholders in the oil and gas sector indicated their agreement that the policy objective of local content law was not a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.4.2 Utilisation of indigenous human resources by INOCs

This statement inquired into the respondents' opinions on the utilisation of indigenous human resources by Nigerian INOCs. The respondents' opinions were sought in order to clarify whether the utilisation of indigenous human resources was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

From Table 7.28, it can be confirmed that the respondents did not share the same opinion. However, the most popular opinion of the stakeholders confirmed their agreement with utilisation of indigenous human resources as a significant barrier to the adoption of state-of-the-art IS. Subsequently, 70 (50%) of the respondents agreed that the utilisation of indigenous human resources was a significant barrier, while only 48 (34.3%) disagreed and the remaining 22 (15.7%) remained neutral. A median score of 3.00 and a mean value of 3.89 have shown a neutral position or undecided opinion.

The differences in opinion amongst the respondents could be as a result of the different perceptions they adopted in their responses. Those that agreed that utilisation of indigenous human resources as a significant barrier was as a result of looking at the quality of knowledge considering Nigerians studying abroad or working in diaspora (see for example: Nwapa, 2007; Ukaegbu, 1991) . While those who disagreed that utilisation of indigenous human resources was not a significant barrier was as a result of considering Nigerians who have been studying and working in other developed countries (see for example: Talib & Malkawi, 2011; Gouvea, 2007; Heeks & Nicholson, 2004).

Cross-tabulation analysis was conducted among the various groups of stakeholders. While a substantial percentage remained neutral, the percentage of agreement with the utilisation of indigenous human resources as a significant barrier was NNPC 18 (45%), INOCs 14 (40%), PENGASSAN 13 (68.4%), NETCO 8 (47.1%), educational institutions 13 (86.7%) and NCS/ITAN 4 (28.6%).

Mann-Whitney tests were computed among the groups of stakeholders in order to check significant differences between them. The result has indicated that, significant differences had existed between the stakeholders of INOCs, NCS/ITAN, NETCO on the one hand, and PENGASSAN and educational institutions on the other. The result is displayed in Table 7.30.

Table 7.30: Mann-Whitney tests for indigenous human resources

Statement: Indigenous human resources						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC						
INOCs			.044		.013	
PENGASSAN						
NETCO					.020	
Educational Institutions						
NCS/ITAN					.008	

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

The significant differences that existed might be as a result of the available information they had at their disposal. Utilisation of indigenous human resources can be a significant barrier, if Nigerians in diaspora fail to return back and work for their country (for example, the Nation, 2012). This argument and opinion has been strengthened by the stakeholders of ICT in Nigeria. These stakeholders include ITAN, NCS, the Association of Telecom Operators in Nigeria (ATCON), Nigerian Communication Commission (NCC), the National Information Technology Development Agency (NITDA) and Internet Services Providers of Nigeria (ISPN) have all agreed with the incapacity of indigenous human resources as a significant barrier to the adoption and success of state-of-the-art local content policy (The Nation, 2012). They noted that, capacity development was an issue that was gaining ground between them, because an efficient, reliable and improved workforce is necessary. As a way out of the utilisation of indigenous human resources, Nigeria needs to learn lessons from India. India's achievement can be attributed to its citizens in diaspora. After getting their independence from Britain, they stayed and helped to transfer knowledge to India to develop their country's ICT industry. As a result, they became one of the leading and best ICT nations globally (The Nation, 2012).

Furthermore, cross-tabulation of groups of stakeholders indicated their agreement that utilisation of indigenous human resources without Nigerians in diaspora through government support was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs as in Chapter 3 Section 3.3 because 23 out of 42 respondents which constitute (54.8%) from computing and ICT professionals agreed that indigenous human resources without bringing Nigerian experts in diaspora was a significant barrier, while (23.8%) remained neutral or undecided and the remaining percentage of only (21.5%) disagreed.

In the final analysis, the collective opinion of the stakeholders in the oil and gas sector confirmed their agreement that utilisation of indigenous human resources was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.4.3 Utilisation of indigenous material resources by INOCs

The opinion of stakeholders has been sought with respect to the utilisation of indigenous material resources by Nigerian INOCs. The statement sought to clarify, whether utilisation of indigenous material resources was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

Consequently, it has been shown in Table 7.28, that the stakeholders who responded to this statement did not share the same opinion. However, a majority of them were of the opinion that, the utilisation of indigenous material resources was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. A mean score of 3.26 and median of 4.00 were in the range of neutrality and agreement respectively. In addition, from the Table 7.28, a significant number and percentage of respondents of 79 (56.5%) agreed that utilisation of indigenous material resources was a significant constraint to the adoption of state-of-the-art IS by Nigerian INOCs. In addition, 42 (30%) disagreed while 19 (13.6%) were neutral.

Cross-tabulation analysis of various stakeholders amongst their independent groups was conducted. The result indicated mixed-reactions on whether the utilisation of indigenous material resources was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. Furthermore, stakeholders from NCS/ITAN 12 (85.7%) and educational institutions 14 (93.3%) agreed that utilisation of indigenous material resources was a significant barrier. However, stakeholders from INOCS 15 (42.8%) disagreed and 7 (20%) remained neutral or undecided.

The different opinions recorded could be as a result of the perception of the respondents who had looked at the statement. Based on their responses, there was no doubt about their agreement that indigenous material resources were a significant barrier. This is due to the fact that, there was no industry or company that produced state-of-the-art ICT resources in the whole country as discussed in Section 3.8 of Chapter 3 of this thesis.

In line with our finding, Soriyan and Heeks (2004) examined Nigerian software industry and found an average of virtually 100 privately-owned industries and mostly around the South-West. He also discovered that, they were mostly small in size. In addition, only 16% of Nigerian software industries partake in software development, which is being used in small industries, institutions and companies (Soriyan & Heeks, 2004).

Mann-Whitney tests were conducted among the groups of stakeholders. The result has indicated significant differences between groups of stakeholders.

Table 7:31: Mann-Whitney tests for utilisation of indigenous material resources

	Statement: Indigenous material resources					
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC			.002		.004	
INOCs			.001		.003	.015
PENGASSAN						.030
NETCO			.005		.006	
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

Consequently, significant differences existed between NNPC, INOCs and NETCO on the one hand, and PENGASSAN, NCS/ITAN and educational institutions on the other. The opinion of PENGASSAN, NCS/ITAN and educational institutions was the strongest considering their roles as discussed in Chapter 6 Section 6.7 of this thesis.

In the final analysis, the most popular opinion was that, utilisation of indigenous material resources was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.4.4 Directive to NETCO to produce state-of-the-art indigenous technology

The opinion of stakeholders has been sought with respect to the directive given to NETCO by Nigeria's government to produce state-of-the-art indigenous technology for the oil and gas sector. The statement sought to clarify whether the directive given to NETCO to produce state-of-the-art indigenous technology for indigenous oil and gas sector was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

From Table 7.28, it can be confirmed that the respondents did not share the same opinion. However, the most popular opinion of the stakeholders affirmed their agreement with the directive given to NETCO to produce state-of-the-art technology for the oil and gas sector as a significant barrier to the adoption of state-of-the-art IS. Subsequently, 85 (60.7%) of the respondents agreed that the directive given to NETCO was a significant barrier, while only 32 (22.9%) disagreed and the remaining 23 (16.4%) were neutral. A median score of 4.00 has confirmed their agreement, while a mean value of 3.44 has shown a neutral position.

Furthermore, a cross-tabulation analysis was conducted amongst the stakeholders with the aim of identifying their opinions based on their independent groups. The stakeholders from NNPC 22 (55%), INOCs 16 (45.7%), PENGASSAN 14 (73.7%), educational institutions 15 (100%) and NCS/ITAN 11 (78.6%) all indicated their agreement that the directive given to NETCO to produce state-of-the-art technology was a significant barrier to the adoption of the state-of-the-art IS by Nigerian INOCs. Interestingly, stakeholders from NETCO itself indicated mixed-reactions in their responses. Out of 17 respondents, 7 (42.1%) have agreed that, the directive given to the company was a strong barrier, while 7 (41.2%) disagreed and 3 (17.6%) were neutral or undecided. However, they deserve commendation as a majority of them have disclosed their technological weakness in producing state-of-the-art goods and services for Nigerian INOCs.

Consequently, Mann-Whitney tests were conducted in order to check significant differences between groups of stakeholders. The result has indicated five significant differences as displayed in Table 7.32.

Table 7:32: Mann-Whitney tests for directive to NETCO to produce state- of-the-art technology

Statement: Directive to NETCO to produce state- of-the-art technology						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC					.012	
INOCs					.001	
PENGASSAN						
NETCO					.010	
Educational Institutions						
NCS/ITAN			.006		.016	

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

The Mann-Whitney tests indicated differences between NNPC, INOCs, NCS/ITAN and NETCO on the one hand, and PENGASSAN and educational institutions on the other. Conclusively, based on the opinion of stakeholders, including NETCO itself, the achievement of NETCO's objective is almost impossible, without improving its expertise, skill development and technological advancement because, according to relevant literature, NETCO'S main objective is to fulfil the strategic vision of NNPC for developing indigenous engineering capacity which can assist the citizens to analyse, design and implement systems for the country's oil and gas sector (NNPC, 2002).

In the final analysis, the most popular opinion was that, the Federal Government of Nigeria's directive to NETCO to produce state-of-the-art indigenous technology for the indigenous oil and gas sector was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.4.5 NETCO's inability to attract international partnerships

The opinion of stakeholders has been sought with respect to NETCO's inability to attract international partnerships. The statement sought to clarify whether NETCO's inability to attract international partnerships for the oil and gas sector was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

Descriptive analysis has indicated the agreement of stakeholders that NETCO's inability to attract international partnerships was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. Statistically, 87 (62.1%) were in agreement, while 31 (22.1%) disagreed and 22 (15.7%) remained neutral. In the

same context, a median score of 4.00 has indicated the agreement of the stakeholders, while a mean value of 3.49 indicated a neutral position or undecided.

In order to discover the opinion of the independent groups of stakeholders, a cross-tabulation analysis was also conducted. After the analysis, the result has confirmed the agreement of all the groups of stakeholders that NETCO's inability to attract international partnerships was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. NNPC 20 (51%), INOCs 18 (51.4%), PENGASSAN 15 (78.9%), NETCO 7 (51.1%), educational institutions 15 (100%) and NCS/ITAN were all in agreement that NETCO's inability to attract international partnerships was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. However, that can be as a result of the Nigerian content policy that allowed a specific percentage of foreign goods and services. The literature suggested that, NETCO identified a skill gap and employed the services of expatriates, which cannot exceed 5-10% of the total number of project personnel that are required for the project (NETCO, 2010).

However, the finding is inconsistent with a significant part of the relevant literature. Some researchers have observed that, too much dependency on importation of both human and material resources was a barrier to the progress of Nigerian INOCs. Akinyele (2001) identified too much dependency on imported technologies and services for exploration and production as the main factor of delaying the progress of the Nigerian oil and gas sector. Baker (2006) advocated for grooming highly skilled indigenous experts to replace/readdress the foreign domination of the sector and he emphasised by considering it as an imperative towards promoting the sector. However, the researchers do not directly challenge international partnerships for training Nigeria's indigenous human skill in order to serve their country.

Moreover, Mann-Whitney tests were conducted among the groups of stakeholders. The results have confirmed the absence of any significant difference.

In the final analysis, the general opinion of respondents has established that, NETCO's inability to attract international partnerships was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.4.6 Answering sub-question with regard to government policy

From the general finding with regard to all the statements of the variables (A-E) in this section, it appeared that the questionnaire-survey participants did not agree that all the variables of government policy were significant barriers to state-of-the-art IS adoption by Nigerian INOCs. Therefore, sub-question $\mathbf{Q_4}$ is answered by the findings of variables B, C, D and E, namely the utilisation of indigenous human resources, utilisation of indigenous material resources, directives to NETCO to produce state-of-the-art technology and NETCO's inability to attract international partnerships respectively.

7.5.5 Government incentives

This section has addressed the fifth sub-question of the study. The sub-question which is to be analysed and answered using the responses to five variables relating to section F of the research instrument, is restated as follows:

Q_5. Is government incentive a significant barrier that limits the adoption of state-of-the-art IS by Nigerian INOCs?

Prior literature suggests that, when evaluating bids for projects, all promoters and operators shall consider the Nigerian content and the one having the highest local content will be considered (see NNPC, 2006), provided the Nigerian content in the selected bid at least 5% higher than its nearest competitor (NNPC, 2005). Further, stakeholders' opinions were sought in order to indicate their opinion on whether government incentives with respect to the utilisation of indigenous human and material resources was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

Descriptive frequencies were conducted for each variable in every part of the general analysis. The result of the descriptive frequencies for government policy is displayed in Table 7.33.

Table 7.33: Descriptive frequencies relating to government incentives on upstream IS

Statement	Median	Mean	SD	D	N	A	SA
Incentives integrated into local content policy of government.	3.00	3.03	7 (5.0%)	41 (29.3%)	35 (25.0%)	55 (39.3%)	2 (1.4%)
Lack of import duty waiver on state-of-the-art ICT infrastructure.	4.00	3.34	3 (2.1%)	25 (19.9%)	39 (27.9%)	67 (47.9%)	6 (4.3%)
Inadequate motivation of government incentives towards state-of-the-art ICT adoption.	4.00	3.67	2 (1.4%)	17 (12.1%)	20 (14.3%)	87 (62.1%)	14 (10%)
Absence of government incentives on adoption of up-to-date international material resources.	4.00	3.64	2 (1.4%)	18 (12.9%)	17 (12.1%)	94 (67.1%)	9 (6.4%)
Lack of government incentives towards international partnership.	4.00	3.56	2 (1.4%)	22 (15.7%)	21 (15.0%)	9 (6.4%)	86 (61.4 %)

Note: i) SD= Strongly Disagree; D= Disagree; N= Neutral; A= Agree; SA= Strongly Agree.

ii) All figures in brackets are percentages of relevant responses.

Table 7.33 presents the mean, median and percentages of agreement, disagreement and neutrality on government incentives as a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. A total of 140 respondents for each of the five variables were recorded.

7.5.5.1 Incentives integrated into local content policy of government

This statement inquired into the respondents' opinions on incentives integrated into the local content policy of government. The respondents' opinions were sought in order to clarify whether incentives integrated into local content policy of government was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

From Table 7.33, it can be confirmed that the respondents did not share the same opinion. However, the most popular opinion of the stakeholders indicated their agreement with incentives integrated into local context policy as a significant barrier to state-of-the-art IS. Subsequently, 57 (40.7 %) of the respondents agreed that the incentives integrated into local content policy of government was a significant barrier. In contrast, a significant percentage of 48 (34.3 %) disagreed that it was a significant barrier and the remaining percentage of 35 (25.0 %) were neutral. A median score of 3.00 and median score of 3.03 have shown a neutral position or

undecided opinion. However, there was a significant difference between the respondents.

Furthermore, cross-tabulation analysis was conducted among the groups of stakeholders. The result has shown that NNPC 14 (35%) agreed while 13 (32.5%) remained neutral; INOCs 16 (45.8%) agreed while 9 (25.7%) remained neutral; PENGASSAN 12 (63.2%) agreed while 3 (15.8%) remained neutral; NETCO 5 (29.4%) agreed while 3 (17.6%) disagreed; educational institutions 1 (6.7%) agreed while 4 (26.7%) remained neutral; and NCS/ITAN 9 (64.3%) agreed while 3 (21.4%) remained neutral. From the responses, using simple majority only stakeholders from PENGASSAN and NCS/ITAN strongly agreed with the incentives integrated into local content policy of government as a significant barrier, while the remaining stakeholders from NNPC and INOCs agreed but not significantly. In contrast, while stakeholders from NETCO and educational institutions disagreed with the incentives integrated into local content policy of government as a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. The incentives integrated into local content law of government were a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Mann-Whitney test was conducted among the stakeholders to check the existence of any significant difference. The result has indicated some significant differences as displayed in Table 7.34.

Table 7.34: Mann-Whitney tests for incentives integrated into local content policy

Statement: Incentives integrated into local content policy						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC					.022	
INOCs					.009	
PENGASSAN				.012	.001	
NETCO						
Educational Institutions				.001		
NCS/ITAN				.020		

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

The result has indicated significant differences between NNPC, INOCs, NCS/ITAN and PENGASSAN on the one hand, and NETCO and educational institutions on the other.

Based on the position and responsibility of NNPC, INOCs, NCS/ITAN and PENGASSAN's stakeholders, their opinion was much stronger that incentives integrated into local content policy of government was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs as reviewed in reviewed by this study in Chapter 4 Section 4.5.5 of this thesis.

In the final analysis, the incentive integrated into local content law was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.5.2 Lack of import duty waiver on state-of-the-art ICT infrastructure

The opinion of stakeholders has been sought with respect to the lack of import duty waiver on state-of-the-art ICT infrastructure. The statement sought to clarify whether the lack of import duty waiver on state-of-the-art ICT infrastructure was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

Descriptive analysis has indicated the agreement of stakeholders that the lack of import duty waiver on state-of-the-art ICT infrastructure was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. Statistically, 74 (52.2%) were in agreement, while 28 (22%) disagreed and 39 (27.9%) were neutral. In the same context, a median score of 4.00 has indicated the agreement of the stakeholders, while a mean value of 3.34 indicated a neutral position or undecided opinion.

Cross-tabulation analysis was also computed in order to discover the opinion of stakeholders according to their independent groups. The result has confirmed the agreement of the majority of stakeholders that the lack of import duty waiver on state-of-the-art ICT infrastructure was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. INOCs 21 (60%), PENGASSAN 16 (84.2%) and NCS/ITAN 10 (71.4%) were all in agreement. In contrast, NNPC 18 (45%) agreed while NNPC 10 (25%) disagreed, NETCO 4 (23.5%) agreed while 7 (41.2%) disagreed, and educational institutions 4 (26.7%) agreed while 6 (40%) disagreed. Based on the evidences emerged so far, the opinion of INOCs, PENGASSAN and NCS/ITAN was stronger due to their responsibility and independence from government which can make them feel the impact of waiver, contrary to NNPC, NETCO and educational institutions that were owned by the government as in Chapter 6, Section 6.7 of this thesis.

