An actor-network approach to understanding the Implementation of mobile phone-based innovations in Less Developed Countries.

A thesis submitted for the degree of Doctor of Philosophy

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ABSTRACT

This thesis aims to assess the usefulness of actor-network theory (Latour, 2005) in understanding the process of implementing mobile phone-based innovations within the broader government–led public sector in less developed countries. An examination of the literature on implementations of innovations involving mobile-phones suggests that previous studies have either focused on the social elements or the physical elements in isolation and have failed to consider how one influences the other. It is proposed that actor-network theory may be able to provide an alternative ontological perspective that bridges this social physical divide and allows the influence of the relationships between the human and the non-human elements to be taken into consideration.

In order to assess this, the thesis utilises a single case study from its inception, through development, to its eventual end. The case in question, is the implementation of a mobile phone- based information system known as MADEX. This effort, is a nation-wide project made by the federal government of Nigeria to deploy this innovation within the government-led public health sector. MADEX was designed to support a nation-wide scheme known as the Midwives Service Scheme (MSS); a public sector initiative that was set up to address the United Nations Millennium Development Goals (MDG) relating to mother and child health. The main objective of MADEX in its initial stages was to enable the routine reporting of maternal health information from primary health facilities across the country up to the national level (NPHCDA) where this information is required by public health administrators for action - that is regular and timely monitoring of key maternal and child health indicators as well as strategic planning and the setting of priorities.

The expectation was that, MADEX will bring about increased information accessibility for monitoring and planning, ensure global transparency and accountability in the area of maternal and child health statistics and promote m-health activities. An interpretive approach using qualitative methods was adopted in this research to obtain and analyse the data acquired through interviews. These

interview, were conducted with a total of about 75 participant from across the various levels of the public health system.

Whilst initially these events are narrated using a traditional chronological format, the use of such a format hides the complex nature of the relationships that enable the case under study. Actor-network theory therefore provides a means of exposing some of this complexity and as a result can be regarded as a useful methodology for understanding mobile phone innovations deployed in the public sector of LDCs. In addition, the thesis shows that the actor-network perspective allows the process of implementing mobile-phone innovations, to be considered in a manner that demonstrates the complex interdependent relationships between the physical and the social dimensions as well as the impact of non-humans in shaping this process.

ACKNOWLEDGEMENTS

shown immense generosity, selflessness and commitment to family in a manner that is indeed exemplary.

..But you are my God, and I will praise you; you are my God, and I will exalt you. I give thanks to the Lord, for he is good; and his love has no end.

Psalm 118 v. 28-29

DECLARATION

The following papers have been published as a direct result of the research discussed in this thesis:

Ezenwa, C., & Brooks, L. (2013).The introduction and use of Mobile phones in Health information Systems: A case from Nigeria. In 'proceedings of the 12th International Conference on Social Implications of Computer in Developing Countries' IFIP 9.4 Ocho Rios, Jamaica.

Ezenwa, C., & Brooks, L. (2014). Understanding the Introduction and use of a Mobile Device Supported Health Information System in Nigeria. Electronic Journal of Information Systems in Developing Countries, 62 (7) pp1-20.

ABBREVIATIONS

ANT	Actor-Network Theory
HIS	Health Information Systems
IS	Information Systems
ICT	Information and Communication Technologies
LDC	Less Developed Countries
MADEX	Mobile Application Data Exchange System
MNCH	Maternal and Neo-natal Child Health
NPHCDA	National Primary Health Care Development Agency

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Chapter 1: Introduction

1.1   Overview

This chapter serves as an introduction to this research. It introduces the research study by outlining the research questions, the research aim and objectives, the approach adopted by the researcher to help achieve the objectives. It also highlights the expected contributions of this research. This chapter concludes with an overview of the chapters to come.

This research is an examination of the process of implementing a mobile phone-based innovation within the broader government-led public health sector in Nigeria. Specifically, it examines how actor-network theory can help us better understand situations of deploying large scale mobile-phone information systems in a less developed country setting. This study looks at a particular case known as the MADEX system, a nation-wide mobile-phone information system implemented in Nigeria. The motivation to implement this system was the 4th and 5th United Nations Millennium Development Goals (MDGs) which centres on improving mother and child health.

Within the developing world, mobile phones is changing everything such as the way people conduct transaction, share and source information etc. Basically, the widespread availability of mobile phones, in conjunction with its affordances, has resulted in stimulating a new wave of optimism among development practitioners and public sector agencies in less developed countries about the potentials of this technology (Mechael et al, 2010; WHO, 2011). Specifically, within this context, mobile phones have emerged as the leading form of information and communication technology in which most development initiatives rely on, as it has succeeded where a number of other technologies such as computers and landline telephony have failed (Dodson, sterling and Bennett, 2013).

Many ICT4D scholars, have allude to the potential and benefits that can be derived from the use of this technology. Basically, considering that this technology lends itself to more than telephony, as it able to support audio and video messaging as well as the rapid collection, transmission, storage and transformation of data through text messaging (Heeks and Jagun, 2007). These has led to benefits such as timely access to data, real time monitoring of data gathered for programme activity, rapid analysis and auto-generated reporting, just to mention a few (Donner, 2009; mHealth alliance,2013). Thus the use of mobile phones especially in development sectors can bring about such benefits as listed above of which can improve processes, productivity as well as reduce cost and enrich the delivery of services rendered to citizens in LDCs, all of which could lead to huge developmental gains.

The growing recognition of the potential of this technology alongside the proliferation of mobile-phone based innovations (albeit mainly pilot efforts), across development sectors, has inspired a number of research endeavours and publications from different perspective (Gomez, Baron and Fiore-Silfvast, 2012).

Notably, a large portion of the literature on mobiles in developing countries has focused on examining the impact of this technology on people and businesses. For example, researchers have paid attention to the impact of mobiles on micro enterprises (Jagun,2012) as well as small and medium enterprises (SMEs) (Donner and Escobari 2010; Barrantes et al. 2012) while others have examined the impact of mobile on agricultural productivity (Ghandi, et al, 2009).

Aside from assessing the impact of mobile phones on economies and business, research work in the area have also paid attention to using mobile phones to empower people in rural areas (Donner,2006). Alongside this studies, some researchers have also centred their research on explaining and predicting adoption of mobile phone innovations such as mobile banking or payment systems (Luarna & Lin, 2005; Brown et al, 2003).

1.2   Research Problem

Notwithstanding the considerable efforts of previous studies, an examination of previous literature relating to mobile phone innovation in developing countries (see Chapter Two) made it possible for the researcher to identify three essential points.

First, notwithstanding the great effort exerted by the different scholars in studying different aspects of mobiles phones in less developed countries, no previous research has been conducted to explore all the actors that may have an influence on the process of implementing mobile innovations and how these actors interact with each other. In other words, past studies have largely ignored examining the role of individual actors and how their attitudes and actions affect the process of implementing mobile phone innovations.

Second, review of the literature points to an issue which is that the dominant approach of studies in the area of mobile phone adoption and use in less developed countries, is one that is techno-determinist (Donner,2008). Specifically, this techno-deterministic effect studies assumes mobile phone adoption is meant to bring about certain effects, such as development. In other words, these studies assume that technology problems can be solved by technology solutions. While this approach is a logical one, there are other essential issues that should be taken into consideration:

For instance, this approach that treats such adoption of mobile innovation as purely technical matter, overlook the fact that technology does not function in a vacuum, away from humans who operate and use it (Latour, 1999). Clarke (2003 pp.224) highlights the importance of taking people into consideration when dealing with technology, by stating the following :

"Consider, for example, what might happen if the computers containing the so-called information had no human beings to use them"

His statement above implies that technology has no impact independent of the purposes of those who would use it and the responses of those who have to work with it.

Thus, given that technology is only one part of the process (or one part of the information system, like in the case of MADEX) that produces some kind of service, and also bearing in mind that it does not function independently of the humans who interact with it or even the context in which it is situated, it can be expected that the actions and attitudes of people alongside other socio-institutional factors will also affect the process of its implementation and use within a LDC context.

Third: Aside the effort exerted by the different scholars in studying different aspects of mobile phone based innovation, no previous research has been conducted to examine the actors that may have an influence on this process as well as how these actors interact with each other. In other words, although previous studies covered different aspects that are related to mobile phone innovations, they have treated some aspects in isolation from other aspects.

Also, a review of the literature on mobile phones adoption and use in less developed countries has shown that within literature, while there has been a growing number of studies on mobile phone based innovation, these efforts have mainly reported on pilot or small scale stand-alone projects within non-government organisations and non-mainstream government or public institutions (Mehl, et al, 2013). Studies of large-scale implementation of these mobile phone innovations within mainstream government–led public sector has been limited.

Notably, more recently, there has been considerable interest among development practitioners and government in extending the use of mobile phones, by integrating it within mainstream public institutions and broadening its use towards improving service delivery processes and strengthening information systems (Wolff-Piggott, 2013) However, a shortage of robust, credible empirical evidence supporting its successful deployment and highlighting best practices is scarce. Bearing in mind that governments in less developed countries face myriad of challenges and have competing priorities, of which affects their ability to invest in innovations (WHO,2011), it is imperative that they have guidance about deploying such innovations based on credible and robust empirical work prior to making any investments.

The above gaps in current knowledge needs to be filled, by studies that adopt a different approach and perspective. In order words research work that addresses the above issues is imperative. Therefore, this research contributes in filling these gaps, in the following ways:

Firstly, this study took place in Nigeria a country that comes under the classified as a less developing country. Notably, no previous research about the implementation of mobile phone based innovation with mainstream government led public sector has been conducted in this country. The researcher chose to conduct the field work in this country because it is her home country, so there are less barriers of language, or culture. In addition, a major advantage in gaining access to the NPHCDA, the government agency that provided leadership for this study was possible for the same reason.

Secondly, this study was guided by a socio-technical approach, namely, Actor-Network Theory (ANT). This pragmatic sociology of process developed by scholars including Latour (1986, 1987, 1993, 2005), Callon (1986, 1987, 1999), and Law (1992, 1999, 2002), can be argued to be a superior framework for studying IS innovations. The proponent of this approach, calls to consider both the social (humans) and the technical (non-humans) aspects, or actors, when analysing any situation and to adopt a symmetrical approach when dealing with them, without giving priority to any of the actors. They argue that each actor has a crucial role to play in any given "network".

Thirdly, adopting ANT to be the theoretical framework guiding this study allowed the researcher to fill a major gap in knowledge. Specifically, ANT enabled the researcher to see the world in diverse ways and from different perspectives (Lee & Hassard, 1999). Consequently, ANT helped the researcher to examine the process of implementing mobile phone innovations from a different perspective. Specifically, this research shows that this process is a combination of many socio-technical aspects that emerges from the interaction between different actors. In other words, this study presents the process of implementing a mobile phone based

innovation in a LDC context as a network of heterogeneous social and technical, entities that are brought together into associations. Additionally unlike the majority of studies on mobile phone based innovations in LDC that examine pilot efforts, this study examines a large-scale implementation effort of the situation of attempting to implement mobile-phone interventions within mainstream government-led public sector. Considering that several researchers have highlighted that national-level implementation efforts are not only scarce, but there is also little known about such efforts (mHealth alliance,2013; Chib, van Velthoven, & Car, 2015). This study is a step in that direction as it has the potential to inform not just new implementation efforts but also improvements to existing implementation process, including the management of key processes and other aspects of implementation.

Having provided the background to this research and the research problem, the next section which is 1.3 will outline the aim and objectives of the research and the questions guiding this study. Closely following section 1.3 is section 1.4 which provides an introduction to the research approach adopted in this study. Section 1.5 briefly discusses the theoretical approach adopted in this study. The expected contribution of this work is presented in section 1.6 while 1.7 provides an overall structure of the thesis as well as brief summary of the chapters to come.

1.3   Research Aim and Objectives

The main aim of this research is: *to use actor network theory to better understand the process of implementing the network of a mobile-phone based information system and the outcomes that arise from such effort.*

In fulfilling this aim, the following objectives are considered important to be achieved:

RO 1: First, to unpack and understand the process of implementing large-scale mobile phone based innovations by carrying out an empirical study of an implementation effort within a LDC context.

RO 2: To identify the main actors (both human and non-human) that have an influence on the process of implementing large-scale mobile phone based innovations within a LDC context. This objective is achieved by "following the actors" (Latour, 1987) that are identified by the research participants in this study.

RO 3: To examine the enrolment of heterogeneous actors to create the network of deploying mobile phone based innovations. This objective is achieved by adopting an interpretive approach to interpret the data collected from the different stages of the field work through the lens of ANT. This theoretical approach seeks to examine the process of constructing and maintaining the MADEX

RO 4: To examine how actors in this "network" interact together.

Figure 1 below summarises the objectives of this research and how they are to be achieved in this study.

The above research aim and objectives lead to the following research questions:

RQ1   What do the theoretical resources from ANT reveal about the process of implementing MADEX within a LDCs setting?'

RQ2   What relations have emerged between humans and non-human and how do these relations enable and/or constrain their actions towards the implementation?

RQ3 What are those factors that have been found to shape the implementation process of this new initiative?
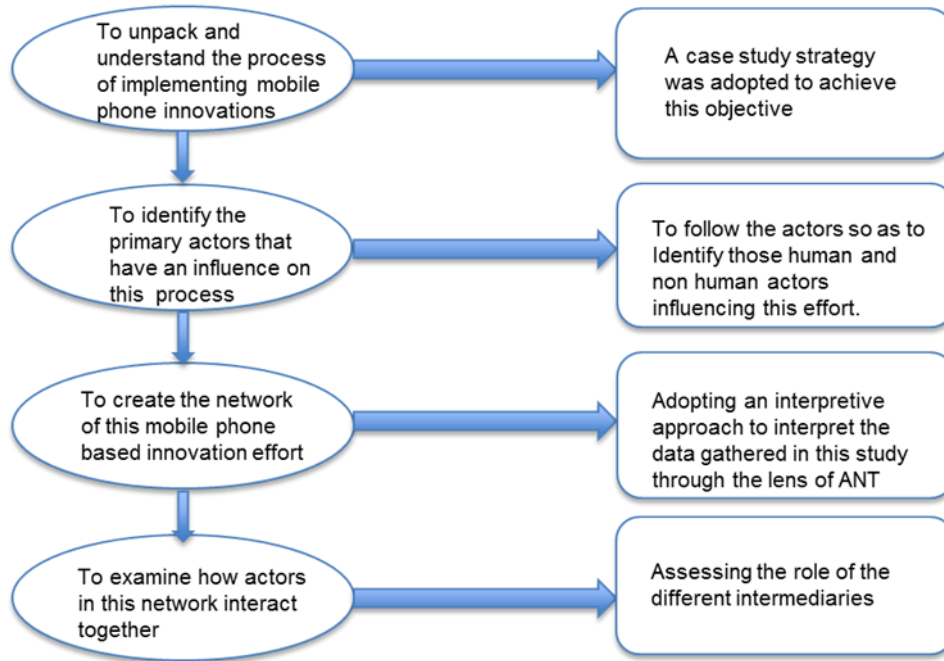
Figure 1-1 Research objective and the process through which they are achieved in this study.

1.4   Research Approach

 To effectively address the research aim and objective outlined above, a broadly interpretive approach has been adopted in this study. This approach, which has become well established in the information systems (IS) domain, has been used to study the implementation of ICT-based innovations in various contexts. This approach begins with the assumption that access to reality whether given or socially constructed is only through social constructions such as language, consciousness and shared meanings (Oates, 2006; Orlikwoski and Baroudi, 1991). The primary aim of the interpretive paradigm is to provide an understanding of contemporary phenomena through the meaning people (participants) within a given context assign to them (Walsham, 1995).

Also, since the goal of this study is to gain understanding and provide insight, the interpretive approach is the most appropriate for studying the process of implementing a mobile phone based innovation within a less developing country context. In an efforts to better understand this phenomenon within its real-life

context a case study research method was found to be well-suited for this study. Case study research is the most common qualitative method used in information systems research to describe a phenomenon as well as the real-life context in which it is occurring (Yin, 2014). The use of this method within this study, made it possible to gain understanding of the context where this mobile phone-based innovation has been introduced and the processes that have influenced and are also influenced by this effort. Another benefit derived from using the case study method for this research is that it afforded the researcher the opportunity to engage with the participants of the research context in a longitudinal manner. This approach enabled the collection of data at different stages during this project which made it possible to gain access to the complex and changing nature of the participant's actions and meanings.

The specific case that was examined is the 'MADEX project'. MADEX - a mobile phone-based health information system was introduced nationwide, to support a public sector initiative in Nigeria on maternal and child health, known as the Midwives Service Scheme (MSS). This initiative, was set up to address the United Nations Millennium Development Goals (MDG) relating to mother and child health in Nigeria - a country in the sub-Saharan African region. Considering that Nigeria has a very poor record of maternal and child health outcomes (an estimated 53,000 women and 250,000 children die annually - WHO,2012), this scheme under the leadership of the National Primary Health Care Development Agency of Nigeria (NPHCDA) - the agency responsible for co-ordinating primary healthcare activities throughout the country, was designed to address this specific developmental goal. Thus, this mobile phone-based innovation was set-up by the Nigerian government for the routine reporting of maternal, neonatal and child health (MNCH) information from primary health facilities across the country up to the national level (NPHCDA) where this information is required by public health administrators for action - that is regular and timely monitoring of key maternal and child health indicators as well as strategic planning and the setting of priorities. Thus, by introducing this intervention, the expectation was that, it will bring about increased information accessibility for monitoring and planning, ensure global transparency and accountability in the area of maternal and child health statistics and promote

m-health activities, with the overall intent being to improve maternal and child health outcomes throughout the country.

The specific data collection effort in this study constituted a combination of interviews, participant observations and document analysis. Interviews were conducted with key stakeholders at the national office of the NPHCDA and at the health facilities and local government offices at the local level. These interviews were supplemented with phone calls and emails for follow up conversations.

Observations consist of visits to the health facilities at the local level were the primary users of the mobile phones were located. Document analyses entail reviews of project reports, presentations and other materials gathered online relating to the effort under study. In order to analyse the data collected, this study employed the concept of thematic analysis. This approach is a widely recognised method used in analysing qualitative data. Basically, it is a flexible technique adopted by this research to systematically identify, organise and offer insights into patterns of meaning across data sets (Braun and Clarke, 2006). These insights were offered in relation to the research question that this study set out to address.

1.5   Theoretical Approach

The Actor network theory (ANT) was employed as the theoretical lens to help better understand this process. Within the information systems field, ANT is considered as an appropriate methodological approach, used to study processes of ICT innovations in various settings (Cordella & Shaikh, 2003).

Essentially, this socio-technical approach brings together social and technical considerations with the primary goal of understanding how the world of the social is connected within itself (Callon, 1991). Put differently, ANT has a major emphasis on showing and describing how associations are made and transformed over time (Latour, 2005). Also, unlike many other theoretical approaches used in studying efforts of this kind and treats social and technological issues as entirely

different, actor-network theory (ANT) proposes a socio-technical account where neither social nor technical positions are privileged. It shifts the focus to the inter-relatedness of both in the implementation process as the interactions and associations between actors and networks are the important thing, as actors are seen only as the sum of their interactions with other actors and networks. Basically, what this implies is that research adopting an actor-network approach, would concentrate on issues of network formation as well as investigating the human and non-human actors and the alliances and networks they create (Latour, 2005). Further, such research would focus on the negotiations that allow the network to be configured by the enrolment of both human and non-human actors.

As a theoretical approach, ANT has been recurrently applied to the study of issues around design, development and implementation of information systems innovations in healthcare settings and beyond (Whitley and Pouloudi, 2001; Cresswell et al. 2010; Doolin and McLeod, 2005; Braa et al, 2004). This theory when applied in studies of this kind, has helped to examine why some efforts have better outcomes than others. It has also helped to proffer answers as to what makes some networks more stable and others less stable or what makes some networks more durable and others less durable?

With that been said, in applying actor-network theory to examine the effort under study, no attempt is made in this study to describe the entire domain of this theory; rather it assess some of its central tenets (particularly the moments of translation), and the principle of general symmetry and applies it to interpret the stories that have emerged from the empirical work.

Before moving on to present the expected contributions of this study it is important to clarify the use of the term mobile phones, hereafter referred to as mobiles is used as an overall term describing the applications of the GSM and CDMA enabled handsets and networks used by a huge number of people on a daily basis around the world. Therefore, devices such as - laptops, older non-telephony PDAs, handheld GPS units, pagers, and a whole variety of other technologies although" mobile" in some way, are not included in this definition. Also in a similar vein, the use of the term "less developed countries" (LDC) in this study points generally to low income

countries such as Nigeria, facing desperate challenges in meeting specific development goals such as better healthcare, basic education for citizens, improved government services and reduced corruption.

Also it is important to mention that the research reported in this thesis, reflects mainly upon the social realities and events taking place at both the primary level of the Nigerian healthcare system (where mobile phones were introduced and used to capture and report data) and the national level (at the national office of the NPHCDA) were this information is being transmitted to, for continuous monitoring, action, planning and decision making.

1.6   Expected Contribution

This thesis contribution is twofold both practical and theoretical. They both relate to the domain of information systems generally and the domain of mobiles for development otherwise known as M4D.

Theoretical Contribution

This study is expected to make a theoretical contribution by the empirical examination of the implementation of mobile phone –based innovations within the broader government-led public sector using ANTs concepts. Further, the findings that emerge will add to the body of knowledge in the mobiles for Development (M4D) domain.

Practical Contribution

The findings of this study is expected to serve as guidelines and high level strategies for development practitioners and sponsors looking to implement or better manage on-going efforts of mobile phone innovation deployed in mainstream government-led public sector.

1.7   Thesis Structure

The rest of this thesis is structured as follows:

Chapter two provides an overview of the empirical context. Then it goes on to provide a critical review of the key literature influencing this study which is the relevant literature pertaining to implementing ICTs within a LDC context. It also examines the literature pertaining to mobiles in development. It highlights existing work already done and areas were more work can be done.

Chapter three discusses Actor Network Theory (ANT) the theoretical frame underpinning this study. A description of this theoretical approach including some of its key concepts adopted in this research, are presented here. This chapter ends with a discussion on some of the criticisms and limitations of Actor Network Theory.

Chapter four provides a discussion about the research philosophy and underlying assumptions that guided the way this research was conducted. It concludes by presenting the case study and introducing the social and historical background of the research setting.

Chapter five is the first empirical chapter. Here the findings from the case are presented using the theoretical concepts presented in chapter three.

Chapter six Discusses and reflects upon the findings obtained with the help of the theoretical lens - Actor-Network Theory.

Chapter seven summarises the findings of this study and presents the contribution of this study. Recommendations for future study as well as the research limitation is presented. The chapter concludes with a personal reflection of the researcher.

Chapter One	Introduction and Background to the Research
Chapter Two	Literature Review
Chapter three	Conceptual Framework
Chapter four	Research Methodology
Chapter five	Case-Study Narrative
Chapter six	Case-Study Analysis and Discussion
Chapter seven	Conclusion and Future work

Table 1-1 Thesis Structure

Chapter 2: Empirical Setting and Literature Review

"There can be no development without peace and there will only be slow development without ICTs. Hence, the need to understand and use ICTs appropriately and meaningfully to meet the Millennium Development Goals and Targets" -Usha Rani Vyasulu Reddi, Professor in Education and Director of the Centre for Human Development, Administrative Staff College of India".

2.1   Overview

In chapter one, the research motivation, the research questions and the expected contributions of the thesis was presented. In this chapter, some background information about Nigeria, which helps to describe the empirical setting of the study analysed in this thesis is provided. This contextual background also helps to understand some of the historically existing conditions of the context. The study presented in this thesis is based on empirical research carried out within the public health setting of Nigeria.

The chapter is organized in to three broader sections. In the first section, the socio-political context is described to provide an overall understanding of the background of Nigeria and the health sector where the study is set. The second section provides a review of the key literature on ICT in developing countries and for development. In the last section, the key literature on mobiles in developing countries and development is explored. This chapter will conclude with a section on the limitations of previous research work on IS innovation research. It will conclude with a discussion on how this study addresses this limitation.

2.2 Empirical Setting

This section provides an overview of the setting in which the study took place.

2.2.1 The Nigerian Context

With an approximate population of about 150 million, Nigeria is the most populous country on the African continent (World Bank 2011). It has a total area of 923,768 km, making it the thirty-second largest country in the world. It has a coastline of at least 853km and shares borders with Benin (773 km), Cameroon (1,690 km), Chad (87 km) and Niger (1,497 km). Nigeria has 36 states and a federal capital territory in Abuja. These states are divided into six geopolitical zones: North-Central, North-East, South-East, South-South, South West and North-West. There are approximately 776 Local Government Areas (LGAs) in the country with some of the smallest having less than a population of 80,000 (DfID HSRC, 2000). The country boasts of a wide array of ethnic groups, each of which has its own indigenous languages and dialects (World Bank 2011). However, while there are three main languages spoken i.e. Hausa (mostly in Northern states), Igbo (in Eastern states) and Yoruba (Western states), the national language is English and this dates far back to British colonial rule.

2.2.2 Economic Overview

According to the World Bank classification of countries, based on Gross National Income (GNI) per capita, Nigeria is ranked as a developing, low-income economy, with a Gross Domestic Product (GDP) per capita income estimated at US$1.092 (World Bank, 2011). It is also rated amongst the poorest countries in the sub-Saharan Africa region, with a ranking of 142 out of 169 countries in the Human Development Index (UNDP, 2010).

Nigeria is endowed with natural resources most notably crude oil, vast arable land for agriculture, natural gas, tin, limestone, coal etc, However, since the oil boom of the 1970s, Nigeria has neglected its strong agricultural and light manufacturing

bases in favour of an unhealthy reliance on crude oil. For example, statistics from the World Bank show that in 2000, oil and gas exports accounted for more than 98% of export earnings and about 83% of federal government revenue.

New oil wealth and the concurrent decline of other economic sectors fuelled massive migration to the cities and led to increasingly widespread poverty, especially in rural areas (LOC, 2008, the World Bank, 2014).

In recent years though, the Nigerian economy has shown continued growth at a rapid 6-8% per annum (pre-rebasing), and this growth has been driven by diversification into other sectors such as agriculture, telecommunications, and services(African Economic outlook,2015). Overall, the medium-term outlook for Nigeria is supposed to be good, assuming oil output stabilizes and oil prices remain strong. Also, fiscal authorities pursued counter-cyclical policies in 2011-2013, significantly reducing the budget deficit. Monetary policy has also been responsive and effective. Following the 2008-9 global financial crises, the Nigerian banking sector was effectively recapitalized and regulation enhanced.

However, despite its strong fundamentals, oil-rich Nigeria has been affected by inadequate power supply, lack of infrastructure, delays in the passage of legislative reforms, restrictive trade policies, an inconsistent regulatory environment, a slow and ineffective judicial system, insecurity, and institutionalised corruption which has become deeply embedded in the socio-political nature of the Nigerian society (Oshewolo, 2010). What this implies is that, economic diversification and the growth experienced have not translated into a significant decline in poverty levels - as a majority of Nigeria's citizens still live in extreme poverty. That said, the present administration of president Buhari is working to develop stronger public-private partnerships for roads, agriculture, and power, while also working hard to put measures in place to combat corruption and increase transparency in his administration.
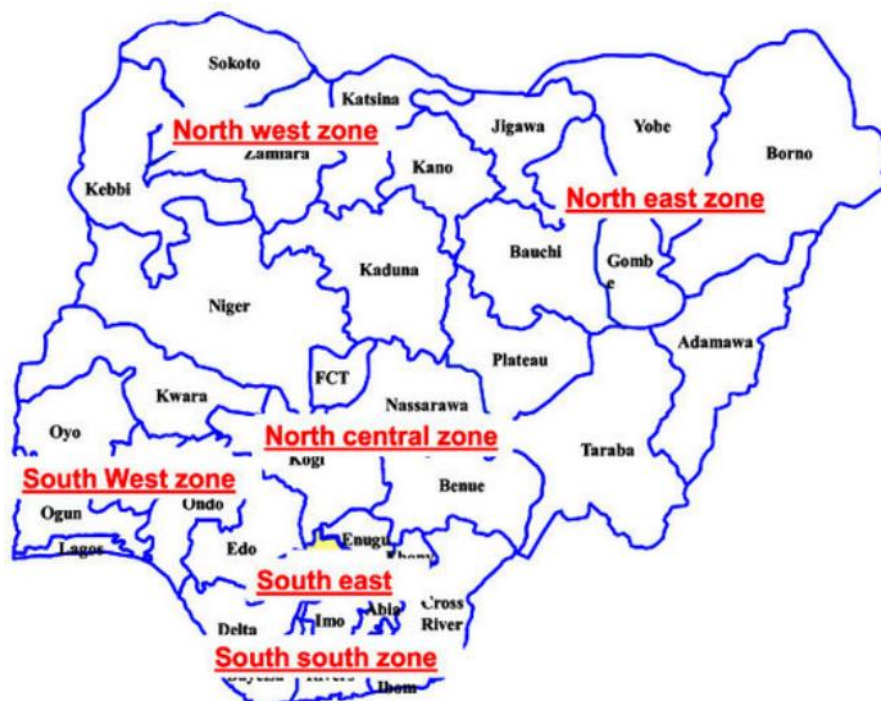
Figure 2-1: Nigeria's 36 States and the Six Geopolitical Zones (Dineen et. al. 2008)

2.2.3 Development Challenges

Like many of its less developed countries counterpart, Nigeria experiences multiple development issues ranging, from poor living conditions, poor conditions of infrastructures, inefficient provision of health care services and the prevalence of poverty - with more than 70 percent of the population still living in absolute poverty and have limited access to safe drinking water and sanitation.

In an attempt to counter this prevailing situation of poverty, the Nigerian government has implemented various poverty alleviation and Economic Recovery Program in different sectors, including healthcare. The majority of these programmes were specifically targeted at those in rural areas and their focus was to raise the country' standard of living through a variety of reforms, including macroeconomic stability, deregulation, liberalization, privatization, transparency, and accountability. Some of these programs include better life program (BLF) for rural women, National Economic Empowerment and Development Strategy

(NEEDS) aimed at citizen in rural areas and the United Nations (UN)-sponsored National Millennium Goals for Nigeria etc.

However, despite this array of programmes that appear to be laudable, poverty still remains endemic and pervasive in the country as these programmes have been criticised for lacking clearly defined policy frameworks with proper guidelines for poverty alleviation hence making it difficult for them to deliver on the intended benefit (Garba, 2006); this, is in addition to present day issues such as poor governance, high unemployment rates, distasteful looting among government officials and very importantly the continuous menace of the sect called Boko Haram (World Bank, 2016).

The rise of this terrorist group Boko Haram, over the past few years, has posed a huge threat such as no other, to the achievement of development in Nigeria. In North Eastern Nigeria, which is the main hub of Boko Haram, the actions of this group have caused millions of citizens to be displaced and dependent on government and foreign aid for assistance. Also in this region, there has been major destruction of infrastructure along with the loss of lives and impoverishment of citizens (World Bank, 2016). Consequently, a huge challenge for the present government will be the short term financing of major programs to combat this menace as well as reconstructing the North East that has been devastated by the activities of this group.

2.2.4 Political context

Taking a look at its political system, Nigeria operates a democratic system of government with one president, and a governor in each of the states.

These states are sub-divided into senatorial districts as well as constituencies, each with representatives at the law-making national assembly. Since declaring independence from Britain in October of 1960, its democratic rule has been interrupted by several years of military dictatorship rule. Many are of the view that this intermittent military intervention in governance has been a major cause of economic instability and underdevelopment in the country which is made visible by the high levels of youth unemployment, poor health status, widespread hunger

and starvation especially in rural areas. The logic behind this view, is that during forceful changes in government, ongoing public sector initiatives and infrastructural development projects are either interrupted or in most cases abandoned or discontinued (Maiye, 2012). This simply means that the benefits of these efforts never get to be realised and a lot of resources tends to be wasted in the process, as the life span of this efforts are cut short.

Although Nigeria has, since transitioned from one civilian rule to another since 1999, with minimal interference of the military, it is yet to show significant improvements in the area of socio-economic development. Notably, its effort in this area has been affected by past events as well current social problems such as heightened criminal activities, institutionalised corruption, gender disparities, terrorism, a weak judicial system and so on. Currently, the new administration is making fighting corruption, the issue of unemployment, the economy as well as security its top priorities.

2.2.5 Overview and Structure of the Healthcare System

In this section of overview of the health sector is provided. The researcher deemed it necessary to provide this overview considering the case study is situated within the government led public sector. This gives the reader a general idea of the specific context.

Health Care in Nigeria

Nigeria promotes a combination of preventive and promotive healthcare services through two major health providers within the National Health System: the public and the private profit making sector. The public sector is responsible for the management of more than 95% of the health infrastructure within the country, and currently is the major health services provider to the population.

On the other hand, we have the private profit-making sector which is continually growing, especially in the urban areas of the country. The inadequacy of the public

health system in Nigeria has given increasing prominence to this sector, as well as to traditional and spiritual healers and also the private-not for profit group.

 Structure of the healthcare system in Nigeria

In principle, Nigeria operates a decentralised system of healthcare as all three tiers of government - Federal, State and Local - share responsibilities for providing health services and programmes. At the federal level, the federal ministry of health (FMOH) is in charge of the policy and technical support to the overall health system, inter-national relation on health matters, national health management information system matters and the provision of health services through the tertiary hospital. In addition, the federal government is responsible for disease surveillance, drug regulation, vaccine management and training health professionals and the management of teaching, psychiatric and orthopaedic hospitals and the running of some federal medical centres.

At the state level, the State ministry of health (SMOH), in addition to its role of providing regulatory and technical support for primary health care services, is responsible for secondary health facilities like the general hospitals, and in some cases tertiary hospitals. The training of nurses, midwives, health technicians and the provision of technical assistance to local government health programs and facilities are also the responsibility of the state authorities.

At the local level, it is constitutionally recognised that local government agents have the principal authority and responsibility for PHC delivery. This means that within this level, The 774 local governments oversee the operations of primary health care facilities within their geographic area. The Local Government Chairman is the political head of the PHC system while the Primary Health Care Coordinator is the most senior public health officer. The Monitoring and Evaluation (M&E) Officers are public officials responsible for health facility data in the area. Depending on the type of facility, there is usually an Officer in Charge, nurse, midwife and a number of Senior and Junior Community Health Extension Workers (CHEW). Health posts usually just have an Officer in Charge who is likely to be a CHEW. A junior CHEW

is often assigned to the community who are helped by a number of volunteers like Village Health Workers (VHW).

As earlier mentioned, the federal government has a mandate of providing support to primary healthcare services. One agency through which the federal government performs this duty is a parastatal of Nigeria's Federal Ministry of Health known as the National Primary Health Care Development Agency (NPHCDA). An Executive Director who is a political appointee heads this agency (NPHCDA). The agency has a primary responsibility to mobilise financial, human and technological resources for primary healthcare (PHC) throughout the country and provide technical support to states and LGAs. A key aspect of this support is to develop PHC standards and guidelines to monitor, supervise and evaluate the delivery of PHC services across the country.

ICTs in Nigeria and the health sector

The use of ICTs in Nigeria dates back to the early 1950s when electronic media and print were introduced (Idowu et al., 2003). At that time, only the private sector demonstrated ICT initiatives and there was no major ICT policy; hence, full presence and awareness of technology was still absent. However, in 1999, Nigeria took a significant step in the development of the infrastructural base for ICT by launching what was known as the National Policy on Telecommunication. This policy document paved the way for private investors in the telecommunication market as controlling ownership of the Nigerian telecommunication (NITEL) was transferred to private investors. Following this privatisation effort, a breakthrough in telephone infrastructure emerged in January 2001 when the sector was totally liberalized with the licensing of MTN and ECONET - both private mobile phone companies (National policy on telecommunications, 2002). In just over a year, both companies had infused over a million lines into Nigeria as part of the Global System of Mobile Communication (GSM). Over time, other major players such as Glo-mobile, Etisalat etc, came into existence, making the telecommunication industry a highly competitive one. While this GSM Operators in Nigeria have some presence across all the states in the country, the telecoms infrastructure present in the North East and North West regions are significantly less dense than that of other areas.

Some of the reasons for this include insecurity issues, sparse distribution of the population, and poor demand are among the key reason which restricted the spread of telecommunications services to these regions.

In relation to the health sector, the advent of GSM technology has helped enhanced the exchange of information especially in Nigerian teaching hospitals. For example, mobile phones are used by physicians to reach other physicians in an emergency, to consult with their fellow colleagues as well as for referrals between their colleagues. However, it is important to mention that neither the hospital management nor the government provide the mobile phones being used by physicians for this purpose and neither do they take responsibility for the cost of calls made, as the physicians take sole responsibility for the cost (Idowu et al, 2003).

 Aside this type of informal use, there is little or no use at all of this technology within the public health sector to help improve quality, comprehensiveness, and timeliness of routine reporting of data from primary health facilities. However it is important to mention that, in terms of using SMS or mobile phones for data reporting, that there are a number of pilot projects around the country which are either sponsored by private bodies or development institutions, that seek to apply this technology most especially for public health purposes in different parts of the country. The effort described in this thesis will be the first nationwide government-led attempt of using ICTs specifically mobiles and other associated technologies within the public health sector in Nigeria.

Following the launch of the National Policy on Telecommunications in 1999, the next action that further opened up opportunities for ICT use in the country was the formulation and launch of the Nigeria National Policy on Information Technology in 2001, along with the creation of the National Information Technology Development Agency (NITDA). This bureau which was established by the Obasanjo administration was tasked with the implementation of the IT development policy. Particularly, this agency has a mandate of creating a framework for the planning, research, development, standardization, application, coordination, monitoring, evaluation and regulation of Information Technology practices and activities in Nigeria of which includes overseeing the development and deployment

of information technology in the country through human capital development, provision of IT infrastructures and creation of an enabling environment for the development of IT, so as to enable Nigeria to become a key player in the global knowledge-based economy (NITDA, 2007). However despite this mandate, the agency's focus on the health sector has been seen to be lagging behind till date. This simply means that as at yet, ICTs do not play a central role in the processes of strengthening the informational basis of decisions related to health care delivery and disease control in the country as the health information system is largely paper-based. For example, the processing and analysis of routine health data is still done manually, reporting health data from the lower level to the higher levels of the health administration hierarchy is also still done manually. However, in recent times, there have been instances whereby international donors have supported various ICT projects. An example of one such (donor-led) international project is the implementation of DHIS 1 and 2 which is an open source software/tool developed by the Health Information Systems Programme (HISP). This programme, which is been funded by Norad, Research Council of Norway, PEPFAR and the global fund, is used in Nigeria for data capturing and monitoring from some facilities in the country.

In summary, the above background information provided helps to situate the study in terms of its context, history, and current status of the health sector. Also, based on the present socio-historic and political conditions of the context discussed above, it is evident that Nigeria represents a complex case of a nationwide effort of introducing and using mobile technology within its public health sector. For example, the poor state of public infrastructure can have implications on the introduction of this type of effort particularly in rural areas.

Having outlined the socio-political and historic landscape of where the effort under study is being introduced, I now proceed to the next section, where I describe in detail this project from which our empirical data for this study is drawn.

2.2.6 The midwives Service Scheme (MSS) Initiative

The midwives service scheme (MSS) is an initiative under the long-term economic development program of the United Nations (UN)-sponsored National Millennium Goals for Nigeria. The MDGs set by the UN during the UN-millennium summit in 2001, has a set of eight specific goals or objective which are intertwined with each other. Notably, Nigeria as with many other countries around the globe is expected to achieve these goals, which many have referred to as "ambitious objectives" aimed at alleviating poverty globally and ultimately fostering sustainable development. The first of these goals seeks to eradicate poverty and hunger, while the second aims to achieve universal basic education. The third MDG seeks to promote gender equality and empower women, the fourth and fifth aims to reduce child mortality and improve maternal health respectively, the sixth seeks to combat HIV/AIDS and other such diseases while the seventh and eight aim to ensure environmental sustainability and develop global partnership for development respectively. Given that these goals have a strong link to the socio-economic development of a country, especially the health related goals (4, 5 and 6), efforts to achieve this goals are considered a priority by both the international community as well as the Nigerian government.

Coming back to the MSS, this scheme was initiated by the federal government of Nigeria (but executed and managed by the NPHCDA), under the federal appropriation act in 2009 to address the both the fourth and fifth MDG that centres on reducing maternal and child mortality.

According to a recent WHO report (2013), Nigeria has the third highest rates of maternal death in the world and together with India, accounts for one third of maternal deaths globally. While precise figures are not available, the Nigeria 2008 demographic and health survey estimates the overall maternal mortality ratio (MMR) 545/100,000 with wide variation across the geopolitical zones while new-born and under five morbidity/mortality indices stand at 171/1,000 live births with variations across geopolitical zones. Basically, some of the key reasons that have been cited as being responsible for this alarming statistics range from infrastructure

and access to health care services and human resource needs, poor monitoring of maternal and child health indicators among others. Notably, in spite of all previous efforts by its government to reduce this incidences, maternal and new-born morbidity and mortality indices have shown only marginal reduction, in the past five years, making the MDGs target unachievable by the year 2015 using current strategies alone.

Thus, in order to reduce the incidences and ultimately reverse this poor trend and keep the national hope of achieving the MDGs 4 and 5 on track, the midwives service scheme (MSS) was developed. The MSS is a public sector initiative and a collaborative effort between the three tiers of government in Nigeria. A memorandum of understanding between the Federal, State and Local governments set out clearly defined shared roles and responsibilities, which are supported by the strategic partners of the MSS such as World Health Organisation (WHO), United Nations (UN) etc.

The MOU, which has been signed by all 36 states of Nigeria, is designed to mobilize midwives, including newly qualified, unemployed and retired midwives, for deployment to selected primary health care facilities in rural communities. The aim is to facilitate an increase the coverage of Skilled Birth Attendance (SBA) to reduce maternal, new-born and child mortality.

The MSS consist of 8 strategic components namely: management and coordination, building partnership and consensus among key stakeholders, strengthening community participation, deployment of human resource to frontline health facilities in rural communities so as to improve the coverage by skilled birth attendants, PHC support with basic equipment's, capacity building/training of midwives to improve care quality, programme communication and lastly, monitoring, evaluation and ICT support strategy. Each of these components above is seen as an important strategy in the current effort at improving skilled attendance at delivery and indeed accelerating progress in the attainment of the MDG 4 and 5.

However the focus of this study will be the last component which is monitoring, evaluation and ICT support strategy. A key part of this component was the

implementation of a mobile application data exchange system known as MADEX, the mobile phone-supported information system that will support the MSS project.
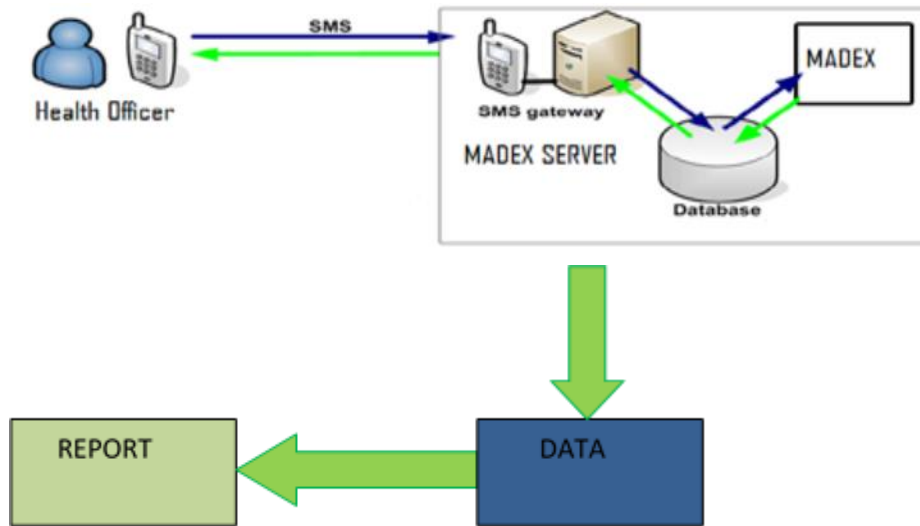
Figure 2-2: Overview of the MADEX Information System (adapted from the NPHCDA report).
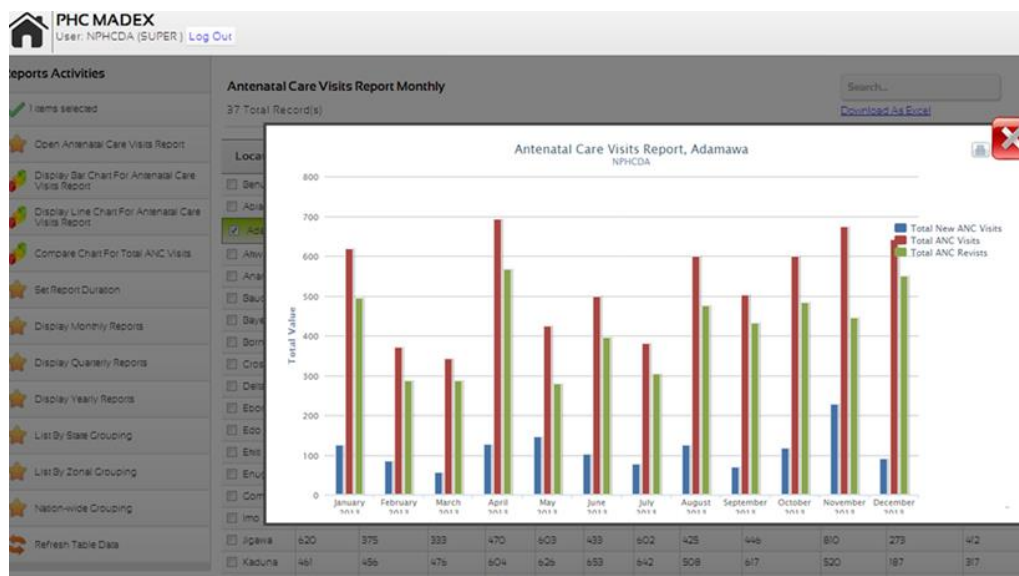
Figure 2-3: A screen shot of a chart depicting antenatal visits.

This report provides a graphical representation of ante-natal care visits in the whole of Adamawa state, a state in northern Nigeria, from the month of January to December 2013. This type of query would be generated by senior data monitoring personnel's at the national office of the NPHCDA. These officers are responsible for analysing the data generated from the MADEX platform. They not only carry out various query on the data, they also are responsible for actively monitoring the data coming in. It is at this national office that decisions are made regarding MADEX and the MSS initiative as a whole.

Figure 2-4: A screen shot of the MADEX application report on one of the smart phones.

M&E officers at the health facilities and local government health offices were responsible for entering data on the key set parameters (as shown on the left hand side of the screen) such as ante-natal care and pregnancy outcome, maternal mortality and other such parameters on to the application on the smart phones.

This data is then transmitted as SMS on a monthly basis to the server at the control room of the NPHCDA national office located in Abuja. The particular screen above shows data captured on ante-natal and pregnancy outcomes.
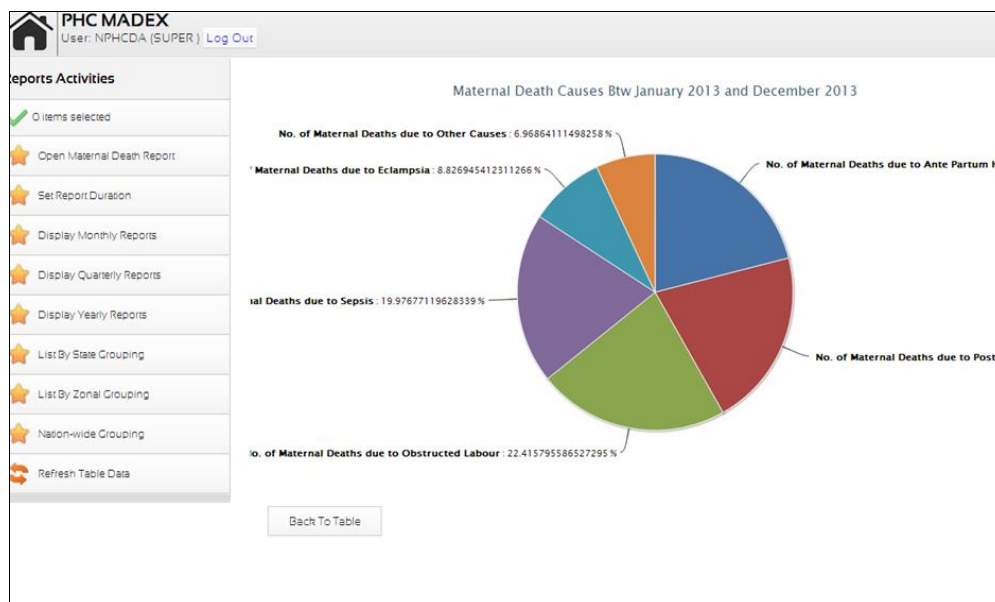
Figure 2-5: Screen shot of a query generated by senior data monitoring

Senior data monitoring personnel's were responsible for running queries on the data received after which they would prepare status reports accordingly or as required by management and key decision makers of the NPHCDA.

Basically, MADEX was initiated with the following objectives in mind; first, to develop a simple form-like MNCH data collection tool that could be used on mobile phones as a cost effective and efficient means of reporting accurate data quickly via SMS from PHC facilities across the country, up to the national level (national office of the NPHCDA) for quick monitoring and decision making (see figure 4 above). Second, to create a platform for improved data quality and accountability in maternal and child mortality and third, to explore the potential or value of using mobile technology as part of work practices within the public health care system in Nigeria.

Against this background, mobile phones were introduced as a simple ICT to facilitate this process of collecting key maternal, neo-natal and child health (MNCH) information reflecting the MSS core indicators, from primary health facilities from across the country, and forwarding it by text format to a server in the NPHCDA headquarters in Abuja. Here, the data is imported from the server into the MSS database, were senior data monitoring officers were charged with the responsibility for querying the data so as to monitor what was taking place in various health facilities as well as preparing reports on a quarterly basis. These reports are then shared with stakeholders such as state governors (during forums), the presidency and also strategic development partners for the purpose of measuring progress against the MSS core objectives such as reduction in maternal deaths.

In addition to capturing information on key MNCH indicators, the MADEX platform was also used to monitor the availability of midwives deployed at the PHC facilities as well as provide information on a monthly basis on stock level of vaccines and commodities (provided by the NPHCDA) to be used at the facilities for example "mama kit" a bag that contained essentials, used for delivery.

Having provided a brief background to the MSS scheme and the objective of MADEX innovation, the remainder of this chapter will be examining the literature on ICTs in developing countries and in development effort.

2.3   Section ICTs and Development in LDC

The notion that information and communication technologies (ICTs) are being used to support development activities in many LDC is widespread and not new in the literature. Central to this perspective, is the view that 'investment in ICT and its effective use do matter for the economic development of a country' (Mann, 2004). For instance, the UNDP's 2001 Human Development Report (United Nations Development Programme 2001, p. 29) strongly acknowledges that ICTs have the capacity to improve the performance of state institutions, the delivery of health and education services, as well as democratic participation (United Nations Development Programme, 2001). Encouraged by such potentials, governments in

LDC, in collaboration with key development institutions have committed valuable resources to the implementation of ICTs across a wide range of development sectors especially within the context of LDC with the hope of achieving some form of locally relevant development goal.

Studies within literature have shown that often times, within a LDC context, efforts to apply ICTs to development areas such as healthcare, have not always resulted in successful outcomes or the achievement of the anticipated developmental goals (Wade, 2004). Indeed, there are many examples of partial or complete failure of such efforts (e.g. Avgerou and Walsham, 2000). What such situations clearly tell us is that ICT by itself do not have influence on its own, rather there are other determinants that shape and are in turn are shaped by ICT adoption processes, in order that it can take place successfully and deliver on the intended benefits.

2.3.1 Perceptions guiding the adoption and use of ICTs

Reported cases of ICT adoption efforts in LDC tend to suggest that the success or failure of ICT interventions in LDC will depend on how governments, national and international development agencies, non-governmental organisations, public agencies and stakeholders generally conceptualise technologies (Harindranath & Sein, 2007). Basically, this conceptualization, tends to have a huge influence on stakeholders collective understanding of the nature and role of ICTs in organizational and socio-economic practices of which in turn, significantly influence the outcome of such effort.

The four views

Orlikowski and Iacono (2001) in their seminal paper, identify and discuss four distinct conceptualisation of ICTs, following their review of the IS research journal spanning 10 years.

The tool view. Which is one of the four view, mainly concerns itself with the technology. Basically, technology and how it works are seen to be largely technical matters as the technology is seen as a tool which is capable of delivering specific

outcomes such as increased productivity and enhanced information processing etc. **The Second, is the computational view**. Here, the focus is primarily on the computational capabilities of the artefact, such as its ability to execute algorithms, as well as modelling or simulating aspects of the real world;

The third is the proxy view: This view focuses on aspects that are considered critical in assessing the significance of the technology e.g. value in terms of money, or extent of its diffusion amongst individuals and fourth, is the ensemble view otherwise known as the socio-technical view. This view emphasises the IT artefact, as a dynamic element in constant interaction with people in the context of some socio-economic activity. Of the above paradigms, the most dominant in the IS literature are the tool and the socio-technical view. Below a detail discussion on notions surrounding both of this paradigms is presented.

The tool view

Past studies which have examined the use of ICTs within LDC, generally point out that among stakeholders and drivers of ICT interventions, the tool view arguably continues to be the most dominant (or received) paradigm of ICTs in this context among all the perspectives (Harindranath & Sein, 2007).

The tool perspective, rests upon the belief that ICTs and the social or organisational context in which they are developed and used, exist in isolation and are separable from each other. Within this view are four sub-views were ICT is conceived as a substitute for labour, as a means to improve productivity, as way to increase information processing, and as a means of improving/ maintaining social relations. Overall, this view conceives of technology as having the potential to produce efficiency gains when used in development sectors (such as healthcare) within a LDC context, regardless of other contextual determinants. Notably, this paradigm appears to be the most explicit perspective which underlies most ICT initiatives that take place within LDC, where the majority of interventions are geared towards the achievement of a development goal which seems to follow a `silver bullet' approach (Fornazin & Joia, 2013).

Past studies which have examined the use of ICTs within healthcare, generally point to a situation where the absence of an 'ensemble' view that situates ICT within a given socio organisational context is mainly the case. In other words, within these studies, ICT is mainly viewed as a tool for capturing and transmitting data mainly to meet the needs of the bureaucracy. Consequently, within this tool view, there is a high tendency for the IT artefact to have an administrative or managerial focus when deployed and used. For example, Sahay (2001) recounts how managers and those in higher authorities tend to use the data and information gotten from ICT supported health information systems for the purpose of control and to reprimand already overworked and in most cases poorly motivated health workers. He argued that (regrettably) within this view, because of the administrative and managerial focus of such systems, the information or data they produce is rarely used to guide local action at the local level (where this data is captured most times), in which case, the system provides little or no value to the primary users of the technology. A similar observation was also made by Darbyshire, (2004) who found that the dominant view of clinical information systems as merely tools to automate processes, are most times of little or no value to the end users (that is the nurses) of the system as it fails to facilitate the less concrete aspects of nursing work practices carried out by clinicians (Darbyshire, 2004).

Arguably, the main drivers and actors of the tool conception of ICT initiatives in LDC tend to be international development agencies. These agencies not only promote and give special attention to ICTs, through their publications, they also seek to present a clear association between ICTs and desirable development effects, such as enhancement of livelihoods in rural areas (Duncombe and Heeks, 2002), or improved government services (Krishna and Walsham, 2005), and improved health and education services (United Nations Development Programme 2001). For example, around the late 90's, the World Bank "Knowledge for Development" report was recognised as one of the key reference document in the discourse on the application of ICTs for development.

From this documents' perspective, new ICTs have the potentialities to make a difference in the developing world. More specifically, it also put forward a strong

argument which is, the use of ICTs can help LDC to skip stages of technological development that their developed counterparts had to pass through (World Bank 1999, p. 57).

Similarly, in 2001, the United Nations Development Programme (UNDP) also produced a report, called the UNDP's Human Development Report (2001). The main goal of this report was to highlight the relationship between technology, particularly new ICTs and human development. More specifically, the report chose to elaborate mainly on the argument that ICTs can contribute to achieving developmental goals. In the same year, the United Nations Development Programme (UNDP) produced another report, "Making new technologies work for human development" which centred on how people can create and use technology to improve their lives. Soon afterwards, the World Summit on Information Society (WSIS) which held in 2005 also produced a report titled "Tunis Agenda for the Information Society". This report highlighted the connection between ICTs and the millennium development goals MDGs and basically emphasised the key role of digital ICT as an enabler of development.

"We agree that the financing of ICT for development needs to be placed in the context of the growing importance of the role of ICTs, not only as a medium of communication, but also as a development enabler and as a tool for the achievement of the internationally agreed development goals and objectives, including the Millennium Development Goals" (WSIS, 2005, pg. 2).

Following this techno-optimistic perspective, several international and national donor organisations have continued to devout vast amount of resources including huge funds to finance ICT interventions targeted at development particularly in LDC; with the hope of achieving far-reaching changes that will lead to healthier lives, greater social freedoms, increased knowledge and more productive livelihoods (UNDP, 2001). For example, interventions involving new ICTs such as the internet as well as mobile phones have been introduced in various areas of development such as e-learning and m-learning, e-health and m-health and so on.

However, the literature on information systems (IS) in developing countries, of which comprises a substantial amount of empirical work, most of which are case studies of using ICT as part of development efforts, have revealed that a large number of these efforts have had undesirable outcomes and ended up in some type of failure (Heeks, 2002). Notably, there has been a growing realization among social science researchers that such efforts, have achieved only limited success as useful information systems in part, because of the conceptualisation of ICTs as a tool. Not only does this tool perspective view technology and what it does, largely as technical matters, it conceives of them as independent of the social arrangement in which they are developed and used (Orlikowski and Iacono, 2001).

For example, Latour (1987), expresses his dissatisfaction about this perspective by arguing that, social scientist tends to make new ICTs into "black boxes" by making the assumption that they are stable, settled artefacts that can be passed from hand to hand, used as it is, by anyone, anytime, anywhere to achieve planned and consistent results and calls for the unpacking of the boxes.

Thoughtful criticisms such as that of Latour, have not only exposed the tool view as being a narrow view that tends to overlook deeper socio-cultural structures within the context in which they are being introduced or embedded, it has also motivated more awareness about the need for an alternative perspective that can that can accommodate the complexities of designing ICTs and under- standing their use in social settings.

The socio-technical view

One approach that can provide a broader view of ICTs is the socio-technical view otherwise referred to as the ensemble view. Within this perspective, ICTs are not considered as independent tools which can be detached from the context in which they are used, rather, they are viewed as dynamic element which form an integral part of a larger social context, embodying elements of this broader social context Goldkuhl (2013) . The two most significant sub-views within this perspective seem to be the embedded system view and the social structure view. In the embedded view, ICT is emphasised as a contextual phenomenon, that it is embedded in a social

context that is both complex and dynamic while within the social structure view, ICT is seen to embody social structures, i.e. rules and resources, built into the technology during its design (Orlikowski and Iacono, 2001).

Essentially, given that the conceptualisation of ICTs from an ensemble or socio-technical perspective is not only "context-sensitive" but also one that pays attention to the complex interaction between people and technology, this study's conceptualisation of the ICTs, is based on the ensemble view and this comes from the recognition that the adoption and use of technology, goes beyond analysing technological artefacts, spanning a wider analytical space of which includes socio-cultural and political arrangements (Avgerou, 2010).

 A notable example of a theoretical approach which conceives of technology from this socio-technical perspective is Actor Network Theory. Actor Network Theory (ANT), as proposed by Callon (1986) and Latour (1986), emphasises the significance of the interplay between technology and society. Specifically, its proponents argue that since we live in a world made of both social and technical artefacts; we cannot detach society from technology, neither can we isolate technology in the abstract (Cordella and Shaikh, 2006). As Law and Bijker (1992) argue, "Purely social relations are found only in the imaginations of sociologists, among baboons, or possibly, just possibly, on nudist beaches; and purely technical relations are found only in the wilder reaches of science fiction"(p. 290).

This approach is discussed in more details in Chapter Three (Theoretical Framework) as it is adopted as the theoretical basis for this study. Within the discussions, ANT is critiqued in light of the above ideologies and other theoretical approaches that may be considered suitable for a study of this kind (See chapter 3).

Nevertheless, ANT's perspective on the trajectory of the adoption or implementation process of ICT innovations (such as the MADEX case under study), involves promoting the dynamic and simultaneous mutual influence of both the social and the technical (Law and Bijker 1992).

2.4   The use of ICTs in development efforts in LDC

Considering that this research sits within the domain of ICT and development, which examines the use of new ICTs in achieving development goals such as, improved healthcare for citizens as is the case herein, it is important to understand the conception of development shaping the use of ICTs in efforts of technological innovation because it helps in bringing to light the key motivations that have influenced the design of such effort.

For decades, many LDC including Nigeria have relied on aid from international institutions, such as the World Bank, as a key approach for development. Within this structure, these institutions conceptualised development mainly by using economic indicators like the increase in per capita income, while paying little or no regard to issues of people's capabilities and their social context (Sen, 2004). Specifically, this perspective which could be described as the economic-growth approach, viewed poor countries as just low-income countries whose primary strategy for rising above the problems of underdevelopment had to be through economic growth, increasing Gross National Product etc (Prakash and De', 2007).

Notably, from around the mid 1990's during the time of the first dot-com boom, these development institutions were attracted by the potential that new ICTs such as the internet (and subsequently mobiles), could have, in terms of bringing the anticipated economic growth and ultimately contributing to solving development problems. A key argument around their position at the international level, was the view, that some LDC could "leapfrog" stages of development by focusing on the use of new technologies such as mobiles and the internet to increase productivity and become "knowledge" economies (Steinmueller, 2001).

For example, Kenny (2000) (who has affiliations with the World Bank) argues about the application of new ICTs as a tool for economic growth and ultimately development. In his paper, he argues that new ICTs could play a major role in reducing poverty, particularly in rural areas of less developed countries. This view is based on the reasoning that low rural income is been brought on by "information poverty" - that is, the lack of access to information and "knowledge" of which could

improve earning potentials. In other words, if citizens (especially those residing in the rural areas) have access to market-related information and knowledge, their potential earning power could increase leading to development.

Pieterse (2001), who holds similar views, presses on this argument by stating that, LDC do not have what it takes to break out of traditional and obsolete ways of production because they are neither equipped with the knowledge nor the resources required to do so. Thus to achieve growth and development, he goes on to argue, that they would need to follow in the footsteps of developed countries - that have taken advantage of the influence of technology and other such things like a skilled workforce to achieve growth (Sein and Harindranath, 2004).

Although the above standpoint has been heavily criticised for being techno-deterministic, it remained highly influential (as voiced by international agencies in various policy document, see section 2.3 above). Those within the research community who have criticized this view have deemed it problematic for two key reasons: first, it overestimates the influence of technology in fundamentally changing irregular economic relationship and second, because it often tends to underestimate the costs and complexities associated with many ICT in development efforts (Kling, 2000), perhaps a key reason why most of them, as yet, have been unable to reap the potential benefits (Sein and Harindranath, 2007).

However, over the years, this economic growth perspective of development, of which reflects the "tool" view of ICTs, (recall earlier discussions about the different perspectives of IT in information systems research by Orlikowski and Iacono, 2001) has been criticised for not only failing to deliver on the promised practical result, but for also being commercially driven as well as being too top-down in its approach (Puri, 2003). Following this dissatisfaction and critique, efforts to widen the conceptions of development beyond GDP and modernisation, towards a more holistic understanding of human development which was more centred on the individual their context and capabilities emerged.

One such conceptualisation is the 'capability approach' devised by the economist and philosopher Amartya Sen. This approach, which was first developed in the

1980s and carried on into the 90s was a radical departure from existing conceptions of development. More specifically, Sen's contemporary approach to development includes taking into account inter-connected factors in conceptualizing development such as economic facilities, social opportunities, human capabilities and other such things.

Sen conceptualizes development in terms of existing social opportunities, which he refers to as 'the arrangements that society makes for education, health care and so on, of which influence the individual's substantive freedom to live better' (Sen 1999 p. 39). From the above definition, it is evident that the focus is on the well-being of the citizens and their assets and capacities (Sen 1999). Noticeably, this conceptualization of development as put forward by Sen, highlights that, the absence of fundamental assets such as employment opportunities, education and health care, can prevent citizens from participating in development activities. Consequently, this focus on the understanding of capability deprivation has exposed facets of poverty often not visible if development is measured solely using economic indicators.

Sen's perspective of development along with other human-centred conceptions of development in which the focus is on the development of citizens, finds itself at odds with the economic growth perspective.

Specifically, this people-centred approach, places a significant importance on the individuals' context (to ensure that their substantial freedoms are not taken away) in understanding the impacts that a technological project has or can have on citizens and on the society (Prakash and De', 2007).

In sum, the discussion so far, highlights two broad positions concerning the conception of ICTs in efforts aimed at solving development problems. On the one hand is the tool conception which indicates an instrumental role of technology as tools that enable desired states of development. Within this position, emphasis is placed on adoption of ICT interventions as a way of bringing about greater efficiencies in government service delivery, which is closer to an economic growth perspective (otherwise referred to as the modernisation perspective) for

development whereby sometimes it is difficult to see the benefit it provides at an individual level.

On the other hand, we have the ensemble conception, which suggests a more mediatory role for ICTs as artefacts able to support the achievement of specific and locally relevant development objectives. Specifically, this conception aligns closely with the human-centred approach to development in which such efforts objectives, seeks to not only build capacities for the people, but also, it seeks to provide benefits at the individual level as well. Additionally, this perspective takes into consideration that, beyond the issues of access, are other socio-cultural aspects involved in accommodating ICTs (Warschauer, 2003). This simply implies that within this view, such ICT efforts are not viewed solely as matters of technology, but also as a matter of the socio-political, institutional and cultural contexts which shape people's access to and use of technologies in development activities within LDC (Kling, 2000;Warschauer, 2003).

2.4.1 Advantages of mobile-phone based Interventions

If implemented successfully, mobile phone-based interventions can improve and enhance activities for the stakeholders involved, such as citizens, businesses and government agencies. In addition, successful mobile phone-based innovations can create outcomes with positive effects on both social and economic development. In a study by (Elder and Rashid, 2009) on the use of mobile phones for development, they discuss multiple categories of mobiles contribution to development and ultimately its benefits. These benefits can be grouped as follows.