The Mann-Whitney test was also conducted among the groups of stakeholders. The result has indicated significant differences between five groups of stakeholders as displayed in Table 7.35.

Table 7.35: Mann-Whitney tests for lack of duty waiver on state-of-the-art ICT infrastructure

Statement: Lack of duty waiver on state-of-the-art ICT infrastructure						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC						
INOCs				.011	.015	
PENGASSAN				.001		
NETCO						
Educational Institutions						
NCS/ITAN				.005	.005	

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

The result has presented significant differences between groups of stakeholders; INOCs, PENGASSAN and NCS/ITAN on the one hand, and NETCO and educational institutions on the other. As displayed and discussed in analysing cross-tabulation results, the opinion of stakeholders from INOCs was stronger, due to their position as non-governmental companies that pay full import duty during their importation contrary to companies owned by the government which comprises NNPC and NETCO (See: Shonsaya, 2013; Blackherald, 2012).

In the final analysis, the most popular opinion was that lack of import waiver on state-of-the-art ICT infrastructure was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.5.3 Inadequate motivation of government incentives

This statement inquired into the respondents' opinions on inadequate motivation of government incentives towards state-of-the-art ICT adoption. The respondents' opinions were sought in order to clarify whether inadequate motivation of government incentives towards state-of-the-art ICT adoption was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

From Table 7.33, it can be noted that the respondents did not share the same opinion. However, the most popular opinion of the stakeholders confirmed their agreement that inadequate motivation of government incentives towards state-of-the-art ICT

adoption was a significant barrier to state-of-the-art IS by Nigerian INOCs. Subsequently, 101 (72.1 %) of the respondents agreed that the inadequate motivation of government incentives towards state-of-the-art ICT adoption was a significant barrier. In contrast, only 19 (13.5 %) disagreed, while 20 (14.3 %) were neutral. A median score of 4.00 indicated an agreement while a median score of 3.67 has shown a neutral position opinion which can be rounded-up statistically as agreement.

Cross-tabulation analysis was also conducted to discover the opinion of the stakeholders according to their independent groups. The result has indicated the agreement of the majority of stakeholders that inadequate motivation of government incentives towards state-of-the-art ICT adoption was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. Statistically, NNPC 31 (77.5%), INOCs 27 (77.2%), PENGASSAN 18 (94.7%) and NCS/ITAN 14 (100%) all agreed that inadequate motivation of government incentives was a major obstacle to the adoption of top-class ICT resources. However, stakeholders from NETCO only 8 (47.1%) agreed, while 5 among them (29.4%) remained neutral. In addition, participants from educational institutions only 3 (20%) agreed with inadequate motivation of government incentives as being a significant barrier, while 6 (40%) remained neutral or undecided in their opinion. In the analysis so far, the opinion of stakeholders among the participants is that inadequate motivation of government incentives was a significant barrier to the adoption of state-of-the-art IS by INOCs in Nigeria was stronger.

Moreover, the Mann-Whitney test was also conducted in order to check any significant differences that existed between the groups of stakeholders. The result has enunciated some significant differences as displayed in Table 7.36.

Table 7.36: Mann-Whitney tests for inadequate motivation of government incentives towards state-of-the-art ICT adoption

Statement: inadequate motivation of government incentives towards state-of-the-art ICT adoption						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC				.023	.001	
INOCs				.047	.001	
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

From Table 7.36 of Mann-Whitney, the opinion of stakeholders from NNPC, INOCs, NCS/ITAN and PENGASSAN differed significantly with the opinion of stakeholders from NETCO and educational institutions. In spite of that disagreement, the opinion of stakeholders from NNPC, INOCs, NCS/ITAN and PENGASSAN is consistent with the literature of other developing nations as in Chapter 4 Section 4.9.1 of this thesis. It is the responsibility of NNPC, INOCs and PENGASSAN's stakeholders to purchase state-of-the-art ICT as well as to assess government incentives and evaluate them critically.

In the final analysis, as also in Chapter 4 Sections 4.9.1 and 4.9.2 of this thesis, the most popular opinion was that inadequate motivation of government incentives towards state-of-the-art ICT adoption was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.5.4 Absence of government incentives

This statement inquired into the respondents' opinions on the absence of government incentives towards the adoption of up-to-date international material resources. The respondents' opinions were sought in order to clarify whether absence of government incentives towards the adoption of up-to-date international material resources was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

From Table 7.33, it can be noted that the respondents did not share the same opinion. However, the most popular opinion of the stakeholders confirmed their significant agreement on the absence of government incentives towards the adoption of up-to-date international material resources as a significant barrier to state-of-the-art IS by

Nigerian INOCs. Subsequently, 103 (73.5%) of the respondents agreed that the absence of government incentives towards the adoption of up-to-date international material resources was a significant barrier, while 20 (14.3%) disagreed and the remaining percentage of 17 (12.1% %) were neutral or undecided. A median score of 4.00 indicated an agreement of the stakeholders while a median score of 3.64 has shown a neutral position or undecided opinion.

In addition, cross-tabulation analysis was conducted for the groups who participated in the study. The result has indicated the agreement of a majority of the stakeholders. The stakeholders from NNPC 30 (75%), INOCs 25 (71.4%), PENGASSAN 17 (89.5%), NETCO 10 (58.9%) and NCS/ITAN 14 (100%) all agreed that the absence of government incentives towards the adoption of up-to-date international material resources was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. The agreed opinion was that the absence of government incentives being a major obstacle to the adoption of world-class IS was stronger based on the percentage of the agreement.

Consequently, the Mann-Whitney test was conducted among the groups of stakeholders in order to check the existence of any significant difference. The result has confirmed significant differences between four groups of stakeholders as displayed by Table 7.37.

Table 7.37: Mann-Whitney tests for absence of government incentives on adoption of up-to-date international material resources

Statement: inadequate motivation of government incentives towards state-of-the-art ICT adoption						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC					.042	
INOCs					.005	
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN					.002	

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

ii) NNPC= Nigerian National Petroleum Corporation; INOCs= Indigenous oil companies; PENGASSAN= Petroleum & Natural Gas Senior Staff Association of Nigeria; NETCO=National Engineering and Technical Company Limited; NCS/ITAN= Nigerian Computer Society/Information Technology Association of Nigeria.

The result has displayed significant differences between NNPC, PENGASSAN and NCS/ITAN on the one hand, and educational institutions on the other. Similarly, the opinion and perception of stakeholders from NNPC, PENGASSAN and NCS/ITAN on is consistent with the relevant literature as in Chapter 4 Section 4.11.1 of this thesis.

In the final analysis, the most popular opinion was that the absence of government incentives on the adoption of state-of-the-art international material resources was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.5.5 Lack of government incentives towards international partnerships

This statement sought the respondents' opinions on the lack of government incentives towards international partnership. The respondents' opinions were sought in order to clarify whether the lack of government incentives towards international partnerships was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

From Table 7.33, it can be confirmed that the respondents did not share the same opinion. However, the most popular opinion of the stakeholders confirmed their agreement with the lack of government incentives towards international partnerships as a significant barrier to state-of-the-art IS by Nigerian INOCs. Subsequently, 95 (67.8 %) of the respondents agreed that the lack of government incentives towards international partnerships was a significant barrier, while 24 (17.1%) disagreed and the remaining 21 (15.1 %) were neutral. A median score of 4.00 indicated their agreement while a median score of 3.56 has shown a neutral position or undecided opinion which can be rounded-up statistically as an agreement of the stakeholders.

Cross-tabulation analysis was also conducted among the groups of the stakeholders. The result has indicated strong agreement of five groups of stakeholders out of six. Furthermore, NNPC 26 (65%), INOCs 22 (62.8%), PENGASSAN 16 (84.2%), educational institutions 11 (73.4%) and NCS/ITAN 12 (85.7%) all agreed that the lack of government incentives towards international partnerships was a major obstacle to the adoption of state-of-the-art IS by Nigerian INOCs. It can be deduced from the opinions that emerged so far, that lack of government incentives was a significant barrier to the adoption of world-class ICT resources.

In an attempt to check the significant differences between the independent groups of stakeholders, the Mann-Whitney test was conducted among them. The result has confirmed the presence of only one significant difference among the groups in spite of their collective agreement. The finding of Mann-Whitney test is displayed in Table 7.38.

Table 7.38: Mann-Whitney tests for the lack of government incentives towards international partnerships

Statement: Inadequate motivation of government incentives towards international partnerships						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC						
INOCs						
PENGASSAN				.048		
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

From the result of Table 7.38 that displayed one difference of opinion between PENGASSAN and NETCO. The opinion of PENGASSAN is inconsistent with the success of other developing countries like India and Norway as in Chapter 4 Section 4.5.3 of this thesis.

In the final analysis, the most popular opinion was that, the lack of government incentives towards international partnerships was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.5.6 Answering research sub-question with regards to government incentives

From the major findings with regards to all the statements of the variables (A-E) in this section, it appeared that the questionnaire-survey participants did agree that all the variables with regards to government incentives were significant barriers to state-of-the-art IS adoption by Nigerian INOCs. Therefore, the sub-question $\mathbf{Q_5}$ is fully answered by the findings of the variables A, B, C, D and E which represent incentives integrated to local content law, the lack of import duty waiver, inadequate motivation on the part of the government, the absence of government incentives on state-of-the-

art international material resources and the lack of government incentives towards international partnerships respectively.

7.5.6 Environmental factors

This section has addressed the sixth sub-question of the study. The sub-question which is to be analysed and answered using the responses to six variables relating to section G of the research instrument, is restated as follows:

$Q_{6.}$ Is environmental challenge a significant barrier that limits the adoption of state-of-the-art IS Nigerian INOCs?

Furthermore, many writers have revealed that corruption is the greatest threat to Nigeria's democracy, industrialisation and socio-economic development (Chiluwa, 2011; Ogundele, 2008). They further observed that, there are security issues in parts of Nigeria and specifically within the Niger-Delta region (Chiluwa, 2011; Amaraegbu, 2011; Ogundele, 2008). Moreover, stakeholders' opinions were sought in order to indicate whether environmental factors were a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not. The results of the statistical findings are displayed in Table 7.39.

Table 7.39: Descriptive frequencies relating to environmental factors as significant barriers to the adoption of state-of-the-art IS by Nigerian INOCs.

Statement	Median	Mean	SD	D	N	A	SA
Effect of corruption in the Nigerian oil and gas sector.	5.00	4.54	1 (0.7%)	2 (1.4%)	1 (0.7%)	52 (37.1%)	84 (60.0%)
Effect of corruption on the availability of technical expertise.	5.00	4.39	0 (0%)	8 (5.7%)	5 (3.6%)	52 (37.1%)	75 (53.6%)
Effect of corruption on misuse of funds allocated to state-of-the-art ICT adoption.	5.00	4.66	0 (0%)	0 (0%)	2 (1.4%)	43 (30.7%)	95 (67.9%)
Effect of insecurity in general within Nigeria.	4.00	4.27	0 (0%)	6 (4.3%)	13 (9.3%)	58 (41.4%)	63 (45.0%)
Effect of security threats to lives in the Niger-Delta region.	4.00	3.99	0 (0%)	8 (5.7%)	13 (9.3%)	91 (65.0%)	28 (20.0%)
Effect of security threats to property in the Niger-Delta oil region.	4.00	4.07	0 (0%)	6 (4.3%)	11 (7.9%)	90 (64.3%)	33 (23.6%)

Note: i) SD= Strongly Disagree; D= Disagree; N= Neutral; A= Agree; SA= Strongly Agree. ii) All figures in brackets are percentages of relevant responses.

Table 7.39 presents the mean, median and percentage of agreement, disagreement and neutrality on environmental factors as being significant barriers to the adoption of state-of-the-art IS by Nigerian INOCs. A total of 140 responses for each of the six variables were recorded.

7.5.6.1 Effect of corruption in the Nigerian oil and gas sector

This statement inquired into the respondents' opinions on the effect of corruption in the Nigerian oil and gas sector. The respondents' opinions were sought in order to clarify whether the effect of corruption in the Nigerian oil and gas sector was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

From Table 7.39, it can be confirmed that the respondents did not completely share the same opinion. However, the most popular opinion of the stakeholders strongly indicated their agreement with the effect of corruption on the Nigerian oil and gas sector as a significant barrier to state-of-the-art IS. Subsequently, 136 (97.1%) of the respondents agreed that the effect of corruption on the Nigerian oil and gas sector was a significant barrier, while an insignificant 3 (2.2 %) disagreed and the remaining 1 (0.7%) remained neutral. A median score of 5.00 indicated a strong

agreement and a median score of 4.54 has also shown an agreement as well. In addition, there was an insignificant difference between the respondents on their agreement, disagreement and neutrality. Because only 3 respondents out 140 disagreed while 1 person remained neutral or undecided.

Cross-tabulation analysis was also conducted among the groups of stakeholders. Similarly, the result has strongly indicated their agreement. The stakeholders' respondents from NNPC 39 (97.5%), INOCs 33 (94.2%), PENGASSAN 19 (100%), NETCO 16 (94.1%), educational institutions 15 (100%) and NCS/ITAN 14 (100%) all disagreed that corruption in the Nigerian oil and gas sector was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCS.

Furthermore, Mann-Whitney tests were also conducted in order to check whether any significant difference existed among the groups of respondents. Similarly, the analysis has discovered four significant differences as displayed in Table 7.41.

Table 7.41: Mann-Whitney tests for the effect of corruption in the Nigerian oil and gas sector as a significant barrier to the adoption of state-of-the-art ICT by Nigerian INOCs

Stakeholders: Effect of corruption in the Nigerian oil and gas sector						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC					.003	
INOCs			.003		.001	
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN					.005	

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

In spite of their strong agreement, the result has expounded significant differences between the stakeholders of NNPC, INOCs, NCS/ITAN on the one hand, and educational institutions and PENGASSAN on the other. The opinion of stakeholders' respondents from NNPC, INOCs and NCS/ITAN is stronger due to its compatibility with the relevant literature. The finding is consistent with the relevant literature as discussed and elaborated in Chapter 4, Section 4.6.1 of this thesis.

In the final analysis, the most popular opinion was that the effect of corruption in the Nigerian oil and gas sector was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.6.2 Effect of corruption on the availability of technical expertise

This statement sought the respondents' opinions on the effect of corruption on the availability of technical expertise in the Nigerian oil and gas sector. The respondents' opinions were requested to clarify whether the effect of corruption on the availability of technical expertise in the Nigerian oil and gas sector was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

As displayed in Table 7.39, it can be confirmed that the respondents did not completely share the same opinion. However, the most popular opinion of the stakeholders strongly indicated their agreement with the effect of corruption in the Nigerian oil and gas sector as a significant barrier to state-of-the-art IS by Nigerian INOCs. Subsequently, 127 (90.7%) of the respondents agreed that the effect of corruption on the availability of technical expertise in the Nigerian oil and gas sector was a significant barrier to the adoption of state-of-the-art IS in the INOCs, while an insignificant 8 (5.7%) disagreed and 5 (3.6%) were neutral. A median score of 5.00 indicated a strong agreement and a median score of 4.39 also confirmed the agreement as well. From all angles of the descriptive frequencies, it was confirmed that the respondents agreed on the effect of corruption on the availability of technical expertise in the Nigerian oil and gas sector as a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Consequently, cross-tabulation analysis was also conducted among the groups of stakeholders. Similarly, the result has indicated their general agreement strongly. The stakeholders' respondents from NNPC 35 (87.5%), INOCs 31 (88.5%), PENGASSAN 19 (100%), NETCO 13 (76.4%), educational institutions 15 (100%) and NCS/ITAN 14 (100%) all disagreed that the effect of corruption on the availability of technical expertise in the Nigerian oil and gas sector was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Mann-Whitney tests were also computed in order to check the existence of any significant difference between the groups of respondents. Furthermore, the analysis has discovered four significant differences as displayed in Table 7.42.

Table 7.42: Mann-Whitney tests on the effect of corruption on the availability of technical expertise as a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs

Statement: Effect of corruption in the Nigerian oil and gas sector						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC					.001	
INOCs					.001	.025
PENGASSAN					.018	
NETCO					.003	
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

The result has confirmed significant differences among the groups of stakeholders. The stakeholders of NNPC, INOCs, NETCO and PENGASSAN significantly differed with the stakeholders of NCS/ITAN and educational institutions. In this context, the opinion of stakeholders from NNPC, INOCs, NETCO and PENGASSAN is consistent with the literature as discussed and elaborated in Chapter 4, Section 4.6.1 of this thesis.

In the final analysis, the most popular opinion was that the effect of corruption on the availability of technical expertise in the Nigerian oil and gas sector was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.6.3 Effect of corruption on the misuse of funds allocated to state-of-the-art ICT

This statement inquired into the respondents' opinions on the effect of corruption on the misuse of funds allocated to state-of-the-art ICT adoption in the Nigerian oil and gas sector. The respondents' opinions were sought in order to clarify whether the effect of corruption on the misuse of funds allocated to state-of-the-art ICT in the Nigerian oil and gas sector was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

From Table 7.39, it can be confirmed that the respondents did not completely share the same opinion. However, the most popular opinion of the stakeholders strongly confirmed their agreement that the effect of corruption in the Nigerian oil and gas sector was a significant barrier to state-of-the-art IS. Subsequently, 138 (98.6 %) of the respondents agreed that the effect of corruption on the Nigerian oil and gas

sector was a significant barrier, while none of them disagreed that it was a significant barrier and the remaining of 2 (1.4%) were neutral. A median score of 5.00 and a median score of 4.66 have also shown the agreement. In addition, amongst all the 140 respondents, nobody disagreed that the effect of corruption on the misuse of funds allocated to state-of-the-art ICT adoption was a strong barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Furthermore, cross-tabulation analysis was also computed among the respondents across their groups. The result has also confirmed their agreement significantly. Moreover, most of the groups unanimously agreed that, the effect of corruption on the misuse of funds allocated to state-of-the-art ICT adoption was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. The respondents from NNPC 39 (97.5%), INOCs 34 (97.2%), PENGASSAN 19 (100%), NETCO 17 (100%), educational institutions 15 (100%) and 14 (100%) all agreed that the effect of misappropriation of funds and corrupt practices being perpetuated in the Nigerian oil and gas sector was a major obstacle to the adoption of state-of-the-art IS by Nigerian INOCs.