(1) Increasing Efficiency and Effectiveness of Service Delivery in development areas such as health, commerce, agriculture etc: In addition to voice communication, mobile phones allow for the transfer of data, through which it is possible to send out up-to-date information. A typical example will be to use mobiles in the area of agriculture to improve efficiencies in the supply chain, through the provision of up-to-date price information.

(2) Reduced poverty and improved livelihood: by expanding and strengthening social networks; as well as increasing the ability of citizens to deal with emergencies; cut down travel costs and enhance efficiency, in order to reduce vulnerability. For example, mobile phones make it possible for traders and farmers to obtain information that allows them to deal with seasonal factors (e.g. weather information), hence reducing the imbalance between themselves and those they trade with. In a similar way, the use of mobile phones also reduces costs of doing business and increases productivity by helping rural traders and farmers to secure better markets and prices; and promptly communicate business related information.

(3) Quality Improvement in Decision Making: Also, by facilitating access to timely information, mobiles have made it possible for decision makers to capture rich information in a timely manner even at the grass root level of communities that would otherwise have been difficult to reach.

4) Empowerment of People in Rural Communities: mobile phones which are increasingly affordable to the lower strata of the population are helping to empower people in poor communities by providing them with fast and easy modes of communication, thereby increasing their ability to undertake diverse livelihoods strategies as well as improving the social and political participation of this disadvantaged groups.

Nonetheless, despite these immense benefits highlighted above, a majority of mobile phones innovation in LDC, has not achieved scale – it is either localised or at the pilot or proof of concept stage (Donner, 2009). This realisation creates a curious situation regarding mobile phone based innovations in LDC, for which this research explores and uncovers more relevant facts.

Notwithstanding, this technology has the potential to overcome many of the information asymmetries that characterize traditional paper-based information system which is still prevalent in most LDC, as well as the physical infrastructural challenges faced by using computer-based health information systems within the same context.

In light of these benefit and potentialities that could be derived from the adoption and use of mobile phones in the delivery of health services, many LDC have been drawn into investing hugely in mobile phone-based innovations as a means of delivering more efficient public services to its citizens not just within the health sector, but also other development sectors. Regrettably, in most cases, this desired outcome has been difficult to achieve. Consequently, there is an increasing need to thoroughly investigate such efforts to better understand the situation of attempting to deploy a mobile-phone supported information system. The rationale is that lessons from such studies can help inform future mobile phone innovation efforts of which could result in better outcomes.

2.5 Categorisation of mobile previous phone based intervention research

A review of the literature on mobile technology in LDC has identified three broad research foci. The first of this, adopts an "upstream" perspective, exploring the broad area of mobile adoption and diffusion. Specifically, studies within this perspective seek to explain the unique rates of mobile diffusion in LDC, while others focus on explaining regulatory structures that allow or prohibit the uptake of this technology. Studies within this category have applied models such as innovation of diffusion models (e.g. Wei, 2006), technology acceptance model (TAM) (e.g. Meso, Musa, & Mbarika, 2005) and even the theory of reasoned action (TRA) to examine mobile adoption in countries such as Nigeria, China and Kenya etc.

Most of the studies in this category identify barriers to mobile diffusion, with affordability and income being the main ones, especially among low income populations. However, it has been found that different strategies are being employed to mitigate this issue. These strategies include making very few outgoing calls, miss-calling or "beeping", etc. (Elder and Rashid, 2009).

On the whole, adoption studies identify predictors of mobile diffusion at both the micro and national level. They also identify the important role of regulatory structures (in particular liberalisation) in facilitating mobile penetration, raise important questions about the gaps left even after liberalisation, and suggest policy and technical interventions to close those gaps (Donner 2008).

The second stream of mobile phone research takes a "downstream" perspective and focuses mainly on the impact of mobile phones (eg. Heeks et al, 2008). Research in this perspective anchors itself on the claim that mobile technologies are indeed instruments that can improve socio-economic development especially within the context of LDC. Specifically, they bring careful attention to the role of mobiles as a tool that can solve development problems and contribute hugely towards the achievement of broader wellbeing of citizens (Duncombe and Heeks, 2002). Examples of studies within this category can be found mainly within the ICT4D literature. While some studies within this perspective explore mobile's impact on other institutions and human domains, such as non-governmental organizations etc., the majority tend to be concerned with micro economic benefits (Donner, 2008). Two case studies widely cited in the literature that belong to this set are, Jensen's (2007) study on mobile information service for fishermen in Kerala, India and the mobile payment system, M-PESA operated by safaricom in Kenya.

Jensen's study found that the introduction of mobiles brought significant and immediate reductions in the variability of price and the amount of waste in the fishing market, resulting in increased profits for the producers and reduced prices to consumers as people were equipped with better and timely information. In the case study of the mobile payment system M-PESA, since its inception in 2007 as a donor-driven financial services development project, it has achieved significant penetration into parts of the population that were previously excluded from any form of financial service provision, making it possible for people without bank accounts to be able to carry out financial operations Duncombe, 2010). According to (Safaricom, 2010), this effort has attracted a customer base of approximately 9 million users and 17,000 service delivery agents over a three year period.

The final research stream in this area focuses on the interrelationships between mobile phones and its users and how to improve them. Studies within this dimension examine the application of mobiles within the socio-economic development domain such as education, health, governance etc. Within this perspective, the majority of the studies tend to focus on the interplay of social, economic, and cultural factors with this technology as these studies posits that mobiles are best understood as complex artefacts and its use is a co-constructed phenomena (Donner 2008; Fortunati, 2005). These studies tend to suggest that many constraints and challenges are being faced in the successful application and use of mobiles in efforts within the aforementioned socio-economic domain (Donner, 2004, 2007, 2008; Duncombe, 2011; Elder & Rashid, 2009; Heeks, 2010).

Donner 2008, points out that the successful applications of mobile technology within this category in a developing country contexts are admittedly still rare. Also earlier, (Castell et al, 2007) in their paper made a similar observation by stating that evidence of the application and use of mobiles has been noted to be minimal and insufficient within the public sector of LDC (Castell, et al, 2007).

This research is situated in the third stream of research interest, as it focuses on understanding the process of implementing a nation-wide effort of introducing a mobile phone based innovation within the government-led public health sector in Nigeria.

By doing so, it addresses the concerns of Castell et al, 2007 and Donner 2007 by adding to the literature of introducing mobile phone interventions within the public sector of a LDC for the purpose of deriving some development benefit.

2.5.1 Mobile phones in development efforts in LDC

Having presented the key paradigms as regards technology usage and how it relates to development perspectives, this chapter will now provide an overview of the specific technology under study. Mobile phones are being recognised as one of the major components of ICT in less developed countries. Essentially, besides playing a key role in satisfying the desire to communicate cheaply, mobile phones (hereafter

referred to as mobiles) have been viewed as an instrument particularly appropriate for supporting economic growth, human development, and precisely the achievement of development goals in many less developed countries (Duncombe, 2011).

Since the 1990's, the usage of mobile phones in LDC, has witnessed a dramatic increase year after year, making it now the most popular ICT device used in LDC. Research from the World Bank (2012), shows that there are now about 6 billion mobile subscriptions worldwide, 77% of which are in less developed countries.

Basically, this technology has been seen as playing the same crucial role that fixed telephony played in the richer economies in the 1970s and 1980s (Rashid et al, 2010). For example, while mobile phones substitute for fixed lines in less developed countries, in advanced countries, they complement fixed lines, implying that they have a stronger growth impact in less developed countries.

The ubiquity of mobiles in LDC has caught the attention of the development community as well as government, as they see in this technology a convenient and inexpensive means to reach remote areas and thus to address various development problems, ranging from issues relating to poverty and inequalities. For example, the International Telecommunication Union (ITU), which is the leading United Nations agency for ICT issues, argues in their 2010 report that economic and human development can be strengthened by ICT technology, including mobile/wireless and internet access (ITU, 2010).

Academic scholar, as well as development practitioners who also subscribe to this argument are trying to make sense of how mobiles can be diversified and effectively used to improve capabilities, and provide better economic and social opportunities for citizens in LDC, especially for the poor and marginalised (Donner, 2008; Heeks and Jagun 2007). Their belief in the potentialities of this technology in improving the lives of the poor stems from the high penetration levels of this technology among low-income populations (Donner, 2008; Duncombe, 2011; Elder & Rashid, 2009; Heeks, 2008;Walsham, 2010). Besides, some of these scholars argue that within a LDC context, mobile phones can have more advantage compared to other

fixed ICTs given that they are lower-priced, easier to use and require a less expensive infrastructure to deliver applications in development areas such as health and so on (Donner, 2006; Duncombe, 2011; Wade, 2004).

2.6   Benefits of using mobile phones within LDC

This section looks at the benefits that can be derived from using mobile phones with special emphasis on the health system.

Currently, mobile phones are one ICT component increasingly being used in key areas within a LDC context. Specifically, literature reviews of mobile phone innovation, have identified mobile phones making important contributions in major areas (Donner, 2009; De Silva, 2008). These include using mobile phone applications for information, communication and transactional processes in support of agricultural development, micro-financial service provision, micro-enterprise, and data gathering and dissemination for projects concerned with social development sectors covering health, education, the environment and humanitarian relief in response to disasters and emergencies.

Also, specifically, if we take a look at the health sector, due to availability and connectivity of this technology, it is being used to support health information systems and for improving the dissemination of public health information Walsham (2010). For example, mobile phones are used in LDC as computers are used in developed countries in the sense that, mobile phones are used to capture routine health information from the health facilities situated in rural areas after which they are reported to higher level health administrations. Most times, this information is of a statistical nature and can be sent by SMS.

Still on the health sector, prior to the advent of mobiles, other forms of ICTs in form of computers and Internet technologies have been introduced in health systems both in the developing world and LDC mainly for the purpose of managing healthcare information. A report by the world health organisation (WHO, 2004) for instance, acknowledged that Information and Communication Technologies (ICT) have an important role to play in healthcare considering the information-intensive nature of

this sector. Further, this report goes on to point out that introducing ICTs into the health sector can be beneficial as it can serve as a means to reach a series of desired outcome such as health workers making better treatment decisions; hospitals providing higher quality and safer care; assisting citizens with making informed choices about their own health; governments becoming more responsive to health needs; national and local information systems supporting the development of effective, efficient, and equitable health systems; policymakers and the public becoming more aware of health risks; and people having better access to the information and knowledge they need for better health. Based on this notion, ICTs have gained an increasing role as major enablers of health care reforms by the governments of both developed and less developed countries.

A classic example of a government committed to the idea that ICTs are key to implementing the necessary changes and indeed has a major part to play in the new ways of delivering care in the 21st century is the UK government. Basically, its National Health Service (NHS), has been at the centre of a long-term effort by successive governments to modernise its health care services and at the same time creating an information-led, cost efficient institution via the introduction of information and communication technologies (Aderibigbe et al, 2007). Essentially, the information management group of the NHS executive (the body responsible for the execution of its healthcare policy in the UK) sees the greatest potential for the use of ICTs in healthcare in its ability to support communication flow that spans a variety of information flows across the different levels of the health system (Whitley and Poulodi, 2001). Additionally, this group also envisages the potentials of ICTs in promoting knowledge management and technology-assisted decision making for health workers as well as providing training and development for all NHS staff (Aderibigbe et al, 2007).

Notably, the largely successful use of ICTs in health systems in advanced countries of the world like in the UK, has raised expectations in many LDC that ICTs can be used to enable improvements in healthcare service delivery as well, and can also support the meeting of broader developmental goals that have an impact on health (Chandrasekhar & Ghosh, 2001).

Braa et al (2004), further emphasises the potential of an ICT supported health system by putting forward the argument below:

"All countries need a national health information system at least partially based on modern IT linking the various levels of the health system and addressing the information needs of policy makers, managers, health programmes, service providers, staff and increasingly patients... without reliable, relevant HIS, healthcare managers and providers cannot optimally allocate resources, improve the quality of health services or address epidemics such as HIV/AIDS".

Overall, the use of ICTs, within health settings offers immense potentials, such as increasing access to healthcare services, improving the ability to diagnose and treat diseases, and expanding access to health education and training for health workers. As a result, they are seen as a key prerequisite to improved health care delivery in LDC.

Notably, despite the immense potential of ICTs in healthcare, experiences from the literature so far, show that various reform efforts related to the introduction of computer to support health systems have died premature deaths as "pilot projects" (Heeks, Mundy, & Salazar, 2000). In other words, these interventions have failed to be sustainable or even scaled-up at all.

According to (Kimaro, & Nhampossa, 2005), one of the major conditions that have been said to contribute to unsustainable computer based HIS efforts in LDC is the issue of inadequate sound infrastructure. Kimaro & Nhampossa, go on to argue that the implementation of such computerised HIS, requires sound technical infrastructure such as hardware, software, and networks, as well as well-functioning physical infrastructure such as roads, power supply, and communication infrastructure (e.g. fax, and Internet connectivity).

An example of how poor infrastructure can lead to a weak health information system is provided by Sahay and Walsham (2006). In their case study, where they analyse a project relating to the design, development, and implementation of a computer-based information system as part of the Health Information Systems

Project (HISP) programme, they bring to the spot light a number of infrastructural challenges that impeded efforts of introducing a computer based health information system in Andhra Pradesh (AP), a state in Southern India. Specifically they point out that power fluctuations and the resulting damages on computers as well as issues with internet access were among some of the challenges experienced particularly at sub-national levels when trying to introduce and use computers as part of work practices in Andhra Pradesh. Thus, they argued that, a lack of sound infrastructure creates the risk of failure of efforts to introduce computers to support health information systems in LDC.

Given the existing inadequate infrastructure issue in LDC, the use of mobile phones in such low resource settings has been considered as an alternative technology for gathering health information and ultimately supporting health information systems.

Basically, many believe that this low-cost, low-maintenance device, lends itself as a suitable technology in such settings, as it provides a fundamental leverage that had been lacking in these settings – that is, reliable network infrastructure for electronic data transmission even from remote areas Asangasi and Braa (2010). This properties, together with the ease of use of mobiles compared to computers, has led to the frantic rise in applications of mobiles as an alternative technology to support health information systems.

It is on the above premise and following from the observation that mobiles and mobile phone networks generally are evolving that this research study is set. Essentially, the use of mobiles as a technology to support health information systems, has huge potential for circumventing the aforementioned infrastructural challenges highlighted above, hence better supporting the process of gathering data from the lowest level of the health system (such as health facilities and communities) and reporting it upward to the national level. By using mobiles in this way, this technology can benefit the poor even though indirectly, through improved health care provision.

2.7   Limitations of previous research on mobile-phone (by implication ICT) innovation implementation

Before proceeding to discuss the limitations of previous research on mobile phone innovation, I will provide clarity to the term innovation as used in this study. Very simply, the term innovation can be used to describe an idea that can be conceived as new by a person or group of persons within a given context (Roger, 1995).

Like the MADEX system, most efforts aimed at introducing an ICT supported information system brings with it some newness and (or) change and as such can be seen as an innovation. Within the IS literature, previous approaches to information systems research, of which concerns the way people build or use ICTs such as computers or mobile phone based systems to produce useful information, can be categorised in a continuum. At the one extreme we have technological determinism, of which places high importance on the technical aspects of the innovation. Basically, this approach to studying IS innovation stresses the benefits of a technology irrespective of the organisational or social context. Accordingly, technological deterministic approaches to IS research, emphasizes the transformational power of information and communication technologies (ICT).

At the other extreme of this continuum, we have what is known as social determinism. This kind of approach, assume that relatively stable social categories can be used to explain technical change (Law and Callon, 1988). Basically, this strong dichotomist distinction between the social and the technological dimension that has characterised the early studies of IS innovation in society (Walsham, 1997) has been described as an essentialist approach to understanding IS (Tatnall and Davey, 2005). He goes on to point that adopting an essentialist view such as this in IS research, can result in the researcher simply outlining the characteristics of the technology and the advantages and challenges associated with its use and then making the inference that the successful implementation or (not) of the IS can be attributed to these characteristics. Notably, while this simple explanation does hold some truth, it has been criticized for not highlighting the complex nature of

deploying IS, as it is not only incomplete but also it fails to provide a holistic explanation as it tends to leave out influences due to interaction between actors.

Actor network theory, the theoretical approach used in this study, has been seen as breaking this symbolic boundary addressing the problem right from the 'inside'. From an ANT view point, Information technology and those who use it, are not defined outside their relationship but in their relational networks. Thus, this approach contributes to the above debate from an intermediary position that systematically avoids the dualism between technology and society (Bloomfield and Vurdubakis, 1997) and focuses on the processes through which socio technical networks are created. As Law (1999) puts it, "...entities take their form and acquire their attributes as a result of their relations with other entities" (Law, 1999). In the same way, Law (1992) argues that society, organization, agents and technological artefacts are all effects generated in patterned networks of diverse materials. These considerations move the focus of the analysis from the actor, either technology or society, towards a more complex and less defined phenomenon, that is the interaction.

Another major limitations of previous research on mobile phone innovations has to do with the lack of studies that focus on assessing broader development impact of mobile for example, in relation to public goals. Basically a review of key studies on mobile innovations has shown that a majority of studies on mobiles are around impact. Duncombe (2011) categorises these impact studies into three distinct groups. The first is concerned with immediate outputs associated with an intervention*,* mainly micro-level changes (in behaviour or practices) that are associated with use of mobile phones. He goes on to state second group focuses on the resultant and more immediate outcomes of such innovation. Within this category, the focus is on the measurable differences in cost and benefit associated with an intervention involving mobile phones. Examples of studies that have focused on assessing the output and outcomes of mobile innovations, have found such innovation giving rise to specific outputs and outcomes such as new communication patterns, better information flow and new ways of conducting transactions. Notable among these studies are (Aker, 2008; Donner, 2006;

Aminuzzaman, 2003; Goodman, 2005; Abraham; 2007; Walia & Goodman (2007); Jagun et al 2008; Jensen, 2007 and Overa, 2006).

The third group has to do with the broader and longer term impacts of such innovations and is defined as the contribution of mobile phone intervention to broader development goals. Notwithstanding the benefit of studies in the first and second category, scholars in the field have called for more studies within this category (Duncombe, 2011, Heeks and Molla, 2009).

Thus, this current gap in knowledge is filled by this study as it sits within this third category. Specifically, this study seeks to fill this gap by examining the process of deploying a mobile phone intervention geared towards addressing a development goal. Further, in other to deviate from previous studies of mobile innovation that concentrated on the technology as the driving force, or studies that ignore the effects of the technology and concentrated on the human and social interactions involved, this study adopts an actor network theory approach. Basically in socio-technical situations such as implementation efforts of ICT innovations, adopting an approach like ANT (see chapter 3), will enable the researcher by-pass the dualities (social and technical determinism) present in current studies in order to provide a balanced account of events. Considering, that ANT values the contribution of both the human and non-human actors, it will allow the researcher bring both human and non-human entities into the frame of analysis so as to gain deeper insight into the complexities that are part of this process. Further, an ANT approach will enable the researcher examine the actors that may have an influence on the process of implementing mobile innovations and examine the interaction between them

Last but not least, previous studies on mobile phone innovation have mainly reported on pilot efforts. Notwithstanding the contributions of these studies, research that examines large-scale implementation effort of the situation of attempting to implement mobile-phone interventions within mainstream government-led public sector have been found to be limited (mehl et al, 2013). This study addresses this gap in knowledge.

2.8   What comes next?

This chapter provided an overview of the research setting in which this study is carried out. This was closely followed by a review of the key literature around ICTs and development. This chapter also examines the literature on mobiles in developing countries and for development efforts. The chapter concludes with a section on the limitations and gaps in the literature in relation to mobiles in LDCs. The next chapter, which is chapter 3, will provide the basic background of the theoretical frame - ANT, used in this study. It will discuss such things as its emergence and its key concepts. Further, it will shed light on the application of ANT in IS research. Finally, the chapter will conclude by discussing key limitations and concerns associated with this approach.

Chapter 3: Theoretical Framework

..All things are what they are in relation to other things... Latour (1998)

3.1 Overview

This chapter introduces and discusses core theoretical concepts of actor-network theory, the framework underpinning this research. Actor network theory views efforts of technology change, such as implementation of innovations, as the interaction between the technological, the social and political. In this study, this chapter explains the highly useful set of theoretical resources of this theory before using them later on, (in chapter 5 of this thesis) to help interpret the stories that have emerged from the field work.

This chapter first provides a brief overview of ANT, then goes on to review well known theoretical approaches in the field of IS used to study the implementation of information systems as well as situations of technological innovation. These include the social construction of technology (SCOT), actor network theory (ANT), and diffusion of innovation approach, structuration theory and the technology acceptance model (TAM). In reviewing these perspectives, the researcher aims to highlight their strengths and weakness. By doing so, the researcher is able to make a case for why an actor-network perspective was chosen for this study in light of all these other approaches. Next, this chapter will discuss the use of this approach in IS research and in the sub-domain of ICT in developing countries. This chapter will conclude with a discussion highlighting the limitations and concerns raised in the literature about this approach.

3.2   About Actor-network theory

Given that a key element of this research is the methodological application of actor-network theory to the research herein, it is important to commence with an overview of this theory.

Actor-network theory (hereafter referred to as "ANT"), is a compilation of theoretical and methodological principles progressively, which emerged within the Paris Group of Science and Technology Studies (STS). It's early development has been attributed to three key authors: Bruno Latour, Michel Callon and John Law. First and foremost, this theory views the world as networks of technical, natural and social actors (or entities) and treats them symmetrically or as Latour puts it, is viewed as a call for the close empirical study of associations (Latour, 2005). Essentially, the challenge of ANT is to explore how actor-networks come to generate effects, to trace what associations exist, how they move, how actors are enrolled into a network and how networks achieve temporary stability (or not) and how some networks are more successful than others (Mclean and Hassard,2004).

ANT's early research works (mostly in the 1980's), carried out by the three main proponents of this theory, were known to focus mainly on scientific and technological innovation (e.g. Latour,1987) such as Latour's Pandora's Hope, Science in Action and Callon's seminal study (Callon,1986) of the domestication of scallops and fishermen in St Brieuc Bay. However, over the years, this theory has become widely adopted by an ensemble of interdisciplinary researchers who have applied it in their own terms in various areas such as geography (Murdoch,1997), development projects (Mosse, 2004), and other such areas. As a result of this, ANT itself has been described as a heterogeneous network of approaches and anti-approaches that has change over time, resulting in repeated reinterpretations and revisions of the theory, causing many to describe it as being both unstable and lacking a unified body of knowledge (Walsham,1997). However, in recent times, ANT has since re-emerged and currently the best known introductory texts are Latour (1999), Law (2004) and Latour's Re-assembling the Social (2005). For the purpose of clarity, the interpretations of ANT that underpin

this research are mainly the seminal works of ANT, particularly Latour (2005), Callon (1986, 1999) and Law (1986, 1987).

It is worth mentioning at this point though that much of the seminal work written by ANT theorist have been in part, inspired from post-structural semiotics, such as the work of Foucault (1995 and 2003). For example, key writings of Foucault, highlighting how social structures are shaped through relations of different entities and how knowledge and power can be seen as interwoven relational effects, have been adopted by ANT theorists. Indeed, the notion of relational materialism as suggested by Foucault is also adopted by ANT as Law points out that, central to ANT is its emphasis on the 'relational materiality' of our society (Law, 1992). In addition to this, ANT's concept of translation is known to be influenced also in part by the writing of Foucault, Law states that concepts of translation in ANT "owe more than a little to the writing of Foucault" (Law 1986).

That said, another important point about ANT is that, even though it is often referred to as a theory, it is not necessarily a "theory" in the real sense of the word. As its proponents argue: 'the actor-network approach is not a theory...no more than cartography is a theory on the shape of coast lines and deep sea ridges' (Latour 1996, 374).

They go on to add that usually while other social theories try to explain why specific things happen in certain ways, actor-network theory is descriptive rather than foundational in explanatory terms (Law, 2007). Therefore, ANT "is not necessarily a theory of the social, but rather a way in which one can study the social" (Czarniawska, 2007).

Before concluding this section, it is worth mentioning that, in adopting ANT as the theoretical lens in this study, the researcher is aware that until now, ANT is a controversial and still profoundly contested approach of thinking about how networks of actors come into being. However the belief is that notwithstanding this, ANT's rich concepts and its emphasis on the dynamic and relational aspects of a problem makes it a useful lens for studying processes of technological change in relation to development.

3.3 Approaches to researching situations of technology innovation

The often challenging process of embedding technology into the routine of our daily lives continues to remain an issue of concern for scholars and practitioners alike owing to the complexities that sometimes surround this process. In order to better explain, evaluate, understand, manage or predict these situations of technological change (which includes technology innovation, diffusion, adoption, implementation and use), IS researchers have resorted to adopting and making use of various social theories as well as models. When used in studying these situations, these theories have the potential to advance current research and practice. Notable among these are the social construction of technology (SCOT), structuration theory, technology acceptance model (TAM) (Davis, 1989; Davis et al., 1989), diffusion of innovation theory (DOI) Rogers, 2003), and actor network theory (ANT).

Diffusion of innovation theory

DOI (Roger, 2003) is viewed as one of the most dominant approaches in innovation research. It is primarily concerned with explaining and developing theoretical accounts of the distribution of technological solutions within an organisation or social setting and its widespread use (or not). DOI puts forward the assumption that five characteristics of innovation affect the diffusion and subsequent use of a technology, and they are: relative advantage (that is the extent to which a technology offers improvement over currently available tools), complexity (that is concerning its ease of use), trial-ability (the chance to try an innovation before committing to using it), and lastly observability (which is the extent the technologies gains and benefits are clearly demonstrable). Clearly, through these conceptions, the DOI approach can offer something towards our understanding of situations involving technology change. However, as regards this technology and development effort under study, the innovation diffusion approach has a number of limitations which makes it insufficient. For example, when examining efforts of technology change, the DOI is known to focus mainly on the innovation itself (the technology), its innate characteristic and how these may help or hinder the adoption;

while failing to challenge the implementation of the technology (Dı́az Andrade, and Urquhart, 2010). This indifference of the DOI (towards the implementation process) makes it an unsuitable approach for this study as one of the main objectives is to be able to provide a rich and detailed description of the processes and events that make up this effort. Also, it has been noted, that the DOI fails to provide answers to some of the pertinent questions being raised by those seeking to better understand technology-and-development efforts (such as development practitioners and researchers).

For example, it fails to address questions that centre around issues of alliances and network formation, for example understanding how alliances fall apart (or alternatively how they become stronger over time), or even how the interest of actors advance (or fail to) during such efforts and the consequence of this on the project outcome. Notably, its silence on these issues can results in providing an impoverished understanding of what actually takes place during such development projects as specific events are omitted in such accounts. Therefore, it is sufficient to say that the ideas within this theory are not tailored in such a way as can assist in the study of this phenomena as a process, neither can it assist in understanding salient issues within the processes, such as listed above. Overall, the DOI theory is a less appropriate approach for this study.

The next theory that has been used as a valuable framework for understanding and explaining IS implementation efforts and situations of technology change both in organisations and society – is known as: Structuration theory. Structuration theory has been widely used in the information system field by a large number of researchers. Evidence from the literature has shown that this theory has provided many researchers with valuable insight into the social process relating to the adoption and use of information systems and situations involving technology change. Essentially, structuration as a theoretical approach concerns itself with understanding the relationship between the activities of knowledgeable human actors and the structuring of social systems (see Giddens, 1987). The main concept of this theory, known as "the duality of structure" simply means that structural properties are at the same time the result and medium of practices which are

organized in a recursive way. In other words, this notion of Gidden's is saying that only through action and interaction are structures themselves reproduced. A particular appeal of this approach is the author's insistence on a non-dualistic account of the structure/agency relationship and its dynamic conceptualization of structure as being continuously produced and reproduced through situated practice (Orlikowski, 2000). All in all, structuration theory does provide researchers investigating situations of technology change with a new perspective to better understand the interaction between user and information technology, the implications of these interactions, and the way to control their effects (Pozzebon and Pinsonneault, 2005).

However, despite the extensive use of this approach, the use of structuration theory in information systems research has been subjected to several critiques (Orlikowski 1993, Monteiro and Hanseth, 1996). Monteiro and Hanseth (1996) argue that this theory is not overly concerned with the interactions between individuals and technology. They go to point out that this is because that the concepts in this approach do not naturally lend themselves to examining in-depth the relationship between individuals and technology, neither do they allow detailed questioning of the relationship between individuals and technology. They explain further by listing some key concepts such as actors, networks, moments of translation and inscriptions (Monteiro, 2000), that can be found, specifically within theories that belong to the STS perspective, such as actor network theory (ANT).

In a similar vein, (Orlikowski and Iacono, 2001) also lend their voice to this debate. They go on to argue, that the conceptions of structuration, do not allow the researcher to deeply engage with the IT artifact. Given that Orlikowski and Iacono's (2001) claim for more emphasis on theorising the IT artifact in IS research has been welcomed by many IS scholars (see Monteiro and Hanseth 1996), then structuration theory is seen as limiting in this regards. Therefore, it is considered that this approach will not be suitable for conducting this study as the research seeks to heed the call of IS scholars (see Orlikowski and Iacono, 2001) about theorising the IT artifact by exploring in detail the interactions between the IT artifact and its social context.

To achieve this, the researcher will need to adopt a theory whose vocabulary makes room for investigating the links between social and technical elements.

Another important critique of this theory concerns its relative neglect of technology. For Giddens, structure does not exist in material artefacts, such as technology, but in human memory traces and are seen to be enacted through social practices (Jones and Karsten, 2003). Monteiro and Hanseth (1995) present the following critique of structuration theory's relative neglect of technology by compellingly arguing that,

"Our principal objection to conceptualizations like (Orlikowski and Robey 1991; Orlikowski 1991; Orlikowski 1992; Walsham 1993) is that they are not fine-grained enough with respect to the technology to form an appropriate basis for understanding or to really inform design (Monteiro and Hanseth 1995, p. 330)".

From the above, it is clear that this approach, when used to understand IS phenomenon, relegates technology to the background and fails to grant it an active materiality during analysis. The implication of this is that, studies examining information systems innovation based on theories such as structuration will not be able to address the role of technology in a proper way (Hanseth and Aanestad 2004:117) and, this can result in creating a poor understanding of the role of technology in the situation under study. Therefore for the conduct of this study, the researcher seeks an alternative approach that brings technology into the frame of analysis, not in a passive way but in an active way, enabling the interrogation in detail of the role technology plays in efforts of this kind so as to achieve a balanced account of events.

The Technology acceptance model (TAM)

TAM is yet another popular approach used in the IS field to gain a better understanding of technology adoption and use. This perspective, as propagated by Davies 1989, is a derivative of the theory of reasoned action (TRA).TAM, is primarily concerned with predicting the acceptance of information systems and new technologies. According to this theory, acceptance and use of a technology is determined by two factors, namely: perceived usefulness (the degree to which a

user thinks that engaging with the system will enhance his or her performance) and perceived ease of use (the extent to which the user believes that using a system will be free from effort). Notably, within the IS field, this theoretical approach has been tested by a large number of researchers and found to be robust in predicting as well as explaining users' technology acceptance in IS related studies.

For example Agarwal and Prasad (1997), Taylor and Todd (1995) and Keil et al. (1997) are among those that have used this theory to examine the introduction of office automation software as well as systems development applications. Despite the usefulness of this theory in this regard, TAM (as well as its revised versions, such as TAM2 (Venkatesh and Davis, 2000) has been criticised for leaving out significant factors relating to both human and social change processes (Legris et al, 2003). In other words, the problem with adopting a TAM perspective for this study is that it tends to sit somewhat within the techno-deterministic perspective hence paying little attention to the interlinked effect between the technology and the social. Arguably, since this research considers a socio-technical perspective on ICTs as the most appropriate for understanding the social process of the introduction and use of mobiles in the public health sector, TAM will not be an appropriate theory for this study as it fails to address more directly the characteristics of the material world. Also this approach to the study of technology, like most traditional approaches is criticized for focusing mainly on assessing outcomes and impact and failing to go a step further to assess such things as the factors causing the technology to have such impact. Further, the ideas and concepts of TAM, are not well suited to providing rich detailed descriptions that can allow the researcher to understand such things as relations (between individuals and technology), processes and agency. In sum, since the research is keen to understand such things as relations between actors, etc., TAM will not be a suitable theoretical approach for this study.

Social construction of technology (SCOT)

Social constructivism is an approach that emerged from a long-standing critique of the techno-determinism perspective. SCOT, as proposed by Trevor Pinch and Wiebe Bijker (1987), has been used as a method for analysing the history of

technology. Essentially, Pinch and Bijker offer a process for understanding how social factors concurrently influence artefacts by presenting a valuable model for understanding particular technological innovations. Specifically, in their model, they outline four components to the social construction of technology, namely: relevant social groups (this basically refers to the users of the technology first and foremost and then other such actors like producers, implementers and even politicians - through which the IT artefact is described through their eyes), interpretive flexibility (denotes that a technological artefact can have different meanings and interpretations for the different actor groups and these different interpretations can co-exist together as they are dependent on desired outcomes), closure and stabilization (refers to the point where design of the artefact ceases and no further modification is required because the artefact is now able to address the specific problems of all the relevant actor groups) and lastly the wider context (this refers to the wider socio-cultural and political setting in which the IT artefact is developed or implemented). These components or foundational concepts as they are sometimes called have proven useful for researchers as they have been successfully applied in a large number of technology studies.

Despite the usefulness of the SCOT approach, it has still been found to be somewhat unsatisfactory by many. For example, in their rejection of technological determinism, SCOT and social shaping theorists are being accused of a form of social determinism since they place a lot of emphasis on social choices and environment at the expense of technical consideration (Howcroft et al, 2004). That being the case, the SCOT approach will not be suitable for this study as the research seeks an approach consisting of conceptual tools that can enable a better examination of the technology and at the same time the particular processes and the wider context that surround the technology effort.

Having looked at some of the key social theories used in IS research, an overview of ANT of which will highlight its suitability for this study will now be discussed. Before that, it is important to mention that while many of the frameworks discussed so far in this section will no doubt be useful in researching situations involving technological change, they are considered insufficient for this study as none of them

would be suitable on their own as a theoretical lens for meeting the objective of this research.

About actor-network theory? Actor Network theory (ANT) even though an approach within the science and technology studies (STS) perspective like SCOT, differs greatly from SCOT in terms of its analytical approach. Otherwise referred to as the 'sociology of translations' (Callon 1986; Law 1992), is an increasingly valuable tool in the social study of technology. This distinctive approach is concerned with studying how sets of human and non-human entities with diverse interest come together to create relatively stable networks, which mean that in these networks the breaking down of associations is less likely (Latour, 1992; Law, 1999).

Essentially, the fundamental (ontological) assumption underlying this approach is that social reality is actually a complex network of relationships that always involve human and non-human entities. In other words, ANT can be seen as a kind of relational materialism (Law and Mol, 1995) in which networks of relations develop via negotiations and trade-offs between actors; where each actor is understood as not having any innate capacities or attributes other than a capacity to negotiate with other actors in forming relationships.

A key aspect of the ANT approach is it's assertion that both social and technical determinism are flawed, hence it promotes a socio-technical account (Callon and Latour, 1981), in which neither the social nor the technical is privileged. According to ANT theorists, what appears to be social is partly technical and what appears to be technical is partly social (Law, 1991). Based on the above viewpoint, a major focus of ANT, is to provide a rich approach for understanding the building of socio-technical networks of aligned interest. Specifically, it explores the ways whereby relatively stable networks of aligned interests are created, maintained and stabilized over time -alternatively, determining why such networks fail to stabilise or establish themselves over time.

ANT suggests that successful social networks of aligned interests are created when the focal actor(s) enlist other actors to invest in or follow a particular program

(enrollment); and the translation of their interests so that they are willing to participate in particular modes of thinking and acting that maintain the network (Callon, 1986). ANT thus offers a distinctive approach to theorising situations of technology change, such as the introduction and use of new ICTs in healthcare settings.

WHY ANT?

Some of the key tenets that make ANT distinct from other approaches and thus a well suited approach for the conduct of this study are presented below:

•   Its insistence on anti-dualism: by dissociating itself from what can be termed "methodological dualities" (such as social vs. technical; micro vs. macro; local vs. global; inside vs. outside; agency vs. structure, etc.) that are common in the social sciences, ANT allows technological change situations to be researched from a neutral position, hence giving better insight about the phenomenon under study.

•   Its insistence on anti-determinism: ANT tries to avoid both forms of determinism, in other words it is neither technologically-nor-socially deterministic. It achieves this through its attempt to by-pass the distinction between the so-called social and natural (that is technological) world (Callon, 1986) and regards efforts involving the introduction and use of ICTs as a process of network building. Thus, by avoiding both forms of determinism, the researcher is able to focus on a socio-technical account in which the social and technical are inseparable but where all the actors "co-evolve (Latour 1991). This kind of viewpoint is indeed significant because it offers this research the conceptual basis for a holistic narrative in studying the patterns of event contained within the technology effort under study.

Further reasons for the choice of an ANT approach in this study has been explained most clearly by Heeks (2013). Basically, he argues that, in studies of technological innovation especially in a developing countries context (where some form of development benefit or goal is anticipated), an ANT approach is valuable for the following reasons:

• ANT's focus on detailed descriptions of situations offers researchers the opportunity to study technological processes from a dynamic, human perspective.

• It recognises the active role played by technology in technology innovation efforts. This contribution is significant in that material objects or non-human entities (such as technology) which are normally side-lined by most approaches are equally brought into the frame of analysis, thus allowing them an active materiality which exposes the role they are able to play during such processes.

• It helps explain the micro-politics of technological change and the associated modification of goals, identities and interests, through the notion of translation. In this, ANT demonstrates its value and ability to uncover the rich detail of efforts in development areas that can otherwise be overlooked.

• ANT is largely concerned with the interactions between technology and the social (eg. individuals). Thus it provides IS researchers with rich concepts (such as actors, networks, etc.) and a language, generally speaking, that allows the interrogation in great detail of how technical and non-technical mechanisms can form a network of actors.

In sum, for the researcher seeking to describe in great detail as well as understand the processes and events surrounding ICT interventions in LDC, ANT's language and concepts and underlying principles have the potential of opening challenging questions and exposing patterns in events in such rich ways that can bring to light the complexities and sometimes issues that are embedded in such efforts causing them not to become established or succeed over time. Interestingly, because of its ability to focus at the actor level, details of these failures of new ICTs to embed or become durable as caused by an actor can be elaborated.

3.4 Explaining key concepts of Actor-Network Theory

In support of ANT's effort to by-pass essential differences, ANT provides us with a particular language or vocabulary. Some of the key terminologies that form part

of this language are explained in this section, in order to facilitate further understanding of this approach.

The concept Actors/Actants explained

The first of this is the term actors otherwise known as actant. Law describes an actor as any entity that has the ability to act or to which activity is granted (Law, 1986). He goes on further to say that this ability to act is not restricted to humans alone but also non-human entities such as biological elements, institutions, scientific and technical artefacts and so on and so forth - hence the use of the term and concept actant. According to Howcroft et al, (2004) the use of the term actant for both human and non-human actors is a consequence of the undertaking not to make a priori distinction between what is technical and what is not. They go on to add that this concept allows the researcher to discuss, in a non-deterministic way, the "impact" of socio-technical networks.

Callon, together with Law, provides an example which better explains how non-human entities come to qualify as actants. They do this by inviting people to consider the way in which a telephone can cause a person to act. They state that although a telephone may appear to be an ordinary, passive technology, this impression changes when the telephone rings.

Even if one decides to ignore the call, the telephone has still provoked a decision making process and elicited a response (Callon & Law, 1995). Ant uses this example to demonstrate that non-human entities such as technologies also possess the ability to act upon humans, shaping their subjectivities as well as their actions (Dolwich, 2009) and for that reason, proponents of ANT assert that non-humans, be also considered actors.

Still on the concept actors, Latour categories actors into intermediaries and mediators. He explains that while intermediaries are actors that can be counted as stable; as a black box, where knowing the input is as good as knowing the output,

this is not the case with mediators as there is less certainty with this kind of actors. (Latour, 2005, p.39).

Intermediaries

In ANT, intermediaries play a fundamental role and can be described as anything that circulates between actors and help define the relation between them (Latour, 2005). The notion of intermediary covers diverse and heterogeneous materials such as drawings, texts and inscriptions (reports, scientific articles, laws and regulations, stories, etc), software, disciplined bodies, contracts and money in all forms (Gherardi and Nicolini, 2005).

In the words of Latour, while an intermediary, "transports meaning or force without transformation" (pg. 39), mediators, unlike intermediaries, "transform, translate, distort, and modify the meaning or the elements they are supposed to carry" (pg. 39). In other words, objects that describe mediators transform meaning whereas objects that describe intermediaries do not transform.

A pertinent question posed by ANT enthusiast, is how do we make a distinction between mediators and intermediaries? For Latour, this is the first uncertainty in Actor-Network Theory; that is, whether or not objects behave as intermediaries or mediators, and it is also the source of all other uncertainties that follow. However, he offers some explanation by stating that while intermediaries account for predictable outcomes, mediators, unlike intermediaries are unpredictable. For example, a mediator may become complex and blow out in multiple directions like a banal conversation "where passions, opinions, and attitudes bifurcate at every turn" (Latour, 2005, pg. 39)

The concept of Network explained

Moving on to yet another central tenet of ANT, that is the term network. Within the social sciences, the understanding of this concept differs from its use in ANT. Within the social sciences, while network is primarily understood as a medium or channel between nodes that transports messages without deforming them (Latour,1999), in ANT terms, the notion of networks points towards chains of

associations between both human and non-human entities. These networks are more like an interactive assemblage of a number of actors. They are multiple and relationally heterogeneous (Murdoch, 1997), involving the alignment of a number of materials that we tend to tag as technical, social, natural etc. In effect, by using the metaphor network, ANT seeks to draw our attention to both the simultaneously social and technical attribute that underlie any social arrangement and the interconnected heterogeneity that underlies socio-technical engineering (Law & Callon, 1988).

A key attribute of a network, is that it leaves a physical trace of some prior activity (that can be followed by a researcher and recorded empirically). As pointed out above, these networks tend to mirror both the multiplicity of materials used in its construction and also the relations established between its combined elements (Dolwich, 2009). If, all the elements within these networks act in unison and if these networks become successfully established, it then follows that these networks will automatically take on the properties of actors (Latour, 1987; Law, 1994), which brings us to the term actor-networks.

As Law puts it, the concept actor-network is deliberately 'oxymoronic' as it refers to a centred actor, on the one hand, and a decentred network, on the other (Law, 1997, p. 3). What this implies is that both terms are linked such that one cannot be defined without the other. Callon explains this concept better by stating that "an actor-network is reducible to neither an actor alone nor a network ..... as an actor-network is simultaneously an actor whose activity is networking heterogeneous elements, that is, many dissimilar elements and at the same time a network that is able to redefine what it is made of" (Callon, 1987; p.3).

Therefore, the hyphen between the terms actor and network is essential as it does not hold the terms actors and networks apart, rather it draws attention to the inter-relationship between them as defining each other in action.

Law contributes to the discussion on the concept "actor-network" by pointing out that an actor is not only a "single node" but also an assemblage of heterogeneous elements themselves constituting a network, therefore making an actor also a

simplified network at the same time (Law, 1992). Callon (1986a) presses on this argument by likening an actor to a black-box that appears naturalised and immutable thus concealing from our view all the negotiations that has brought it into being. However, when the lid of this box is opened, it will be seen to constitute a whole network of other, perhaps complex, associations (Callon 1986).

Law tries to illustrate this concept by using a working television as an example. He outlines that," for many of us, most of the time a television is a single and coherent object with relatively few apparent parts. However, when it does breaks down, for that same user – and even more so for the repair person – the television rapidly turns from a single actor into a network of electronic components and human interventions. Law goes on to explain that from the above example, the reason why sometimes we don't get to see the network that lies behind the actor is because the network is effaced into one single actor due to a "precarious simplificatory effect" which actor-network theorists refer to as punctualisation (Callon,1987; Law, 1992, p.385).

Latour has consistently argued that punctualisation is a process or an effect, rather than something that can be achieved once and for all time. He also draws our attention to the idea that the punctualised state of a network i.e. the disappearance of the complex actor-networks and the appearance of unity as it were, is one that is always precarious. The reason for this is that the punctualised actor-network that is the "single node or point" can face resistance and have its stability threatened at any time by roles played by other actors either internal or external to the actor-network (Law, 1992). As a consequence, there is a high tendency of the once "punctualised" or "black-boxed" actor-network degenerating into a failing network, hence appearing again as a complex assemblage of actors. For this reason, Latour presses on this argument by advising that, since networks have a very high tendency of becoming precarious, in order to prevent it from falling apart, continuous work is needed so as to sustain its linkages (Latour, 2005).

Moving on to consider other key tenets of ANT, Callon (1986) is again consulted. ANT puts forward three methodological principles namely: the principle of agnosticism, generalized symmetry, and free association (Callon, 1986) as it seeks to address the need to treat both human and nonhuman actors fairly and in the same way.

The first of these tenet agnosticism (Callon, 1986), calls for the abandonment of any a priori assumptions of the nature of networks, causal conditions. In research terms, this simply means that analytical impartiality is demanded from the researcher, as he or she is required to refrain from judging the actors whether they be human or non-human actors.

Second is the principle of generalised symmetry, an extension to the social epistemology principle of 'symmetry'. Essentially, it insists that the concept of "actors" be also extended to include material objects. As Law puts it: To insist on symmetry is to assert that everything deserves explanation and, more particularly, that everything that you seek to explain or describe should be approached in the same way (Law, 1994, pp. 9-10).

For the researcher, what is required here is that humans are not treated any differently from nonhumans, nor are they given any special explanatory status, as everyday objects, technologies, texts, furniture, plants ...and all things generally are assumed to be capable of exerting force, joining together, changing and being changed by each other. Consequently, in Callon's widely cited paper (Callon, 1986) he warns that researchers should not shift registers when moving from concerns of humans to that of non-humans. Instead, he demands that we analyse both in the same terms by the use of a neutral vocabulary that works the same way for both entities, hence avoiding any form of discrimination (Callon, 1986; Latour,1987, Law, 1987).

Murdoch (2005) tries to elaborate on this principle further by saying that "In a network, all entities are assembled 'symmetrically': such that, the natural entities are just as likely to be active as those labelled 'social', so, the process of 'construction' cannot be seen as emanating from purely social or human causes."

(2005: 67). Law adds to this debate by pointing out that this radical ideology is simply 'an analytical stance, and not an ethical position (Law, 1992, p.4).

Lastly, is the principle of free association where it is demanded that the researcher abandons all a priori distinction or pre-given categorisation between classes of possible actors (technical, natural, global, local, social etc) and instead focus on the process of network building and formation (Callon, 1986). As Callon (1986:200) puts it: "The rule which we must respect is that we must not change registers when moving from the technical to the social aspects of the problem to be studied".

In sum, under the principles of agnosticism, generalised symmetry and free association, it is evident that ANT aspires impartiality towards all actors within a given actor-network, whether human or non-human, and insists that we make no distinction in approach between the social and the natural (that is technological). In effect, it is sufficient to say that these principles highlights a major position of ANT which is that the world consists of heterogeneous relations where human and non-human entities are treated fairly and in the same way as possible and that agency is not an exclusive attribute of humans alone but on the contrary "objects have agency too" (Latour 2005,p63).

The sociology of translation explained

Still on terminologies, I now proceed to discuss a key term that lies at the centre of the actor-network approach and can help us better conceptualise what goes on during the formation of networks, that is, the concept of translation.

'Translation' (in this case) refers to the effective persuasion of actors (by the focal actor) that it is in their interest to use a particular technology in a given manner - as the technology is the answer to the(ir) problem. In order for the focal actor (s) to enlist other actors into his/her plan, the focal actor(s) basically reinterprets and displaces the interests (goals, problems, solutions) of the other actors, in a bid to align those actors' interests with his own interest (Callon, 1991). During this process of translation, what also tends to happen is that the focal actors (s) play the role of "an obligatory passage point" through which the other actors can realise their

own objectives. The focal actor is also responsible for ascribing roles for the other actors and seeks to stabilise their identity. Thus, through this process of translation (where actors align the interests of others with their own) networks progressively take their shape as certain actors exact control over others within the network (Heeks and Stanforth, 2015).

On the issue of translation, Latour identifies five translation strategies (Latour, 1987, pp.108-121) the focal actor(s) or network builders can adopt, in order to pursue their interest despite the personal interests of the other actors. These strategies are briefly discussed below, in relation to the technological effort described in this thesis.

The first translation strategy relates to the focal actor of this effort tailoring this initiative in such a manner that it "appeals to the explicit interest of the other actors". This approach is considered the most reliable strategy in terms of "locking in" the interests of all the actors concerned in this effort. The second strategy has to do with the focal actor mobilising the other actors towards the goal of this effort. In order words, the focal actor of this effort will have to displace or shift the explicit interests of the other actors towards his/her interest using such tactics like persuasion. The third strategy suggested by Latour requires that the focal actor creates a good detour by blocking the other actors off from any other path being followed while cutting out a new path (the actors solution) for them to follow, employing tactics such as seduction if need be. This action taken by the focal actor can be translated to mean "you cannot reach your goal straight away, but if you come my way, it will be a short cut and an easier way, so you can reach it faster". According to Latour, the success of this strategy will largely depend on the path being cut off or the new detour, among other such things. The fourth strategy has to do with the focal actors attempt to rid other actors in the network off any explicit interest they might have. This strategy could be achieved by adopting different courses of action such as the focal actor aligning his/her solution with a particular problem faced by the target actor(s), making the process of detour invisible to the other actors etc. The fifth and final translation strategy has to do with the focal actor rendering him/herself as indispensable. In effect, the five strategies described above can actually result in

making the focal actor indispensable, which, if this happens then implies that translation has been successful.

Callon also writes about the concept of translation, with a specific focus on what he termed "the moments of translation". The basis for this approach is Callon's (1986) widely read seminal paper on the story of scallop fishermen in St. Brieuc Bay in France and a scallop breeding program proposed by a group of research scientists. Following their endeavour, Callon identifies the translation process as having four moments which he says are in reality intertwined and interact with each other. He named these moments - problematization, interessement, enrollment, and mobilization (Callon, 1986).

These moments, of which constitute the different stages of the translation process, serve as an "organising tool" for researchers seeking to apply ANT in studying how networks are formed in situations or efforts involving implementing or adopting technological innovation.

The figure below provides a brief synopsis of the four moments of translation. A discussion of these moments will follow subsequently.
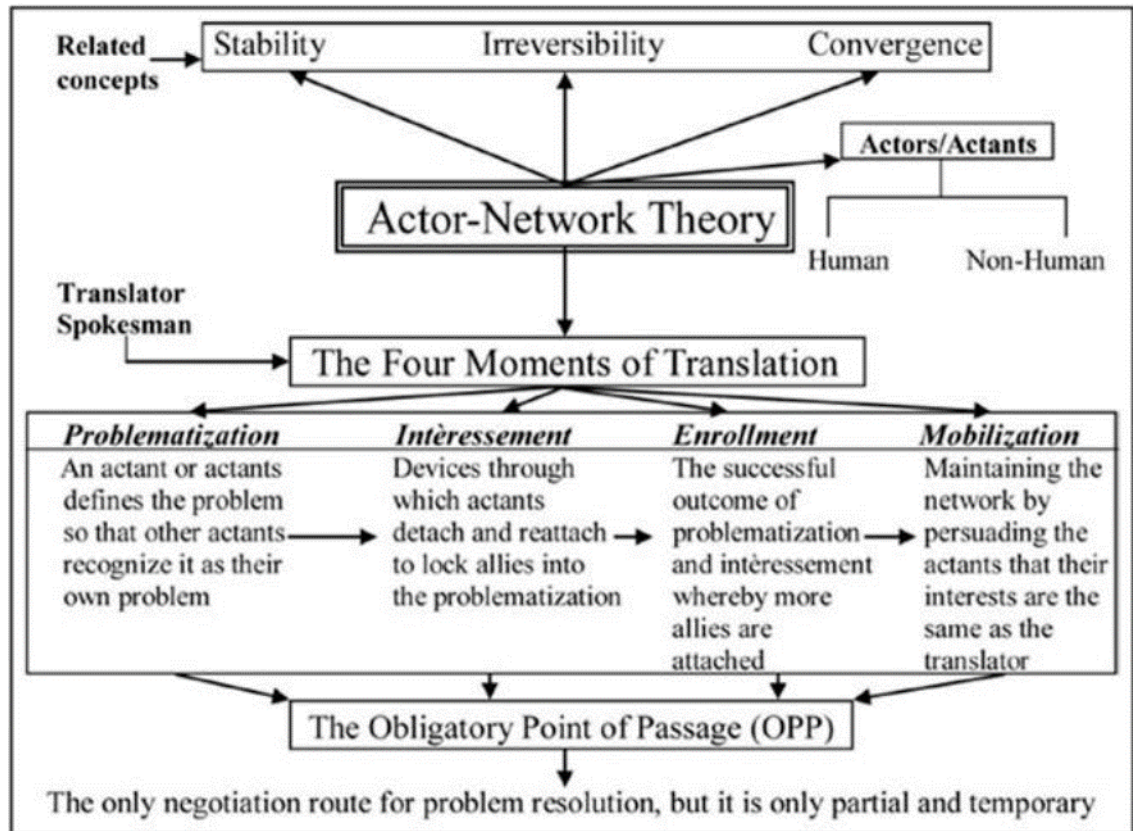
Figure 3-1: Four moments of translation and other key analytical constructs of ANT (Rhodes, 2009)

Problematization

Callon uses this term to refer to the identification of the problem. The term problematization is used as opposed to problem definition for two primary reasons, First, it highlights how the problem definition emerges from a performance and not just from a perspective (Mol, 1999) and secondly, it implies that the problematization process is an on-going event, not a singular one, as it can take place repeatedly depending on the focal actor(s)' efforts to convince others to subscribe to his/her own view.

In an effort to achieve translation, the focal actor may suggest that it shares a "common" problem with supposed allies - this is known as problematization (Callon, 1991). A key action that characterises the problematization moment is that the focal actor(s) of the initiative makes an effort to persuade other actors that he/she

has the necessary skills, knowledge and resources to bring about a solution to a "common" problem. In this moment, in addition to establishing roles and identities for the other actors, the focal actor(s) goes on to make themselves indispensable by establishing him/herself as an 'obligatory passage point' commonly known as the OPP. The OPP refers to a situation that must occur for all the actors to achieve their interests when a change in a network is introduced (Callon, 1986). To pass through the obligatory passage point, the other actors must accept a set of specific conventions, rules, assumptions and ways of operating laid down by the focal actor (Tatnall, 2009).

Interessement

Interessement as the term implies, is concerned with the action of building interest. As Callon puts it, "it is the group of actions by which the focal actor (s) attempts to impose and stabilise the identity of the other actors it defines through its problematization". Put this simply, the Interessement involves a process of persuasion of the other actors in this emerging network to make them become interested in the proposed solution. To achieve a successful interessement, the focal actor needs to employ different methods which may include the creating of incentives for other actors if necessary to "lock-in" the interest of the other actors so that they can perform the roles assigned to them and refrain from considering alternative courses of action. If this Interessement process is successful, then, the third moment of translation, known as the enrollment, occurs (Callon,1986).

Enrollment

Callon posits that interessement does not necessarily lead to successful alliances and eventually translation of interests. Rather, as pointed out by Walsham, "successful networks of aligned interests are created through the enrollment of a sufficient body of allies, and the translation of their interests so that they are willing to participate in particular ways of thinking and acting which maintain the network" (Walsham, 1997). Consequently, in seeking to maintain and stabilise the actor-network, it is important that the interessement moment be reinforced by a key moment referred to as enrollment (Callon, 1986). Callon (1986: 211) describes

enrollment as the group of multilateral negotiations, trials of strength and tricks that accompany the interessement, enabling them to succeed. Put simply, enrollment involves a somewhat political process whereby the focal actor(s) engage(s) in continuous persuasion and negotiations so as to convince other actors to embrace the underlying ideas of the emerging actor-network and also to keep the behaviour of the other actors in line with the specific technological arrangements (Allen, 2004). It has been noted however that sometimes, persuasions or even negotiations are not always needed to achieve enrollment. The reason for this is that in some instances, some actors willingly accept or buy-in to the solution proposed by the focal actor and as such they are enrolled into the actor-network without any resistance.

Mobilisation

The fourth, and final, moment of translation mobilisation is about stabilizing the actor-network by making relations durable and irreversible. During this stage, the notion of representation comes into effect as the focal actor borrows the force of allied actors, mobilising them and assigning them the role of spokesperson, to speak for one or more entities. During this moment, the focal actor uses a set of methods to ensure that these allied actors act according to their agreement and would not betray his/her interest (Callon, 1991). For the mobilisation process to be described as successful (i.e. the actor-network has achieved stability), it will require that all actors now "speak with one voice". This simply means that all actors within the network are working together as the proposed solution has gained wide acceptance, become institutionalised, 'black-boxed' and is no longer viewed as controversial.

While the above presentation of the moments of translation may seem to suggest that this process is one that is always linear and sequential, Callon (1986) argues that more often than not, the process of translation is neither linear nor deterministic as it is difficult to predict what entities are capable of doing when they come together. Consequently, he warns that the moments (as outlined above) have the potential to overlap and sometimes occur in a disorderly and iterative manner. Also, on the moments of translation, Mahring et al. (2004) concur by stating that sometimes, the translation process does not necessarily pass through all the

moments (as described above), as there is the possibility that the translation processes can fail and stop at any stage. This argument, implies that actor-networks are indeed unpredictable, and that situations whereby all the moments of translation are achieved i.e. the translation process becomes successful, is difficult and also quite uncommon. This is especially the case when the interest of the actors in the network has failed to align. Consequently, the situation occurs where the actor-network becomes unstable and fails to establish. Subsequently, the network could either become disbanded and disappear as quickly as it came or it may need to be reconstituted again, possibly in another form.

However, if the four moments of the translation process are realised in full, then the stability of the network can be seen to be achieved and the notion of irreversibility has been established. This notion of irreversibility, simply refers to the degree to which it is subsequently nearly impossible within a network to go back to a point where alternative possibilities exist (Callon, 1991).On the notion of irreversibility, Hanseth and Monteiro (1998) point out that irreversibility is often the result of the inscription of interests into technological artefacts, whereby those interests become increasingly difficult to change. In effect, irreversibility can be viewed as a natural end-product of the establishment of a network.

Inscriptions explained

Another important concept of ANT besides the moments of translation, that is critical to the formation and stabilising of actor-networks is the notion of inscriptions. An inscription is the result of the translation of one's interest or social agenda into material form (Callon 1991, p.143). Such social agendas can be inscribed into virtually any material or medium including formal discussions, public declarations, texts, and technical objects (Callon 1991). Hanseth & Monteiro (1997) highlight four interesting aspects of the notion of inscriptions, which are:

• What is inscribed - that is which anticipations of use are envisioned;

• Who inscribes them;

• How these anticipations are inscribed - that is what the material for the inscriptions is;

• How strong are the inscriptions - that is the degree to which an inscription succeeds in enforcing a desired behaviour.

The process of inscription is critical to building networks, as most artefacts within a social system embody inscriptions of some interests. Compared with translation, inscription to a large extent tends to occur simultaneously and interrelatedly; it starts as soon as a technology enters the picture and is beginning to be formed by its "creators" (Akrich, 1992; Latour, 1992).

Through processes of inscriptions (as well as translations), focal actors/project planners are able to embed their social agendas or interests into material artefacts, such as IS/technologies. Then, as these information systems or technologies become diffused in social settings where they are assigned relevance, they help the focal actor of the network achieve control and socio-technical stability (Latour, 1987). Also, as the inscriptions become stable, over time, they are less likely to be challenged or questioned.

Having discussed actor-networks and the moments of translation, this section now concludes with a summary of the key points relating to both the process of translation and network-formation. Drawing from Murdoch (2005, p66 - who also draws from the work of Latour) this research highlights the following salient points:

First, processes of translation must be enacted so that the actors and entities are enrolled into network relations.

Second, translation means that the enrolled actor is persuaded to identify with the network. This may require some modification in the actor's identity and/or it may mean some amendment in the shape of the network to accommodate a new actor.

Third, the process of translation can be implemented either consensually or coercively, or through some combination of the two. In other words, actors can be

persuaded to join a network because they believe it is in their interests', or alternatively they can be forced to join against their 'interests'.

Finally, once enrolled into the network, the relations between entities must be stabilised. These stabilisations are often delegated to non-human entities such as technologies, because materials are considered to be generally more stable than human actions.

3.5   Actor network theory in Information Systems Research

Actor-network theory has been highly influential in the discursive processes of implementing information systems as well as situations involving technological change. Over the course of the 1990s, there has emerged a growing body of IS researchers (particularly within the interpretivist context) using ANT to address the role of technology in social settings and the processes by which technology dynamically shapes and is shaped by social elements in a given context (Walsham, 1997, Monteiro and Hanseth, 1996). Within the IS literature, it has been observed that those researchers that employ ANT as a theoretical lens, or better still a descriptive methodology in the study of IS development and use, do so with the intention of:

Examining more than just the technological system, or just the social system, or even the two side systems side by side; ... but the phenomena that emerge when both interact (Lee 2001: iii).

Observation of the IS literature points out that ANT clearly distinguishes itself from other theoretical approaches in the IS field that seek to provide explanations for understanding IS phenomena, especially situations involving the introduction and use of technology. For example, ANT supports the IS researcher in being more specific about the technology when studying IS phenomena. As argued by leading IS researchers, this important area has largely been ignored by most social theories such as Structuration Theory. For example, Hanseth and Aanestad (2004:p117), in

their introductory paper to a special issue of ANT in the Information Technology and People journal, highlight this point by emphasising the supremacy of ANT over other popular theories in the field such as structuration and institutionalism. They go on to state that:

'The Structuration theory approach has been picked up by a vast number of scholars and a wide range of studies have been carried out. These have given us many valuable insights into the social processes related to adoption and use of information systems. There is one aspect of these studies that is of crucial importance here. That relates to the role of technology in these studies as well as the theories they are based on. These go equally well (or more precisely, badly) for both Structuration theory and institutionalism. The studies of information systems based on these theories do not address the role of technology in a proper way. This fact is largely a consequence of the fact these theories totally ignore technology. This makes ANT – and the technology studies part of the STS Field – different. And in this respect, ANT offers some unique and very important contributions to information systems.'

As noted in the quote above, ANT's attention to the important role played by technology in sociotechnical networks makes it well suited to the study of IS phenomena and situations involving technology change. A second example has to do with ANT's ability to provide alternative explanations of the nature of the dynamics of the interplay between technology and people.

Within the IS field, it has been observed that conventional models of analysis of this interplay have sometimes sat within the "structurational" perspective (Orlikwoski 2000, Walsham 1993), which pays consideration to only one aspect of this interplay, that is the process of social construction of technology. This perspective fails to consider that the characteristic of the technology is an important element to consider when seeking understanding regarding the possible ways technology can be shaped (Law 1992). Inadvertently, it implies that technology plays no role in the development of technology. On the other hand, observation of the literature has also shown that the analysis of this interplay can sit within a techno-deterministic perspective. In this understanding, technology is seen to develop independently from social contexts but directly affect society (Cordelia and

Shaikh, 2004). This basically implies that the development of technology follows its own logic and the technology determines its use (Winner, 1977 in Hanseth and Monteiro, 1997). Presently, the majority of researchers in the field adopt an intermediary stance somewhere in between the two positions discussed above. According to Monteiro and Hanseth, a large number of these accounts end up with important but crude insights. One such key insight that cuts across most theoretical frameworks, such as structuration theory and hermeneutics, is that IT enables and constrains (Orlikwoski and Robey,1991).

However, the use of ANT in the IS field offers an alternative explanation (beyond the enable -constrain distinction) which allows for a richer conceptualisation of the interplay between the IT artefact and people. Specifically, many IS researchers argue that ANT brings closer a more detailed understanding of information technology and its use (Akrich and Latour, 1992; Callon 1994). ANT is able to achieve this through its rich vocabulary, which goes a long way in describing which, and how actions are enabled and constrained (Hanseth and Monteiro, 1997).

Actor-network theory views society as a completely interwoven socio-technical web in which the technology and people are considered equal and co-defined. In line with its semiotic roots, ANT grants the same explanatory power to artefacts and people. By doing this, it helps to reconsider socio-technical relationships. More specifically, ANT suggests not distinguish a priori between technical and social elements of this socio-technical web but rather encourages a detailed description of the mechanisms at work which seek to hold the network together. This perspective holds promise for the IS researcher as it has the potential of enhancing both the level of accuracy and detail.

The alternative explanations, as offered by ANT, have been found to provide valuable insights into the study of diverse IS phenomena such as: information systems implementation; organisational change efforts, systems design, development of IT infrastructure, the institutionalisation of new ICTs in diverse context, evaluation of IS projects among others.

Some IS researchers who have applied ANT to the study of the implementation process of certain technologies include Vidgen and McMaster, who studied the implementation of an automated access control system for a car park (Vidgen & McMaster, 1996) and Scott and Wagner (2003) who analysed the implementation of enterprise resource planning systems into an academic administration. Elbanna, (2008) also applied ANT as a critical lens to her study of the implementation of an enterprise resource planning (ERP) system in an international organisation. Specifically, she applies ANT to explain the notion of project drift and also to demonstrate the impact of other projects on (software) implementation effort.

In addition, Cho et al. (2008) applied ANT to the study of the implementation of a radiology network system in a Swedish hospital. Their study revealed how complex contextual dynamics had a disruptive effect on the implementation process. In a similar way, Mahring et al. (2004) apply ANT to their study of IT project escalation - a persistent problem facing most contemporary organisations. The above studies, through the conceptual tools of ANT, particularly the concepts of translation, have been able to shed new light on the process of IS development and use mainly within a single organisation or a segment of an organisation.

ANT has also been applied to wider controversies in the IS field, most of which transcend the introduction of ICT innovations to just a segment of an organisation. Specifically, it has demonstrated its value in explaining IS initiatives within the public sector. For instance, McGrath (2002) examined the redeployment of a computer-aided dispatch system for the London ambulance service. Also, Walsham & Sahay (1999) analysed the introduction and use of geographical information systems (GIS) for district-level administration in India using ANT, and Poloudi and Whitley (2001) examined the NHSnet programme in the UK. Monteiro and Hanseth (1996) applied ANT in examining the role of standards in the shaping of large information infrastructure, to name just a few.

Basically, all of these studies that have used ANT have in one way or another demonstrated how an ANT perspective has both inspired new lines of inquiry and ways of analyzing IS phenomena and also broken certain central assumptions about knowledge, subjectivity and the social. Thus, the reminder of this section will be

devoted to looking at some of these key features of the ANT approach and their implications for IS research. Some examples are discussed below.