Consequently, Mann-Whitney tests were conducted among the groups of stakeholders that participated in the research to check the existence of significant differences in spite of their general agreement. The result is displayed in Table 7.43.

Table 7.43: Mann-Whitney tests on the effect of corruption on the misuse of funds allocated to state-of-the-art ICT adoption by Nigerian INOCs

Statement: Effect of corruption on the misuse of funds allocated to state-of-the-art ICT						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC						
INOCs					.001	.018
PENGASSAN					.034	
NETCO					.048	
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

The result of Mann-Whitney tests indicated significant differences between the participants from the stakeholders of INOCs, NETCO and PENGASSAN on the one hand, and educational institutions and NCS/ITAN on the other. However, all the

groups agreed that the effect of corruption on the misuse of funds allocated to IS was a significant barrier. Similarly, the finding is consistent with the literature, as in Chapter 4, Section 4.6.1 of this study.

In the final analysis, the most popular opinion was that the effect of corruption on the misuse of funds allocated to state-of-the-art ICT adoption in the Nigerian oil and gas sector was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.6.4 Effect of insecurity in general within Nigeria

This statement sought the respondents' opinions on the effect of insecurity in general within Nigeria which has a negative impact on the Nigerian oil and gas sector. The respondents' opinions were requested to clarify whether the effect of insecurity in general within Nigeria was a significant barrier to adoption of state-of-the-art IS by Nigerian INOCs or not.

As displayed in Table 7.39, it can be noted that the respondents did not completely share the same opinion. However, the most popular opinion of the stakeholders strongly confirmed their agreement with the effect of insecurity in general within Nigeria as a significant barrier to state-of-the-art IS. Subsequently, 121 (86.4%) of the respondents agreed that the effect of insecurity in general within Nigeria was a significant barrier to the adoption of state-of-the-art IS in the INOCs. In contrast, 6 (4.3%) disagreed and 13 (9.3%) were neutral. A median score of 4.00 and a median score of 4.27 confirmed and supported the agreement as well. From all angles of the descriptive frequencies' findings, it was confirmed that the respondents agreed on the effect of insecurity in general within Nigeria as being a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Furthermore, cross-tabulation analysis was also computed among all the groups of stakeholders in order to clarify their agreement as well or otherwise. The result has indicated their agreement that the effect of insecurity in general within Nigeria was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. The respondents from NNPC 33 (82.5%), INOCs 27 (77.2%), PENGASSAN 19 (100%), NETCO 13 (76.5%), educational institutions 15 (100%) and NCS/ITAN 14 (100%) all agreed that the effect of insecurity within Nigeria in general was a major obstacle to the adoption of state-of-the-art IS by INOCs.

Mann-Whitney tests were also computed to check significant differences among the groups of respondents. The result has confirmed five significant differences across the six groups of respondents as displayed in Table 7.44.

Table 7:44: Mann-Whitney tests on the effect of insecurity in general within Nigeria

Statement: Effect of insecurity in general within Nigeria						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC			.001		.000	.004
INOCs			.003		.000	
PENGASSAN						
NETCO						
Educational Institutions						
NCS/ITAN						

Note: i) Mann-Whitney test results with p- values of equal to or less than 0.05 are indicated in the table.

In spite of the general agreement of stakeholders' groups that insecurity within Nigeria in general is a significant obstacle to the adoption of world-class ICT resources, they differed significantly in the level of their agreement. The respondents from NNPC, INOCs and NETCO maintained almost equal and moderate levels of agreement on the one hand, while the respondents from PENGASSAN, educational institutions and NCS/ITAN on the other maintained almost equal and extreme level of agreement and differed significantly with the former groups. However, all the groups agreed that it was a significant barrier. There exists a consistency and agreement between this finding and the literature reviewed in Chapter 4, Section 4.6.2 of this thesis.

In the final analysis, the general opinion of respondents has established that, the effect of insecurity in general within Nigeria is a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

7.5.6.5 Effect of security threats to lives in the Niger-Delta region

This statement sought the opinions of respondents on the effect of security threats to lives in the Niger-Delta region. The opinions of respondents were requested to identify whether the effect of security threats to lives in the Niger-Delta region was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

As displayed in Table 7.39, it can be confirmed that the respondents did not completely share the same opinion. However, the most popular opinion of the stakeholders strongly indicated their agreement with the effect of security threats to lives in the Niger-Delta region as a significant barrier to state-of-the-art IS. Subsequently, 119 (85.0%) of the respondents agreed that the effect of security threats in the Niger-Delta region was a significant barrier to the adoption of state-of-the-art IS in the INOCs, while 8 (5.7%) disagreed and 13 (9.3%) were neutral. A median score of 4.00 indicated an agreement and a median score of 3.99 indicated a neutral position that can be rounded-up as an agreement as well. The most popular opinion that emerged from the descriptive frequencies' findings confirmed that the respondents agreed on the effect of security threats as a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Cross-tabulation analysis was also computed among the various groups of stakeholders to verify their agreement or otherwise as to the effect of security threats to lives in the Niger-Delta region. The result has confirmed the agreement of all the groups of respondents that participated in the study. The respondents from NNPC 30 (75%), INOCs 28 (80%), PENGASSAN 19 (100%), NETCO 13 (76.4%), educational institutions 15 (100%) and NCS/ITAN 14 (100%) all confirmed their agreement to the fact that the negative effect of security threats to lives of the stakeholders and other technical staff of the oil and gas sector was a significant obstacle to the adoption of state-of-the-art IS by Nigerian INOCs.

Mann-Whitney tests were computed one after the other among all the groups of respondents to check significant differences between them. However, the result has indicated an absence of any significant difference between all the six groups of the respondents.

In the final analysis, the most popular opinion that emerged was the effect of security threats to lives in the Niger-Delta region as a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. This finding is consistent with the relevant literature reviewed in Chapter 4, Section 4.6.2 of this thesis.

7.5.6.6 Effect of security threats to property in the Niger-Delta oil region

This statement sought the respondents' opinions on the effect of security threats to property in the Niger-Delta oil region. The respondents' opinions were requested to clarify whether the effect of security threats to property in the Niger-Delta oil region

was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs or not.

As displayed in Table 7.39, it can be confirmed that the respondents did not completely share the same opinion. However, the most popular opinion of the stakeholders strongly confirmed their agreement as to the effect of security threats to property in the Niger-Delta oil region as being a significant barrier to state-of-the-art IS. Subsequently, 123 (87.9%) of the respondents agreed that the effect of security threats to property in the Niger-Delta oil region was a significant barrier to the adoption of state-of-the-art IS in the indigenous oil companies, while only 6 (4.3%) disagreed, and 11 (7.9%) were neutral. A median score of 4.00 and a median score of 4.07 also confirmed their agreement. From all angles of the descriptive frequencies' findings, it was confirmed that the respondents agreed on the effect of security threats to property in the Niger-Delta region as a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs.

Cross-tabulation analysis was also conducted between all the groups of stakeholders. It has been confirmed from the result of the analysis that, all the groups of respondents from the stakeholders have agreed that the effect of security threats to property in the Niger-Delta oil region was a significant obstacle to the adoption of state-of-the-art IS by Nigerian INOCs. The respondents, NNPC 33 (82.5%), INOCs 28 (80%), PENGASSAN 19 (100%), NETCO 14 (82.3%), educational institutions 15 (100%) and NCS/ITAN 14 (100%) all strongly agreed that the negative effect of security threats to property in the Niger-Delta oil region was a real constraint on the adoption of state-of-the-art IS by Nigerian INOCs.

Mann-Whitney tests were computed one after the other among all the groups of respondents. The result has completely indicated an absence of any significant difference.

In the final analysis, the most popular opinion that emerged was that the effect of security threats to property in the Niger-Delta region was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. This finding agreed with the literature reviewed as in Chapter 4, Section 4.6.1 of this thesis.

7.5.6.7 Answering sub-question with regards to environmental factors

From the general findings with regards to all the statements of the variables (A-F) in this section, it appeared that the questionnaire-survey participants did agree that all the variables with regards to environmental factors were significant barriers to state-of-the-art IS adoption by Nigerian INOCs. Therefore, the sub-question $\mathbf{Q_6}$ is fully answered by the findings of all the variables- A, B, C, D, E and F which represent the effect of corruption on the Nigerian oil and gas sector, the effect of corruption on the availability of technical expertise, the effect of corruption on the misuse of funds allocated to state-of-the-art ICT adoption, the effect of insecurity in general within Nigeria, the effect of security threats to lives in the Niger-Delta region and the effect of security threats to property in the Niger-Delta oil region respectively.

7.5.7 Significant differences from Mann-Whitney of the entire Chapter 7

This section presents the total of all the significant differences that existed between the various groups of stakeholders through Mann-Whitney tests. The table has presented the sum of all the 38 variables that have been analysed through questionnaire survey.

Table 7.45: Summary of differences of all of the significant barriers of the questionnaire survey

Statement: Significant differences of questionnaire						
	NNPC	INOCs	PENGASSAN	NETCO	Educational Institutions	NCS/ITAN
NNPC			9	1	14	4
INOCs			10	7	15	5
PENGASSAN		1		3	8	1
NETCO			4		8	2
Educational Institutions						
NCS/ITAN			1	2	9	

The result has indicated significant differences between NNPC and INOCs on the one hand and educational institutions on the other. Interestingly, most of the significant differences existed in the same line of opinion. For example, they existed between two alternatives of “strongly agree” and “agree” only. Also, another significant difference existed between INOCs and PENGASSAN.

These significant differences are summarised below:

i. INOCs differed significantly 15 times with educational institutions;

ii. NNPC also differed significantly 14 times with educational institutions; and

iii. INOCs also differed significantly 10 times with PENGASSAN.

7.6 Conclusion

This Chapter has analysed and presented data collected through the questionnaire-survey. The chapter has analysed all the data generated for the 38 variables of the survey. In the process of analysing the questionnaire, the study has also discovered the cost of: state-of-the-art upstream online monitoring systems; cost of its maintenance; cost of state-of-the-art SCADA; and cost of state-of-the-art 3-D seismic capability were significant barriers to the adoption of state-of-the-art IS. While cost of state-of-the-art ICT infrastructure, software, renewal of licenses, hardware and telephone support system were not significant barriers to the adoption of state-of-the-art IS by Nigerian INOCs.

Furthermore, this empirical investigation of significant barriers to the adoption of state-of-the-art IS by Nigerian INOCs has been achieved successfully. In addition, significant barriers were discovered by the study. These significant barriers include quality and quantity of skill development, poor managerial interest, knowledge, dynamism, age bracket, ability, willingness, ICT-oriented culture, lack of proper governance, some government policies, government incentives and environmental factors, such as corruption and insecurity. These constraints do not only limit the adoption of state-of-the-art IS in most companies, but also impede its adoption completely.

According to the empirical investigation of the study, the strongest, most significant barriers to the adoption of the state-of-the-art IS by Nigerian INOCs were corruption and insecurity. These two environmental factors have been unanimously agreed upon by most of the stakeholders as being the strongest, most significant barriers that limit the adoption of state-of-the-art IS by the Nigerian INOCs.

The next chapter will analysis the follow-up interview that is conducted after the questionnaire analysis. The main reason for the follow-up interview is to address the significant differences that existed between the groups of stakeholders as confirmed through Mann-Whitney test and also serve as a member validation.

CHAPTER EIGHT

Analysis of Follow-up interviews on Questionnaire Findings

8.1 Introduction

This chapter analyses and presents the data collected through follow-up interview surveys. The interview was conducted as a result of some significant differences that existed between some groups of major stakeholders in questionnaire findings as in Chapter 7, Section 7.5.7 of this thesis. In order to resolve the issue, follow-up interviews were conducted. To accomplish this task of resolving the significant differences, the chapter is divided into four relevant sections. Section 8.2 presents an overview of interview analysis. Section 8.3 discusses and presents interview analysis of significant views. Section 8.4 then concludes the chapter.

8.2 An overview of interview analysis

Resolving the significant differences that existed among the three groups of stakeholders as in Chapter 7, Section 7.5.7 was one of the main reasons for conducting the follow-up interview survey (see Appendix H for follow-up interviews). To accomplish the task of analysing the interview and obtaining valid and reliable findings, certain methods and procedures are respected sequentially. These methods and procedures comprise generating, coding and interpreting data with the aim of obtaining useful and authentic information with respect to the objectives of the study (Stephen, 2009; Grbich, 2007; Miles & Huberman, 1994). Generally, these steps of the procedure include but are not limited to data writing, data display, data reduction, data interpretation and the generation of its conclusion (Stephen, 2009; Miles and Huberman, 1994).

Twelve senior personnel were interviewed. Six of them were the same personnel interviewed during the first set of interviews prior to the main data collection of the questionnaire survey. In addition, the remaining six were also selected from the six groups of stakeholders. Therefore, two experts were selected from each group of stakeholders.

The twelve senior personnel interviewed comprised of: two engineering managers; two general managers; two computer scientists; two exploration and production engineers; two senior geologists; and two information systems analyst. The interviewees are coded and represented with acronyms such as IP01, IP02, IP03, IP04, IP05, IP06, IP07, IP08, IP09, IP10, IP11 and IP12 respectively. Their transcribed responses will be analysed and discussed elaborately in this chapter.

In line with the above argument, the study has adopted its proposed algorithm after minor corrections and amendments during its pilot study. The algorithm is presented in Chapter 6, Section 6.5.1.8 of this thesis.

8.3 Follow-up interview analysis of major views

In the process of analysing the follow-up interview, qualitative content analysis is used (Hsieh and Shannon, 2005; Patton, 2002). Furthermore, five major areas were identified and selected which needed further clarification from the chosen experts who participated in the follow-up interviews:

i. avoidance of bias and misleading questions;

ii. significant differences that existed in questionnaire findings;

iii. the implication of significant differences

iv. resolving the significant differences between the stakeholders; and

v. recommendations from the chosen stakeholders

8.3.1 Avoidance of bias

It is highly recommended when researching, to establish a high degree of flexibility and avoid being biased or presenting misleading question as discussed in Chapter 6 Section 6.5 of this thesis. As a result, the follow-up interview-survey started by requesting the interviewees to indicate the groups of stakeholders from the six chosen groups which they perceived differed in their opinions or views on the adoption of the state-of-the-art IS by Nigerian INOCs. Their responses will assist in making a comparison as to whether their views agree with the findings of this study through questionnaire-survey or not.

Interestingly, their views significantly agreed with the findings of this study. Their views are summarised and presented in Table 8.1

Table 8.1: Interviewees' opinions on the anticipated disagreement of perception between the chosen groups of stakeholders

Interviewees	Major findings	Quotations	Role of interviewees in oil and gas sector
IP01	-NNPC & educ. Inst. -INOCs & educ. Inst.	"NNPC and INOCs on the one hand can differ significantly from educational institutions on the other."	Engineering Manager
IP02	-NNPC & educ. Inst. INOCs & educ. Inst.	"NNPC can differ from educational institutions, while INOCs can also differ from educational institutions."	General Manager
IP03	-NNPC & PENGASSAN -INOCs and NCS	"Based on my perception, NNPC and INOCs on the one hand could differ seriously from educational institutions and PENGASSAN respectively."	Computer Scientist
IP04	-INOCs & educ. Inst.	"I predict that INOCs and educational institutions will have a significant difference in their responses."	E&P Engineer
IP05	-INOCs & educ. Inst. -NNPC & educ. Inst.	"I think there will be a significant difference between INOCs and educational institutions… and also between NNPC and educational institutions."	Senior Geologist
IP06	-PENGASSAN & INOCs -NCS & INOCs	"I expect both PENGASSAN and NCS will differ from INOCs."	Information systems' analyst
IP07	-NNPC & educ. Inst. -INOCs & educ. Inst.	"Experts of NNPC and INOCs on the one hand, and educational institutions and NCS on the other."	Engineering Manager
IP08	-NNPC & educ. Inst. -INOCs & educ. Inst.	"I perceive both NNPC and INOCs as differing from educational institutions in their perceptions…"	General Manager
IP09	-NNPC & PENGASSAN -INOCs & educ. Inst.	"Stakeholders of NNPC could differ from PENGASSAN, while INOCs could differ from educational institutions."	Computer Scientist
IP10	-NNPC & educ. Inst. -NNPC and PENGASSAN	"NNPC will differ from educational institutions. Similarly, NNPC will also differ from PENGASSAN."	E&P Engineer
IP11	-INOCs & PENGASSAN -INOCs & educ. inst.	"I anticipate stakeholders of INOCs to differ from PENGASSAN. I also expect stakeholders of higher institutions to differ from INOCs."	Senior Geologist
IP12	-NNPC & PENGASSAN -INOCs & educ. Inst	"Chosen experts of NNPC and PENGASSAN can differ significantly. There is a high level of probability of significant differences between INOCs and academicians from educational institutions."	Information systems' analyst

(Source: Author generated)

The chosen stakeholders who participated in the survey have correctly predicted most of the groups that had significant differences in their opinion on the adoption of the state-of-the-art IS by Nigerian INOCs. The summary of their prediction has been presented in Table 8.1 of this chapter. All twelve of the chosen interviewees have chosen at least one correctly out of the three combinations of the different stakeholders' groups. However, the question did not necessarily require them to choose more than one combination. As a result, some interviewees selected only one combination, while most of them selected two combinations.

IP01 has predicted and selected two combinations correctly. These are NNPC and educational institutions, then INOCs and educational institutions also. IP02 and IP03 have also predicted and selected two combinations correctly, which are the same as IP01. These are NNPC and educational institutions as well as INOCs with educational institutions.

Furthermore, IP04 has predicted only one combination which happened to be correct. IP04 predicted the possibility of a significant difference between the stakeholders of INOCs and the stakeholders of educational institutions. In addition, IP05 has predicted two combinations correctly. These are INOCs and education institutions as well as NNPC and educational institutions. However, IP06 has also predicted two combinations in which one of them appeared to be consistent with the finding of this study. The prediction is between the stakeholders of INOCs and PENGASSAN.

Consequently, the above six interviewees were the same personnel who participated in our first set interviews prior to the questionnaire survey as discussed in Section 5.7 of Chapter 5. Their prediction has a very good level of precision and accuracy. Looking at the predictions, none of them failed all his predictions. Further, looking at their perceptions as well, four out of six predicted all their combinations correctly, while the remaining two stakeholders predicted at least 50% correctly.

The remaining six stakeholders from IP07 to IP12 were new stakeholders who had not participated in the first interview survey presented in Chapter 5 of this thesis. The result has also indicated that all the new chosen interviewees were correct in at least in one of their combinations on the probability of the emergence of significant difference between the chosen stakeholders of the research.

Therefore, IP07 has predicted all his two combinations correctly. These combinations were NNPC and educational institutions as well as INOCs and educational institutions. Similarly, IP08 has predicted the same with IP07 from all angles. However, IP09 has predicted two combinations, in which one of them was right, and the other one was partially correct, even though the significant difference was not like the chosen groups. That was the significant difference between the stakeholders of NNPC and PENGASSAN. In addition, IP10 predicted one out of his two predictions in agreement with the finding of this study. Similarly, IP11 has predicted his two selected combinations in consistent with the finding of the study in Chapter 7, Section 7.5.7 of this thesis. That was INOCs and PENGASSAN, as well as INOCs and educational institutions. Similarly, IP12 has predicted two combinations. Out of these two combinations, one of them was INOCs and educational institutions which happened to be in agreement with the findings of our study as in Table 7.45.

As presented, the chosen interviewees with IP07, IP08, IP09, IP10, IP11 and IP12 codes have indicated all their views. Out of these six interviewees, three stakeholders made all their predictions correctly in accordance with the finding of this study as in Table 7.45. The remaining three predicted at least 50% of their predictions in agreement with the findings of this study. Interestingly, all the last three had the same prediction, which was not among the most significant differences selected for this survey. This was the possibility of the existence of significant differences between the stakeholders of NNPC and PENGASSAN. However, in spite of the fact that this combination was not among the three combinations chosen for this follow-up survey, it was undoubtedly the fourth one, because NNPC and PENGASAN differed significantly 9 times out of the 38 possible outcomes. Further, this difference is just 1 less than the third combination. That was the disagreement between the stakeholders of INOCs and PENGASSAN, in which they differed 10 times.

Therefore, the prediction of the chosen experts who participated in the research has significantly and absolutely agreed with the major discoveries of this study in this area. This serves as the foundation of avoiding bias in presenting the significant differences that existed among the groups of stakeholders in the findings of the questionnaire-survey as in Chapter 7, Section 7.5.7 of this thesis.

8.3.2 Significant differences that existed in the questionnaire findings

After analysing the data obtained through the questionnaire-survey, some significant differences existed and occurred among some groups of stakeholders. The details of all the differences have been displayed in Chapter 7, Table 7.5.7 of this thesis. The significant differences emerged between 4 groups. INOCs differed 15 times with educational institutions. Similarly, NNPC differed 14 times with educational institutions, while INOCs differed 10 times with PENGASSAN. This study attempted to investigate the reasons behind these significant differences among these major groups of stakeholders. The summary of the major views are summarised in Table 8.2.

Table 8.2: Interviewees' opinions on the reasons of the occurrence of significant differences among some groups of stakeholders

Interviewees	Quotations	Major findings
IP01	"The reasons responsible for that are: Availability of resources which include financial and informational ones. Then applications of information systems and supporting software… then there is a difference in the level of knowledge and understanding of the business/industry, which is the difference between practice and theory. We still have a variation of company sizes and their level of exposure to various software applications."	-Availability of resources -Applications of information systems/software. -Difference in level of knowledge and understanding of the business/industry (practical vs. theory). -Variations in companies' sizes.
IP02	"There are many factors that are responsible for that, which include differences in financial strength between the companies. Not only that, there are differences in knowledge between technical experts and researchers who may not have sufficient knowledge of the practical aspects of exploration and production. There is also lack of sufficient research in the indigenous sector."	-Differences in financial strength -Differences in knowledge between technical experts and researchers, who know theory. -lack of research in the indigenous oil sector.
IP03	"Stakeholders of Nigerian INOCs have limited research that to update them as to the real picture of the entire sector… sometimes differences occur among stakeholders based on their general disposition. Some are government workers and are loyal to their employers, while others are activists."	-insufficient research in the sector. -Difference in opinion between loyalists and critics.
IP04	"These could be as a result of differences in exposure between them in terms of theory and practice. In other words, stakeholders of INOCs are more into practical management of IS, while the stakeholders of educational institutions are more involved in academic research than the practical aspect. Further, the availability of information between them also differed."	-Difference between practical and theory. -Lack of sufficient information.
IP05	"The challenges and their factors could be many, but undoubtedly there are variations in the size and expertise of the companies. There is also a difference between what is obtainable practically	-Variation in the size and expertise of the companies. -Difference in perception between

	and otherwise. Lack of record or research that combines the opinion of technical experts, government and academicians."	practical and theory. -Lack of research in the sector
IP06	"Differences with respect to companies and level of investment and variation of knowledge."	-Variation in investment -Variation in knowledge
IP07	"Perception differs between activists and other workers. There is also a difference of experience."	-Difference in perception between activists and other workers. -Difference in experience.
IP08	"Factors that are responsible for that could be many. However, the major ones can be: size of the companies; available knowledge at their disposal; and the level of investment."	-Size of the companies. -Availability of knowledge. -Level of investment.
IP09	"Because NNPC and INOCs are more into exploration physically, whilst the stakeholders of educational institutions and PENGASSAN are more educated with the logical knowledge.	-Variation between practice and theory.
IP10	"Lack of sharing knowledge between the various stakeholders. Then there is a difference in the amount invested by the various companies in the indigenous sector."	-Lack of sharing knowledge between the stakeholders. -Level of investment
IP11	"Investment by other companies is higher than the others. Companies rarely share useful knowledge between themselves. Also, the level of their expertise with as regards the application tools also differs."	-Level of investment. -Sharing of useful knowledge. -Level of expertise.
IP12	"All of them could be right in their opinion. However, what I observe is that, our indigenous companies don't share information on technological advancement and its importance to their sector. All the stakeholders you mentioned are important, but INOCs are more into E&P than others. So their opinion will be more reality than just empirical evidence. There is need for research into the area to bridge the gap"	-Sharing of information -availability of knowledge -Lack of research in the indigenous oil sector.

(Source: Author generated)

From Table 8.2, all the twelve interviewees indicated their views with regard to the significant differences that existed between the groups of chosen stakeholders that responded to the enquiries of this study. The study has categorised the views of the interviewees on the reasons behind the significant differences between them. The reasons are as follows.

8.3.2.1 Level of knowledge

Differences in levels of knowledge have been indicated to be among the reasons that were significantly responsible for the existence of major differences between the few groups of stakeholders. Some of the groups of stakeholders were more involved in practical aspect of exploration and production, while others were more involved in

theory. This was the view of six chosen interviewees who participated in the study. And the remaining six interviews who remained silent on the issue and did not disagree with the other interviewees.

Furthermore, the six interviewees that indicated the view in their responses were IP01, IP02, IP04, IP05, IP09 and IP12. However, the interviewees used synonymous phases in indicating their views. The major view as observed by IP01, IP02 and IP03 are presented below. IP01 stated that:

> *"Then there is a difference in the level of knowledge and understanding of the business or industry, which is the difference between practice and theory" (IP01).*

Similarly, IP02 was specific in his view. He expressed that, the main difference was between those in the exploration field on the one hand, and researchers in various institutions on the other. He observed that:

> *"There are differences in knowledge between technical experts and researchers who may not have sufficient knowledge of the practical aspects of exploration and production" (IP02).*

In addition, IP04 was more specific in his views. He categorically mentioned some groups with their names and the reasons why they could differ significantly. He stated that:

> *"These could be as a result of differences in exposure between them in terms of theory and practice. In other words, stakeholders of INOCs are more into the practical management side of IS, while the stakeholders of educational institutions are more involved in academic research than the practical work" (IP04).*

Considering all the major arguments given by the interviewees, one can establish that, there is a justification that, among the factors that brought about some significant differences between the groups of stakeholders that participated in this study was the difference in their roles in the oil sector. In other words, the significant difference emerged as a result of the difference between the stakeholders based on their knowledge variation of practice and theory.

7.3.2.2 Insufficient research in the indigenous oil sector

It has been stated by some of the interviewees that, insufficient research on upstream IS was among the factors responsible for the significant differences that existed between some groups of stakeholders. The interviewees observed that, when there is

insufficient research and reliable records with respect to an issue, this can lead to the existence of divergent views among stakeholders. This is due to the lack of reliable documents that can be compiled on all the various companies or areas and also serve as reference material for the stakeholders and other researchers.

Five interviewees specifically mentioned the challenge of insufficient research on upstream IS in the sector as being among the factors that were responsible for the emergence of significant differences among some groups of stakeholders who took part in this study during the questionnaire survey as displayed in Table 8.45. The interviewees that stated this view were, IP02, IP03, IP04, IP05 and IP12.

Furthermore, IP02 indicated that insufficient research was among the three factors he observed. The view is stated below:

> *"…Also there is lack of sufficient research on the indigenous sector" (IP02).*

Similarly, IP03 has indicated his view more openly. He said in his response:

> *"Stakeholders of Nigerian INOCs have limited research to update them as to the real picture of the entire sector…" (IP03)*

While mentioning the factors responsible for the existence of significant differences among the groups of stakeholders, IP05 stated that:

> *"(There is) a lack of record or research that combines the opinion of technical experts, government and academicians."*

Similarly, IP04 expressed his view by mentioning that the unavailability of information regarding the indigenous sector, could be a reason for the existence of significant differences between some groups of stakeholders who participated in the study. The unavailability of information can be undoubtedly related to insufficient research in the sector.

From the views discussed so far, it can be stated that, insufficient research on upstream IS was among the issues responsible for the significant differences between the groups of stakeholders. Similarly, prior to this research, as observed by this study in Chapter 3, Section 3.5, Nigerian INOCs have been found to have no reliable empirical research concerning the adoption of IS for upstream operation.

8.3.2.3 Sharing of knowledge and relevant information

Lack of information sharing and relevant knowledge on IS adoption among the groups of stakeholders has been observed to be among the factors that were very much responsible for the existence of significant differences between them. Six interviewees clearly observed, lack of sharing relevant information or useful knowledge could be one of the major reasons responsible for the obstacle.

The interviewees, who observed that, were IP01, IP04, IP08, IP10, IP11 and IP12. However, the interviewees used different words or phrases but pointing in the same direction, and also conveying the same meaning.

The major views of some of the interviewees will be presented here. In his contribution, IP01 while stating the reasons for the existence of significant differences among some groups of stakeholders, he specifically mentioned the issue of availability of resources. His view was that:

> *"The reasons behind this are: availability of resources, which includes financial and informational resources…" (IP01)*

In addition, IP04 noted that:

> *"These could be as a result of differences in exposure… and also the availability of information between them also differed"… (IP04)*

IP08 also expressed his views. In his opinion, he stated that:

> *"Factors contributing to this could be numerous. However, the major ones are: size of the companies; and knowledge availability at their disposal…" (IP08).*

Consequently, IP10 also stated that a lack of sharing knowledge between the various stakeholders could bring about significant differences between them. While IP11 has the same view with the other interviewees mentioned earlier. He stated that:

> *"Companies rarely share useful knowledge between themselves. And also the level of their expertise with various application tools also differs" (IP11)*

In addition, the last interviewee IP12 made the same assertion with other interviewees who had similar views. He noted that:

> *"All of them could be right in their opinions. However, what I observe, our indigenous companies don't share information on technological advancement and its importance to the sector" (IP12)*

Therefore, in the final analysis, it can be stated the lack of sharing relevant information and useful knowledge on upstream IS was a factor responsible for the occurrence of significant differences between some groups of stakeholders. Furthermore, the study observed the need for an intercompany relationship through which relevant information and knowledge of IS can be exchanged and shared accordingly.

8.3.2.4 Level of investment in the companies

Level of investment has been indicated as one of the factors that brought about significant differences between the groups of stakeholders. Level of investment also determines the size of a company. As a result, some interviewees used the size of company to explain the level of investment.

Six interviewees observed that level of investment or size of companies can be one of the factors responsible for the significant differences, while the remaining six did not disagree with them. These interviewees were, IP10, IP02, IP05, IP06, IP08, IP10 and IP11. The major assertions of some of the interviewees are summarised and discussed as follows:

IP01 highlighted his opinion by stating the size of the company, which invariably depends on the level of investment. He stated:

> *"We still have a variation in companies' sizes and their level of exposure to various software applications." (IP01).*

Similarly, IP02 has made almost the same observation. He observed that:

> *"There are many factors which are responsible for that, including differences in financial strength between the companies" (IP02).*

Financial strength undoubtedly depends on the level of investment which leads to the size of the company. Furthermore, IP05 also indicated the same view. He noted that:

> *"The challenges could be many, but undoubtedly there are variations in the size and the expertise of the companies…" (IP05)*

In addition, IP08, IP10 and IP11 also highlighted that levels of investment between the companies differed. Therefore, that could be among the reasons for the emergence of significant differences between them.

8.3.2.5 Perceptions of workers

Among the interviewees who participated in this study, some observed that difference in perception between workers was one of the factors responsible for the emergence of significant differences. They indicated that some workers were only loyal to their employers, while others were members of pressure groups. The members of pressure groups were mostly activists and critics. However, they mostly had their employers, but this hardly had any serious impact on their activism.

In line with this, IP03 and IP07 opined the implication of this different perception between critics and loyalists. IP03 stated that:

> *"Sometimes differences occur among stakeholders based on their general disposition. Some are government workers, and they are loyal to their employers, while others are activists"… (IP03).*

Similarly, IP07 also made the same assertion with IP03. He noted:

> *"Perception differs between activists and other workers and there is also a difference in experience" (IP07).*

In the final analysis, this study can deduce that, there is an element of justification that difference of perception can be a factor that is responsible for the differences between some groups of stakeholders. The stakeholders of INOCs, NNPC and NETCO were mostly loyal to their employers and/or government as well. However, the interviewees from PENGASSAN, and educational institutions were members of associations who happened to be activists and critics as in Chapter 6 of this thesis.

8.3.3 The implications of significant differences between the groups of stakeholders

This study attempted to investigate the implications of the significant differences among these major groups of stakeholders. This implication was to investigate whether the significant differences that emerged were "significant barriers" to the adoption of state-of-the-art IS by Nigerian INOCs or not. In other words, did the existence of significant differences between the stakeholders prevent Nigerian INOCs from adopting state-of-the-art IS for their exploration and production or not?

The summary of the major quotations are presented in Table 8.3. Similarly, the table also presents the major findings of their responses.

Table 8.3: Interviewees' opinions on the implication of significant difference between some groups of stakeholders

Interviewees	Quotations	Major findings
IP01	"Yes. Variation in those characteristics between companies can result in variations in the level of IS they can implement. Some understand that they need state-of-the-art IS and can afford it, while others cannot."	Significant difference among the groups of stakeholders is an obstacle to the adoption of IS.
IP02	"Yes. If stakeholders differ significantly, it will definitely affect the adoption of state-of-the-art Information systems."	Significant difference among the groups of stakeholders is an obstacle to the adoption of IS.
IP03	Yes it will be a great obstacle. This is due to the fact that, their differences could not allow them to unanimously pursue the adoption of the best information system."	Significant difference among the groups of stakeholders is an obstacle to the adoption of IS.
IP04	"When there is a big difference between the groups of stakeholders that will definitely be an obstacle to the adoption of the latest information technology. Therefore their agreement is very important in order to address the challenges facing the indigenous sectors."	Significant difference among the groups of stakeholders is an obstacle to the adoption of IS.
IP05	"This could be a significant problem. Without the agreement of the stakeholders there could be difficulty making progress towards the adoption of excellent information systems."	Significant difference among the groups of stakeholders is an obstacle to the adoption of IS.
IP06	"Yes, it can be a significant difference."	Significant difference among the groups of stakeholders is an obstacle to the adoption of IS.
IP07	"Yes, it will be a great barrier to modern ICT adoption."	Significant difference among the groups of stakeholders is an obstacle to the adoption of IS.
IP08	"Yes, united we stand, and otherwise we fall. Stakeholders must agree relatively between them before taking action."	Significant difference among the groups of stakeholders is an obstacle to the adoption of IS.
IP09	"Yes, no doubt it is a great obstacle to the adoption of the latest IS by INOCs."	Significant difference among the groups of stakeholders is an obstacle to the adoption of IS.
IP10	"Yes. No doubt about it."	Significant difference among the groups of stakeholders is an obstacle to the adoption of IS.
IP11	"Yes, I think it can be a major obstacle. Decision makers have to agree on the importance of IS before they adopt it."	Significant difference among the groups of stakeholders is an obstacle to the adoption of IS.
IP12	Yes, it is an obstacle because stakeholders rarely meet to discuss such issues. There is an urgent need for that."	Significant difference among the groups of stakeholders is an obstacle to the adoption of IS.

(Source: Author generated)

From Table 8.3, all the interviewees indicated their views. Surprisingly, all of them agreed that the divergent views of some groups of stakeholders that existed in

Chapter 7 Section 7.5.7 were significant barriers to the adoption of the state-of-the-art IS by Nigerian INOCs.

Furthermore, IP01, IP02, IP03, IP04, IP05, IP06, IP07, IP08, IP09, IP10, IP11 and IP12 all shared the same view. That is, the significant differences that existed between them were obstacles to state-of-the-art IS adoption by Nigerian INOCs.

8.3.4 Resolving the significant differences between the groups of stakeholders

The chosen interviewees had indicated their views on how to resolve the significant differences that existed between the various groups of stakeholders. However, the significant differences occurred with only three combinations of groups of stakeholders out of all the computations of the Mann-Whitney tests.

All twelve interviewees have outlined their opinions on how to resolve the challenge between the groups of stakeholders. The summary of their views are presented in Table 8.4.