First, the concept of translation (Callon, 1986).The use of Callon's moments of translation has given IS researchers a novel perspective on IT based change in organisations. Specifically, the shared premise drawn from studies that have used the concept of translation to analyse what takes place during software implementation projects such as enterprise resource planning (ERP) in organisations is that such implementation projects do not follow a rather clear-cut and predictable trajectory as they have no inherent in-built inertia in themselves. In other words, the outcome of such projects cannot be pre-determined as its engagement with an assemblage of new actors can either propel it forward towards the intended direction or drag it away in a different direction.

One major conclusion that can be drawn from this is that, IS phenomena are never merely diffused, adopted or implemented; rather, they are adapted and translated and can take on new properties when they interact with an assemblage of actors. This characteristic described above is clearly unfolded in the studies of Elbanna (2007; 2010) and Pouloudi and Whitley (2001) among others.

Second, in some of the studies listed above and most IS studies generally that have adopted an ANT perspective, it can be seen that the IT artifact or technology device is granted an active and prominent role because they are seen as actors in their own right that take part in the creation, construction and even stabilization of "network" activities. In principle, they are a significant example of what Latour refers to as non-human actors or entities (Latour, 1987). However, it is important to mention that in ANT terms, an actor is never isolated neither do they act alone; the notion of the actor-network points to the over-riding insight of this approach which is that action is distributed. This simply implies that the ability to act is directly related to the heterogeneity of actors in networked relations, as actants which can only proceed to action by association with other human and non-human actors such as persons, objects, knowledge etc. Two key implications can be drawn from the above: First, by granting an active materiality to technologies in an ANT informed studies, the IS researcher is able to bring into focus those actors traditionally left

out of social scientific analysis, as is the case in some of the studies highlighted above. Consequently, an ANT perspective has contributed in repositioning the IT artefact in the sociological explanation of IS phenomena, hence presenting the IS researcher with a richer conceptualization of the interaction between technology and society. The second implication from this perspective centres on the idea that completeness of an IS phenomenon is determined less by its relation to an underlying social reality than to its role in the particular network that makes it important and translates it in a particular way. This characteristic is also demonstrated in a number of the studies listed above and it implies an emphasis on the active materiality of technologies.

Therefore, from an ANT point of view, the technology or IT artefact are viewed as inscriptions that are the contingent effects of specific actions.

Third, IS research inspired by ANT rejects traditional sociological dichotomies, such as micro/macro, subject/object, structure/agency and technical/social. ANT considers this binarist thinking that views our reality in two different spheres as problematic and as such seeks to surpass it (Castree, 2002). Thus by rejecting this (ontological) binarism, ANT encourages researchers to think relationally in terms of associations instead of separations or compartmentalisation. This rejection of ANT re-establishes the detailed description of processes and actions at the empirical level with Latour (2005a, p. 165) arguing for a perspective that keeps everything flat (Latour, 2005a, p. 190). Walsham and Sahay(1999), in their study, take on this methodological advice and, through detailed empirical analysis, see how it gives rise to a host of unanticipated side effects for explaining IS change and practices.

Fourth, in attempting to understand complex social situations, ANT refutes the extremes of technologically-deterministic and socially-deterministic approaches that have plagued most of IS research. The technological-determinist approach to researching diffusion of technology in society, mainly views technology as the 'solution' to social problems and also contends that all outcomes of technological change are attributable to the 'technological' rather than the 'social' (Grint and Woolgar 1997). On the other hand, social determinism assumes that relatively stable social categories can be used to explain technological change (Law and

Callon 1988), and concentrates on the investigation of social interactions, relegating the technology mainly to the context. Both approaches (techno-deterministic and socio-deterministic) underestimate the importance of the interaction between technology and society, and the processes that mutually shape the two. However, ANT fills this gap by positioning itself in the middle of both approaches and focuses on the dynamic interaction between the two - as it contends that one does not pre-exist without the other.

Finally, ANTs emphasis on relational materiality (Law, 1999) offers a novel perspective in conception and practice of IS initiatives. Specifically, when considered in its ontological dimension, ANT adopts a relational view of the world. Its insistence on relational materiality (i.e. that actors achieve their form and attributes as a consequence of their relations with other actors) brings to the fore a crucial as well as controversial notion of actors, which is that they are perceived as network effects and unconceivable without relations (Jóhannesson, 2005). This notion of ANT basically incites a rethink about socio-technical relationships as open ended sets of interactions, in which the actors of the socio-technical interplays do not pre-exist the relationships; rather, the actor is generated in and by these relationships (Cordella and Shaikh, 2006). A number of different IS studies, such as Walsham and Sahay (1999) and Monteiro and Hanseth (1996), have used this inspiration to shed light on how IS phenomena takes place through hybrid network practices of different actors, which include both humans and non-humans. Following this assumption, it is sufficient to say that the social therefore is not simply human, but as Law argues, it is intrinsically related or linked to other materials or objects such as technology etc. (Law, 1992). Law tries to better explain this ideology with an example of what a sociologist is. He suggests that if 'you took away my computer, my colleagues, my office, my books, my desk, my telephone, I wouldn't be a sociologist writing papers...I'd be something quite other' (1992, p. 4). By this example, he implies that his identity as an academic goes way beyond his human body, to include a patterned network of heterogeneous relations. To explain further, Latour offers an example of the gun and the human, pointing out two slogans typically found in debates about guns and their possible restriction. First 'Guns kill people' and second 'Guns don't kill people; people kill people'

(1999b, p. 76). Latour argues that while the first slogan attributes all the agency in the gun (object) and the human (subject) is a mute intermediary for the gun's intentions, whereas the second slogan attributes agency to the human (subject) while the gun (object) is a mute intermediary of a human's intentions. Consequently either the gun or the human is effectively everything or nothing. ANT, however, argues that together, the gun and the human realise a heterogeneous relationship (of the gun-human) which in turn translates into achieving a purpose.

Accordingly, with ANT, neither the gun nor the human is the sole explicator or just a mute intermediary as both bring something to the situation under study.

Arguably, this perspective of ANT not only provides a possibility for IS researchers to by-pass dualisms of modern ontology, such as nature–society, global and local, and subject–object, but also it incites them to think relationally and also appreciate the importance of materiality's in conception and practice of IS, hence offering a promising analytical framework for IS researchers, which allows for a more detailed understanding of the complexities surrounding processes involving technological innovation.

To sum up, it can be argued that despite ANT's status as a controversial and marginal approach in the social study of science and technology, among other things it has provided the IS field with new perspectives on sociological method, notably through analysis of deconstruction and representation, reflexivity and 'otherness', managerial power and organizational technologies, and the ontological status of theories (McLean and Hassard, 2004). That said, it is sufficient to argue that, the utilization (and contribution) of ANT for IS studies generally lies in: its emphasis on general symmetry which renders it open to take non-human entities (material objects) seriously and bring it into the human frame of observation and analysis and its insistence on relational materiality, which depicts a world of movement and constant flow in which everything is a relational field. Also, for the IS researcher, ANT creates space for recognising the role technologies also plays in making IS phenomena happen. This section has highlighted one other main aspect of ANT, that is of specific significance for IS research; namely the concept of translation. ANT's concept of translation sheds light on the net-work underlying

the different categories such as (technical, natural, global, local, social etc) we are familiar with. Further, it demands that instead of our point of departure to centre on studying network effects, we should focus on tracing the process of network building and formation of the particular network under study in order to better understand the change process, as well as how the network has come into existence (Callon, 1986).

Following from the discussions above, it is sufficient to conclude by saying that ANT contributes to the IS field not only by means of its strong conceptual principles and vocabulary, but also through the various ANT inspired case studies (such as the ones highlighted above) that tells a lot about the development and use of technologies in society - of which is of great significance to the field.

Having examined the contribution/relevance of an ANT perspective to the IS research domain, the next section will briefly examines the use of ANT in the sub-domain of ICTs and Development (ICT&D).

3.6   Actor-network theory and ICT in LDC research

The preceding section provided some insights into the potential of ANT, its applicability and its contributions to the IS domain. This section outlines the potential contribution and insights that ANT can provide as a theoretical approach to help us gain a more holistic appreciation of the complexity of introducing mobile phone innovations within the sector of a LDC.

There are a variety of ways that ANT could be applied to ICT in development studies or research. ICT and development research refers to the deployment and use of ICT interventions within development areas such as healthcare directed at specific development activities. For example, ANT could be applied to the study of specific development institutions such as the 'World Bank', it can also be applied to the very notion of development and also to the study of a single project aimed at some development outcome (Scott-Smith, 2013).

This study focuses on the last category that is the study of a single project. When applied in this way, ANT offers an alternative means of reconceptualising technology as it contributes, to a more holistic understanding of the complexity of technology introduction in LDC context. Considering that ICT in development efforts taking place in LDC most times occurs across multiple levels such as global, national and local level, such efforts brings together a myriad of actors from these different levels. From an analytical view point, it can become quite challenging to theorise such efforts as a result of both the multiplicity of actors, and the demarcation that can exist between these levels. However, the good news is that ANT, through its methodological and ontological principles, helps in addressing this issue.

The two key principles of this approach that have been identified as particularly relevant to addressing this issue are the principle of flat ontology and generalised symmetry. The first, the principle of 'general symmetry', insists that actors be it humans or non-humans should be treated as equal for the purposes of explanation. As can be seen in the IS literature, the second, the principle of 'flat ontology', has provoked a large literature, which understands the world and everything in it on a single level devoid of any hierarchical presupposition about size or power, such as macro or micro, local or global. ANT theorists argue that actors are localized or globalized by the accounts made of them. Accordingly, Latour presses this point by stating that, "no place dominates enough to be global and no place is self-contained enough to be local" (Latour 2005, p 204). He goes on to relate this to the two fundamental arguments championed by ANT, which are: first, that we put asunder the divide i.e. the human (society) and the material (technology), as this is irrelevant for understanding the world of human interaction and second the micro/macro distinction used to categorise actors suppresses any attempt at understanding how society is being created (Latour 2001).

In asking that these presumptions and a priori distinctions are removed from perceptions of social actors and events, ANT offers an alternative known as the network approach, with which to better study and understand these types of effort.

In this approach, the global, national, and local or the macro and the micro, levels are not considered concentric domains contained in each other, but heterogeneous networks of elements such as people organisations, objects, ideas, and hardware that become larger or smaller depending on the range of their associations (Faik et al, 2013; Latour 1996b). It is important to mention that networks as used in ANT, are in no way comparable in size so that one network would be bigger or larger than another, rather, they are comparable only on the basis of the intensity and strength of their connections. Notably, these feature of the network metaphor which provide a level playing field, makes it particularly suitable for tracing the dynamics and interactions of all the actors, both human and non-humans, of ICT efforts taking place in LDC.

Based on these core principles then, there are three main ways in which an ANT approach can contribute to ICT and development research.

The first and maybe most fundamental contribution of ANT to this research will be that it provides an alternative structure for analysing why ICT intervention efforts within a LDC contexts generally has so often failed to live up to expectations. For example, it challenges researchers to move beyond the common view that such efforts succeed on the basis of their high-quality objective or level of planning, and points in the direction of other considerations such as the locking in of interests of actors, the strength of alliances formed, etc.

Further, in carrying out studies of this kind, ANT provides an alternative view of how one might understand socio-technical networks, however seemingly complex, by assisting with removing the confusion brought on by hierarchy or levels (as it presses forward the notion of flat ontology). In other words, ANT allows efforts of this kind to be seen as socio-technical arrangements consisting of heterogeneous assemblages of people, ideas, objects, hardwares etc. By studying such effort as a network and refraining from making any a priori distinctions between the technical and social elements, it is much easier to describe in detail and also to understand the processes, dynamics and events that are actually taking places during such efforts. For instance, the study can better describe the active role played by individual people as well as the technology itself.

A second contribution concerns the way technology is conceptualised in such efforts. A review of the IS in developing countries literature shows that ICTs have become deeply implicated in efforts aimed at achieving development goals (Walsham, 2012). However, most theories used to date in this field have either utterly failed to integrate technology into conceptualisation of development or as argued by Iacono and Orlikwoski (2001), have failed to properly engage the IT artefact when researching the uptake of ICTs in development areas within a LDC context.

According to Heeks (2013), actor-network theory solves this problem by according technology neither non-status nor special status, but equal status with all actors. This basically ensures that the technology is fully integrated into our understanding of these kinds of efforts, and also that the role it plays in the failure or success of such effort is evident.

Thus, to summarise, this study draws on Heeks and Stanforth (2014), to highlight the unique insights that this theoretical approach can offer towards the study of the uptake and institutionalisation of mobile phone innovations within the Nigerian public health setting: first, ANT is able to provide detailed descriptions on process and explain structure (for example health organisations, or the political environment in Nigeria); second, it is agnostic about levels, collapsing notions of macro and micro or global and local. Third, it recognises the active role played by mobile phones; and through the notion of translation it helps explain the micro-politics of ICT and development efforts and the associated modification of goals, identities and interests of actors.

3.7   Concerns and Limitations of ANT

Although explanations provided by ANT continue to hold promise for research in IS in LDC and the IS domain more generally, several potential limitations and criticisms have been noted. Essentially, serious concerns have been raised about its strong conceptual principles and these concerns centre around four closely related issues categorised as: dualism, general symmetry, actors and actions and lastly

ethics and power. In this research, in addition to highlighting the strength of this theory, the researcher considers it important to discuss these limitations and criticisms in order to show her clarity about the key ontological, epistemological and political commitments that accompany this theory. Consequently this section is devoted to that, in addition, it will highlight some of the responses elicited from ANT's proponents in relation to each one of these limitations and criticism.

The problem of Inclusion and Exclusion

This first criticism concerns the debate raised by ANT's critics of who to include and who to exclude when conducting ANT studies. Specifically, many ask the question where and when do we "cut the network"? For example, in his review of Latour's book Aramis (Latour, 1996), Miller (1996) argues that following the actors like Latour suggests, is likely to not only introduce a bias in the choice of which actors to follow but also, it presents researchers with a wide range of associations and actors without a clear vision about which actors to choose or not to. He expressed this concern explicitly by stating:

"Who decides who the actors are? It's fine to tell us that we should believe them when they speak to us, that we should refrain from judging them, but we have to know who to speak to in the first instance, which meeting to attend, who to call on the telephone, who to email, and who to ask for an interview!" (Miller,1996: p358).

In response to this issue of inclusion and exclusion, the proponents of ANT argue that, since there is no prescription on how to go about "cutting the network", IS researchers intending to use ANT in their studies need to reflect very well on all who may be involved in order to make better judgements about who or what to include or exclude. In other words, the researcher needs to depend on his/her human skills and judgement to identify the boundary of the network. Monteiro and Sahay (2000) contribute to this discussion by suggesting that a typical ANT informed research study should start by identifying key actors, interests, and scenarios, and then trace them over time.

McLean & Hassard (2004) also contribute to this discussion by arguing that researchers cannot follow all the actors everywhere and as such, they will have to engage in a process of ordering, sorting and selecting the actors they wish to follow. They go on further to add that, considering that there is a danger of privileging, researchers will need to explicitly mention the guidelines that specify which actors have been included and which actors have been excluded in their study. In line with McLean & Hassard, in this current research the researcher makes explicit (see chapter 4) the strategy adopted for the inclusion of participants for this study. However it is important to mention that in this research study, issues around time, financial cost and access to certain groups of participants, impacted partly, on the process of inclusion and exclusion of actors.

On the issue of human and non-humans

Having discussed issues around the inclusion and exclusion of actors, this section moves towards one of ANT's major principles (the principle of general symmetry) that has been the cause of considerable controversy, especially among those critics that call this approach to question. For instance, Collins and Yearley (1992) have criticised ANT's commitment to this 'radical' form of symmetry, that is the call for equal treatment of seemingly dichotomous factors such as society and nature, humans and non-humans and the social and technical (McLean and Hassard, 2004). Taking the example of the issue of humans and non-humans, the ideology of non-human agency i.e. the granting of actionable power to material objects such as technology is possible because the principle of generalized symmetry argues for a radical fairness of both human and non-human entities by demanding that no agential priority be given to humans. Consequently, the concept 'actor' or "actant" can be also extended to include IT artefacts because in principle, the can be viewed as having the same degree of agency as a person (Callon 1986, Callon and Latour, 1992).

Critics of ANT have reacted to this by arguing that while it is possible to give agency to natural living entities, it shouldn't be the case for non-humans as this would be implying that non-human entities such as technology are also endowed with intentionality through their agency (Collins & Yearley, 1992). They further

add that treating the social and technical alike, implies that ANT is ascribing capabilities to technology which tends to diminish the potential for human agency.

Scaffer (1991, p.182) presses on the argument by Collins and Yearly by stating that it is indeed illegitimate and unnecessary to ascribe will or interest to non-humans in the network referring to it as "heresy of hylozoism - i.e. the attribution of purpose, will and life to inanimate matter, and of human interests to the nonhuman". He argues that this "hylozoism" can move the researcher away from the important human actors in the network, as the researchers' attention is turned towards seeking non-human explanations which can result in hindering understanding.

Responding to this criticism, Law (2003) first of all makes it clear by stating that "to say that there is no fundamental difference between people and objects is an analytical stance" (p. 4), not an ethical one. Also, Callon respond to this criticism by arguing that even though they extend symmetry to vocabulary, they by no means extend intentionality to things as well (Callon and Latour, 1995). He explains the granting of agency to non-humans by first stating that "by themselves" material things do not exercise agency in the precise sense that humans do. Callon further consolidates his argument by stating how "agency is an emergent characteristic" which means that agency emerges only through the interaction and performance of a variety of actants (Callon and Latour, 1995). He further clarifies his point by adding that in reality, they are no things "by themselves" rather, there are relations, and these relations at times create things. Callon also makes clear that the redistribution of "actantial role" are themselves subject to negotiation and empirical evidence as opposed to an a priori determination of which he says would be both a methodological mistake as well as a huge error of political judgement (Callon, 1995 in Shaikh and Cordella, 2006). Putting all of this together, it is clear that this principle has profound implications for the information systems researcher as it argues for the attribution of actionable power to non-human entities within the network. Put simply, what ANT aims to achieve by this principle is to draw our attention and make us more aware of a different view, which is that nonhuman actants are of particular significance in social reality. This implies that non-human

entities such as technology play a key role in contributing to creating the reality around us.

An amoral and apolitical stance

Another broad area of criticism centres on ethics and political issues. ANT authors, are frequently chastised for either failing to examine in detail or remaining completely silent on moral and political issues underlying the specific technologies under study. In particular, Winner (1993) criticizes the almost total disregard of this issue by the ANT researcher, suggesting 'they have little to say about the deep-seated political biases that can underlie the range of choices that arise for relevant actors' (Winner, 1993, p. 370).

Latour refutes this criticism of apoliticism and moral relativism, by suggesting that a refusal to explain 'the closure of a controversy by its consequences does not mean that we are unsympathetic to the possibility of judgement, but only that we refuse to accept judgements which transcend the network, somehow originating from outside the empirical events and relationships that actor–network theory describes' (Latour, 1991, p. 130). Mclean and Hassard (2004) have also remarked on this matter by first arguing clearly that no piece of social research can ever be amoral or apolitical.

They elaborate by explaining that in ANT informed studies, notions of ethics and politics are dealt with both implicitly and at other times, explicitly. Having said that, they provide examples of ANT informed studies within literature that appear to have engaged explicitly with what might be considered as political implications and/or agendas, including Bijker, 1993; Boland and Schultze, 1996; Monterio and Hanseth, 1996).

Still on the issue of apoliticism or moral relativism, McLean and Hassard advise that notions of ethics, and the distributions of social power, are concepts that require greater assessment in terms of the research process and they demand that these notions be acknowledged to a larger extent within the methods researchers employ in the selection and representation of actors, as well as in the ways the accounts are

inscribed. As IS researchers seeking to produce ANT accounts, advice of McLean and Hassard can be seen whereby explicitly dealing with issues of ethics and power within the case (such as exposing the power and politics underlying actor networks). However, for IS researchers who do not find ANT robust enough to examine political and ethical implications relating to information systems, Walsham offers them some advice. Specifically, he suggests that to better examine ethical and moral implications related to IS, researchers can draw on political, ethical and moral theories from outside the actor–network.

Regarding Privileging and status

In addition to the issues raised above, critics of this approach have also questioned the way in which ANT sometimes appears to provide non-humans with a higher status in terms of their relation to humans. We refer again to Collins and Yearley (1992) who find this problematic and argue that under ANT, material actors are granted 'reality' and 'potency' far beyond that which should be bestowed to them by humans, describing this ideology as a 'misconceived extension' of symmetry. In response to this criticism, Callon and Latour point out that the failure of its critics to understand ANT's arguments about the symmetry of nonhumans and privileging as claims operating on the level of method is what has given rise to this criticism. They continue by asserting that, this so called 'extreme' stance on symmetry of humans and non-humans is primarily for analytical purposes. As Callon and Latour (1992) claim most compellingly:

"It is not our intention to say that scallops have voting power and will exercise it, or that door-closers are entitled to social benefits and burial rites, but that a common vocabulary and a common ontology should be created".

To further clarify their point, they go on to add that ANT by no means intends 'to ascribe free will to objects, nor human characteristics or attributes either, rather it recognises that objects act upon other objects and upon humans' - hence becoming actors/actants themselves.

To summarise, it is sufficient to say that the majority (certainly not all) of the controversy and criticisms surrounding this perspective centres mainly around ANT's position on the symmetry of nonhumans and their agency. Theorists of this perspective however make it clear that a failure to understand ANT's arguments as claims operating at the level of method (Latour, 2005), infra-language (Latour, 2005), or positional strategy (Latour, 1988b) will continue to create some form of confusion. Latour (1998) is clear in this regards as he points out that ANT has no general theory of agency. Therefore, claims centred on the agency of nonhumans are part and parcel of the conceptual infra-language of the perspective. This perspective overtly represents some form of methodological sensibility (Callon and Latour, 1992: 356; Latour, 2005: 142), one that creates uncertainty concerning the nature of agency and the possible extent to which nonhuman entities might be actants in a chain of events. Following this explanation, it is sufficient to say that ANT theorists expect that researchers do not treat claims regarding the agency of nonhumans as strict theoretical principles that affords a full account of all nonhumans equally.

On the other hand if we are to give priority to the methodological role of this theory, what we will find is that it primarily seeks to incite researchers to stay open to the possibility that non-human entities can add something that is of sociological relevance to a situation or an event. Consider for a moment, if we were to commence our analysis with the ideology that nonhumans never acted, or never added anything that was sociologically relevant, then a major aspect of analysis which is absolutely essential to the understanding of the inner-workings of events or situation would otherwise be automatically neglected or foreclosed (Sayes, 2013). Consequently, these conceptions of ANT (such as the principle of general symmetry) indeed provide a useful beginning point for researchers by providing a proper interpretation of the complexity of the associations formed with other humans as well as nonhumans. And, these conceptions of ANT even though prone to criticisms, again equips us with the tools to better attend to the smallest displacements, translations, practices, processes, protests, arguments and struggles - no matter what form or shape the actors involved may take.

Overall, it is important to note that ANT is not a theory or method that can explain every phenomenon. All theories are limited in one way or another, and ANT is no exception to this. However, the use of this theoretical approach allows the researcher see and draw on important things in this research.

Having discussed the key criticisms of this theory, section 3.7 provides a chapter summary as well as a brief introduction of what is to come in the next chapter.

3.8   What comes next?

This chapter has shed light on the ANT perspective which is the theoretical lens for this study. Specifically, it provided a clear picture of ANT as a distinctive research approach well suited to investigating the deployment and use of ICTs such as mobile phone in contemporary society, especially as it pertains to development efforts. This chapter also discussed the potential contributions of an ANT perspective to the ICT and Development field and concludes by examining some of the key criticisms of this theory. The next chapter, 4, will present and discuss in detail the philosophical standpoint of this research including the methods employed to collect and analyse the data obtained throughout this research.

Chapter 4: Research Methodology

4.1   Overview

While the preceding chapters of this thesis addresses the questions what is being studied and why it is studied, this chapter will be addressing the "how it is being studied" question, that is how this study was carried out - in other words the methodological approach adopted in the conduct of this study. The answer to this question will form the basis of this chapter as it seeks to both describe and justify the approach chosen for carrying out this study.

4.2   An overview of the research process timeline

Before going into detailed explanations on the research methodology adopted and philosophical assumptions underpinning this study, this chapter will begin by presenting an overview of the research process from start to finish. Specifically, this timeline will highlight key milestones achieved as well as the key activities carried out over a total of a four year period.

Figure 4-1 above provides a chronology of the key activities and milestone that took place throughout this research. In the first year, four key activities were carried out by the researcher and they are as follows: developing and subsequently confirming the research problem and question; developing of the research design and research proposal; requesting and gaining ethical approval to conduct this study and lastly preparing an annotated bibliography document from the initial literature review process.

During the second year of this research, the researcher broadened the literature review search to include not just studies on implementation of IS innovations (with a focus on mobile phones technology), but also, the researcher was able to conduct

a review that examined in detail, the theoretical approach chosen for this study that is (ANT), as well as other theoretical approaches that have been used in previous studies to examine the adoption of IS innovations. After a thorough review, the researcher was able to uncover the shortcomings of other theoretical approach in terms of addressing the research questions. Specifically, considering that the research was aimed at analysing the emergence of relations between human and non-human actors and how these relations can enable and/or constrain the implementation effort under study (Callon, 1986; Law, 1986), ANT was seen as a powerful theoretical tool to examine this phenomena. Also, within this second year of this research, the researcher developed and finalised sampling plan and also finalised the development of data collection instrument in an effort to conduct the first phase of field investigation, were interviews were the main source of data collection.
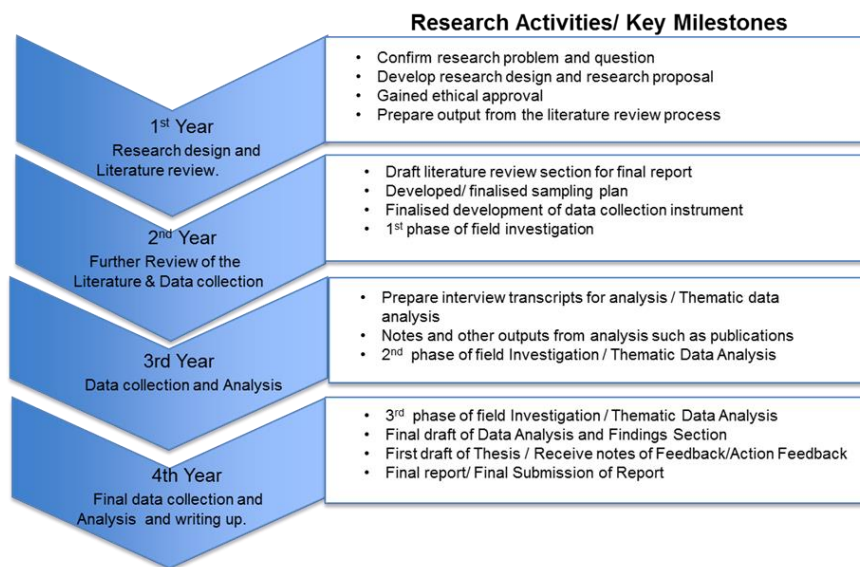
Figure 4-1: Research timeline showing key activities

At the start of the third year, the researcher engaged in the following four activities: firstly, the researcher prepared the interview transcripts following the first round of data collection (which was guided by an a priori theory) at the end of the second year. Afterwards, the researcher adopted the theoretical resources from ANT to make sense of the data collected at this stage. The next activity that followed in the third year was the analysis of the data collected and documenting of the findings.

Having successfully completed a round of data collection and analysis, the researcher considered it appropriate to share the findings of this research with the academic community by submitting a paper to the Electronic Journal of Information Systems in Developing Countries (EJISDC) this paper was later accepted. At the end of the third year, since this implementation effort was an on-going effort taking place in Nigeria, the researcher decided to engage in a second round of data collection. It was important to collect data at different interval to enable the researcher capture the changing realities that was taking place in both people's situations and with the implementation effort as a whole.

Moving on, in the fourth and final year of this research, the researcher engaged in the third and final phase of field Investigation. The researcher used the list of questions (please see Appendix B) to structure the interview on all three occasions. However, during the second and third phase of data collection she made sure to investigate the changing realities in relation to the participants and the implementation generally. After the final collection of data, the researcher proceeded to analyse the data and subsequently proceeded writing up the fifth and six chapter of this thesis that is the findings and discussion chapters respectively. Over the next few months that followed the researcher was able to complete the entire first draft of the thesis and submitted it to her research supervisor for comments and feedback. The feedback and comments were discussed during face to face meetings that held every two weeks. After the meetings, it was the responsibility of the researcher to action the feedback. The feedback and comments were discussed during face to face meetings between the researcher and the research supervisor, this took place every two weeks. After each meeting, it was the responsibility of the researcher to action the feedback accordingly. This process continued, until the researcher's supervisor was satisfied with the final thesis report and deemed it fit for submission to the department.

4.3 Methodological and Philosophical research perspectives

Having provided an overview of the research timeline, the rest of this chapter will be devoted to positioning this research within its philosophical tradition. This section elaborates on the research methods, philosophical assumptions and beliefs that underline the way in which this inquiry was conducted. The rationale and justification for these methodological choices and philosophical perspectives are also discussed.

4.3.1 Methodological Perspective

Research methods can be classified in various ways; however Avison and Pries-Heje (2005) suggest two common distinctions in social research methodologies namely: quantitative research (predominantly based on numeric data) and qualitative research (predominantly based on verbal data). According to Oates (2006), the quantitative method, which was developed in the natural science, is a process of inquiry based on testing a theory made up of variables, measured with numbers, and analysed using statistical techniques. In contrast, the qualitative research method, originally developed in the social science is used to study socio-cultural phenomena of interest that needs to be explored in their natural setting.

The methodological perspective adopted for a study that seeks to evaluate a specific information system, depends largely on the evaluation goal of the researcher. For instance, when the research centres on constructs such as user satisfaction, costs and benefits, timeliness etc quantitative methods tend to be more appropriate as selected features of the technology, the organization or the user generally are treated as independent, objective, and discrete entities hence are unlikely to change during the duration of the study (Kaplan and Maxwell, 1999).

However, when the intent of the researcher centres around examining social impact and understanding the dynamics of a process arising from the implementation of an innovation as is the case in this study, qualitative methods tend to be appropriate and more useful as they can provide the researcher with a detailed understanding of the social or human problem within the given social and institutional context.

This research

In this study, the researcher adopted a qualitative approach as it enabled her over time to understand the way participants in this setting construed, conceptualize, and made sense of the technology effort under study. Other important considerations that informed the researchers choice of adopting a qualitative methodology in studying this effort includes the need to explore a social phenomenon, that is the process of implementing this innovation in its particular social and institutional context. Gaining a detailed account and insight in to how the actors of this information system view and evaluate the system and to ascertain what meaning it has for them.

To understand the various distortions and obstacles arising from the institutional conditions, that shapes the outcome of this effort. The researcher achieved this by conducting a context-sensitive study in other to be immersed in the natural setting of the participants whose ideas, thoughts, meanings and interpretation she wished to explore.

To study this innovation as it developed and emerged, as oppose to just investigating the outcome of this effort. The researcher's aim here is to be able to provide the reader with explanations of the actual events and processes that led to the specific outcome.

To provide formative recommendations based on findings for sponsors and policy makers of which can help inform future efforts.

Following from the above, a qualitative research methodology was deemed appropriate for the conduct of this study. This approach proved beneficial in this study as it allowed the researcher explain the actions of the actors within this

system. Last but not least, this approach allowed the researcher study this effort as a process rather than as an event of which was useful in drawing lesson from the start to finish of this project.

Evolution of the qualitative research strand

Before describing further the research process adopted in this study, it is worth taking a brief look at how the qualitative strand of research in the information systems domain has evolved over the years from a previously quantitative dominated discipline. For the most part, research work published in the IS field has been mainly quantitative. But it was not until the late 1990s that qualitative research started to gain ground and has since been consistently published within the IS domain (Trauth, 2001), gradually making its way to the fore of IS research.

Myers (1997) provides a possible explanation for this by suggesting that this could be as a result of the general shift in IS research away from purely technological to socio-technical issues, hence generating a growing interest among researchers in better understanding people and the socio-cultural context in which they live.

Sarker (2007) contributes to the discussion on qualitative research in the IS domain by providing an impressionist account of the evolution of qualitative methodology within the domain. Or in other words, traces its growth up to this present time in an attempt to shape our understanding of qualitative research as a methodological choice in the IS community. In seeking to better describe this evolution process, Sarker interestingly starts by conceptualising qualitative research within the IS discipline as an innovation within a social system. He then goes on to highlight the distinct phases of this development. The first stage which he terms the initiation phase refers to the introduction of qualitative studies into the mainstream IS research arena. During this phase, the quantitative researcher dominated the methodological discourse in the field as "research" at the time meant "quantitative research," as studies without hypotheses and statistical analysis were excluded from the definition of research itself.

Nonetheless, some qualitative researchers continued to publish in journals and conferences within the discipline that the majority of mainstream scholars were unaware of, while struggling at the same time to legitimise this form of research through various efforts. Some of these efforts include making qualitative research methodologies more accessible and understandable to mainstream audience, arguing for the virtues of methodological "pluralism" in the IS research community, etc (Fitzgerald and Howcroft, 1998).