Table 8.4: Interviewees' opinions on resolving the significant difference(s) among some groups of stakeholders

Interviewees	Quotations	Major findings
IP01	"The solutions are: adequate investment in information technology/information systems; inter-company information and knowledge sharing/interchange; IT/IS capability building of company staff; and training and retraining of staff.	-Adequate investment in IT/IS. - Intercompany information and knowledge sharing. –Training and retraining of staff.
IP02	"The significant differences can easily be resolved through the dissemination of knowledge, sufficient investment in ICT infrastructure and the training of decision makers and technical staff."	-Dissemination of knowledge. –Sufficient investment in ICT resources. –Training of decision-makers and technical staff.
IP03	"Organising discussion forums for the experts to address their differences as well as their challenges. Indigenous oil companies need to increase their investment and establish partnership with other oil companies."	-Discussion forums for the stakeholders. -Increase in investment. –Partnership.
IP04	"The first steps to be taken are: Sharing of relevant information between companies and relevant institutions. There is a need for research in ICT related issues in the indigenous oil and gas sector so that the relevant stakeholders will be educated on the general overview of the sector. "	-Sharing of relevant information. –Research in oil and gas section.
IP05	"Information and useful knowledge should be shared through conferences, meetings and workshops of all stakeholders."	-Sharing of information.
IP06	"Adequate investment is necessary. Meetings between the relevant stakeholders and other decision makers is also necessary."	-Adequate investment. –Meeting of stakeholders.
IP07	"Sufficient money should be channelled to the companies by their owners and training programmes and workshops should be organised for all the stakeholders."	-Adequate investment. –Meeting of stakeholders.
IP08	"Training of all relevant stakeholders on the importance of modern technology. There is also a need for meetings, trainings and a sharing of knowledge and information."	-Adequate investment. –Training programmes.
IP09	"To resolve the challenges there is a need for huge investment, developing the skill of technical staff and all the companies should be responsible enough to give invaluable information to other companies, so as to advance together."	-Training and retraining of staff. –Huge investment. –Sharing of information.
IP10	"I think promoting a mutual understanding between the stakeholders is important. IT/IS Investment into the sector has to increase as well as a sharing of useful knowledge and experience as regards modern technology."	-Mutual investment. –IT/IS investment. –Sharing of knowledge.
IP11	"There is an urgent need to organise conferences for all the stakeholders in order to bridge the gap that exists between them. Through the conferences useful information should be shared. There is also a need for more investment by all the companies in IS for exploration and production purposes. "	-Conferences for the stakeholders on ICT. –Sharing of information. – Huge investment in ICT resources.
IP12	"All stakeholders should have meetings on the adoption of high quality IS by the local oil companies. Experts should be invited to make presentations. Investment in ICT for oil and gas must be increased.	-Meeting for the stakeholders. – Adequate investment.

(Source: Author generated)

8.3.4.1 Sharing of relevant information and knowledge

The interviewees observed that, there is an urgent need to share relevant information and useful knowledge between the Nigerian INOCs. According to the majority of the interviewees, the lack of sharing information and useful knowledge on IS adoption among the various stakeholders brought about significant differences in their perceptions. In order to resolve the differences, stakeholders strongly advised on the necessity of sharing information and useful knowledge on IS adoption and its advantages.

Eight out of twelve interviewees indicated that, there is need for sharing relevant information and knowledge with regards to state-of-the-art IS as in Table 8.3. The interviewees are IP01, IP02, IP03, IP04, IP05, IP08, IP09, IP10 and IP11 observed the need for sharing knowledge among the indigenous oil companies on IS resources for exploration and production.

The major assertions of the respondents are summarised here. For example, IP01 observed the need to share relevant knowledge among the solutions to the significant differences that existed between the groups of stakeholders. He stated that:

> *"The solutions are… inter-company information and knowledge sharing and interchange…" (IP01).*

In addition, IP04 noted that:

> *"The first steps to be taken are: sharing of relevant information of the value of latest ICT resources between companies and other relevant institutions (IP04)"*

IP10 indicated the need for sharing knowledge and experience of modern ICT resources. He stated that:

> *"I think promoting mutual understanding between the stakeholders…and also sharing of useful knowledge and experience as regards modern technology" (IP10).*

However, major companies employ a marketing strategy of hiding information from their competitors, in order to dominate the market as in Chapter 2, Section 2.12 of this thesis. This strategy should not be adopted by INOCs with regard to state-of-the-art IS who are looking for survival and development. If Nigerian INOCs agree to share relevant knowledge as noted by eight interviewees, it will help in eliminating the significant differences between them, and also help in their technical advancement in IS adoption.

8.3.4.2 Trainings, meetings and conferences on ICT resources

It has been observed by many interviewees who participated in the study that organising meetings, conferences and training of stakeholders on the state-of-the-art IS adoption will bridge the gap that existed between the groups of the chosen stakeholders of the study. Most of the interviewees indicated the need for training and retraining of technical staff, meetings of stakeholders and organisation of conferences on the adoption of state-of-the-art IS and other related issues. This is consistent with the findings of this study as in Chapter 7 Section 7.3.6.3 of this thesis.

The interviewees that stated the need to either arrange meetings, conferences or workshops were nine respondents. These are IP01, IP02, IP03, IP06, IP07, IP08, IP11 and IP12.

The major views are summarised here. IP01 stated that:

> *"The solutions are: Information Technology/Information Systems capability and building of company staff and training and retraining of staff." (IP01).*

Similarly, IP06 opined on the need for meetings between stakeholders on the adoption of state-of-the-art IS in the Nigerian INOCs. He noted that:

> *"Meetings between the relevant stakeholders and other stakeholders is necessary."*

In addition, IP01 indicated the need to bridge the gap, between the stakeholders through organising conferences. He observed that:

> *"There is an urgent need to organise conferences for all the stakeholders in order to bridge the gap that has existed between them. Through the conferences, useful information should also be shared."*

Furthermore, from the views presented as in Table 8.3 and the other views discussed so far, there is a need for meetings, conferences and training of staff and other stakeholders of Nigerian INOCs on the adoption of state-of-the-art IS for upstream operations.

Meetings and conferences between various stakeholders can bring about a cordial relationship between loyalists and critics. The poor relationship between the loyalists and activists/critics brought about significant differences as observed by IP03 and IP07 as in Table 8.2. In addition, the issue of a lack of research on ICT resources in oil and gas as indicated by IP02, IP03, IP05 and IP12 can also be addressed intellectually through meetings, conferences and workshops with the stakeholders.

8.3.4.3 Huge investment in state-of-the-art upstream IS by INOCs

Many interviewees agreed with the fact that, sufficient and adequate investment was very essential to bridge the gap that existed between the groups of stakeholders. Differences in investment brought about significant differences in their views.

Nine interviewees among the twelve observed the need to increase investment on the part of Nigerian INOCs in order to address the challenges that emerged between the stakeholders. These are IP01, IP02, IP03, IP06, IP07, IP09, IP10, IP11 and IP12.

Some major views of the stakeholders are presented here. For example, IP01 noted that:

> *"The solutions are: adequate investment in information technology/information systems… IT/IS capability building of company staff, and training and retraining of staff" (IP10).*

Similarly, IP02 shared the same view on insufficient investment. His view noted that:

> *"The significant differences can easily be resolved through dissemination of knowledge, sufficient investment and training and retraining of decision makers and technical staff" (IP02).*

While IP10 made a similar observation. He stated that:

> *"I think promoting a mutual understanding among the stakeholders and IT/IS investment into the sector has to increase…" (IP10).*

From the views of all the nine interviewees as in Table 8.3, the study advised on the need for adequate investment in state-of-the-art IS for exploration and production. This was the opinion of all the nine interviewees as indicated earlier. This is consistent with the findings of this study as in Chapter 5 Section 5.7.3.6.3 of this thesis.

8.4 The need for state-of-the-art IS

In their views, all twelve interviewees noted and stated that, there was an urgent need for the adoption of the state-of-the-art IS by Nigerian INOCs. All their views indicated the need for the adoption of state-of-the-art IS. For example IP01 stated that:

> *"Yes of course. Today's oil and gas business is becoming increasingly complex and companies across the world are investing in ICT/IS to enable them to have an overall picture of their business at every moment. INOCs must also invest to be on a par with other oil companies across the globe or they will be lagging behind" (IP01).*

Furthermore, IP02 stated the same view with IP01. He noted that:

> *I strongly recommend the adoption of adequate state-of-the-art IS by all Nigerian INOCs. Upstream operations are becoming more complex, as such there is a need for high quality IS so as to address the challenges.*

Similarly, IP10 has the same view with all the twelve views. He opined that:

> *"I absolutely recommend the adoption of state-of-the-art IS by Nigerian INOCs. The adoption will undoubtedly enhance their operational performance as well as boost their production" (IP10).*

8.5 Correlation with the previous chapters as member checking

These follow-up interviews have been designed to address the significant differences that existed between some groups of stakeholders that participated in this study during the questionnaire survey of Chapter 7 of this thesis. The factors responsible for the significant differences between the chosen groups of stakeholders as well as the solutions were presented in Section 8.3 of this chapter.

Furthermore, the chapter also serves as member checking of the previous findings. Member checking is very essential in research as discussed elaborately in Chapter 6, Section 6.5.1.5 of this thesis. During the conduct of the follow-up interviews, the chosen interviewees who participated in the survey of Chapter 5, Section 5.7 and Chapter 7 were able to see the result of this study's findings. Interestingly, they were pleased with the result and affirmed it accordingly without indicating any form of disagreement. In addition, the result of the follow-up survey of this chapter is consistent and also correlates with the findings of the previous surveys of this study as in Chapter 5, Section 5.7.3.6 and Chapter 7 Section 7.5.1 of this thesis. In the final analysis, the purpose of the follow-up interviews has been achieved.

8.6 Conclusion

The investigation of the follow-up interviews was able to discover the reasons for the existence of significant differences between the groups of stakeholders on the state-of-the-art IS adoption used by INOCs. Furthermore, the solutions to the significant differences were also elaborately discussed. In the process of analysing the interviews, the study has discovered the suitability of the interviewees through their prediction which significantly agreed with the findings of the study through the first set of interviews and questionnaire survey.

Additionally, the views of the chosen interviewees were sought on the factors responsible for the emergence of significant differences between NNPC and INOCs on the one hand, and educational institutions and PENGASSAN on the other.

Consequently, the study has also discovered the solutions to the significant differences that existed between the various groups of stakeholders. These findings agreed with the relevant literatures of other developing nations.

In the final analysis, all twelve interviewees unanimously agreed with the urgent need for state-of-the-art IS adoption by Nigerian INOCs. Similarly, they stated that, the adoption of world-class IS can improve performance during exploration and production. This is consistent with the relevant literature on the performance of state-of-the-art IS as in Chapter 3, Section 3.13 of this thesis.

The next chapter will discuss the major findings and original contribution of the study. The chapter will answer all the research questions, address the aim and objectives of the research. The next chapter presents the significant findings of the study as well as original contribution to knowledge.

CHAPTER NINE

Research Findings and contribution to knowledge

9.1 Introduction

This chapter presents the major findings of this study. The findings include the discovery of significant barriers to the adoption of the state-of-the-art Information systems by Nigerian Indigenous oil companies. The chapter has also answers the research questions formulated for the study. In addition, the original contribution of knowledge has also been discussed and presented.

9.2 Summary of the answer to the research question, the aim and objectives with findings of the study

The study had the aim of identifying whether Nigerian INOCs have adopted state-of-the-art upstream IS, if not, then what were the significant barriers, if any, that limited the adoption. The aim and objectives of the research have been realised and achieved, and the summary of the findings has been presented below, through addressing the research question(s) of the study. The research question was:

> *Do Nigerian indigenous oil companies adopt state-of-the-art IS and, if not, what are the significant barriers that limit the adoption?*

The main research question has two parts: i) investigation into whether Nigerian INOCs have state-of-the-art IS? And if the answer is not affirmative; and ii) what are the significant barriers that limit the adoption?

The research has also identified the answers to the relevant parts of the main research question and has fully addressed all the objectives of the study. The summary of the findings is presented below accordingly.

9.2.1 Summary of the answer to the first part of the research question and the aim and objectives of the study

There were many reasons that vindicated to us that, as of now, Nigerian INOCs did not adopt adequate state-of-the-art IS for E&P. These have been outlined and presented below.

9.2.1.1 Findings from interview analysis

Many discoveries were made with regard to upstream IS adoption by Nigerian INOCs. These findings and discoveries were achieved as a result of conducting interviews which served as the foundation and background of the questionnaire survey. The summary of the first interview's findings (of Chapter 5, Section 5.7) is summarised and presented here.

9.2.1.1.1 Finding on knowledge of IS used by Nigerian INOCs

There was evidence that the stakeholders obtained first-hand information and knowledge on the state of IS used for E&P by Nigerian INOCs. All the relevant stakeholders selected or nominated for the interview have confirmed their knowledge with the current state of the upstream IS used by Nigerian INOCs.

Many researchers suggested the need to investigate the impediments to the advancement of upstream operation in Nigeria (Ozigbo, 2008; Okereke, 2008; Nwapa, 2007; Lenhard, 2004). Prior literature suggested that, no investigation has ever been conducted in the past that theoretically or empirically addressed the adoption of the IS by Nigerian INOCs (Okereke, 2008). As a result, the respondents' knowledge with the area of study is very essential so as to serve as the basis and foundation of this study.

9.2.1.1.2 Unavailability of in-house upstream state-of-the-art IS

Prior literature suggested unavailability of research on the current situation of upstream IS (Iledare 2008; Baker 2006). As a result, this study investigated and discovered in-house adoption of state-of-the-art upstream IS by Nigerian INOCs was unavailable in the sector. Similarly, the quality and quantity of the upstream IS were not of state-of-the-art standard. This has been confirmed by all the chosen senior officials and technical experts of the companies that participated in the interview as in Chapter 5, Section 5.7.3.2 of this thesis.

Nigerian INOCs have also been categorised into two with respect to the adoption of state-of-the-art IS for upstream operation. Some of them were relatively functioning, while others were not. However, two of the Nigerian INOCs that were technically involved in E&P of oil adopted state-of-the-art IS, but not adequately. However, there were some that mostly depended on multi-national oil companies for most of their

upstream activities. This is as a result of the lack of in-house adoption of state-of-the-art IS as observed by the interviewees as in Chapter 5, Section 5.7.3.3 of this thesis.

Conclusively, the in-house adoption of upstream IS has been unavailable in most of the INOCs, and outsourcing has been inefficient and ineffective. As a result, the study is considered as timely and important to the indigenous oil sector by interviewee IP01 as in Table 5.1 of this thesis.

9.2.1.1.3 Unavailability of effective state-of-the-art upstream software

State-of-the-art upstream software which is an integral part of world-class E&P operations was indeed inadequate or unavailable in Nigerian INOCs as observed by the interviewees as in Chapter 5, Section 5.7.3.3 of this thesis. This leads to ineffective upstream operations by INOCs. Nigerian agencies dealing with the oil and gas sector have been advised to give more emphasis to state-of-the-art hardware and software adoption as stated by interview participants as in Table 5.3.4.

The general opinion of all the interviewees confirmed their agreement on the unavailability of in-house adoption of state-of-the-art upstream software and renewal of their licenses timely and appropriately. They lamented the sorry state of the companies as in Chapter 5, Section 5.7.3.4 of this thesis.

9.2.1.1.4 Unavailability of effective state-of-the-art hardware in Nigerian INOCs

The study has discovered that Nigerian INOCs did not adopt sufficient state-of-the-art upstream hardware. In other words, there exists a huge gap between INOCs and multi-national ones in the quality and quantity of hardware they deploy for E&P.

Furthermore, the study observed that ordinary computer hardware resources were available in Nigerian INOCs. However there was a shortage of SCADA which has been integrated as part of IS and 3-D capabilities which are all part of world-class upstream IS hardware as in Chapter 5, Section 5.7.3.4 of this thesis.

9.2.1.1.5 Absence of state-of-the-art real-time online monitoring systems

State-of-the-art online monitoring systems for real-time communications during E&P were unavailable in Nigerian INOCs. This view has been stated by all the interviewees that partook in this study through the interview-survey as in Chapter 5, Section 5.7.3.5 of this thesis.

Stand-alone systems have been the only means of E&P operations in Nigerian INOCs. This has indicated unavailability of state-of-the-art online monitoring systems. All the stakeholders that participated in the study during the first set of interviews unanimously confirmed the unavailability of state-of-the-art online monitoring systems for real-time communications in Nigerian INOCs.

The interviews conducted were able to generate sufficient information to answer the first part of the research question as well as objective (i) and (ii) of the study. Similarly, in achieving the first objective of the study which stated:

i) to investigate the importance of having state-of-the-art IS by INOCs;

Prior to this study, literature suggests in a clear term the importance of state-of-the-art IS for upstream operation and the need for its adoption by oil companies (Anisi et al., 2010; Johnson, 2009; Arora et al., 2009; Hill et al, 2008; Gouvea, 2007; Heeks & Nicholson, 2004; Fisher & Kenny, 2000). However, the previous studies did not in any way accommodate Nigerian INOCs. As a result, this study made an enquiry to investigate the stakeholders during the follow-up interviews, whether their current IS was fit for their upstream operation or not. They stated that their upstream IS was not effective for them and there is a need for investment in state-of-the-art upstream IS adoption. For example, interview IP01 stated that:

> *"Yes of course. Today's oil and gas business is becoming increasingly complex and companies across the world are investing in ICT/IS to enable them have an overall picture of their business at every moment. INOCs must also invest to be par with other oil companies across the globe or they will be lagging behind" (IP01).*

Furthermore, all the chosen interviewees who participated in the study expressed the unavailability of state-of-the-art IS as presented in this chapter, Section 9.2.1.1 of this thesis. Their responses had answered the first part of the research question as well as objective (ii) of the study which stated:

ii) to investigate whether INOCs use state-of-the-art IS or not;

In addition, prior literature did not suggest anything specific with respect to the availability or otherwise of the state-of-the-art IS by Nigerian INOCs (Okereke;2008). In contrast, this study has answered and achieved the objective. The findings clearly stated the unavailability of state-of-the-art IS and online monitoring system for upstream operations as in Chapter 5, Sections 5.7.3.2 and 5.7.3.5 of this thesis.

9.2.1.1.6 Significant barriers to the adoption of state-of-the-art upstream IS

Prior literature suggested the existence of barriers to the adoption of ICT, IS, SMEs or e-commerce in developing Nations, such as Sri-Lanka and Nigeria (Gillingham & Sweeney, 2012; Kapurunbandara & Lawson, 2006; PTAC et al., 2005; Kunda & Brooks, 2000). However, literature also suggested that, prior to this study; no empirical study had ever been conducted on the barriers to IS adoption by Nigerian INOCs. Furthermore, this study discovered the significant barriers during first interview- and questionnaire-survey as in Chapter 5, Section 5.7 and Chapter 7 of this thesis respectively. The significant barriers mentioned by the interviewees were: corruption; lack of knowledge; lack of interest; insecurity; managerial attitude; lack of government motivation; funding; management perception; outsourcing of technology; inadequate skill development; and cost of resources.

The findings of this section has answered and achieved the objective (iii) of the study. The objective stated:

iii) to investigate the significant barriers, if any, that limit the adoption of state-of-the-art IS by INOCs;

However, the study noted that corruption, insecurity and poor managerial attitude were the most significant barriers to state-of-the-art IS adoption by Nigerian INOCs. The significant barriers discovered by this study as in Chapter 7, Section 7.3.6 and in relevant literatures as in Chapter 3, Section 3.15 were also investigated through retrieving 140 valid questionnaires as in Chapter 7, Section 7.5 of this thesis.

9.2.1.1.7 Solutions to the significant barriers which emerged from the interviews

Relevant literature of other sectors in developing nations suggested some solutions to barriers of ICT or IS adoption by companies (see for example; Harindranath, Dyerson & Barnes, 2008; Kapurunbandara & Lawson, 2006; Tarafdar & Vaidya, 2006). However, in the previous studies, no empirical or theoretical investigations were conducted on Nigerian INOCs. The research interviewees mentioned some recommendations as a solution to the significant barriers as Chapter 7, Section 7.3.6 of this thesis. Furthermore, the solutions to the significant barriers of internal and external challenges were mentioned through the findings of this study.

Similarly, the solutions to internal barriers are in accordance with the internal obstacles. The solutions comprise: fighting internal corruption; proper funding by the owners of INOCs; appointment based on integrity and expertise; skill development;

measurement of performance; improving managerial knowledge; and enlightenment on the need for state-of-the-art IS. Furthermore, the solutions to external barriers are also in accordance with the external obstacles. These were: improving government policy; fighting national fraud and corruption; improving security; and improving ICT infrastructural development all over the country.

Conclusively, this has achieved objective (iv) of the study. The objective stated:

> *(iv) to identify the way out for removing the impediments that limit the adoption of the state-of-the-art IS;*

However, the same objective is fully achieved through the findings of follow-up interviews as in Chapter 8 Section 8.3.1 of this thesis.

9.2.2 Summary of the answer to the second part of the research question and objectives of the study through the questionnaire-survey

Relevant literature of other sectors discovered the existence of barriers to technology adoption (see for example; Gillingham & Sweeney, 2012; Kapurunbandara & Lawson, 2007). The previous literature did not address Nigerian INOCs. Hence, this study investigated the significant barriers, if any, to state-of-the-art upstream IS adoption used by INOCs. These significant barriers that limit the adoption of state-of-the-art IS by Nigerian INOCs as elaborately analysed and discussed during the interview analysis in Chapter 5, Section 5.7.3.6 as well as in questionnaire analysis as in Chapter 7, Section 7.5.1 of this thesis have answered the second part of research question as well as achieved the objective (iii) of this study. Furthermore, the research question which will also be answered here stated that:

What are the significant barriers, (if any) that limit the adoption of state-of-the-art upstream IS by Nigerian INOCs?

9.2.2.1 Findings from the questionnaire analysis

Many discoveries were made with regard to state-of-the-art upstream IS adoption by Nigerian INOCs. These discoveries were achieved as a result of employing the questionnaire survey in which many stakeholders participated in the survey indicated their perceptions.

9.2.2.2 Cost of state-of-the-art IS

Cost of ICT resources has been a significant barrier to its adoption by many enterprises and companies in many developing countries (Kapurunbandara & Lawson, 2006; Basant, 2006; UNDP, 2004). In contrast, the situation is not always the same when it comes to Nigerian INOCs.

There were mixed opinions with regards to the cost of state-of-the-art ICT used by oil companies. In Nigeria, some expensive state-of-the-art ICT resources can be a significant barrier to some INOCs, but not to all of them. As in findings of Chapter 5, Section 5.7.5 of this thesis: cost of state-of-the-art real-time online monitoring systems; cost of state-of-the-art SCADA systems; and 3-D seismic capabilities were significant barriers to the adoption of state-of-the-art IS by Nigerian INOCs. However, the research discovered that cost of state-of-the-art upstream software, hardware, telephone systems and other supporting devices were not significant barriers to the adoption of state-of-the-art IS by Nigerian INOCs.

9.2.2.3 ICT skill and expertise as significant barriers

Prior literature suggested that skill, expertise and training were significant barriers to ICT or IS adoption in other developing countries (see for example; Kapurubandara and Lawson; 2007 Kunda & Brooks, 2000).

According to this study's finding with respect to Nigerian INOCs, inadequate quality and quantity of skill development, inadequate technical and relevant expertise, and inadequate access to E&P training programmes were significant barriers to the adoption of state-of-the-art IS by Nigerian INOCs as in Chapter 7, Section 7.5.2 of this thesis.

9.2.2.4 Managerial attitude as a significant barrier

Relevant literatures suggested that managerial attitude is a barrier to the adoption of technology as discovered by many writers (Iheduru, 2011; Apulu and Latham, 2009; Kim, 2000; Ginsberg and Venkatramen, 1992). However, their studies neither covered Nigeria nor its indigenous oil sector. According to this study's findings, managerial attitude was a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. Similarly, there are many sub-barriers that fall under managerial attitude and all of them have been identified and discovered as an obstacle to state-of-the-art IS adoption.

Furthermore, as discovered by the study, the major elements under managerial attitude that were significant barriers include: managerial interest; managerial knowledge; managerial dynamism; managerial age bracket; managerial ability; managerial willingness; managerial ICT-oriented culture; and lack of proper governance structure. All these elements of managerial attitude were significant barriers to state-of-the-art IS adoption by Nigerian INOCs.

9.2.2.5 Environmental factors as the most significant barriers

Relevant literature also indicated that environmental challenges were significant barriers to the technological advancement of Nigeria (see for example: Uwuagiaren, 2012; Amaraegbu, 2011; Ogundele, 2008; Sachs, 2007; Ayobolu, 2006; Ayobolu, 2006). However, the previous studies were not specific to Nigerian INOCs. Due to that, this study investigated the negative impact of corruption and insecurity to the adoption of state-of-the-art IS by Nigerian INOCs.

Furthermore, the study has discovered environmental factors as the most significant barriers to state-of-the-art IS adoption by Nigerian INOCs. Undoubtedly, this is to say that, the environmental factors have been identified as the major obstacles that limit not only the adoption of state-of-the-art IS by local oil companies, but the industrialisation and advancement of Nigeria as in Chapter 7 Section 7.5.6 of this thesis.

Similarly, the effects of corrupt practices and insecurity on the Nigerian oil and gas sector have been discovered as the major obstacles to the development of the sector. These obstacles include: the effect of corruption on the availability of technical expertise; and the effect of corruption on the misuse of funds allocated to state-of-the-art IS adoption. In addition, the effect of insecurity in general within Nigeria, the effect of security threats to lives in the Niger-Delta region and finally, the effect of security threats to property in the Niger-Delta oil region have been considered as the major barriers to the technological advancement of local oil companies in specific and Nigeria in general. As a result, many stakeholders believe that, if corruption and insecurity are addressed, the development of Nigeria in terms of technological advancement in all sectors will undoubtedly be achieved within a short period of time due to the country's abundant resources.

This section has answered the second part of the research questions intensively as well as objective (iii) of the thesis. The objective (iii) stated:

To investigate the significant barriers, if any, that limit the adoption of state-of-the-art IS by INOCs;

The findings of this study as analysed and discussed elaborately in Chapter, Section 7.5 of this thesis and summarised in this chapter, Section 9.2.2 have undoubtedly discovered the significant barriers to state-of-the-art IS adoption by Nigerian INOCs and answer the second part of the research question. However, both the research question and the objective (iii) were also answered by the interview findings as in Section 9.2.1.1.6 of this thesis.

9.2.2.6 Elements of government policy are significant barriers

Government laws and policies have been identified as barriers to ICT or IS adoption in other developing countries (for example see: Kapurubandara and Lawson; 2007; Kunda & Brooks, 2000; Peterson et al., 2002; Abdul-Gader, 1997). However, the negative impact of government policies on the adoption of state-of-the-art IS by Nigerian INOCs was not investigated. In this study, government policy was an issue that brought about divergent views as to whether it is a significant barrier or not. However, the different views emerged as a result of different perceptions and interpretations as in Chapter 7, Section 7.5.5 of this thesis.

According to this study, the most popular view indicated that Nigeria's local content policy *per se* was not a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. However, utilisation of indigenous human resources without developing their skills, utilisation of indigenous material resources without improving their quality, directives of Nigeria's government to NETCO for the production of state-of-the-art technology and NETCO's inability to attract international partnerships have all been identified and discovered as significant barriers to state-of-the-art IS by Nigerian INOCs.

9.2.2.7 Government incentives as significant barriers

Previous studies indicated government support, motivation and incentives as being significant barriers to technology adoption (Ihua, Ajayi & Eloji, 2009; Kapurubandara and Lawson; 2007; Oladele, 2001). However, the researchers did not investigate the negative impact of government support on the adoption of state-of-the-art IS by Nigerian INOCs.

As a result, this study investigated and found that government incentives were significant barriers to state-of-the-art IS adoption by Nigerian INOCs. The most

popular opinion according to this study's findings, was that government incentives, such as incentives integrated into local content policy of government, lack of import duty waiver, inadequate motivation of government incentives, absence of government incentives as well as lack of government incentives towards international partnerships have all been considered as major obstacles to the adoption of state-of-the-art IS by Nigerian INOCs. Further, there was indeed a lack of government motivation, support and also encouragement towards the adoption of world-class IS resources by Nigerian INOCs.

Conclusively, Sections 9.2.2.6 and 9.2.2.7 of this thesis has successfully achieved objective (v) of the study. The objective stated:

> ***v)*** *to review government policy and support for Nigerian INOCs and advise appropriately on their modification (if any) and implementation in order to motivate INOCs to adopt the state-of-the-art IS.*

Furthermore, the study advised the government on policy modification later in this chapter, in Section 9.4. Prior to that, the study made recommendations to the government on policy implementation and modification as in Chapter 7, Sections 7.5.4 and 7.5.4.1 of this thesis.

9.3 Original contribution to knowledge

While studying the constraints that limit the adoption of state-of-the-art IS by Nigerian INOCs, the study has significantly contributed to knowledge in many areas. They have been identified as contribution to knowledge because they have not been discovered in the Nigerian INOCs prior to this study. In addition, they are important due to their potentials for enhancing the INOCs and helping researchers and other stakeholders who are interested in similar research. The areas are presented as follows.

9.3.1 Current situation of upstream IS

The study has contributed to knowledge by identifying and documenting the current situation of upstream IS used by Nigerian INOCs. Prior literature and empirical investigation have confirmed that, before conducting this study, the general situation of IS of all Nigerian INOCs had not been investigated, established and recorded (see for example: Ozigbo, 2008; Nwosu, 2006).

Furthermore, this study has become the first theoretical and empirical investigation that critically studied the INOCs in Nigeria in terms of the quality and standard of their upstream IS. In addition, the level of ICT adoption as well as the skill development of INOCs based on the opinion and views of stakeholders has been elaborately x-rayed, investigated and recorded in this study. This makes it good reference material for further research and study.

Consequently, key stakeholders of Nigerian INOCs were interviewed on the current situation of the state-of-the-art IS used by local oil companies for exploration and production. Similarly, investigative surveys and an analysis of stakeholders' opinion are indeed giant steps towards getting and documenting first-hand information and knowledge of state-of-the-art IS used by Nigerian INOCs. This is also the first time that engineering managers, computer scientists, exploration and production engineers and IS analysts were interviewed and their opinions were sought on the state of upstream IS adoption by the Nigerian INOCs. The discovery and documentation of the current situation of IS used by Nigerian INOCs is among the most noble contributions of this study because it is indeed a common practice that some stakeholders always fail to disclose the weaknesses of their companies. However, the situation is not the same here, as stakeholders portrayed the good, the bad and the true picture of their companies. Interestingly, this has confirmed the integrity of the chosen stakeholders for the survey as investigated by this study as in Chapter 9, Section 9.3.1 of this thesis.

9.3.2 Discovery of significant barriers

The study has also contributed to knowledge by discovering the significant and major barriers that limit the adoption of state-of-the-art IS used by Nigerian INOCs. Prior to this empirical investigation, no study has ever been conducted with the aim of identifying significant barriers to state-of-the-art IS adoption by Nigerian INOCs. However, there are other empirical investigations in some developing countries, but in Nigerian INOCs, this is the pioneer empirical investigation.

The solutions to the significant barriers identified can assist the government of Nigeria as well as the owners of the INOCs to address the constraints as well as develop the INOCs technologically to a world-class oil sector. The identification of significant barriers by this study is undoubtedly the first step towards eliminating them and adopting the state-of-the-art IS. The significant barriers range from: the

cost of expensive state-of-the-art upstream ICT resources; skill development; managerial attitude; some government policies; government incentives; corruption; and insecurity. This is also among the noblest contributions of this study due to their negative impact on performance of Nigerian INOCs. The sub-questions formulated for the study as in Chapter 1, Section 1.4 have been successfully addressed and answered by the discovery of the significant barriers.

9.3.3 Relationship between state-of-the-art IS and the efficient upstream operation of local companies of developing nations

Prior literature suggested an absence of any empirical research that investigated the relationship between state-of-the-art IS and Nigerian INOCs. The relationship between state-of-the-art IS and the improving performance of upstream operation has been established. The adoption of state-of-the-art IS and improving operational and efficient performance are interwoven. As a result, international oil companies have always adopted world-class IS resources and maintained them technically in order to improve their operational performance for exploration and the production of oil and gas (See for example: Anisi et al., 2010; Johnson, 2009; Evans, 2002).

The establishment of this relationship contributed to knowledge by creating awareness among the management of Nigerian INOCs as to the adoption of state-of-the-art of ICT resources, SCADA, skill development and maintenance. This kind of relationship has not been established in Nigerian INOCs prior to this study. In the opinions of the stakeholders who participated in the study, there was an urgent need to adopt state-of-the-art IS by Nigerian INOCs in order to improve performance as discussed in Chapter 8, Section 8.3.5 of this thesis.

9.3.4 Reasons for the existence of significant differences between the groups of stakeholders

The study has contributed to knowledge by identifying the reasons for the existence of significant differences. After conducting and analysing the questionnaire-survey of this study, some significant differences emerged between some groups of stakeholders as presented in Chapter 7, Section 7.5.7 of this thesis. More importantly, these groups of stakeholders comprised of NNPC and INOCs on the one hand, educational institutions and PENGASSAN on the other.

The study has conducted follow-up interviews on the questionnaire findings. The aim of the interview was to discover the reasons for the existence of significant

differences and how to resolve them. The 12 chosen interviewees mentioned the reasons why stakeholders differed in their opinions with regards to the state-of-the-art IS adoption by the INOCs. The study discovered the reasons for the existence of significant differences which comprise of: variation in the availability of resources; differences in the level of knowledge between practice and theory; variations in companies' sizes; differences in financial strength; lack of academic research on the INOCs; differences of opinion between loyalists and critics; lack of sharing of relevant information and useful knowledge on IS adoption; and level of investment.

9.3.5 Resolving the significant differences between the groups of stakeholders

The study has discovered and contributed to knowledge by identifying the ways and solutions towards resolving the significant differences between the groups of stakeholders. These ways-out and solutions are identified from the responses of the chosen interviewees.

The ways-out and solutions were: training and retraining of staff; intercompany information and knowledge sharing; adequate investment in state-of-the-art IS; discussion forums for the stakeholders; and meetings and conferences on state-of-the-art IS adoption. These solutions are indeed relevant in resolving differences between the groups of stakeholders of Nigerian INOCs. This is due to the fact that, the study has discovered that, the existence of significant differences between the groups of stakeholders was among the factors impeding the progress and development of the INOCs as in Chapter 8, Section 8.3.4 of this thesis. This has also achieved objective (iv) of the study as in Section 9.2.1.1.7 of this chapter.

Furthermore, the study has also discovered that there is an urgent need to adopt state-of-the-art IS by the INOCs. This will improve the performance and safety of the workers as in Chapter 5, Section 5.7.3.6 of this thesis.

9.3.6 Development of technology barrier model

In the process of undertaking this study, various frameworks and models developed by other researchers were reviewed one after the other and analysed accordingly (for example: Lawrence & Tar, 2010; Kapurubandara & Lawson, 2008). Additionally, after identifying the strengths and weaknesses of the previous models, this study developed a technology barrier model for INOCs in Nigeria and other developing countries.

The integration or development of this model is a great contribution to knowledge not only to the INOCs but also to researchers and analysts. There are many models developed by other researchers, but their greatest weaknesses lied in the absence of some elements, such as environmental challenges and maintenance that are significant barriers to ICT or IS adoption in developing nations, Nigeria inclusive.

However, this study argues that, the weaknesses of the model were in addressing the external barriers to ICT adoption in developing countries (see for example: Lawrence & Tar, 2010; Kapurubandara & Lawson, 2007). Some of the significant barriers that impede IS adoption in developing countries which has been discovered by this study include: some government policies; incentives; and above all, environmental factors, such as corruption and insecurity.

After a critical review of ICT adoption, acceptance, diffusion and barrier models, this study appreciated a significant idea from Kapurunbandara and Lawson's model (2008) and developed a new model as in Chapter 5, Section 5.8 of this thesis that can be applied to local/independent oil companies of developing countries. The developed model is one of the noblest contributions of this study to knowledge.

9.3.7 Application of the developed technology barrier model

The study has also contributed to knowledge by applying the developed model to the Nigerian INOCs. Based on this research's knowledge, prior to this study, neither the technology barrier model nor the conceptual barrier to adoption model has ever been applied to Nigerian INOCs in any study with regard to upstream IS adoption.

This study has successfully piloted its developed model as in Chapter 5, Section 5.8 of this thesis and applied it to Nigerian INOCs in order to assess the significant barriers to the state-of-the-art IS adoption. The model can also be applied to the local oil companies of developing nations.