Following these efforts and many more, the progression to the second phase, known as the contagion stage was finally attained. The transition to this stage not only witnessed an increase in the number of qualitative studies published within the IS domain but also led to the legitimisation of the qualitative method within the domain. This era brought about a mind-set of openness from a methodological standpoint where everyone was invited, such that research studies about many ill-understood IS phenomena not captured by earlier theories were welcomed. The consequence of this was that, out of the large volume of research work being published during this era, it was noticed that only a few actually adhered to the recommended methodological guidelines (Dube and Pare, 2003) thus generating a huge concern around the issue of quality methodological rigor. Sarker points out that in an attempt to address this problem, the IS research community (conceptualised as the social system) had to self-correct the degree of enthusiastic openness to qualitative research (conceptualised as the innovation). This resulted in an end to the free-for-all era and the emergence of a new phase known as the control stage. This era, was characterised by an increase in principles and criteria's for the conduct, evaluation and publication of qualitative research (Myers, 1997). As a consequence, qualitative researchers were expected to meet criteria's such as internal validity, thick description, transferability, theoretical saturation to mention a few.

The proliferation of these criteria's led to some sort of controversy in the mainstream IS community because it not only brought about positive effects such as the development of some shared values and criteria, but, it also gave rise to some undesirable and unintended consequence. For example, an author or researcher felt

burdened with preparing defensive arguments for manuscript reviewers, who could challenge their research work at any-time by drawing on the above criteria. Obviously, this control caused huge frustration for some researchers who had come to see these criteria's as not only unnecessarily restrictive but also capable of stirring bias. However, in summary, Sarker (2007) provides encouragement particularly to researchers but old and upcoming, by pointing out that qualitative research is indeed entering a maturation stage in which research is likely to witness a widespread recognition of the different genres of qualitative research, beyond the label of "case studies," even "positivist" and "interpretive" case studies.

The qualitative research process

Coming back to the discussion on the research process adopted in this study, in this section, this research now goes on to provide a description of the interconnected phases that made up this research process. In designing this study, this research draws on the phases of a qualitative research process proposed by Denzin and Lincoln (2011). Denzin and Lincoln advises that there are five key phases that should make up any credible qualitative research process; the researcher and the researched as multicultural subjects, the major paradigms and interpretive perspectives, the research strategies, the method of collection and analysing empirical materials and lastly the art and practices of interpretation. In this study, the researcher was inclined to integrate these key parts of the qualitative research process in other to get a better understanding of the research issue under study. It is important to mention at this point that these phases mentioned are by no means distinct; rather they are all interconnected and interrelated in order that the research study can appear as an organized whole rather than as segmented, isolated elements.

A brief discussion of each of this phase is provided below:

Phase 1: The Researcher and the researched. As part of the qualitative research process, it is required that the researcher enters into complex traditions and research perspectives. These traditions locate the researcher in history, guiding and at the same time constraining work in any specific study.

For instance, the researcher is confronted with ethical and political research issues, and at the same time struggles to meet the challenge of developing and applying proper research methods and methodology that apply to the specific research act and its human-to-human relationships. Further, an important part in the qualitative research process is the consideration that both the researcher and the researched are multicultural subjects. In other words, the researcher's background, interest, ethics, political stance and conceptions of self comes to bear in the research.

Also, in the case of the researched i.e. the participant, they also bring to the research their own meaning to the research problem which may very well differ from that of the researchers. Therefore in this study, the researcher keeps a focus on discovering the meaning that the participants hold about the research issue under study. The role of the researcher during the various phases of this study is discussed as I go along in this chapter.

Phase 2: Theoretical paradigms and perspectives. All research are in one way or another guided by some theoretical principles. These principles are a combination of the researchers epistemological, ontological, and methodological beliefs and they are responsible for shaping the way the qualitative researcher views the world and consequently acts in it. Guba (1990) describes the net that contains all these beliefs of the researcher "a paradigm". Within the qualitative research strand, Denzin and Lincoln (2011) identify four major interpretive paradigm structures namely: the positivist and post-positivist, constructivist-interpretive, the critical and lastly the feminist-post structural. This research adopts an interpretive paradigm and reasons for its selection are presented later on in this chapter.

Phase 3: Research Strategy. The research design is the first building block of this phase, which broadly emphasises a clear focus on the question guiding the research and the purpose of the study. It is imperative that this phase also addresses "what information most appropriately will answer specific questions, and which strategies are most effective for obtaining it" (LeCompte & Preissle 1993, p.30). Hence, as regards choosing an effective strategy, in this research a case study approach was adopted. More information on the research strategy adopted and the justification for doing so is discussed in considerable detail in section 4.6 of this chapter.

Phase 4: Methods of data collection and analysis. The core of any qualitative research process is the extensive gathering of empirical data from multiple sources of information. Some of these key sources available to the qualitative researcher include interviews, direct observation, and analysis of documents, informal interaction and even personal experiences. As earlier mentioned, the selection of these methods is usually dependent on the chosen research strategy. For this study, the researcher employed interviews (based on open-ended questions) and document analysis as the main methods for collecting empirical data. The interviews were carried out in person with some follow up conversations conducted (with the consent of the participants) through electronic means such as telephone and emails. In collecting data, it was important to make the respondents aware of the research aims, to give them a shared notion of the expected contributions of the study (Fontana and Frey 2005). Additionally, Observations and informal interactions were useful in supplementing the main data sources as they both served to corroborate responses received from interview participants.

Having collected the data and organised it, thematic analysis (Fereday and Muir-Cochrane, 2006) was employed as the method for analysis.

This involves coding of the empirical data i.e. transcripts of the interviews and notes from both documents and informal interactions into related themes. Following which, concepts from Actor-network Theory (discussed in the Theoretical Framework chapter) were used as illuminating lenses (Gregor, 2006) - to view and interpret the social world of the focal initiative. Further details on the field work, the specific methods used to collect data for this study and how the data was analysed is provided in sections 4.7 and 4.8.

Phase 5: The art, practices and politics of interpretation and presentation. The ability for a qualitative researcher to make sense of their findings is artistic and at the same time political. Qualitative interpretations are construed through a process of using a series of field notes, documents and data to produce the researcher's interpretation to the public. It is through the researcher's insight that qualitative research achieves its ultimate goal. This research presents and discusses its finding in detail in chapter 5 and 6 of this thesis.

4.4   Philosophical Perspective

All social research whether it be quantitative or qualitative is based on some underlying philosophical assumption. As such, to conduct better research, it is important that researchers have knowledge of what these assumptions are. Within literature, there exist a wide range of classifications of the basic beliefs constituting the philosophical positions adopted by researchers towards the world and their work.

In this research, the researcher is inclined to follow Orlikowski and Baroudi (1991) classifications of beliefs (drawn from Chua, 1986) constituting the philosophical stances available to researchers to help inform qualitative research. These beliefs (as explained below) are about social and physical reality, about knowledge and about the relationship between knowledge and the empirical world (Denzin and Lincoln 2005; 2011). These beliefs underlie the qualitative strand of research adopted in this study.

1. Beliefs about physical and social reality: Ontological beliefs - has to do with the essence of phenomena under investigation; that is whether the empirical world is assumed to be objective and thus independent of humans in creating and recreating. Then there are beliefs about human rationality that has to do with the intentions ascribed by researchers to the humans they study. Lastly, beliefs about social relations are concerned with how people interact in organizations, groups and society.

2. Beliefs about knowledge: Epistemological assumptions concern the criteria by which valid knowledge about a phenomenon may be constructed and evaluated. Methodological assumptions indicate which research methods and techniques are considered appropriate for gathering valid empirical evidence.

3. Beliefs about the relationship between knowledge and the empirical world: These beliefs concern the role of theory in the world of practice and reflect the values and intentions researchers bring to their work. In other words, what researchers believe is appropriate to accomplish with their research work, and what the researcher intends to achieve within a specific study.

Further, a very important philosophical assumption made by the researcher, are those relating to the epistemological assumptions (beliefs about knowledge) guiding this study.

Again, the researcher is inclined to follow Orlikowski and Baroudi (1991), who draw from Chua,1986 to suggest three philosophical perspectives in relation to qualitative research in IS; they are positivist, interpretivist and critical. Within the context of IS research, Klein and Myers (1999), offer a rich description for these three perspectives identified above.

According to Klein and Myers, the stance taken by positivist researchers in information systems is generally based on the assumption that reality is objectively given and can be described by measurable properties, which are independent of the observers (researcher) and his or her instrument. One of the key qualities of this

type of research is its quest to test theory in an attempt to increase the predictive understanding of phenomena. This is in line with Orlikowski and Baroudi (1991) who classify IS research as positivist, if there is evidence of formal propositions, hypothesis testing, quantifiable measures of variables and the drawing of inferences about a phenomenon from the sample to a stated population.

On the other hand, Information systems research can be classified as interpretive if it asserts that our knowledge of reality, including the domain of human action, is a social construction by human actors (Walsham, 2006). Interpretive studies generally attempt to understand phenomena through the meanings that people assign to them, and interpretive methods of research in IS are 'aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context' (Walsham 1993, p. 4-5).

Finally, critical research makes the assumption that social reality is historically constituted and that it is produced and reproduced by people. Within the critical philosophy, it is also believed that even though people can consciously change their social and economic conditions through actions, their ability to do so can be constrained by various political, cultural and social authorities (Myers, 1997). Therefore, a key goal of critical research is social critique, whereby the alienating and restrictive conditions of the status quo are exposed and brought to light (Avison and Myers, 2002). In sum, we can say that critical research focuses on oppositions, conflicts and contradictions in contemporary society, it also seeks to be emancipatory as it strives to eliminate the causes of domination and alienation in society.

It needs to be said at this point that, while these three philosophical perspectives discussed above differ philosophically, in the practice of IS research, some argue that there is a blurred line between these distinctions (Avison and Myers, 2002) with some of the view that it is possible to combine all three perspectives.

The table below provides a summary of Orlikowski and Baroudi's findings concerning the underlying beliefs of research, as viewed by the positivist, critical and interpretive research philosophies.

Paradigms Beliefs about	Positivist	Interpretivist	Critical
Physical and social reality (Ontology)	Physical and social world exists independent of humans, and its nature can relatively without any problem be apprehended, characterised and measured	Places emphasis on the importance of subjective meanings and socio-political as well as symbolic action in the processes through which humans construct/reconstruct their reality.	Social reality is historically constituted and hence human beings, organisations, and societies are not confined to existing in a particular state
Knowledge (Epistemology methodology)	Beliefs of hypothetic-deductive account of scientific explanation. Involves the empirical testability of theories, of which can be "verified" or "falsified"	Understanding social reality requires understanding how practices and meanings are formed and informed by the language and tacit norms shared by humans in a particular setting working towards some shared goal	The research methods of choice are mainly long-term historical studies and ethnographic studies of organisational processes and structures
The relationship between knowledge and	Researchers as impartial observers can objectively evaluate or predict	The researcher can never assume a value neutral stance, and is always	The role of the researcher is to create an awareness of the

empirical work	actions or processes, but they cannot get involved in moral judgements or subjective opinion	implicated in the phenomena under study. In other words, the researchers' prior assumptions, beliefs, and values will always intervene to shape their investigations.	restrictive conditions of the status quo thereby initiating change in the social relations and practices, and helping to eliminate the causes of alienation and domination

Table 4-1 : Basic beliefs of the three main research paradigms

4.4.1 Choosing the interpretive research approach

The diversity of research paradigms most times presents complex challenges for researcher in terms of the selection of an appropriate approach for their research. Taking into account the discussion in the above section, the interpretive research approach was selected as the underlying research assumption for the purpose of this thesis.

The interpretive approach as mentioned earlier rests on the assumption that access to reality is only through social constructions such as language, consciousness and shared meanings (Walsham 1993; Myers and Avison 2002). Thus within an organizational context, this reality is socially embedded in the way individuals interact with each other in everyday life.

An interpretive approach within the IS domain is aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context' (Walsham 1993). This approach is very much in contrast to a positivist approach which assumes that the relationship between human and social reality are "independent," implying that the phenomena under study is not influenced by the "bias" of the researcher (Orlikowski and Baroudi 1991). Further in contrast to the interpretive approach, the positivist approach focuses on testing theory in an attempt to increase

the predictive rather than descriptive understanding of phenomena under investigation (Walsham, 1995).

As mentioned above, the overarching strategy guiding this study is the interpretive research paradigm and the three primary reasons for the choice are:

First, from the literature review chapter of this study, an important point raised is that efforts to implement IS innovations, will always be subject to various obstacles and distortions arising from the historical and material conditions that shape the relation. This implies that the study of this effort is indeed intertwined with its historical, social and cultural context and must be studied as such in order not to miss out on these important issues and consideration. Hence in light of the above, an interpretive strategy lends itself as a well suited approach for this study.

The second, reason for selecting an interpretive stance is based on the reasoning that for the researcher to better understand and appreciate the experiences and views of participants in relation to the phenomenon under study, it is important that the researcher becomes familiar with the participants world hence making an interpretive approach well suited for this study.

This is in line with Orlikwoski and Baroudi who argue that interpretive methods are a suitable choice for this purpose since it asserts that our knowledge of reality is gained only through social constructions such as language, consciousness, shared meanings, documents, tools and other artefacts (Orlikowski and Baroudi, 1991).

The third reason that has led to the choice of an interpretive stance in this study is the intent of the researcher to provide interpretive insights into the phenomenon studied. Notably, this kind of detailed understanding can only be gained as the researcher gets immersed in the research setting and at the same time interacts with subjects within this setting, allowing them to tell their story. As Rosen, (1991) puts it, the understanding of social processes requires the researcher to get inside the world of those generating it.

Having presented the reasons for selecting the interpretive research approach, the theoretical foundations underpinning this approach are described briefly in the next section in order to identify their implications for the research design of this research.

4.4.2 Phenomenology and Hermeneutics Philosophical Foundations

Within the interpretive approach, there exist several approaches for researchers to choose from when investigating an IS-related phenomenon. Notably, these competing interpretive approaches do not share the same ontological, epistemological or methodological perspective. Consequently, it is argued that researchers taking an interpretivist stance in their research must provide a clear indication of the philosophical foundations on which their interpretive perspectives are based upon (Butler, 1998).

In this study, hermeneutics and phenomenology, two philosophical strands embedded within the interpretive paradigm (Cope, 2005) have been chosen as the philosophical basis for its analysis. Specifically, the researcher will rely on the related phenomenological and hermeneutics philosophy of Martin Heidegger (1976), a philosopher most concerned with the role and essence of technology in our modern world, and Hans Georg Gadamer (1975) respectively by drawing some of their key concepts to inform this study. Notably, within the field of IS, many prominent researchers have led the way, in terms of adopting a phenomenological hermeneutic perspective (informed by the philosophies of Heidegger and Gadamer) in their work to enhance the understanding of various IS phenomena within diverse context. Some of this works include Myers, 1995; Butler and Fitzgerald, 1997 among others. According to Gadamer, the work of hermeneutics is not aimed at developing a procedure of understanding; rather it attempts to clarify the conditions in which understanding takes place (Gadamer 1975, p. 295). Hence the researcher draws on salient phenomenological and hermeneutic concepts and ideologies from the work of these philosophers. These concepts are briefly described herein and applied in this research to achieve better interpretation and a meaningful understanding of the phenomena under study.

To begin, the concept of the "hermeneutic cycle of understanding" which is perhaps one of the most fundamental concepts of hermeneutics is considered in this research. This tenet advocates that one's understanding has a cyclic structure (Butler, 1998). Heidegger's point of departure on his view of the hermeneutic 'circle of understanding' is that in understanding phenomena, one remains permanently determined by the preventative movement of `pre-understanding'. Thus, by beginning with one's `pre-understanding' (prejudice) the interpretation of a phenomenon (the hermeneutic 'whole') starts by the examination of its component phenomena (the `parts'). Nevertheless, the understanding of the component phenomena can only commence when their relationships to the 'whole' have been uncovered. What this simply means is that, one's understanding of the part (for example a specific text or an act) is established by reference to the whole (such as the socio-cultural context, practices, beliefs and intentionality's and so on) and vice versa. Hence, neither the whole nor the part can be understood/interpreted without reference to the other; hence, it is a circle. In this study, it was necessary for the researcher to adopt this circular structure of interpretation whereby the parts were harmonised with the whole in order that a truly objective interpretation of the phenomenon under study be reached. For example, in this study, in order for the researcher to better understand a specific event that took place, it was necessary that she located the event within its wider cultural and historical context.

The concepts of tradition and prejudice are also important for this research. It accentuates that our pre-understanding is an effect of customs and traditions, of which facilitates and shapes our understanding or as Gadamer puts it, "prejudices" Gadamer (1975, p.240). The term 'prejudice' as used in this context deviates from the everyday meaning were prejudice denotes negativity hence causing one to misunderstand. Rather, Gadamer's use of the term denotes positivity as he goes on further to argue that our "prejudices" (i.e. our experiences, assumptions and personal views) are the very source of our knowledge and can actually promote understanding as a completely open mind understands nothing at all (Gadamer, 1975, p.272).

Thus, since all our intentional thought and actions are constitutively dependent upon this socio-historical "prejudice" of which foreshadows our interpretation of a specific social problem, it is sufficient to say that understanding requires the engagement of a person's prejudices. In this thesis, rather than pretending to have no opinions, the researcher makes explicit her "prejudices" that is to say the personal views of the researcher are expressed during the interpretation of the IS phenomena under study.

Another hermeneutic notion relevant to this research is what Gadamer describes as hermeneutical consciousness. This concept is characterised by the 'logical structure of openness'. In order words, it advocates that a social actor or researcher must endeavour to remain 'open' to what a phenomenon has to say about itself. In carrying out this research, the researcher avoided setting out to prove herself right or wrong. Rather, the researcher displayed "openness" by listening to what the social phenomenon she set out to investigate had to say. Additionally, a practical application of this concept was during the interview stage of this research, the researcher ensured that participant questions were asked in the right manner.

 That is to say, participants were asked semi-structured as well as open ended questions around the phenomenon as opposed to leading questions. As a result of this, the IS phenomenon under study was able to "speak for itself" hence allowing the readers of this work to get to the truth and have an accurate understanding about the social issue being investigated.

In sum, selecting hermeneutic phenomenology within an interpretive approach was beneficial to researching the phenomena presented in this study as it guided the researcher in producing rich textual descriptions that were both valid and accurate interpretation of the social phenomenon under investigation.

4.5 Research Strategy: Case Study

A number of research strategies have been proposed to date to address different issues in information systems research. Denzin and Lincoln (2011) propose the following as possible research strategies that IS researchers can adopt; case study,

grounded theory, action and applied research, clinical research and ethnography to mention a few.

In accordance with the research philosophy employed in this research, a case study strategy was selected as research method for this study. This method is in line with the interpretive paradigm as case studies can be employed when the researcher's intention is to observe change over time and understand events that evolve over time within a given context (Pettigrew 1997, Yin, 2004).

The case study as a research strategy has been referred to as one of the most popular methods employed in conducting IS research (Orlikwoski and Baroudi, 1991). According to (Yin, 2009) a case study, investigates a social phenomenon in its real-life setting, employing multiple methods of data collection to gather information from people, groups or organisations within a given context. In providing additional insight to this concept, Myers (2009) points out that case study research makes use of empirical evidence from one or more entities where an attempt is made to study the subject matter in context. He goes on to add that although multiple sources of evidence are employed, most times, a large part of the evidence is derived mainly from interviews and documents (Myers 2009). Putting together these two definitions of case study brings to light three key characteristics of this method and they are:

☐ A social phenomenon or a "case" which is to be studied.

☐ A natural setting, which is the context in which the phenomenon is studied. For instance this could be an organisation.

☐ A person or group of people from whom or about whom data is to be collected, relies on multiple sources of evidence.

When to use the case study method

When is it appropriate to use the case study method? According to Yin, (2009) the case study is an ideal information systems research strategy for exploring a

contemporary phenomenon in its real life context, of which is the case in this research.

Moreover, case studies have been used as a preferred method in studying the introduction and use of information systems particularly within a health context, in an attempt to understand complex issues as it can help extend experience and add strength to what is already known through previous research.

The justification for the researcher's choice of using a case study method in this study is based upon the three criteria developed by Yin (2003). The first criterion has to do with the kind of question posed. So the main question this study seeks to answer is "To what extent has this technology effort involving mobiles improved maternal and child health outcomes in Nigeria and ultimately contributed to "building a better world"? Yin (2003) argues that "exploratory" "what" questions of this kind can be investigated using case study research methods and other such methods like surveys, histories, experiments etc. However the related sub-questions of this study seek to understanding how, so on that note, the use of the case study method is deemed appropriate. This is in line with Benbasat et al, (1987) who argues that the case study strategy can be used in the study of "why" and "how" questions because these deal with operational links to be traced over time rather than with frequency or incidence. In providing additional insight into the question of when it is appropriate to employ the case study method, Yin goes on further to propose that where the investigator cannot manipulate outcomes and events in the field (as is the case in this research), case studies are indeed appropriate as strategies such as experiments are deemed unsuitable for this purpose.

The third criteria proposed by Yin concerns the "the degree of focus on contemporary as opposed to historical events." Although in structuring the context of this study the researcher considers it necessary to include historical analysis, the principal focus of the investigation will centre on both contemporary challenges and distortions of introducing this mobile HIS and the extent to which it is making a difference in relation to mother and child health. In light of the above, the case study strategy was deemed most suitable for use in this study.

However it is important to mention at this point that of the four different kinds of case study design proposed by (Yin, 2003), a single-case study design was employed in this research. The condition under which it would be deemed suitable to conduct a single case study is when the case is either "critical," "unique," "typical," "revelatory" or "longitudinal," (Yin, 2003) although there are huge risks such as endangering the entire research if the single case fails (Yin 2003). The choice of a single-case design is justifiable from the viewpoint of the case being typical and somewhat longitudinal. Expanding further on what is meant by the case being somewhat longitudinal, the particular case study presented in this thesis is a long term effort that started in 2012 and is still ongoing. Consequently in order capture changes in people's reality over the life span of this effort, it was necessary that the researcher engaged with the subject of this study in a longitudinal way. In other words, this required the researcher to collect data repeatedly at different intervals.

This proved beneficial as it allowed the researcher to be an observer as well as an investigator of which afforded the researcher the opportunity to interact with the subjects of this study repeatedly over time. This helped to increase the researcher's prospects of both clarifying and eliciting more up to date information from the subjects.

Quality assurance of the case study method

Whilst the case study is a distinctive research strategy which presents many advantages to the IS researcher, such as enabling in-depth investigations and understanding of social issues within its real life setting, it is not without criticism. For example, some critics argue that qualitative research methods (of which includes the case study strategy) lacks rigour in the way it is conducted. Others, believe that the study of fewer numbers of cases can offer no grounds for establishing reliability or generalization of findings. Hence they conclude by questioning the merit to qualitative studies saying that it fails to achieve both internal and external validity.

In response to this, some qualitative researchers have argued that the term validity may be in appropriate in the context of qualitative research. In light of this, Guba and Lincoln (1985) in their work explain the traditional notions of validity and go on to propose the concept of trustworthiness as a more suitable alternative. This concept of trustworthiness as put forward by Guba and Lincoln is believed to be more suitable to use particularly within a critical research context (Denzin, 1994 p.151).

Guba and Lincoln don't stop there, in addition to presenting this concept of trustworthiness, in their they work outline four criteria's for trustworthiness and explain how a researcher can achieve them in a given study in other that their work may be deemed trustworthy (in other words valid). These criteria's are credibility, confirmability, dependability and transferability. In this research, the researcher adopts this argument and draws from Guba and Lincoln (1985 pp. 301-318) to briefly discusses the activities undertaken in this research to achieve trustworthiness and to provide a faithful description of the research experience.

Credibility: The criterion of credibility requires that the researcher demonstrate the credibility of the findings by having them approved by the constructors of the multiple realities being studied (Lincoln and Guba 1985: 296). One way this can be achieved is through prolonged engagement with the research subjects and their setting. This provides the researcher with the opportunity to test for misinformation and to develop a better understanding of the context. In this research, the researcher achieved this because of the longitudinal nature of the case study strategy. That is to say, the researcher conducted several field visits at various intervals for the purpose of capturing changing realities in both people's situations and with the on-going implementation effort. For example, the initial perceptions or constructions of realities by subjects that was captured soon after the deployment efforts were assessed again during the second field visit which was several months later. During this latter visit, the subjects were asked to reflect back on their realities and the researcher encouraged them to provide an account on how and why these realities might have changed over time.

Another important step taken to enhance credibility in the research process is the collection of data from multiple sources using various methods. In this research, the researcher collected data via semi-structured interviews, informal interactions, observations and document analysis. This provided the researcher with multiple interpretations and prevented the researcher from falling into the danger of easy interpretation of the phenomenon under study. Additionally, it provided the researcher with the opportunity of comparing and cross-checking the consistency of information gathered during field visits.

Transferability: A second criterion for trustworthiness as proposed by Guba and Lincoln is termed transferability. Transferability determines the applicability of the research findings to other contexts. Guba and Lincoln argue that while it is not the responsibility of the researcher to provide the index of transferability, however, it is the researcher's responsibility to provide the tool (data base) that makes transferability judgments possible on the part of potential appliers (Lincoln 1985, p. 316). To achieve transferability, the researcher provided thick description of the original context of which comprised a detailed and vivid social and historical account of the research setting (in this chapter). The researcher not only provided factual descriptions, she also provided descriptions on theoretical and methodological choices, the process of the research and its results (in this chapter 4), all of which are necessary in enabling future researchers intending to adopt this work to determine whether or not transferability applies while at the same time allowing readers of this research follow the pathway of the researcher.

Dependability: Dependability represents the degree to which research can be replicated in similar context and with similar respondents. A researcher achieves dependability by providing his or her audience with audit trail that notes the changes that the researcher observes through provision of recorded data, personal and field notes. This trail offers an account of different ways in which the change process might have impacted other processes and also be impacted on (Lincoln and Guba, 1985).

Confirmability: Confirmability requires that the researcher provides an account of how the data was gathered and interpreted, in a manner that can be replicated by

others and that should result in similar conclusions (Lincoln and Guba 1985). Confirmability deals with any bias in the process of data gathering as well as an interpretation. In this research, the researcher achieved confirmability by "opening up" the process of how the data was interpreted and handled to her readers, in order to enable them "audit" the analytical steps taken in this study such as demonstrating the merging of narrow categories and themes to generate more broader and interrelated themes.

Sampling Strategy

Within the qualitative research strand, non-probability sampling (otherwise referred to as non-representative sampling) is a widely used strategy employed for the selection of the population for a particular study (e.g. Denzin & Lincoln, 2000; Eisenhardt, 1989). Within this strategy, subjects are chosen to be part of the sample in non-random ways. In table xxx below, the key non-probability sampling methods are presented and the research will provide a brief discussion on the particular sampling technique adopted in this research.

Sampling technique	**Definition**
Quota Sampling	It is based on the premise that sample will represent the population as the variability in your sample for various quota variables is the same as that in the population.
Purposive Sampling	Enable the researcher to use judgement to select cases that will best enable to answer research questions and meet objectives.

Snow ball Sampling	Used when it is difficult to identify members of the desired population. Initial members are asked to identify similar possible members, and they in turn are asked, and so on. Stops when no new cases are identified.
Self-selection Sampling	The researcher allows a case, usually an individual, to identify their desire to take part in the research process.
Convenience Sampling	Involves selecting haphazardly those cases easier to obtain for sampling.

Table 4-2: Non-probability sampling techniques (Sanders et al, 2000).

In this research, the researcher adopted the snowballing technique as an approach to recruit participants for this study. This kind of sampling allows participants to suggest to the researcher, other potential interviewees, that have the knowledge and experiences that might contribute effectively to the study. For instance in this study, after the researcher gained permission from senior management to conduct this study, the researcher asked them to identify potential new cases (participant). These new cases were also asked to identify further new cases, and so the sample continued to snowball. Eventually, the researcher stopped this process as there were "no more new cases". This technique was beneficial as is it helped the researcher to gain access to most participants with less stress and effort on the part of the researcher.

Having discussed the research strategy and sampling strategy adopted in this study, this research will now provide a discussion on the fieldwork, starting with the data collection process.

4.6   Data Collection and Fieldwork

Having looked at the substantive elements of the research, i.e. the nature and boundary of what is to be researched, this section details the operational aspects of the research i.e. issues surrounding the fieldwork and data collection. So, bearing in mind that the fieldwork is based on an interpretive research paradigm (Walsham 1993) and in particular interpretive case study (Walsham 1995), the researcher's fieldwork objective was mainly to observe, elicit views and opinions so as to build a coherent narrative containing issues addressing the research questions.

To begin, I present the data collection method employed in this research. Data gathered for this research work can be broadly classified as being primary and secondary data, with the researcher eliciting more primary data over secondary. The reason being that the primary data, which is data derived from first hand from the original source, tends to be more credible as it has not been previously published neither has it been altered, hence making it more objective and authentic compared to secondary data.

Accordingly, this research adopted semi-structured in-depth interviewing as its primary data collection method to support the research objective. This was supplemented by other secondary methods such as the analysis of documents and archival record (Creswell, 2003), informal discussions and the observation of participants. The remainder of this section provides a description of these methods used in this research study to elicit data. Additionally, it will discuss details of the fieldwork and the role of the researcher during this process.

Interviews

Interviews are undoubtedly the most prevalent method available to qualitative researchers for collecting data. Interviews enable the researcher to explore the views, experiences, motivations and beliefs of participants about a particular phenomenon. Consequently, they are undoubtedly more suitable where little is known about a social phenomenon as they tend to offer detailed understanding of

the specific phenomenon. This understanding is achieved most times through a one-to-one interaction of both the researcher and the participants.

Indeed, it is being argued that interviews are not simply just about the interaction and conversations between participants and researcher. Rather, it is about the researcher or interviewer possessing innate attributes and interviewing skills which can lead to better communication thereby creating better stories for the audience. Some of these skills include the ability of the researcher to develop the art of hearing (Rubin and Rubin, 2005), the ability to know when to probe the interviewee and also knowing when and how best to use follow-up questions.

Interviews are categorised mainly as being structured, unstructured and semi-structured. Structured interviews though quick and easy to administer, are criticised for providing little or no room for follow-up questions to responses that need further clarification. Conversely, unstructured interviews are criticised for being time-consuming and difficult to manage owing to the absence of pre-determined questions. Semi-structured interviews are preferred by most qualitative researchers as it provides both the researcher and participants with guidance on what to discuss about. Also, the flexibility offered by semi-structured interviews provides a number of advantages to the researcher of which includes the opportunity to discover or elaborate on information that may not have been anticipated or considered important at the onset.

This research

In this research, semi-structured interviews were used to assess the reflexivity of actors (healthcare workers such as local government monitoring and evaluation officers, health administrators and decision makers) in action. This approach is a well-recognised approach used in the evaluation of ICT supported efforts, as it provides an understanding on how the introduction and use (or lack of use) of the technology is conceptualised and perceived from the point of view of those who interact with it. The point of view of those who are involved in this process is crucial

to studying the events taking place within the setting were this study is been carried out.

The field work was carried out in Nigeria and took place mainly at different levels of the health system namely the federal, local government and community levels. Specifically, data was captured both at the national office of the national primary health agency office in Abuja which represents the tertiary level of the health system and the community and health offices at the local level of the health system in various states within the country. The table below provides an overview of the participants interviewed in this study.

Location	Participant Interviewed	Participant code prefix	Content of interview	Number of interviews
Abuja-NPDCDA	Director and project staff (Focal actor)	FA	Background of MADEX, aims, the implementation process, management process	5
Abuja-NPDCDA	Senior (data monitoring) Officers	SO	Experience with MADEX and the implementation process	5
Primary health facilities	LGA M& E officers	LM&E	Experience using MADEX and the implementation process	24
Primary health facilities	Facility-in-charges	FI	Experience using MADEX and the implementation process	27
Abuja-NPDCDA	IT operations officer	ITO	Experience with MADEX and the development process.	8

Locality	Vendor	V	Experience with deploying MADEX and the implementation process.	2
			Total number =75	

Table 4-3: Overview of the participants interviewed in this study

The interviews with participant groups at the national level of the healthcare system were conducted within the NPHCDA premises in Abuja which is the federal capital territory of Nigeria and the interviews were held in the offices of participants of the respective interviewee groups. Also, interviews with participants at the lower level of the public health system, took place at both the M&E office situated in the local government complex and at primary health facilities located in the various states listed in table 4-3 above.

Interviews with participants were carried out by the researcher on a one-to-one basis. Interviews with interviewees ranged between thirty minutes to one and a half hours each; and were conducted in English. The researchers resorted to note-taking on paper and via a laptop mainly, as most respondent were not comfortable with the researcher using a digital recorder.

Interviewees were made aware of the research objectives so as to give them a shared notion of the expected contributions of the research (Fontana and Frey 2005). Additionally, the participants who took part in this study were informed of the possibilities of conducting follow up conversations via electronic means such as telephone and email and they agreed.

An important role played by the researcher during the interview process to ensure a successful outcome was establishing a good rapport right from the beginning with the participants of this study. This was done with the aim of building trust between the participant and the researcher so that they could openly and freely discuss and

share their feeling and views with the researcher. During the interview process, it was important for the researcher to be respectful of participants and their opinion without being judgemental. Hence the researcher made sure to listen to the story participants wanted to tell.

The initial set of questions posed to the participants were open ended and loosely framed around the area under investigation. The aim here was to try and avoid leading the interviewee in a particular direction as much as possible. However, following the first round of interviews, these questions were revised and as such were designed to be more focused. This enabled the researcher to further probe specific issues which emerged and were of relevance to the study. Highlights the questions posed to participants.

The role and contribution of Secondary data in this research

Observation

Another very important approach to inquiry as well a primary data collection employed in qualitative research is observations. Skilled observation as it is sometimes called can provide the researcher with rich data that can complement data gathered via other sources such as interviews. As a method, observation can broadly be classified into two: namely participant and non-participant observation. While participant observation typically involves active involvement of the researcher in the setting studied over an extended period, non-participant observation involves the researcher being present at the research site for a short period of time during which he/she records data without playing any overt role during this time.

Basically, observation requires that the researcher takes notes and records of events such as user's behaviours as they occur within the setting to better understand the nuance of what actually is taking place. This observational record is commonly referred to as "field notes".

Observation presents several advantages to the researcher. It allows the researcher uncover complex relations and interactions in the natural setting of the research

through body language and cues; and it also gives the researcher the privilege of hearing, seeing, and experiencing reality within the setting as the participants do (Marshall and Rossman, 1999).

As a method, observation also plays a pivotal role in qualitative studies as it provides the observer (the researcher) with important questions that can form future interview question. It also presents the researcher with the opportunity of raising questions in order to gain clarification of what is taking place in the setting.

The above qualities and benefits of observation presented above highlights a key point which is that, observation as a data collection method is crucial in the evaluation of new information systems were situated meanings and practices are of huge importance. Thus, the researcher believes that this research which seeks to understand the process of introducing and using a mobile supported information system can benefit from the additional insights that observation provides.

This research

In this research, while the researcher was conducting the fieldwork, she played the role of non- participant observer as she did not participate in the activities taking place in the setting nor did she influence the actions of participants. However, she observed what the users of the mobile technology actually did, rather than simply depending on the verbal reports or information provided by the participants.

The total hours spent by the researcher for observations was 20.5 hours. Most of the observation involved watching data reporting officers use the mobile device for uploading and sending information.

These observations were beneficial and contributed to the rich understanding of the process of introducing and using mobiles as part of this information system. It afforded the researcher the opportunity to directly experience the research setting in all its complexities and to take record of ongoing activities as well as descriptions of the research setting.

For instance the researcher was able to see first-hand the ease with which users operated the mobile device and used it to report health information. She was also able to see how poor telecommunication signal made it difficult for LM&E officers to send their monthly report.

Also in this study, non-participant observation provided the researcher with a benchmark against which she could check the validity of the data captured via other methods such as interviews.

Document Analysis/Review

Another important source of data collection technique employed in this study, was the review of documentation. As a qualitative method for collecting data, the analysis of documents has several advantages. For instance, they were particularly useful as they afford the researcher the opportunity to better understand the historical context of a specific setting by providing background to the research Marshall and Rossman (1999).

Category	Examples
Books/Publications	• Abimbola S, Okoli U, Olubajo O, Abdullahi MJ, Pate MA (2012) The Midwives Service Scheme in Nigeria. PLoS Med 9(5): e1001211. https://doi.org/10.1371/journal.pmed.1001211 • The MDG-DRG funded midwives service scheme - concepts, process and progress, MADEX user guide. 2010 edition and 2012 edition. • NIGERIA MDG+10 SHOWCASE NO. 7. Midwives Service Scheme. Accessed May 2012 • FEDERAL REPUBLIC OF NIGERIA. Using Strategic Information and Investment to Improve Availability of Skilled Providers in Underserved

	Areas in Nigeria. The Nigerian Midwives Service Scheme. By DR MOHAMMAD MURTALA MAI, MEMBER, GOVERNING COUNCIL, NPHCDA. Count down to 2015. Accessed 21st June 2013.
News/blogs reporting	• Telemedicine and e-health: Antidote towards reaching Nigeria'sMDGs.http://alexchiejina.blogspot.co.uk /2010/09/telemedicine-and-e-health-antidote.html. Accessed 12, July 2013. • Celebrate solutions: The midwives service scheme. http://archive.womendeliver.org/updates/entry/cel ebrate-solutions-the-midwives-services-scheme-nigeria. Accessed 18th, March 2012.

Table 4-4: List of document used in this study

This research

As part of the research process, in addition to the interviews and observations conducted, the author collected and reviewed various documents in order to better understand this implementation effort and to help create the empirical narrative of this study.

Documents used in this study were obtained by the researcher both from online sources and from the research setting i.e. the NPHCDA office in Abuja. These documents are listed in the table above. Some of the documents were obtained from the Internet while others were provided by the NPHCDA.

The above documents provided the researcher with an overview of the project from its inception. Together with interviews, this informed the description concerning

the project discussed in chapter 2. In addition, the document contributed in establishing the actors that were part of this effort and how they were deployed (please see chapter 5 table 5-1).

Phase	From	To	Duration	Interviews	Observation
1st Phase	May 2012	July 2012	2 months	18 interviews	7.5 hours
2nd Phase	July 2013	October 2013	2.5 months	33 interviews	8 hours
3rd Phase	January 2014	March 2014	2 months	24 interviews	5 hours

Figure 4-2: Data collection phase

4.7 Summary of the field work

Having discussed the data collection techniques used I will now provide a summary of the field work experience and the role of the researcher during this stage. In sum, the researcher made a total of three trips to the field. The first phase was from May of 2012 to July of 2012, the second was from July 2013 to September of 2013 and the last phase was from January 2014 to March of the same year (please see table 4 above). The total duration amounted up to six (6) months and a few weeks, of which yielded a total of 75 interviews with participants and a total 20.5hrs of non-participant observation. The first defining phase of the fieldwork was the visit made in May to July of 2012. It was during the first visit, that the researcher gained permission to carry out this study. Also during this first visit, the researcher was able to speak to a director and some high ranking officials of the agency. This visit will form the foundation of the field work as the researcher was able to capture background information, get directions on how best to proceed as well as obtain

key project documentations all of which served as a good platform to build subsequent field visits.

The role of the Researcher

In a qualitative study, the role of the researcher is an important role primarily because the researcher is considered an "instrument" of data collection (Denzin and Lincoln, 2003). In contrast to quantitative research whereby data is mediated through inventories or questionnaires in qualitative research, data is mediated by the researcher or as Denzin and Lincoln put it "the human instrument". This concept simply emphasizes the distinctive role of the researcher's knowledge, perspective, as well as subjectivity in the process of collecting data.

Consequently in a qualitative study such as this, readers of the research have a right to know about this human instrument. This implies that the researcher needs to provide a description of which comprises of relevant aspects of their self, including any biases and assumptions and experiences to qualify his or her ability to conduct the research (Greenback, 2003) Also as advised by Walsham 1995, the researcher needs to let readers know the role they have assumed while carrying out the research. This could either be the role of an "emic" researcher that is an insider who fully participates in activities taking place in the research setting or an "etic" researcher otherwise referred to as an outsider or a participant observer who has no direct involvement in activities taking place in the field. My role in this research was that of a participant observer. The next section, which is the data analysis process, describes the approach in detail how the findings of the research were derived.

4.8   Data Analysis Process

In a qualitative study such as this, the analysis of data is an important step as its aim is to search for coherence within data sets with the goal of developing an understanding that will prove useful to the researcher in answering the research question. In this study, the process of data analysis was carried out manually and it

began with the transcribing of all interview and field notes and storing them electronically.

The data analysis approach employed for this study is thematic analysis. More specifically, a hybrid (inductive and deductive) approach was used. Thematic analysis as an approach is widely used in the analysis of qualitative data owing to its accessibility and flexibility. This approach involves searching across data sets in order to find and make sense of commonalities as well as shared meanings in the data set relating to the specific research question being explored (Braun and Clarke 2006). A necessary first step in this approach involved the reading and re-reading of the interview transcripts and field notes. The purpose of this exercise was to enable the researcher gain familiarity with the data. Further, whilst reading the interview transcript, the researcher went on to add any notes or ideas on the transcript. Overall, reading through the transcript again and again enabled the researcher to grasp the general ideas participants were conveying as well as understand the general impression and the overall depth of the information (Creswell, 2003: 191).

Having completed this important first step of becoming familiar with the data, the researcher proceeded to the next important step that is, coding.

Coding

Miles & Huberman provide a broad definition for this process by stating that:

"Coding are tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study. Codes usually are attached to "chunks" of varying size-words, phases, sentences or whole paragraphs, connected or unconnected to a specific setting" Miles & Huberman (1994: 56).

Basically, this simply means that coding is an essential method for data reduction (Miles & Huberman, 1994) as it involves assigning words or phrases to portions of the raw data in line with the research question.

In this research, as earlier mentioned, coding was done both inductively and deductively. The first set of codes that was used to interpret the data were the theoretical codes (specifically ANT's concepts of translation) generated from the theoretical framework. The second set of codes emerged inductively from the empirical data. Thus the researcher also engaged in open coding of the raw data. Basically, events were openly coded as they emerged.

The coding process, required the researcher to conduct two key activities concurrently, namely mechanical data reduction and the analytical categorisation of data (Neuman 2006: 460). The process of data reduction required the researcher to reduce large amounts of raw data into small, manageable bundles. The researcher also engaged in categorisation of the data. This activity required the researcher to analyse the data by organising it into categories on the basis of themes, concepts, or topics (Miles & Huberman, 1994: 57).

It is important to mention at this point, that the process of coding was conducted manually by the researcher. While the researcher is aware that coding of qualitative data can also be facilitated by using specialist software such as Atlas, NVivo etc, the researcher resorted to adopting the traditional approach otherwise referred to as the manual method whereby the assistance of specific qualitative analysis software was not required. The reason for this is as follows, first, the researcher was not dealing with very large data set, and as such did not consider it necessary to employ a tool to facilitate this process. The second reason has to do with the view held by some scholars which is that, sometimes software packages can make the analytical process quite cumbersome, as they require that the researcher provides the logic and coding algorithm that would underpin the data analysis (Walsham, 2006). Overall, bearing in mind that these software tools do not automatically make the codes, as the researcher is the one who has to interpret the data, to create the codes, to reorganise and to retrieve them, the researcher resorted to adopting a manual approach throughout this phase.

Following the process of coding the data, the researchers focus, shifted from looking at particular codes, to exploring how different codes could potentially be integrated into themes. As part of this process, regular student-supervisor meetings

took place during this time and was indeed helpful as the research supervisor was able to also provide alternative views to be considered in the analysis. Also the researcher would go back and forth to the theoretical resources and the empirical data as part of this process. This proved to be a good strategy to explore potential themes. As this process evolved, so did the researchers understanding of the data, such that that a series of core aspects relevant to understanding the implementation of mobile phone innovations started to become more evident. The final stage in this process had to do with naming the key themes and reporting the key findings. As part of this final phase, the researcher had to select excerpts from the interview transcripts that capture the essence of each theme presented in the findings section, with the intent of providing a coherent, logical and interesting account (Braun and Clarke, 2006). This is presented in chapter 5 and 6 of this thesis. The analysis along with the interpretations presented in these chapters, reflects the participants' views entwined with the researchers reasoned interpretation of the phenomenon under study. Table 4-3 below presents the six steps taken as part of the thematic coding exercise, while Appendix C shows some sample themes and relevant excerpts from the transcripts and observation notes to illustrate the thematic coding process.

Phase 1:	Being familiar with the data
Phase 2:	Assigning codes to the raw data
Phase 3:	Searching for themes
Phase 4.	Reviewing themes
Phase 5:	Define and naming themes
Phase 6:	Producing the analysis/reporting findings

Figure 4-3: Steps taken as part of the thematic coding exercise (Braun and Clarke, 2006)

Reliability and Validity

To ensure the reliability and validity of the data collection and analysis process, the following steps listed in table 4-5 below were applied concurrently. Specifically, to achieve reliability in the data collection process, the researcher ensured that the data was triangulated by interviewing various participants involved in this effort. Further, by combining secondary data sources such as news reports, websites, and project documents with primary data such as interviews, the reliability of the data and findings was enhanced to a large extent. Also, in an effort to achieve validity, as least two researchers (i.e. the research student and her supervisor) were actively involved during the process of data collection and analysis. We also presented our analysis and findings to other researchers at doctoral research forums to get unbiased feedback so as increase the validity of our findings.

Methods to Ensure Reliability	Methods to Ensure Validity
✓ Conducted semi-constructed interview, adjusted questions based on interviewees responses.	✓ The coding process also involved multiple researchers (i.e. the researcher and her research supervisor). Codes and descriptions were modified or adjusted based on the common view of both researchers.
✓ Data was collected in multiple ways in a bid to ensure data can be triangulated.	✓The findings obtained was presented to other scholars and academic colleagues to elicit unbiased feedback in order to increase the validity of the research findings.

✓ We studied Nigeria's public healthcare environment and the development of MADEX beforehand, so that interview design and data could be contextualized.	✓ The researcher made sure that two researchers were involved in the process of interview: (herself and her research supervisor) one asked questions while the other reviewed the questions, suggested follow-up/complementary questions. Also both researchers then compared interpretations with each other.

Table 4-5: Summary of the key steps taken to ensure reliability and validity of the data collection and analysis.

Having extensively discussed the data collection, analysis and field work phase, this chapter will now provide a discussion of an important area that is intertwined with these phases, that is ethical considerations. However before proceeding with the discussion, an overview of the research methodology adopted for this study is presented in the diagram below.

Research Approach	Choices
Research assumptions	Interpretive
Research Strategy	Qualitative strategy
Role of the researcher	Outside/non-participant observer
Research design	Single case study
Data collection techniques	Semi-structured interviews, observations, document and archival data review

Data analysis	Thematic analysis
Validation	Feedback on research results from other scholars

Figure 4-4: Summary of the research methodology

4.9   Ethical consideration

Researchers conducting qualitative studies tend to confront some unique ethical challenges because of the often evolving and open-ended nature of the inquiry and also because of the direct and close interaction between the researcher and participants observed or interviewed. It is therefore important that at the beginning of such studies, the researcher pays consideration to potential challenges that may arise and put in place measures by which these issues can be addressed.

In this study, the researcher heeded the advice of Creswell (2012) who calls on qualitative researcher to consider ethical issues that occur not only during the data collection phase but also in all other phases of the research process such as those that might occur prior to collecting data as well as during the data analysis and reporting phase. In this section, the researcher provides a description of ethical issues that she considered during the key phases of this research and how she addressed them.

Prior to collecting data: During this phase, the two key ethical issues that needed addressing was first; to seek approval from the researcher's institution of study to conduct this study and second to gain permission from the research setting to carry out this study. To address this issue, the researcher began with submitting the ethics application forms to the Ethical Committee of the School of computing, Brunel University in April of 2012. This application provided details of the nature of research to be carried out, how it would be carried out and the intended participants. In May of 2012, ethical approval for the study was granted, and the process of gaining access to the research site commenced.

An initial email was sent by the researcher to a representative of the NPHCDA (research site) in Nigeria expressing her interest to conduct this study. In this email, the researcher made sure to introduce the research project in detail. Following this email, the researcher was invited to appear in person to discuss with the then research and development director of the agency to explain in person her interest. Following this action, the researcher was given a letter of approval granting her permission to carry out this study in the research setting (See Apendix A).

Having gained access to the research site and also being granted permission to conduct this study, the researcher provided key persons involved with this effort, with information sheets disclosing the purpose of the study and other important information about the study. Having done this, the researcher proceeded to gain their consent to willing participate in this study through the use of a consent form.

The data collection phase

Another important area in the research process that gave rise to ethical issues was the data collection phase. Key issues that surfaced during this phase include; being honest and open to participants about how the data will be used, refraining from exploiting them while interviewing them, respecting participants views and lastly, giving something back to the research setting. To help address the above issues, as much as possible, the researcher brought the participants of this study into the negotiation process. The researcher promised participants of this study that she will maintain confidentiality and also while conducting interviews and observation; she will make sure not to be intrusive, but rather be respectful of the private space of participants. During the interviews, the researcher allowed the interviewees to share their experiences freely by refraining from asking leading questions. She also made sure to respect their views too.

From the onset, the researcher assured the management of the NPHCDA of her willingness to share the findings of this research along with recommendations at the completion of this study. However, the researcher considered it of immense importance to provide the agency with formative evaluation at the end of each cycle of data collection and analysis as a way of contributing to the project.

Analysing and reporting data

In order to analyse large amounts of qualitative data derived from documentary sources and interviews, a coding scheme was developed and applied by the researcher. The code scheme involved grouping similar events under the same heading. Given the range and complexity of the field data, structuring the development of the code scheme in a more detailed way led to a reductionist approach (Walsham & Sahay, 1999). The coding scheme helped to reveal emerging themes related to the trajectory of the actor-network under study.

Overall, the data collected from the early stages of field work involved more open-ended interviews, while the later stages were more directed toward the identification and validating of emerging concepts and themes making it easier to analyse the data.

Finally, in relation to reporting the data, the researcher was sensitive to potential ethical issues that could surface during the process of analysing and reporting the data collected. The researcher was aware of the importance of representing findings accurately so she avoided taking sides with participants of the study and avoided only reporting positive findings that emerged from the study. Another potential issue that could arise in this phase is the issue of plagiarism. The researcher made sure to avoid plagiarism and other potential ethical issues that could crop in this phase by taking key steps in this phase of which include: citing correctly the work of others while writing up, protecting the identity of participants when reporting quotes from interview transcript, reporting multiple perspectives as well as both positive and negative findings and by ensuring that the writing of the report was done in clear and appropriate language in order that it might be meaningful for the intended audience of the study.

4.10 What comes next?

This chapter presented the methodological approach and the ontological and epistemological assumptions underlying this study. The qualitative research approach based in an interpretive paradigm was adopted in this research owing to

the exploratory nature of this study. This enabled the researchers to gain information about the area being examined - an area where scarce theoretical base evaluations have been carried out particularly in relation to the context where this study is been carried out. The next chapter, which is chapter five is the first empirical chapter of this study, it presents the findings of the field work that was carried out.

Chapter 5: Case Study Findings

5.1 Overview

This chapter, the next section 5.2, is concerned with understanding how the MADEX implementation took place. Specifically, it first offers a chronological narrative with the help of the translation moments (from the analytical framework) of how the implementation took place over a period of approximately six years. Then, it examines the complex interactions that took place between both the human and non-human actor of the MADEX network.

5.2 The MADEX Case Viewed Through the Lens of ANT: Sociology of Translation

Going by the sociology of translation, the implementation or introduction of a new technology kicks off with a proposal for new relations between elements, which together will form the emerging network (that is of the new technology). However, it is only when this idea for a new network of relations is taken up by the actors involved, and when all the elements are indeed assembled together in a precise way and remain together in that way, can we say that the emerging technological network is well functioning. Nonetheless, for this process to take place, the elements that are to be assembled together have to undergo transformation. This process of transformation, demands a new way of thinking and acting from the actors, as a result of the uptake of new roles and responsibilities that places it in the new network of relations of the emerging technological network. Essentially, a transformation is necessary to ensure that actors take up their place in the new socio-technical network. This process of transformation otherwise known as the translation can be viewed as a process, by which the normal or familiar way of

conducting activities of an actor becomes transformed. For example, the introduction of the MADEX network, would (translate) the normal way of capturing and reporting data within this health system, which is the manual way via registers, thus making the actors act differently (when it comes to capturing and reporting maternal health data) than it would, prior to the introduction of MADEX.

According to the sociology of translation, implementing or introducing a new technology is the responsibility of the focal actor (s) or network-manager (Latour 1991). Basically this focal actor (s) has a primary responsibility of drawing together various heterogeneous or dissimilar elements and actively translating them, so as to put into place a stable network of relations between them. Further, going by the tenets of ANT's translation process, for this network to achieve stability and indeed become successful and establish, the focal actor must ensure that all actors in the network accept and remain faithful to the new roles and responsibilities assigned them. With that said, the four moments of translation postulated by Callon (1986) (please refer to chapter three) involved in the process of network formation and in this case the introduction of the MADEX network will be applied to provide explanations and analyse how the change process in MADEX took place, and why the outcome turned out to be the way it did.

In an effort to provide structure to the trajectory of the MADEX effort, that lasted approximately six (6) years, the project has been divided into two distinctive periods: 2009–2012 they deployment of MADEX I and 2013–2015 (the deployment of MADEX II). Essentially, as earlier mentioned, the analysis will focus on how the MADEX actor-network came into being and how it changed over time in an effort to establish itself. It will also provide insight into the relations among the different actors in the network (Doolin and Lowe, 2002) and the key events that took place as part of this effort. To do this successfully, this research will adopt one of the famous phrases of ANT which states "follow the actors". By heeding this advice, the intention is to present a clearer picture of the actions throughout the different stages of this effort with the help of this theory.

5.2.1 Phase I - MADEX Implementation (2009-2012)

The problematization

The Problematization is the first "moment" of translation were the initiator defines a problem in such a way that other actants in the given network recognize it as their own problem. As part of this moment, a very important task carried out by the initiator or focal actor is the identification of other actors, in other words to find out who the main actors are and what role each actor will be playing towards achieving the proposed solution.

In the MADEX network, the technical working group (TWG), consisting of top management of the NPHCDA, have been working persistently in translating the interests of others to deploy MADEX; hence, they are identified as focal actors. This group was made up of the executive director and CEO of the agency at the time, other key directors of the National Primary Health Care Development Agency e.g the Director Primary Health Care Systems Development and relevant senior personnel of the agency.

The primary function of this group (hereafter referred to as the focal actor (s) was to provide overall guidance and direction for this effort. Also they had the responsibility of providing regular status reports on the MSS activities as well as progress (or the lack of it) to the Federal Government, who happens to be the main sponsor of this effort. As an initial step, they identified both human and non-human actors within the public health system who would be part of the MADEX actor-network aimed at enhancing the process of reporting and communication of maternal health information from the various levels of the public health system. Overall, by defining the identities of the actors in this emerging network and establishing themselves as an OPP in the emerging network, the focal actors render themselves indispensable in the network.

Identification of actors and defining their roles

In ANT, actors can only act in combination with other actors in which non-humans such as technology can also have agency along with humans. In this study, while

the identification of human actors such as the facility-in-charges, vendors, IT operations personnel who are an integral part of the translation process was straight forward, the identification of non-human actors requires more thoughtfulness. I identified mobile phone as the non-human actor in this implementation effort as it was the technology used to facilitate the communication of maternal health information in this network. Below in table 5-1, is a description of the actors I plan to follow initially, to explore how they align their interests to develop an actor-network.

It is important to mention that neither the women nor the children who accessed maternal and child health services at the facilities could be seen as actors in this network and this is mainly due to the fact that they have no interaction at all with the MADEX system other than benefiting from its output.

The actors listed below were identified through interviews and documentary study. A brief description of their task, interest and the obstacles they had to overcome in the MADEX actor-network is presented below.

ACTOR	TASK	OBSTACLE	GOAL/INTEREST
Focal actors (TWG)	To provide leadership and coordinate this effort. To frame the goals and problems of the other actors. To negotiate, motivate and work with other actors.	To identify suitable strategies to ensure the successful implementation and use of MADEX.	Initiation and implementation of the MSS/MADEX project.
Facility in-charges/ M&E officers	Tasked with entering data (on key MNCH indicators) into the MADEX application installed on the mobile phone and sending this	Lack of awareness of mobile phone-based innovations and its significance in the work place. Difficulties	Ensure that the monthly report is sent via the mobile phone to the IT control centre of the NPHCDA.

			Secure an additional income by committing to this additional task.
Senior data monitoring officers,	To serve agency directors, and other key stakeholders with statistical information from the MADEX platform to support decisions making and planning. Continuous monitoring of key MNCH indicators.	The absence of credible/usable data /information	Fulfilling their work/ professional commitment providing trust worthy reports. The opportunity to receive information on key MNCH indicators quickly, in a digitised format for easy analysis and report generation.
Federal Government	To provide resources and finance this effort generally.	Lack commitment and political will towards this effort.	To see improvement in maternal and child health indices nationwide and eradicate avoidable maternal and child deaths. To be seen to be proactive in achieving the 4th and 5th MDG by the UN and the international community generally.
ICT(mobile phones)	To capture and disseminate MNCH data	The attitude of the users and lack of appropriate support from the focal actor.	Facilitate the process of Reporting routine MNCH data/information in a timely manner.
		Lack of	Provide leadership in

IT Vendor	To successfully deploy the MADEX solution	experience of similar implementation.	cutting-edge innovation of implementing MADEX.
IT Operations personnel	To possess the capability to support the vendors in deploying the MADEX solution and subsequently take responsibility for its day to day management.	To work with MADEX users who are unfamiliar with mobile phone innovations and its significance in the workplace and prefer/are familiar with manual systems.	Support the integration of MADEX and help users to effectively use the technology.

Table 5-1: Showing the main actors, their obstacles and their goals

From the table above, in the view of the focal actor, the goal of the actor-network was to successfully implement the MSS/MADEX project. This basically meant that they wanted to see MADEX fulfil its purpose of capturing accurate data on maternal and child health from primary health facilities across the country and having it being reported in a timely manner to aid the process of continuous monitoring of maternal health indicators as well as decision making. In an effort to achieve this goal, it was essential that the interest of all the other all actors be served. For example, the Federal Government's interest will be served with quarterly reports made available to them by the focal actor showing improvement in maternal and child deaths in addition to the government been seen by the international community as working proactively to eradicate high rates of maternal and child deaths and improving mother and child health; the senior data monitoring officers at the national office of the NPHCDA will be seen as fulfilling their work commitment by providing trust worthy reports and at the same time be opportune to receive information on key MNCH indicators in a timely manner and in a digitised format for easy querying of the data and further analysis.

The facility in-charges/M&E officer's goal was to ensure that the monthly report is sent via the mobile phone to the IT control centre of the NPHCDA. For them also, the opportunity to secure an extra income was of interest to them. For the IT operations personnel, their primary goal was to support the integration of MADEX and help users to effectively use the technology while the vendors interest and goal would be the opportunity to show prospective clients that they have what it takes to successfully deploy mobile solutions within the public sector since this would be the first time they will be providing such service within the public sector and last but not least, the mobile phones themselves will had a goal of capturing, processing and disseminating key MNCH data/information.

Going by "Latour's logic", mobile phones were very much an actor in this network. Easy to use and not too expensive to procure, this actor's role was also key to the success of this effort. Specifically, mobile phones had to be convinced to be used as a tool for routinely capturing and disseminating reliable health statistics data in a timely manner. It not only needed to allow this to happen, it also needed to provide this information in a timely manner and usable format to facilitate effective evaluating and monitoring and analysis of the data. It was the responsibility of the focal actor to make stipend available or in some cases top-up vouchers needed to recharge the phone so as to be able to successfully send the monthly report via SMS via the mobile network. Overall, the accomplishment of these goals would not be easy, as there are key obstacles each of these actors have to overcome. However, if all actors can overcome their obstacles, they would obtain the benefits as set, and the goal of the actor-network would be achieved.

As earlier mentioned, MADEX was initiated late 2009 by the focal actors and the objective was to establish a mobile phone-supported information system for capturing and reporting data on key MNCH indicators such as maternal mortality ratios, neonatal mortality rates in each primary health facility, the proportion of women using family planning services and the proportion of children fully immunised at age one in each facility and so on.

The focal actors being the main protagonist for this effort were responsible for the formulation of the problem and the devising of the particular solution to address

this problem. In positioning this effort on a path for success, it was important for the focal actors to ensure that the given problem needed to be widely understood as being serious and important, while the proposed solution needed to be considered as practical and achievable in terms of addressing the problem.

In this case, the focal actors had identified a problem that they characterised as pervasive: untimely information for monitoring and decision making purposes. Basically, they went on to point out that the existing manual system lacked the ability to turn in data quickly from well over 652 health facilities, across the various states of the federation in a timely manner to allow senior data monitoring officers of the agency, effectively monitor and take immediate action on MNCH issues. This gave rise to the idea of having some form of technology to support the information management process. So technically, the introduction of mobile phones was defined as the solution to the problem. The existing manual system was judged to be functional by some senior staff of the agency and so they suggested that instead of spending money on a mobile supported system, money be given to agency staff in the form of transport and field allowance to enable them go out to the field and capture data on key MNCH indicators that were being monitored. However, the focal actors having weighed the cost of both as well as take into account other factors, decided that this was going to be far expensive considering the scope and would be difficult to sustain in the long term. Finally, it was decided by the focal actors that mobile phone as a technology would be less expensive and appropriate to use to address the problem at hand. Thus, with the focal actor's reaching a decision to deploy the MADEX system, they began promoting this idea within the agency.

Below is a quote from one of the focal actors:

"…The government and the agency are committed to improving maternal and child indices by lowering infants and maternal mortality rates in the country especially in rural areas. So, if we have an efficient information system, supported by some form of technology (in this case mobile phones), we strongly believe that we will be able to collect key data from the facilities and report it very quickly for better monitoring and decision making". (FA1)

Next, the focal actors embarked on a vetting process for the vendor selection to develop this mobile supported solution. The vendor selected a local consulting company known as Dabar Object solutions, even though familiar with providing mobile solutions to clients, had never developed a system of this magnitude. However the focal actors had confidence in their ability and thus recommended them. They basically developed the solution and deployed it with the support of IT operations personnel who were employed at the head office of the NPHCD agency. The focal actors decided that after the main deployment, further management of the system will be done in-house by the agency employed IT staff and so the IT vendors would only be called in when there was a major issue or to provide system updates. It is important to mention that before and during the implementation, the vendors provided training to the agency's operations personnel on how to manage the system and left the door open for other consultancy needs that could arise over time.

Overall, from the above, we can see how the problematization, paved the way for the proposed 'solution'. That is, the introduction and use of mobile phones within this health system with the explicit aim of getting accurate and reliable information on maternal and child health indicators into the hands of planners and decision makers in a timely manner.

A focal actor had this to say about the problematization:

"After series of consultations with other countries and strategic partners, we (the technical working group), are in agreement that the introduction of mobiles to support this information system will help with the capturing of data from the community health facilities upward to the national office of the NPHCDA, in a cost effective and timely manner. We have found this to be successful in other developing countries, this will bring efficiency into the process of monitoring key MNCH indicators ". (FA3)

It is important to mention here, that the proposed solution was one that was viewed by many as being novel in some way (hence an innovation). This simply means that although the idea of introducing mobiles in health settings especially within a developing countries context, is one that has been around for some time (with the

advent and widespread availability of mobile technology), however, this will be the first time mobile technology solutions will be used for a nation-wide effort (not on a pilot scale) but on a large scale within the government-led public sector in an integrated manner that interconnects with existing systems such as other technologies and institutions.

Below is what one of the senior officials of the NPHCDA had to say concerning this matter:

"This will be the first time that a mobile phone solution will be introduced on a huge scale within our countries public health system to support information needs. This solution has been linked with already existing organizations on ground such as the NPHCDA, the local government staff such as the facility in charges, etc." (SO1)

Another senior personnel of the agency also commented:

"Although we have an existing manual system on ground, this seems not to be effective or even efficient enough considering the urgency of the matter at hand. For us to capture data on these key activities from hundreds of facilities geographically dispersed all over the country in a cost effective and timely manner, the routine use of mobile phones is definitely the way forward" (SO3)

In sum, having identified the problem and proposed a solution, the focal actors portrayed MADEX as an indispensable technology solution and established it as the obligatory passage point, as it was only by using this system that reliable data on key MNCH indicators from the various health facilities could be made available quickly, for purposes of monitoring and decision making.

Interessement and Enrollment strategies

Following what seemed to be a successful problematization, in the second moment of translation – which is the interessement – the actors of this emerging network needed to be interested to take up their new roles and task assigned to them by the focal actor. It is important to state that according to ANT, redefining and ascribing new roles to actors is insufficient as these definitions and roles have to be accepted

by the actor. As Callon puts it, Interessement is the collection of "actions by which an entity attempts to impose and stabilize the identity of the other actors it defines through its problematization." (Callon 1986, pp. 207-208).

Basically, to accomplish a successful interessement, the focal actor in this emerging will need to investigate the interests of the main actors so as to analyse strategies to negotiate their interests to align with theirs.

Interviews with the focal actor highlight the use of specific mechanisms such as MADEX training, meetings and the provision of economic incentives by the focal actor to "lock-in" the interest of the other actors (Callon 1986, pp. 207-8). Essentially, the focal actors had envisioned and identified specific devices and mechanisms (such as economic incentives, training workshops and meetings) with which to "interrese" the different actor groups so as to successfully enrol them into the actor-network to enable them perform their given roles.

For example, they not only advocated for giving a little monthly stipend to the facility-charges who now had the additional work of capturing and transmitting data via the MADEX phone (alongside manual registers), additionally, the focal actor recommended that training and workshops on using the MADEX and to explain the benefit of this system be provided in order to ensure successful deployment of MADEX.

One of the focal actor had this to say:

"Already, you know the facility-in-charges have a lot of work to do, also they are responsible for entering the same data captured on the MADEX platform on to the register, this means additional workload. Therefore we (focal actor) have decided to provide them with a little monthly stipend as an incentive to be committed towards this new responsibility". (FA2)

Another focal actor also stated:

"As part of our strategy to see MADEX succeed, we have put together regional trainings and workshops across the country for these officers (facility-in-charges)

who will be using the phones so that they can have a good understanding of MADEX and also how to use the application installed on the phone to capture and transmit routine data" (FA5)

Basically, interviews with participants further revealed that regional trainings were conducted across the six geopolitical zones in the country with the intent of introducing and familiarising the facility in-charges with this effort. Clearly this was a very important strategy introduced by the focal actor in terms of maintaining alliance with the facility in-charges. Essentially, as part of this training, facility in-charges were provided with a Nokia java enabled handset each (in the first phase of this effort). As part of the training, they were introduced to the features of the MADEX application installed on the Nokia phone and trained on how to enter data on to this platform and send it off via SMS to the server located in the operations room of the NPHCDA office on a monthly basis. Also, interview findings revealed that the trainings provided was not limited to simply learning about the MADEX tool but also extended beyond this by providing mentoring support to facility-in-charges.