9.3.8 Methodological contribution

This study has also contributed to knowledge through methodological contribution. It has studied all the government policies and all the components of IS used by INOCs of Nigeria which is the first of its kind. It was a noble approach; because no study in the past has addressed the sector with this scope and in this aspect.

The study has also developed and proposed a foundation for investigating oil companies of developing nations by starting with the interview survey, as a result of

inadequate and irrelevant literature or peculiar situations of different countries that require a special approach and subsequently, build on the findings of the questionnaire survey. Then follow-up interviews were conducted and finally triangulated.

Also as part of methodological contribution, before the conduct of the interviews of this study, an algorithm was designed, developed and adopted based on the argument of previous researchers who recommended the procedure (Geri & Geri, 2011; Mabin & Balderstone, 2003; Goldratt & Cox, 1986).

Algorithm development for analysing interview-survey findings is indeed a contribution to knowledge by this study. The algorithm has been developed and piloted based on qualitative content analysis. In addition, it has seven-steps that are looped until the final variable of interview variables or codes is completed.

In addition, the study has also piloted the algorithm and applied it successfully to the study as in Chapter 6, Section 6.5.1.10 of this thesis. The algorithm has been applied to the interview analysis of this thesis.

9.4 Conclusion

The chapter has presented the findings of the study. These findings include: the unavailability of the state-of-the-art IS; the unavailability of the state-of-the-art online monitoring systems in the Nigerian INOCs; the unavailability of effective state-of-the-art software for exploration and production; and the unavailability of the state-of-the-art hardware.

Furthermore, the chapter has also answered all the research questions and achieved all the objectives of the study. In addition, the significant barriers to the state-of-the-art IS by Nigerian INOCs were also discovered and presented. These significant barreirs include: cost of most expensive ICT resources; skills in terms of quality and quantity; managerial attitude; some inconsistency of government policy; lack of government incentives; corruption; and insecurity.

Additionally, the original contribution to knowledge of this study has also been analysed and presented in this chapter. These contributions include: providing record of upstream IS in Nigerian INOCs; discovery of significant barriers; reasons for the existence of significant differences between the stakeholders of the sector; how to resolve the significant differences; development of technology barrier model;

application of the model; and designing and algorithm for qualitative analysis. The chapter is followed by Chapter 10, which presents the summary, recommendations and conclusion.

CHAPTER TEN

Summary, Recommendations and Conclusion

10.1 Introduction

The thesis has explored whether Nigerian INOCs has adopted state-of-the-art IS, and if not, to discover the significant barriers that limit the adoption. The research was highly motivated because of the underproduction of Nigerian INOCs in oil E&P in spite of their strength in terms of numerical number and government gesture which allocated oil fields to them (Allison-Madueke, 2013; Adeniyi, 2013; Shosanya, 2013). Unfortunately, as of now, these INOCs produce an approximate maximum amount of 11% of the total oil produced in the country (Adeniyi, 2013; Shosanya, 2013).

The methodological approach employed and adapted by the study in order to realise and achieve the aim and objectives of the research includes: i) an extensive and intensive review of relevant literature on the state-of-the-art IS adoption used by multinational oil companies and significant barriers and constraints that impede or limit the adoption of state-of-the-art IS in developing countries, Nigeria inclusive (Chapter 2, 3 and 4); ii) an in-depth review and critical analysis of theoretical frameworks/models that have been developed by other researchers as well as an interview, followed by an analytical discussion and presentation on the methodology of the research (Chapter 5 and 6); iii) analysis of the primary data collected through interviews, a questionnaire survey and follow-up interviews (Chapter 5, Section 5.7 and Chapter 7 and 8); and iv) major findings, which includes summary of the study, original contributions to knowledge are all presented in Chapter 9, while recommendations to the government, researchers and other stakeholders of the Nigerian INOCs and conclusion are presented in Chapter 10.

10.2 Recommendations for Nigeria's government

Looking at the responses of the research participants based on the data generated through interview- and questionnaire-survey, the study proposed some recommendations for Nigeria's government in tackling the external factors that limit

the adoption of state-of-the-art IS used by Nigerian INOCs. The recommendations were articulated and proposed after an extensive review of government policies and laws towards INOCs as the objective (v) of the study. The recommendations are discussed here.

10.2.1 Formulation of a policy towards the adoption of state-of-the-art IS

Besides the local content policy of Nigeria's government, there is the need for another policy for INOCs towards adopting state-of-the-art ICT resources. This will definitely and undoubtedly increase operational and performance efficiency.

With even the formulation of local content law, INOCs and other institutions hardly patronise products that are produced locally. However, not all the ICT facilities that were imported into the country are of state-of-the-art quality. Therefore, as an alternative to a local product, the development of a policy that motivates the adoption of foreign state-of-the-art ICT resources for INOCs will definitely help in their integration to world-class standard.

10.2.2 Reformulation of local content policy

The local content policy should be reformulated to urge the indigenous manufacturers to produce state-of-the-art ICT resources. However, this is difficult as of now with their weakness as regards indigenous manufacturers as discussed in Chapter 7, Section 7.5.4 of this thesis. However, the reformulation of local content policy will go a long way in compelling the indigenous manufacturers and producers to establish an international partnership with other manufacturers in developed nations towards the production and management of state-of-the-art technology resources.

Similarly, this has become necessary due to the fact that, Nigeria's government urges and encourages INOCs to patronise indigenous products while the indigenous manufacturers are incapable of producing and manufacturing state-of-the-art resources for E&P as in Chapter 8, Section 8.5.4 of this thesis. Perhaps, the best approach should start by urging the indigenous manufacturers to produce top-class resources before urging the INOCs to patronise them. Indeed, it is impossible to patronise what is not available.

The reformulation of local content policy should begin by compelling the indigenous manufacturers to produce state-of-the-art human and material resources for

indigenous companies. Then if this is achieved, INOCs will subsequently be urged to patronise them.

10.2.3 Appointment based on competency

The Government and owners should appoint managers and senior officers in national oil companies and other relevant oil boards and agencies based on competency and capability. In contemporary Nigeria, people were mostly appointed to manage oil institutions based on their relationship mostly with the employers, without considering their pedigree, academic knowledge, experience or relevance to the oil and gas sector.

There are many Nigerian experts in diaspora who, if invited and appointed by Nigeria's government to decision-making positions, will definitely integrate and elevate indigenous companies. Development and good management INOCs depends largely on the expertise and integrity of those who manage them. Therefore, this study highly recommends the need to appoint people based on their integrity, academic knowledge, expertise and competency.

10.2.4 Establishment of skill development centres

Considering Nigeria's proven reserves, and the large number of INOCs and oil workers, there is an urgent need to develop modern skill development centres in strategic places within the country. This will not be a duplication of effort with petroleum colleges and Federal University of Petroleum resources of Warri because these colleges and universities produced petroleum workers while the skill development centres will be responsible for imparting modern skill and technical knowledge to various oil workers of INOCs. The centres should be maintained through international partnerships with other world-class institutions of developed nations that excel in exploration and production activities through the adoption of state-of-the-art ICT resources.

The quality and quantity of skill development were significant barriers to state-of-the-art IS adoption by Nigerian INOCs as discovered by empirical investigation as in Chapter 7, Section 7.5.2 of this thesis. If these centres are established as recommended by the study, this will go a long way towards eliminating these significant barriers, particularly in terms of quality and technical expertise.

10.2.5 Integration of NETCO to world-class status

NETCO is a subsidiary of NNPC which is owned by Nigeria's government (NNPC, 2006). The NETCO has been established to produce state-of-the-art technology for Nigerian INOCs. Unfortunately, due to inadequate technical knowledge and other reasons, NETCO cannot produce the required state-of-the-art technology and services as discovered through empirical investigation as in Chapter 7, Section 7.5.7 of this thesis.

The study therefore recommends the need to integrate NETCO and establish partnerships internationally with other world-class companies so as to assist, train and guide NETCO towards successful analysis, design and implementation of its project. This is necessary if the manufacture and production of state-of-the-art technology and services is to be achieved.

10.2.6 Government support initiative

Due to the dilapidated situation of Nigerian INOCs as stated by the Governor of CBN (Sanusi, 2011), there is an urgent need for government motivation towards their technological advancement and maintenance. Government support will definitely help towards technological advancement of the sector.

Government support can have various dimensions and perspectives. In a situation where indigenous human and material resources are not available in state-of-the-art quality, the government should motivate indigenous resources to look for state-of-the-art quality elsewhere. These incentives include, but are not limited to, import duty waiver, adequate motivation of government towards state-of-the-art ICT resources and sufficient motivation towards international partnerships.

10.2.7 War against corruption

Corruption has been discovered as the most significant barrier to adoption of state-of-the-art IS by Nigerian INOCs. Considering the endemic corruption that is destroying the country, some writers have even considered it as something that has already become "official" in Nigeria as in Chapter 4, Section 4. 6.1 of this thesis.

The recent petroleum task force led by Nuhu Ribadu which submitted its report in August 2012 to the president of Nigeria, is a clear testimony of how corruption completely consumed resources that had been dedicated mainly for the industrialisation of the indigenous oil sector and Nigeria in general. Similarly, corrupt

practices must be fought in Nigerian oil sector before attaining any substantial technological advancement and development.

There is a need to establish an independent commission for monitoring and investigating fraud and corrupt practices in the indigenous oil sector. This will not be a duplication of the Economic and Financial Crimes Commission (EFCC) and other similar commission. Looking at the magnitude of corruption in Nigeria there is a need for more effort to fight and address it. The proposed commission should be shouldered with the responsibility of investigating financial crimes and fraud in oil sector only and it can collaborate with EFCC and other relevant organisations where the need arises.

10.2.8 Addressing security challenges

Security challenges are damaging the bright future of Nigeria (Ogundiya, 2009; Ogundele, 2008). They emphasised that, insecurity is threatening the development and industrialisation of the country and its companies. Economic activities are always decreasing and diminishing as a result of crises, kidnappings and robberies. However, prior to this study, the negative effect of insecurity on the adoption of state-of-the-art IS by Nigerian INOCs was not investigated. According to this study's findings, security challenge has been the second most significant barrier to the adoption of state-of-the-art IS by the INOCs.

The study recommends to the government the need to improve the security of lives and property. If stability is achieved, technological advancement will also be attained. Investors avoid places of instability for fear of destruction of their lives and property (Ogundiya, 2009; Mandani, 2004). Stability must be improved and maintained, while security threats to lives and property in the Niger-Delta region and other parts of Nigeria must be addressed accordingly. Adequate security personnel must also be provided for oil workers at home and on the oil site.

10.3 Recommendations for Nigerian INOCs

Considering the responses generated from the research participants through interview- and questionnaire-survey as well as follow-up interviews, the study proposed some recommendations for Nigerian INOCs in tackling the internal factors that limit the adoption of state-of-the-art IS for E&P. The recommendations were formulated after an extensive review and analysis of their responses. The recommendations are:

10.3.1 Provision of sufficient investment

Nigerian investors hardly invest sufficient resources into their oil and gas investments. Some of them have established their companies for recognition and other international connections not for direct economic gains through upstream activities as discovered by Chapter 5, Section 5.7.3 of this thesis. However, the main benefit of recognition and international connections is to generate economic resources through other sources. Similarly, practical knowledge and cost benefit analysis have established that, substantial investment in E&P will generate sufficient resources for the investors.

Therefore, the study recommends to Nigerian INOCs to invest sufficient resources to promote their companies to world-class standard and improve their performance. Furthermore, some of the state-of-the-art ICT resources are costly and there is a need for huge investment to deploy and adopt them. These include state-of-the-art SCADA systems, state-of-the-art real-time online monitoring systems and their maintenance. Respondents among the stakeholders have outlined the cost of some expensive state-of-the-art ICT resources as being a significant barrier to the adoption of state-of-the-art IS by Nigerian INOCs. Therefore, the study recommends huge investment by Nigerian investors.

10.3.2 Improving skill development of oil workers

The respondents who participated in the research have outlined staff skill development as one of the major barriers to the adoption of state-of-the-art IS by Nigerian INOCs. The challenge with skill development has two dimensions- the dimension of quality of skill development and the dimension of its quantity.

Staff skill development is recommended for the technical and managerial staff of Nigerian INOCs. The problem of inadequate technical and relevant expertise must also be addressed by the government of Nigeria and the management of INOCs. Similarly, inadequate access to E&P training programmes has also been identified as a significant barrier by the stakeholders.

Therefore, the study recommends improving the quality of skill development by sponsoring oil workers to attend E&P training courses. In addition, there is an urgent need to address the problem of quantity of skill development by employing and recruiting more technical staff. Furthermore, the study recommends addressing the issues of inadequate technical expertise, inadequate relevant expertise and

inadequate access to E&P training programmes by collaboration with world-class international institutions towards training indigenous oil workers on modern technical, relevant and upstream operations.

10.3.3 Addressing managerial ineffectiveness

There are many shortcomings on the part of managerial cadre of Nigerian INOCs with respect to their technological advancement. The evidence which emerged from the empirical investigations of the study have clearly indicated limitations of management as a significant barrier that limit the adoption of state-of-the-art IS by Nigerian INOCs.

The study recommends addressing the challenges of: managerial interest; managerial knowledge; managerial dynamism; managerial age bracket; managerial ability; managerial willingness; managerial ICT-oriented; and proper governance structure. Similarly, those in management positions should be educated and enlightened about the essentiality and importance of adopting state-of-the-art IS, for upstream operations. This will definitely improve operational and performance efficiency of their companies.

10.3.4 Eradicating internal corrupt practices

Internal corrupt practices and fraud exist within companies. Fraud exists sometimes between one officer and another, particularly between senior officers of a company (Sachs, 2007; Ayobolu, 2006). This is what can be called "intra-company corruption" and can also be addressed internally as in Chapter 4 section 4.6.1 of this thesis.

There is urgent need for oil companies to have special units that deal with internal corruption, misappropriation of funds and fraud. This unit as recommended by the study should be different from the "window units" that were previously found in government institutions and ministries that were mostly toothless and inefficient in fighting financial crimes and frauds. Misplacement of priority also needs to be monitored and controlled by the proposed "Anti-Corruption unit".

10.3.5 Improving the safety of ICT skill experts and other oil workers

Insecurity and instability are also among the significant barriers that limit the adoption of state-of-the-art IS by Nigerian INOCs. Not only expatriates, even Nigerian experts in diaspora, are unwilling to return and serve their country due to security challenges (Amaraegbu, 2011; Ogundele, 2008).

The study therefore recommends improving the safety and general living conditions of ICT skill experts and all other oil workers at home and on the oil site. This arrangement can be done by the management of the INOCs. If the safety of workers is improved, then retaining and recruiting experts will be relatively easy.

10.3.6 In-house deployment of upstream IS

The study recommends in-house deployment of upstream IS by Nigerian INOCs. Respondents from research participants indicated the existence of outsourcing IS by INOCs which is also not efficient due to its weaknesses as discovered in Chapter 5, Section 5.7.3.6 of this thesis.

In-sourcing or in-house adoption of upstream IS must be deployed for the sake of efficiency, expertise and privacy of the companies. Too much reliance on outsourcing may lead to losing workers' skills and technical expertise.

10.4 Theoretical implications

This study is the first of its kind to investigate the adoption of upstream IS used by Nigerian INOCs. Prior to this study, there was no research that empirically investigated the situation of state IS used by Nigerian INOCs.

The research has established that the adoption of state-of-the-art IS increases performance of upstream operations. In addition, the research also discovered that, using state-of-the-art ICT resources and supporting facilities, SCADA systems is integrated to be part of state-of-the-art IS which also gives real-time online monitoring systems for E&P activities. However, the theoretical implication is limited, since the research is an applied one.

10.5 Limitations of the study

It is the belief of the researcher that the findings drawn from interviews, the questionnaire-survey and the follow-up interviews were able to sufficiently and adequately answer the research question of the study. Furthermore, the aim and objectives of the study have also been achieved accordingly.

However, the study has some empirical, theoretical and methodological limitations that need to be stated. The study investigated only the upstream IS without investigating downstream IS adoption.

Furthermore, on the adequacy of the questions in the questionnaire, the questionnaire started by reviewing a little literature in the beginning of every section. That is indeed a limitation which may lead to bias. However, the study was compelled to do that as a result of suggestions from experts during pilot study as discussed in Chapter 7, Section 7.2 of this thesis. Because many experts suggested the need of reviewing a small literature in the beginning of every section for two reasons: 1) the respondents need a guide, because this is the first empirical investigation with regard to IS adoption by Nigerian INOCs; and 2) the questions cannot be understood to many respondents without bringing to them the findings of other countries. Therefore, the study admitted that, reviewing the small literature at the beginning of every section of the questionnaire is a limitation that can lead to bias.

Similarly, there are only 38 technical questions, beside demographic data. The number of questions is relatively small, which is indeed a limitation. However, the 38 questions covered all the areas of significant barriers to state-of-the-art IS adoption in Nigerian INOCs. Similarly, being this study adopted both qualitative and quantitative methods; the limitation of the number of questions on the questionnaire is complemented by the qualitative method of the study.

In addition, the data generated largely depended on the opinions and views of the chosen stakeholders who participated in the study. Besides the critical review of relevant stakeholders before selecting the chosen participants as in Chapter 6 as well as checking of bias that was conducted in Chapter 8, there is no way to check or verify the authenticity of the participants' opinions. Similarly, with regard to theoretical framework, even though the adopted framework was integrated and justified as the most appropriate for this study, it has only captured and addressed barriers to IS adoption and the ways of resolving them. In other words, no other area of the study was addressed by the framework/model.

In addition, there is a gap in the sample of data generated through quantitative and qualitative. The quantitative data has covered more population than the qualitative one. However, the qualitative sample is justified to be sufficient relatively since its findings are consistent with the findings of the quantitative approach.

10.6 Scope for future research

It is the belief and conviction of this study that the data generated and analysed produced significant findings on the major barriers to state-of-the-art IS adoption by

Nigerian INOCs. This study is restricted to upstream operation scope only which is the most essential stream. Hence, the study has recommended and suggested other special areas for future researchers.

Firstly, the study recommends for future research, the need to investigate downstream IS adoption used by Nigerian INOCs. As the literature suggests, there was a lack of empirical investigation of the stream as well.

Secondly, developed barrier models, so far, are applied to industries and companies. This study recommends the need to apply it to public universities of Nigeria. There is limited investigation of the barriers that impedes e-learning and ICT adoption for academic and administrative activities in public universities in the country. In contrast, some private universities in the country have adopted e-learning and online communications for most of their academic and administrative activities. This study recommends for future research integration of the developed model and its application to public universities.

Thirdly, a similar study is suggested to be carried out in other African nations that started the art of exploration. These countries include Ghana, Uganda, Angola, Sudan, Libya, Niger and Chad. They all engage in exploration; however the general technological advancement of the countries is an issue to worry about.

10.7 Conclusions

The study has investigated the significant barriers that limit the adoption of the state-of-the-art IS by Nigerian INOCs. The first chapter has presented the introduction of the study. Chapters, 2, 3 and 4 reviewed the relevant literature of the study. The framework/model of the study as well as a foundation interview is discussed and presented in Chapter 5. In addition, the methodology and methods of the study are presented in Chapter 6. Similarly, Chapter 7 presents the major findings and presentation of the quantitative approach adopted through the use of questionnaire. Chapter 8 also presents the findings of the follow-up interviews which also served as member checking. Further, Chapter 9 presents the major findings and the original contribution to knowledge. The purpose of the study has been accomplished extensively. The chapter has also explicitly answered all the research questions and achieved all the objectives of the study. The noblest contributions to knowledge discovered by the study have also been presented. The study has successfully addressed all the aims, objectives and research questions formulated and developed

for the research. In addition, what was already known through the investigation of other researchers were critically acknowledged, reviewed and analysed.

Further, this chapter (Chapter 10) has summarised the empirical investigations conducted by this study. In addition, the chapter has also made recommendations to the government of Nigeria, INOCs and future researchers. The recommendations, if implemented will improve the upstream operation of the indigenous oil sector. The study concludes the thesis by this chapter.

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APPENDICES of the thesis

Appendix A: Interview Schedule of data collection for Chapter 7

1) Are you familiar with the current state of the upstream information systems used by indigenous oil companies?

2) Do, Nigerian indigenous oil companies have in-house state-of-the-art information systems for exploration and production?

3) Do Nigerian indigenous oil companies have state-of-the-art upstream software? If yes, do they renew their licenses timely and appropriately?

4) Do Nigerian indigenous oil companies have state-of-the-art hardware?

5) Do they have state-of-the-art online monitoring systems during E&P?

6) What do you think are the barrier to deploying state-of-the-art upstream information systems?

7) What do you think are the solutions?

Appendix B: Introductory letter from the supervisory team

July, 2012

.....

Dear Sir/Madam,

Introduction to Isa Ali Ibrahim

My name is Professor Alex Russell. I am Head of the Department of Management at Robert Gordon University and a professor of petroleum accounting. I very much hope that you can assist with a research project that my excellent research student, Isa Ali Ibrahim, is undertaking. We are aware of your expertise in the research areas under investigation and your input will be invaluable to us.

Please find attached a letter to you from Mr Ibrahim.

Yours sincerely

Alex Russell

Professor of Petroleum Accounting
Head of Department of Management
Aberdeen Business School
Chair of the Oil Industry Finance Association

Appendix C: Introductory letter from the researcher

July, 2012

.....

Dear Sir/Madam,

I am a research scholar based in Robert Gordon University, Aberdeen, United Kingdom. My research interest and speciality is **Computing/Information Technology**. I am particularly interested in barriers to state-of-the-art ICT resources related to Oil Companies. I attach a questionnaire relating to the upstream information systems and computing in the Nigerian Indigenous Oil Companies.

I would be very grateful if you can complete the questionnaire so that we can have the benefit of your expertise. Please, be assured that your responses will be treated in strict confidence and that your identity will not be revealed at any time. I am happy to let you have a summary of my findings in due course, should you request one. Information on completing the questionnaire can be found at the beginning of each section.

I would be glad to be contacted any time about the survey or procedures on: +44(0) 7407321123. Alternatively by email at: 1011046@rgu.ac.uk

Many thanks for your time and cooperation

Yours sincerely,

Isa Ali Ibrahim

Isa Ali Ibrahim

Appendix D: Questionnaire for data collection

Survey on Barriers to State-of-the-Art Upstream Information System Adoption in Nigerian Indigenous Oil Companies

Thank you for taking part in this survey; - please note that your responses will be kept confidential and your identity will not be disclosed.

Please note the following abbreviations:

Indigenous Oil Companies …….. (INOCs)

Nigerian National Petroleum Corporation……(NNPC)

Exploration & Production…….. (E&P)

Supervisory Control & Data Acquisition…… (SCADA)

National Engineering and Technical Company Limited….. (NETCO)

SECTION A

GENERAL INFORMATION

(Please tick the box that applies to you)

1. Where is your Working Place? **Box**

Nigerian National Petroleum Corporation (NNPC)	
Indigenous Oil Companies (INOCs)/International	
Petroleum & Natural Gas Senior Staff Association of Nigeria (PENGASSAN)	
National Engineering and Technical Company Limited (NETCO)	
Educational Institution	
Computer Association of Nigeria/Cisco Alumni	

2. What is your role in the company? **Box**

General Manager/Engineering Manager	
Engineers/Maintenance Technicians	
IT Manager/Computer Scientist/ Programmer	
Exploration & Production Technologist	
Other (kindly specify)	

SECTION B

Cost of Resources

Cost of software, information systems, training, maintenance and hardware resources have all been identified as barriers to ICT adoption in South Korea and Sri Lanka (Lee & Kim, 2004; MIC, 2002; Locke & Cave, 2002). Please indicate the extent of your agreement on whether the following statements relating to the cost of ICT are barriers to state-of-the-art ICT adoption by indigenous oil companies in Nigeria.

1	2	3	4	5
Strongly Disagree (SD)	Disagree (D)	Neutral (N)	Agree (A)	Strongly Agree (SA)

	STATEMENT	SD 1	D 2	N 3	A 4	SA 5
a	Cost of state-of-the-art ICT infrastructure.					
b	Cost of purchasing new state-of-the-art E&P software licenses.					
c	Cost of renewing state-of-the-art E&P software licenses.					
d	Cost of state-of-the-art hardware gadgets.					
e	Cost of state-of-the-art online monitoring systems.					
g	Cost of maintenance of state-of-the-art online monitoring systems.					
h	Cost of state-of-the-art SCADA systems.					
i	Cost of state-of-the-art telephone support systems.					
j	Cost of state-of-the-art 3-D seismic capability.					

SECTION C

Skill

Shortage of appropriate training programmes and inadequate relevant expertise have all been identified as barriers to ICT adoption in developing countries, including South Korea, Pakistan, Iran and Malaysia (MIC, 2002; Abell & Lim, 1996; Locke & Cave, 2002). Please indicate the extent of your agreement on whether the following statements relating to skills are barriers to state-of-the-art ICT adoption by indigenous oil companies in Nigeria.

1	2	3	4	5
Strongly Disagree (SD)	Disagree (D)	Neutral (N)	Agree (A)	Strongly Agree (SA)

	STATEMENT	SD 1	D 2	N 3	A 4	SA 5
A	Quality of skill development.					
B	Quantity of skill development.					
C	Inadequate technical expertise.					
D	Inadequate relevant expertise.					
E	Inadequate access to E&P training programmes.					

SECTION D

Managerial Attitude

The attitude of top management has played a vital and significant role towards ICT adoption in organisations, including Brazilian, Malaysian and Saudi Arabian organisations (Grover, 1993; Yap *et al,* 1992 & Beatty *et al*, 2001). The authors also identified managerial interest, knowledge, age and culture as some of the barriers to ICT adoption in organisations. Please indicate the extent of your agreement on whether the following statements relating to managerial attitude are barriers to state-of-the-art ICT adoption by indigenous oil companies in Nigeria.

1	2	3	4	5
Strongly Disagree (SD)	Disagree (D)	Neutral (N)	Agree (A)	Strongly Agree (SA)

	STATEMENT	SD 1	D 2	N 3	A 4	SA 5
A	Managerial interest is significant to ICT adoption.					
B	Managerial knowledge is significant to ICT adoption.					
C	Managerial dynamism is significant to ICT adoption.					
D	Managerial age bracket is significant to ICT adoption.					
E	Managerial ability towards establishing international partnerships.					
F	Managerial willingness towards establishing international partnerships.					
G	Managerial ICT-oriented culture is significant to ICT adoption.					
H	Lack of proper governance structure is significant to ICT adoption.					

SECTION E

Government Policy

One of the Government policy objectives on local content was the value addition to the Nigerian economy through the utilisation of human and material resources for the provision of goods and services to the petroleum industry" (NNPC, 2005). Please indicate the extent of your agreement on whether the following statements relating to local content policy of the government are barriers to state-of-the-art ICT adoption by indigenous oil companies in Nigeria.

1	2	3	4	5
Strongly Disagree (SD)	Disagree (D)	Neutral (N)	Agree (A)	Strongly Agree (SA)

	STATEMENT	SD 1	D 2	N 3	A 4	SA 5
A	The policy objectives of local content.					
B	Utilisation of indigenous human resources by INOCs.					
C	Utilisation of indigenous material resources by INOCs.					
D	Directive to NETCO to produce state-of-the-art indigenous technology for oil and gas sector.					
E	NETCO's inability to attract international partnerships.					

SECTION F

Government Incentives

"When evaluating bids for projects, all project promoters and operators shall consider the Nigerian content and the one having the highest content of local will be considered, provided the Nigerian content in the selected bid is at least 5% higher than its nearest competitor (NNPC, 2005). Please indicate the extent of your agreement on whether the following statements relating to government incentives are barriers to state-of-the-art ICT adoption by indigenous oil companies in Nigeria.

1	2	3	4	5
Strongly Disagree (SD)	Disagree (D)	Neutral (N)	Agree (A)	Strongly Agree (SA)

	STATEMENT	SD 1	D 2	N 3	A 4	SA 5
a	Incentives integrated into local content policy of government.					
b	Lack of import duty waiver on state-of-the-art ICT infrastructure.					
c	Inadequate motivation of government incentives towards state-of-the-art ICT adoption.					
d	Absent of government incentives on adoption of up-to-date international material resources.					
e	Lack of government incentives towards international partnerships.					

SECTION G

Environmental Factors

Many writers have revealed that corruption is the greatest threat to the country's democracy, industrialisation and socio-economic development. In addition, there are security issues security issues in part of Nigeria and specifically within Niger-Delta region (Chiluwa, 2011; Ogundele, 2008; Amaraegbu, 2011). Please indicate the extent of your agreement on whether the following statements relating to environmental factors are barriers to state-of-the-art ICT adoption by indigenous oil companies in Nigeria.

1	2	3	4	5
Strongly Disagree (SD)	Disagree (D)	Neutral (N)	Agree (A)	Strongly Agree (SA)

	STATEMENT	D 1	D 2	N 3	A 4	SA 5
A	Effect of corruption in the Nigerian oil and gas sector.					
B	Effect of corruption on the availability of technical expertise.					
C	Effect of corruption on misuse of funds allocated to state-of-the-art ICT adoption.					
D	Effect of insecurity in general within Nigeria.					
E	Effect of security threats to lives in the Niger-Delta region.					
F	Effect of security threats to property in the Niger-Delta oil region.					

SECTION H

ADDITIONAL INFORMATION

Would you be willing to be contacted for any follow-up questions that may arise?

Yes

No

If your answer was yes, please kindly fill in your contact details below:

Company Name (Optional)……..

Your Name……..

E-mail &/or Phone number ……..

Thank you very much for your time and interest

Appendix E: Follow-up Interview Schedule of Chapter 9

1) Which groups of stakeholders from the following do you expect to differ significantly in their perception on the state-of-the-art information systems adoption by Nigerian INOCs?

   Nigerian National Petroleum Company (NNPC)

   Indigenous Oil Companies (INOCs)

   National Engineering Technical Company (NETCO)

   Petroleum and Natural Gas Senior Staff Association of Nigeria (PENGASSAN),

   Nigerian Computer Society (NCS)/ITAN
   Higher institutions

2) In my study, I have found significant differences between some groups of stakeholders. These are:

i) INOCs differed significantly with educational institutions 15 times
ii) NNPC also differed significantly with educational institutions 14 times
iii) INOCs also differed significantly with PENGASSAN 10 times

What do you think is responsible for that?

3) Do you think the significant differences that existed between them can be a significant obstacle to state-of-the-art IS by Nigerian INOCs?

4) What do you think will be the way out from the significant differences that existed between the various groups of stakeholders?

5) As an expert in this field do you recommend the adoption of adequate state-of-the-art IS by Nigerian INOCs?

Appendix F: Approval for attaching a conference paper and an article

From: Damir Tokic <tokicd@macrotheme.com>
Sent: 15 November 2013 14:40
To: ISA IBRAHIM (1011046)
Subject: Re: SEEKING FOR A PERMISSION AND APPROVAL

Hello Isa,
Request granted. Thank you.
Sure, you can submit your paper.

Best,
Damir

Dr. Damir Tokic

Editor, The Macrotheme Review

From: ISA IBRAHIM (1011046) <i.ali-ibrahim@rgu.ac.uk>
To: "tokicd@macrotheme.com" <tokicd@macrotheme.com>
Sent: Friday, November 15, 2013 1:39 PM
Subject: SEEKING FOR A PERMISSION

Dear Chief Editor,

I am ISA ALI IBRAHIM of Robert Gordon University, Aberdeen UK. I attended your International conference which held in Paris between 27-28 December, 2012. You also published the abstract that emerged from my doctoral study in your proceedings. In addition, I also published an article paper from my PhD thesis in your famous Macrotheme review journal. My paper was published as the led paper of your winter January 2013. All these emerged from my PhD thesis.

Further, I am now approaching the end of my PhD. I wish to seek your permission to attach my presentation and article that you published as an appendix of my PhD thesis as an evidence of peer-review of my research.

Sir, I will appreciate your reply on time granting me the permission to attach them as appendix. And if I want to publish another article in journal can I send it to you for peer review?

Many thanks

Isa Ali Ibrahim

Appendix G

The Macrotheme Review
A multidisciplinary journal of global trends

Dr. Damir Tokic
Editor, Professor of Finance
ESC Rennes International School of Business
2, rue Robert d'Arbissel – CS 76522
35065 Rennes, France
33 (0)2 99 33 48 64 office
33 (0)6 31 66 32 00 mobile – preferred

October 2nd, 2012

Mr. Isa Ali Ibrahim
Robert Gordon University, Aberdeen. UK

Subject: Letter of Acceptance for the Business and Social Science Research Conference: Paris 2012

Dear Mr Isa Ali Ibrahim,

I am pleased to inform you that your abstract titled: "An empirical investigation into managerial attitude as a barrier to state-of-the-art upstream information systems adoption by Nigerian indigenous oil companies" has been peer-reviewed and accepted for an oral presentation at the Business and Social Science Research Conference: Paris 2012 in Paris, France, which will be held on December 27-28th, 2012.

Please complete your registration by visiting our payments webpage (Nov 1st , 2012 is the deadline):http://macrotheme.com/payments. The conference fees are EUR 350 per attending author, EUR 300 for students, and EUR 150 for attending co-authors.

The conference venue is: ESPACE VOCATION PARIS HAUSSMAN SAINT-LAZARE
92, rue Saint-Lazare 75009 Paris. All conference participants are flexible in arranging for their own lodging in Paris depending on their needs, taste, and budget.

The conference dress code is business casual. Our presentation rooms will be fully equipped. All presentations should be between 15-20 minutes long.

All full articles will be considered for the publication in *The Macrotheme Review* or *The Macrotheme Report*, in which case the full articles are due by Nov 5th. Abstract-only submissions will be published in the conference proceedings.

Again, I am pleased to welcome you to the Business and Social Science Research Conference: Paris 2012 and looking forward to your presentation.

Best Regards,
Dr. Damir TOKIC
The Editor, editor@macrotheme.com

The Macrotheme Conference
Business and Social Science
Paris 2012

The Macrotheme Review
A multidisciplinary journal of global trends

Certificate of Participation

Isa Ali Ibrahim
Robert Gordon University, UK

Signature,

Dr. Damir Tokic
The Macrotheme Review, Editor

Paris, France
December 27-28, 2012

ESPACE VOCATION PARIS HAUSSMAN
SAINT-LAZARE 92, Rue Saint-Lazare 75009 Paris

Appendix H

January 2013 Volume 2 Issue 1

The Macrotheme Review

A multidisciplinary journal of global macro trends

An Empirical Investigation into Managerial Attitude as a Barrier to Adoption of State-of-the-art Upstream Information Systems by Nigerian Indigenous Oil Companies

Isa Ali Ibrahim

Robert Gordon University, United Kingdom i.ali-ibrahim@rgu.ac.uk

Abstract

This study critically evaluates managerial attitude as a significant barrier to state-of-the- art upstream information systems adoption by Nigerian indigenous oil companies. Prior literature indicates lack of research on Information and Telecommunication Technology (ICT) infrastructure with respect to Nigerian indigenous oil and gas industry. However, the industry has been considered as the country's mainstay, because it accounts for almost 95 per cent of export revenues. The indigenous oil companies produce only 1 per cent of the total quantity of oil being produced in the country; this may be as a result of many factors, including the type of information systems used by indigenous oil companies. The main objective of the research is to identify the impact of managerial attitude as a significant barrier to upstream information systems adoption by Nigerian indigenous oil companies in their oil and gas exploration and production activities. Furthermore, survey reveals that the multinational oil companies have increased their expertise in using latest technological gadgets for their exploration and production, contrary to their indigenous counterparts. Suitable research tools were used to test the hypothesis. Data were collected and analysed through retrieving 140 valid questionnaires from various stakeholders in indigenous oil companies and ICT experts. A qualitative approach was used in data analysis; the analysis adopts objective statistical tools based on SPSS to identify the impact of managerial attitude towards state-of-the-art information systems adoption. The general opinion of respondents indicated that, they all agreed that managerial interest, knowledge, dynamism, age-bracket, ability, willingness, ICT- oriented culture and lack of proper governance structure were significant barriers to adoption of state-of-the-art information systems by Nigerian indigenous oil companies. The study suggests establishing international partnerships, efficiency, competency and motivation in Nigerian indigenous oil companies.

Keywords*: managerial attitude, information systems, upstream, indigenous oil companies and ICT*