One PHC facility in-charge commented on her training experience by saying:

"The training sessions has helped us (facility in-charges) a lot…. now we know what we have to do, that is, our role in the MADEX system…" (FI 2)

It is important to mention that primary health facility in-charges (FI) are responsible for running the primary health centres, where the majority of maternal and child health activities within the public health system (such as births, immunizations, family planning clinics etc.) take place. Thus bearing in mind that it is at the facility level, that the information on MNCH indicators is captured by the facility in-charges in what is known as the national health management information systems (NHMIS) register, it comes as no surprise that they were considered by the focal actors to be part of MADEX. The focal actors enlisted their support as primary users of the technology to capture key MNCH data on the MADEX application and to transmit it via SMS upwards to senior data monitoring officers at the national office of the NPHCDA for monitoring and decision making.

As shown from interview with focal actors (see above), the focal actor promised to provide a monthly stipend to these actors, as a form of incentive to keep them motivated and ultimately lock their interest in terms of actively carrying out this new responsibility assigned to them for the good of the MADEX network. A major interest for this actor group was the opportunity to secure an extra income by taking part in the MADEX network. In Nigeria, facility in charges all over the country are underpaid and also as it is common practice to be owed salary for months when working in the public sector (be it at the Federal, State or Local government level), the facility in-charges welcomed the opportunity to be part of MADEX with the hope of an extra income.

Still on the issue of interessement strategies, the focal actors had to use persuasion to mobilise alliance from actors such as senior data monitoring officers. For this actor group, it was the promise of getting timely information in a digitised format.

One senior data monitoring personnel from the agency deployed as a MSS state focal person had this to say:

"...we have been told that analysing the data and working on it generally will be easier with MADEX. Considering that MADEX will allow us received maternal health information quickly and in a digitised format, our work of monitoring the data will be made easier compared to working with data from the manual registers for instance we can generate graphs and reports easily".(SO2)

Another strategy developed by the focal actor to align the interest of this actor group was the formalisation of regular meetings with senior personnel of the agency. In these meetings, strategic issues especially about the implementation process were mainly discussed. Also issues such as the co-ordination of project activities, tactics to prevent potential failure of this effort as well as experiences in various facilities were also discussed.

Still on enrolment strategies, the focal actors appointed an official of the national primary development agency in each of the 36 states, to act as a liaison between the national agency office and the facility-in-charges (data collecting officers at the

primary health facilities). This official appointed by the NPHCDA was called the "state focal person" and was supposed to be the first point of contact for queries and be the go-to person in the case of any problems with the use of MADEX phone to capture data at the primary health facilities. Overall the state focal person had a key responsibility of providing support and ensuring the smooth running of the MADEX system in their respective state. Regarding the role of the state focal person, one of focal person had this to say:

"When I have issues with the MADEX application I had to contact the state focal person to resolve this for me. If it's beyond him, he will forward the issue to the national office of the agency to resolve it. But so far, he (state focal person) has been supportive. (FA3)

In an effort to translate the interest of actors in the emerging network, interview findings reveal that the translators that is the focal actors, negotiated and persuaded some actors using what can be termed the mechanics of power (Callon, 1986a, p. 9). By the subtle exercise of power, the focal actors were able to align the interest of certain actors to their own. For example, some senior data monitoring and evaluation officers did not buy-in to the MADEX system as they took interest in another system known as the DHIS system (an open source software platform for reporting, analysis and dissemination of data for all health) which was in its pilot phase and being deployed concurrently throughout the country by the same agency. Those senior data monitoring and evaluation personnel who were not keen on the MADEX innovation, admitted that their rationale for using technology was to align with the management requirement. For example one of them had this to say:

"I think the focal actors wants us to adapt to this new mobile phone innovation that has been brought in. I can say that it (MADEX) is mandatory from our management, so there is no other [way to] go, we have to use it in terms of giving our quarterly report, we would need to present snap shots of performance from the application"
"It is required, so I don't have a choice" (SO4)

This statement above reveals that some senior data monitoring personnel used MADEX as it was obligatory to use screen shot outputs generated for quarterly reports (see figure 2.5). The focal actors used this as an instrument of power for aligning the interests of this actors with their own.

Overall, the section above provides a discussion of how interessement was achieved in the emerging network mainly through negotiations and persuasions and how the senior management of the NPHCDA who were the focal actors, devised a number of enrolment strategies of which included trainings, meetings, economic incentives to create a stable network (albeit temporarily). Having discussed the first three moments of translation, this study will now examine the progression (or lack of it) from enrolment, the third moment to mobilisation the fourth moment.

Examination of irreversibility

The sustainability of the emerging actor-network created by the focal actors, depends on the extent of difficulty to change the actors' positions. Basically, if actors easily revert back to their original positions by breaking their alliance with the focal actors then it point towards the vulnerability of the actor-network. Thus, this section will examine the factors that influenced the implementation and use of technologies and how it helped to mobilise (or not mobilise) more alliances to extend the emerging actor-network.

Interview findings with study participants highlight key factors that during this first stage shaped the process of the implementation effort and they are as follows:

Neglect of Formal meetings: An interessement device that was introduced at the beginning of this first phase but overtime became neglected was the formal meetings. At the start of this initiative, these formal interactions were held on a regular basis to co-ordinate the project activities and to make strategic decisions to be further deployed in the PHC facilities across the country. However, interview findings showed that these formal interactions became less frequent and also were found to rarely involve actors such as facility in-charges. Essentially, many perceived that these meetings could have acted as a platform for the focal actor to

employ strategies such as negotiations and persuasions to influence actors' current assessment of this effort and at the same time, instil notions of desirable outcomes for this actor group. Below is an example of how one of the facility in-charges expressed her feelings about this issue.

"For a big project such as this, I would have expected regular meetings, because then, you are in continuous interaction with all those involved. In those meetings we can talk about our challenges here at the facility and ask all our questions. We can get to know the people at the top. We can have our say and contribute our ideas... unfortunately this is not the case". (FI 6)

Another facility in-charge added to this by saying:

"Despite the good intentions of the TWG formally introducing MADEX and its main functionalities via the regional training sessions..., in hindsight, many of us are in agreement that there could have been more of such sessions. This could have allowed for more interaction between the promoters and the primary users of the technology (that is facility in charges) to discuss MADEX use and benefits in greater detail especially at the local level "(FI 7)

Financial considerations: interview findings with participants highlighted two areas the implementation process suffered as a result of financial considerations. Owing to its huge impact on this process, the researcher considered it an actor in this emerging network. We take a look at the various instance where financial considerations impacted on the implementation process.

The first had to do with financial considerations impacted on the focal actor's ability to continue providing economic incentives to facility-in-charges as agreed. Although the focal actors had promised to provide stipends that will serve as an incentive and also assist with buying top-up to recharge the phone, the focal actors fell back on this promise. Basically with other competing priorities, and with irregular funding from the sponsors that is the federal government, it was evident that this impacted on the ability of the focal actor to deliver on their promise.

Needless to say, this contributed to the breakdown in the interessement process and as interview findings showed, it weakened the alliance of the facility-in-charges.

Below is a comment from one of the focal actors to highlight this point.

"... During the regional meeting, it was agreed that the prepaid vouchers and little stipends would be made available to the facility in-charges on a monthly basis... this has been irregular and after a short while it stopped completely. This has given rise to a situation whereby it has become difficult for facility in-charges to bring in the "quality" service and commitment that was expected of them as regards collating and sending of the monthly report on time". (FA 5)

Still on this issue, one of the facility in-charges had this to say:

...They told us to be patient... that they will send us the money for recharging and toping-up the phones so we can send the monthly information via SMS and also to as a way of incentivising us, but this money has been very irregular ... and even for a while we have not received anything… in the meantime, I have to use my money... but after a while and still no money coming from those at the top (focal actors), I will have to stop. I can't keep using my money to send the report. So now, I am waiting for them to do the right thing as was discussed in the initial meeting. (FI 9)

Below is a comment by one of the PHC facility in-charges on this issue;

"We were told that from the onset, a proposal had been written and submitted to the government and that once it gets approved, we will start receiving little stipends on a monthly basis as an incentive for the additional role and responsibility brought on by MADEX, but this was not the case. Even the top-up for the phone is not forth coming. ... we will still try and send the report although we will have to prioritise our work as we have other very important duties as facility in–charges that needs taking care of". (FI 4)

Also, two senior personnel of the agency had this to say regarding this issue;

"It has been difficult to get full commitment from the facility-in-charges as we have not kept our promise to them. I can correctly recall that, in our meetings, we were

in agreement that the successful cooperation of the facility in-charges relied on the provision of a monthly stipend which was supposed to serve as an incentive for the additional duty of capturing and entering data on to the MADEX platform in addition to entering data into their manual register, in some cases the DHIS platform as well, and other facility duties. ... (SO 1)

...Once the stipend stopped coming in, their (facility in-charges) enthusiasm began to diminish hence resulting in reduced interest of which manifested itself in different ways. For instance some facility in-charges had developed a less committed attitude towards the effort by sending their monthly reports late. Sometimes we had to plead with them to try and send their monthly report across reassuring them that the government will soon release money towards their stipends. (SO4)

Also another senior data monitoring officers had this to say:

"*...sometimes when we don't receive monthly report from a facility, we call to find out why...we are told that the phone is missing or faulty or there is some problem with the application. Generally we are unable to go to the field (health facilities) to respond and resolve queries or do any follow ups or further training for that matter.... as we have to wait for the government to release funds.... and when the fund is eventually released, most times it is not sufficient to take care of all the problems. (SO 3)*

Basically, as can be seen from the above comments, it is clear that the focal actors had gone back on their promise, as a result, the interest of this group failed to advance, causing a decline in their commitment to their assigned roles in the MADEX network. This will in turn have an impact on the ability of MADEX to stabilise as the reporting rate was affected due to a drop in commitment.

Funding post-deployment support plan: financial consideration as it concerns post deployment support plan. It was revealed that providing post implementation support became very difficult as the funding provided by the federal government to the agency to support this effort was not only insufficient but in most cases also untimely. This became an obstacle to the focal actor's goal of successfully

implementing MADEX. In prioritising, the focal actors even though were aware of the importance of post implementation activities, had to channel funds to other areas of the MADEX project. So post implementation activities such as planned field visits by the state focal persons and IT personnel to address technical issues that cropped up after going live such as replacing faulty/missing phones, the carrying out software update etc. was more or less impossible. IT operations personnel of the NPHCDA as well as the IT vendors seemed particularly dissatisfied with how this was plaguing their ability to achieve their goal.

One of the focal actors explained this point by stating that:

"Owing to financial concerns, we (focal actors) are unable to meet some important demands of this implementation effort. Basically, the government needs to do more in terms of making sufficient budget and ensuring that money gets to us on time so that we can support all the activities of this initial stage of the implementation effort" (FA4).

Overall, based on interview findings, it could be deduced that financial considerations came to be viewed as an actor in the MADEX network. The focal actors of this effort viewed the issue of funding as an obstacle to the achievement of its goal of aligning the interest of actors to that of their own. Interview findings reveal that the federal government's (also the project sponsor) inability to provide the necessary financial resource on time and according to the agreed budget, restricted activities of this emerging network, and consequently contributed to its breakdown.

Still on the issues that shaped the process of the initial phase of the implementation effort, interview findings brought to light some other factors which are discussed below:

Technical limitations and glitches

The task of the mobile phone in this network was to capture and disseminate reliable and accurate statistics on MNCH indicators. However, over time it became difficult for this actor to enact this role due to a number of reasons. For example owing to

poor signal strength of such basic Nokia handset, PHC facilities in-charges located in remote facilities that had poor mobile network coverage because of how far away they are from a telecommunication mast (this is not uncommon in Nigeria) found it difficult to send off their report within the stipulated time as getting mobile signal was very difficult. Owing to this issue, the data coming into the MADEX server at the operations room most times was found to be incomplete and unusable when received by server at the operations room. Another technical issue had to do with the type of mobile handset used. Considering that the handset used during this first phase was a basic Nokia handset, its features happen to be very basis as well, presenting a number of limitations as it was only able to provide basic functionalities. For instance this phone could only support a maximum of 160 characters, so instances when the data entered into the application by the facility in-charge exceeded 160 characters, transmitting this as SMS was problematic, as the additional characters were not transmitted and as such contributed to the problem of incomplete data. Another technical issue had to do with the handset getting lost or stolen. Interviews with IT personnel's revealed that this was a common occurrence and because the MADEX I application was not synchronised with the internet, whenever this happened, new mobile phones had to be purchased, and pre-registered onto the MADEX server before sending it out to the facility in-charges. Basically during that time, such facilities lost their capability to report data on the MADEX platform. Overall these technical difficulties discussed above, made it difficult for MADEX to perform its assigned role efficiently.

Staff from the IT department had this to say in relation these technical issues:

"Whenever the volume of data that is reported through the SMS via this application exceeds the 160 character limit, data is often lost in transmission.... unfortunately this type of handset can only support a certain amount of characters so there's only so much that we can do about this". (ITO 1)

"Also owing to the low signal strength of this type of handset, it is hard to pick up service in areas where mobile network connectivity is weak. As a consequence we are unable to receive data on time as we have to wait until when the facility in - charges are able to get good network coverage.... by the time the data gets to us it

is late... this is a problem for us particularly those who need to analyse this data and make decisions with it." (ITO 2)

Political issues

Some interviewees reported that in certain areas, specifically the northern states of the country, it was impossible to report data from most facilities in the area due to political problems specifically caused by the "Boko-Haram sect". Basically for a long time the government has been unable to enforce law in some of these states owing to violence brought on by this sect. The violent activities of this group included destroying telecommunication equipment's and mast, of which caused a breakdown of communication via mobile network. In order to contain this group, the government decided to sabotage their communication by mandating telecommunications network provider to shut down service in the area from time to time of which also made it impossible to report MNCH data from PHC facilities in these areas. Considering that this was a situation that was not anticipated and one that was out of the control of the agency, little or nothing could be done to resolve this issue.

One of the senior personnel at the national office of the NPHCDA summarised the situation by stating that:

....due to the political unrest in some of the northern states, as you must be aware (to interviewer), protesters have burnt down and vandalised some telecommunication infrastructures, and the government has shut down all telecommunication in the affected states until further notice. Because of this, data is not being reported from facilities in those areas... this is a problem…we cannot capture data through the MADEX from this areas and as such monitoring MSS statistics is more or less impossible in these areas." (SO 6)

 Diminished ability of MADEX to evidence its usefulness at the local level.

Another issue that came up in the interview had to do with the primary health care (PHC) facility in-charges not feeling strongly about MADEX because of its

inability to demonstrate its significance in a manner that could be seen, particularly at the local level were the raw data was being captured.

For instance, our findings show that although the information from the MADEX platform was meant to play a strategic role by helping with stock management at the facility level, among other things, this was not the case. For instance, the MADEX application on the mobile device, captured information relating to vaccines. One of such vaccine was misoprostol which was used by the midwives. The idea was that by providing a data field within the application for capturing information on the number of this medication that was used in a month, health planners and senior officials at the national office of the agency who receive this report can manage and control stock via MADEX, by disbursing the right amount of this medication to each facility. Thus, the strategic use of this information by those in the national office will ensure that capital is not tied down by buying more than is needed and more importantly, that there is no wastage of this medication at the facility level. The paragraph below by one of the facility in-charges reflects this point;

...regarding the misoprostol medication which the midwives administers to the expectant mothers , while some facilities have excess stock some other facilities don't even have at all. For those facilities with excess misoprostol, after a few weeks they have to throw away the stock...since this medication cannot be preserve longer than two weeks at the facilities...this is wasting... This continues to baffle us and is proof that the information captured may not be guiding decisions.... this makes us inclined to question the purpose of the MADEX application capturing stock information. (FI 7)

Based on the above, it is sufficient to say that, the inability of the facility in charges to see their effort of capturing and disseminating information upward, translate into some form of strategic advantage, particularly in terms of solving the problem around vaccine management, created some form of cynicism among this actor group. Basically, the ability for MADEX to demonstrate its value at this level would have served as a successful interessement device. However, given that this was not the case, the confidence and motivation of this actor group towards MADEX started

to diminish. Also what this situation demonstrated was that the prospect of mobile phones being successfully embedded within the public health system in such a way that it could be central to activities taking place at the national level as well as the local primary level where it is primarily used, was poor.

The issue of Scepticism

Interviews with study participants revealed a high level of scepticism among some senior personnel at the NPHCDA and also some of the field workers at the facility level about MADEX. Scepticism as used in this paper is based on the definition of Goldfinch (2007) whereby it refers to a reluctance of people to engage in public programs or activities. The interview finding showed a reluctance among some actors particularly those at the facility level towards MADEX. This arose based on two reasons: The first is that within the government-led public sector in Nigeria and most LDC, information management is predominantly done the paper way and this manner of working has become ingrained over the years.

Consequently, there is a lot of doubt and mixed feelings most times, surrounding new ways of working that involves modern ICTs especially at the local level of the health system. Basically, many who work within the government-led public institutions, are of the opinion that ICT supported systems, do not have the capability to thrive or be sustainable in a LDC context like Nigeria. Second, some interviewees expressed scepticism about this effort owing to previous outcomes of similar efforts. Specifically, many of them made reference to the fact that within the public sector, a large number of ICT deployment effort that occur, turn out to be unsuccessful. Essentially, many of them recounted their experiences with these failed efforts, describing them as being laden with unfulfilled promises and in the words of some "are just an utter waste of time and resources". Consequently, this has resulted in a negative mind-set in terms of confidence and credibility towards government led ICT initiatives. This kind of mind-set and reluctance, which is particularly detrimental to the deployment of ICT, was observed to be present in this effort. Needless to say, such scepticism set the pace for the reaction and behaviour of some situated actors towards this effort.

For example, the level of commitment and involvement of some facility in- charges and even senior data monitoring personnel involved in this effort, reflected how much they bought into this way of thinking. Here is what a senior personnel of the NPHCDA had to say on this issue;

"We get reports from local level about the reluctance on the part of some facility in-charge to commit wholeheartedly to the MADEX and use it in the way intended. From their own view point, they have seen many of such systems, similar to MADEX come and go and each time the focus went back to the manual system... How can we convince them that MADEX has the potential to do well and could be different.....we can only try to win their interest". (SO2)

Also a facility in-charge had this to say:

"we have seen this type of efforts come and go, I am not convinced MADEX will be any different. Take a look within the public sector can you name any sector that has use ICT for up to a year successfully without problems here and there…what makes you think this will be any different" (F14)

A strong technological focus

Drawing on the comments expressed by some senior personnel of the agency, it could be said that the focal actors were seen as having a strong technological focus of which many believed affected the success of MADEX. Specifically, interviewees pointed out that the focal actors were fixated with the technology side of things to the detriment of other socio-organisational factors.

They went on further to suggest that the strong focus on the technical side of things, that is getting it right with the mobile devices and the associated technologies as demonstrated by the focal actors, was perhaps because they believed that the success of MADEX, in terms of it achieving its objectives, was largely dependent on getting it right with the technology. To that end, more funds and attention appeared to be channelled towards the technological aspect, with less emphasis on other relevant social influences and processes that could have also better supported MADEX achieving its objective and eventually becoming institutionalised.

For example, the findings show that the focal actors did not proactively interact or engage with the PHC facility in-charges, given the important role played by this actor group in this network. This study identifies a number of limitations in the way the focal actors sought to win their support as well as engage this actor group in this effort. The passages below are useful for understanding this point:

"During the meetings, we had discussions on recent happening and development taking place in the field. A key aspect of our discussions would be around the MADEX application, strategies to improve it and prevent potential breakdown of this technological solution. This same attention was not extended to the people issue such as ensuring monthly stipends for facility in-charges is regular, ensuring that all stakeholders buy into the vision... (SO1)

"There is not a lot of interaction between us (facility in-charges) and the big people at the top. We would like to see strong participation and engagement between us and with them (focal actors) on this project...it's not just enough sending us a phone with the MADEX application to use, it about being part of the bigger picture"

Undoubtedly, the technological component was indeed novel and a very important aspect of this effort as it offered a new way for communicating and coordinating of data in a timely and cost efficient manner. However, many facility in-charges that were interviewed gave the impression that, they didn't receive the necessary attention, as the focal actors not only showed little concern about their involvement in the decision making process but also did not reflect much of their perspective in this effort. Thus overtime, this group of actors would feel marginalised and as a result, start limiting the depth of their engagement with MADEX.

A lack of reliable information: If we recall, the senior data monitoring officers who were also actors in this network, have a primary responsibility of monitoring and evaluating primary health care data on the key maternal health parameters at the national office of the NPHCDA. Specifically, it would be their responsibility to go through data on MNCH indicators, query and analyse it and afterwards produce various health status report.

If we recall, the promise of getting accurate data in a digitised format very quickly, was significant in influencing the senior data monitoring personnel to translate their interest with that of the focal actor. Specifically, the promise of MADEX facilitating the process of monitoring key MNCH parameters almost in real time and also the promise of being able to produce reports quickly was used by the focal actor to ensure they maintained their alliance. However, owing to the issues highlighted above such as technical limitations, political issues and financial considerations and its impact on post implementation support, the reporting of data from the facility-level became irregular, also the data received at the national level as a result was found to be incomplete and in accurate. As a result, the data coming into the MADEX database became unusable as it was incomplete and irregular. Thus, since the key to translating the interests of this actor group was the availability of reliable and accurate information in a timely manner, the absence of this data or "interessement device" as it were, resulted in a situation whereby their support for MADEX started to decline as they would have to revert back to using the manual (paper based) system to meet their information needs.

Despite the efforts made by the focal actor, the emergence of the above issues over time, made it difficult to sustain the MADEX network. If we consider that the degree of irreversibility, depends on the degree of difficulty to change an actors' positions or revert back to their original positions, then, it is sufficient to say that the emerging MADEX network showed properties of reversibility. Specifically, rather than MADEX becoming indispensable, it became undermined as its alliance with actors became weakened.

Further as is evident from the above, the neglect and limitations with the devices of interessement contributed in destabilising the network. For example, as highlighted above, financial concerns made it difficult for the focal actor to continue providing economic incentives in the form of monthly stipends to facility in charges. By neglecting this interessement device the alliance of this actor group became weak. In a similar way, the inability of MADEX to provide usable and reliable information to senior data monitoring officers caused them to act in a manner that was not in

agreement with the focal actor's goal, as such we can see a process of "betrayal", as this actor group had to revert back to using the pre-existing manual system.

The failure of the MADEX network to mobilise

The basis for mobilisation is the existence of enrolled actors (Callon,1986). These actors may well retain their own specific plan; however, they need only find it valuable to be part of the emerging network on the basis of alliances concerning a definite issue. Once the web of alliance is in place, it becomes possible for some actors to speak on behalf of others. Thus, mobilisation is largely about keeping the interest of actors aligned over a period of time, and acting in agreement with the interests of the focal actor. Following this definition of the term, mobilisation, it could be said there was no complete mobilisation in MADEX actor-network because if the actor-network was mobilised, it may have had stability, but that stability was clearly not present in this case. This instability, meant that MADEX was unable to meet its intended objective of capturing key maternal and child health information from primary health facilities nationwide, and making it available to senior data monitoring personnel at the national office of the agency in a timely manner. Consequently, around the beginning of 2013, the focal actors decided to stop the project temporarily, bringing the first phase of the MADEX implementation effort to a stop. The intention here was to enable the focal actor (technical working committee) take a step back and proffer solutions to address the issues that emerged. During this time, the manual (pre-existing paper-based) system took care of the informational needs as regards maternal and child health indicators within the health system.

Thus at this point, the goal of the focal actor was to address the issues faced so as to reposition this network and enhance its stability. As part of this process, the focal actor held series of meetings with key stakeholders. A key outcome of these meeting was the decision to introduce new actors into the network that could strengthen it. Bearing in mind that network strength is all about a series of decisions about alliances, that is, whom to include and whom to displace (Rhodes 2009), there was a lot of deliberation around this strategy.

5.2.2 Re-launch of the MADEX Project: MADEX Phase II (2013-2015)

One of such meetings held by the focal actors was with the IT vendors. Meetings between both parties, centred on addressing the technical limitations and glitches faced in MADEX I. After lots of deliberation, it was decided that the technological component supporting MADEX I will be upgraded to address key technological limitations. As part of this upgrade, it was decided that the low cost java enabled Nokia phones will be substituted for smart phones. Basically, the introduction of smart phones presented advantages such as increased screen size, improved signal strength, increase screen character (over 160), and other such hardware and software capabilities. Also this smart phone came with Wi-Fi connectivity capabilities which meant that it had more to offer compared to the basic phones used in the first phase. This is how Samsung smart phones emerged as a new actor that would later shape the dynamics of the new actor-network. Notably, the successful deployment of the upgraded technological component of MADEX, required the association of the vendors with the IT operations personnel of the NPHCDA. Basically, the working together of both actor's was crucial to the goal of deploying this system as the vendors had to pass down their knowledge and skill to the IT personnel since they would be the ones responsible for managing the system post implementation.

Still in an effort to strengthen the network, a second actor was introduced by the focal actors. Following series of meetings, it was decided that healthcare monitoring and evaluation (M&E) officers (the most senior data trained officers at the primary healthcare level), will replace the PHC facility in-charges. The decision to enrol this actor group into this network was based on the following reasons. First, healthcare M&E officers are well trained and more experienced in the area of managing health data at the local level of the health system compared to the PHC facility in-charges. Also the primary responsibility of M&E officers centres on data management and so the new role even though an additional task will not be deflecting from their primary line of duty, unlike the facility in-charges who had an enormous task of running a health facility. A second reason for enrolling this new actor group was

based on the idea that each M&E officer can be put in charge of 4 facilities clustered within a particular catchment area which seemed effective in terms of human resource management and cost savings. From the focal actor's perspective, it will be efficient to have a single officer co-ordinate the collecting and reporting of data from the four primary health facilities clustered within a particular area.

Finally, late 2013 having reconstituted the network, the focal actor was ready to re-launch MADEX. This newly reconstituted network was referred to as MADEX II. Once the implementation of MADEX II was underway, continuous efforts was made by the focal actor to ensure improvement. A key part of this process involved reconsidering their previous decisions that led to previous pitfalls during the initial stage of the MADEX implementation. Thus as part of their improvement plan, the focal actor engaged themselves in the development of incentives and strategies to gain the full support of all the actors on-board.

One of the focal actors had this to say:

"This time around, we hope that MADEX II will be more successful in achieving its objective. To make sure of this, we will provide trainings were necessary and carry on with giving economic incentives to the LM&E officers who will be helping us report this data from the primary level of the health system" (FA1)

The creation of interessement and enrolment strategies

Once again four main strategies to create interessement and enrolment were developed along the implementation during this stage. First, regional training and briefings sessions were organized for the newly enrolled M&E officers. These training sessions were conducted regionally, and lasted for a day. Second, to reflect that the success of MADEX was important to them, the focal actors re-introduced the provision of economic incentives in the form of monthly stipends to those who were responsible for transmitting the data that is LM&E officers and lastly, the focal actors appointed "state-focal persons" in each of the 36 states to provide support and assistance to LM&E officers whose task it was to capture and report data.

Regarding the re-constituted network, one of the participants working as part of the data monitoring and evaluation team had this to say:

"We are happy with MADEX II and its functionalities and how it helps us with our job, we do believe it has potentials. Take for instance, when the data gets to us at the national office...I am able to make comparisons with the data sets. Also, having this data in a timely fashion allows me to address any red flags in the data promptly. This is much better than the paper based system where we have to wait for the registers to come to us. Depending on the location, it could take a long time for the data to reach us which in turn means a longer time to identify problems and fix them". (SO 4)

Altogether, while the above strategies helped to reposition the MADEX implementation, in a short time, MADEX II started to fail in terms of meeting its objectives. Basically there were challenges with the interessement and enrolment strategies and this began to affect the stability of the network. Below is a couple of examples highlighting the break down:

Discontinuity of economic incentives. As was the case in the first phase that is MADEX I, the focal actors did not follow through with their promise to provide primary users of the technology, in this case the M&E officers, with economic incentives (in the form of monthly stipend) for using MADEX. In neglecting to provide this incentive as promised, it became difficult for the focal actors to motivate the M&E officers to perform the activities required in the actor-network with the expected diligence, commitment and drive. Additionally, many of the M&E officers pointed out that the failure of the focal actors to follow through with their promise has resulted in a situation whereby they found it difficult to trust the focal actors or take anything they say seriously. One M&E officer had this to say:

"We are aware that they (focal actors) have received big money from government for this effort. The little stipends, if provided regularly will be helpful. It can serve as transport allowance to get to hard to reach facilities to collect data and also to buy top-up to send the report by SMS. When we ask why the allowance is not forth coming, they tell us that it was included in the budget sent to the federal government

and that soon the money will become available... this to us has become no more than an anecdotal statement". (LM&E 5)

Also, the formal launch session of MADEX II was perceived by many as lacking the sort of interactions where actors could have been actively involved in the conversations and negotiations taking place. Specifically, LM&E officers were regarded as passive actors that had to follow orders and directives from the top rather than being active participants whose concerns and ideas were being considered seriously and incorporated into further shaping of this network. This kind of autocratic approach was considered to be flawed hence adversely impacting on the MADEX network. As one staff commented:

"No one seeks our opinion on what goes on, they (focal actors) just pass down instruction and all we have to do is follow. We really do not have a say in how things are done". (LM&E officer)

However, while the neglect of the devices of interessement seem to lower commitment and discourage participation among some of the LM&E officers (quite understandably this stipend in addition to being a token to appreciate their effort and serve as a form of motivation, it was also meant to assist with buying top-up/air-time to recharge the phone so as to make reporting of data possible); there were some LM&E officers who seem not to be demotivated by this occurrence. Essentially, considering the smart phone used in this second phase had Wi-Fi connectivity capabilities, some of the LM&E officers were already using this phone to check e-mails and browse the internet. Thus, in-spite of the fact that the focal actors could not meet up with the regular payments, some LM&E officers were keen on sending their monthly reports regularly as their interest seemed to be served some other way. Therefore , it is sufficient to say, that the properties of the smart phone, lent this technological artefact greater durability, of which shaped the MADEX II network as compared to the basic Nokia phones used in MADEX I.

Below are some quotes from M&E officers about their use of the smart phones:

"Having completed my monthly reporting, I take the MADEX phone home with me. In the mornings when I wake up, I can check for the latest news around the world on BBC. I also can check my emails from time to time and I can also play games when I want to relax". (LM&E 8)

".. I downloaded a version of the holy bible on the phone, it is so convenient to use, I like taking it with me to church on Sundays, and it helps me take part in the bible readings of the day". (LM&E 3)

Thus the ability of the (mobile phones) to develop strong relations with actors (that is the M&E officers) and modify the state of affairs even though for a short length of time, highlights its role as an active actor (participant) in this actor-network.

Some of the interviewee went on further to disclose that, considering the smart phone provided them some advantage, they didn't mind recharging or topping-up the smart phones out of their own pocket, in order to send their monthly reports by SMS (short messaging service) when the monthly stipends promised by the focal actors was not forth coming.

Clearly, it is evident that, by establishing itself as an active participant, rather than being a relatively passive piece of equipment, the smart phones succeeded in aligning the interest of some of the M&E officers of which helped to strengthen the network. However, such experiences was not the norm among all LM&E officers across the project, as there were some officers who did not have sufficient IT skill to exploit this functionality offered by the smart phones.

Also, going by (Callon, 1986), the internet technology capability or software can be seen as an intermediary in this network owing to its ability to link new actors (that is the smart phone and LM&E officer) together. As Callon puts it, anything passing between actors, which define the relationship between them can be termed an intermediary.

By-passing MADEX and the issue of competing Networks

Despite the role played by the technology to order the network and increase its stability, similar issues phased in MADEX I re-surfaced making it difficult for MADEX II to meet its objective. As a result some actors were compelled to make a "detour" and by-pass MADEX II.

For example, owing to financial concerns, the focal actor was unable to make money available to support post-implementation efforts issues. For example technical glitches such as when the smart phone developed software issues or has a broken screen that needs replacement where rarely addressed. Basically there was no money for IT operations personnel to go out to facilities that were far away to be able to resolve these issues. Below are some quotes from participants that highlight this situation.

"The MADEX software at the control room is due for an upgrade, I have made this known to the IT operations personnel and the management but they seem not to be able to do anything about it owing to lack of funds for maintenance" (IT Vendor)

"Presently I cannot send my report for this month because the phone fell and the screen cracked and has affected the display screen. I have notified both the "state focal person" and the IT operations personnel but they are yet to do anything about". (LM&E officer)

Consequently funding concerns affected the ability of the IT Vendor and the IT operations personnel to adequately support post implementation maintenance and activities. This gave rise to a situation whereby the reporting rates started to decline gradually. At a point, IT operations personnel's at the NPHCDA office in Abuja found that reporting rate had dropped below 50 percent. At this point, senior data monitoring personnel at the NPHCDA who depended on this data for monitoring purposes and decision making found it to be "unusable" and they had this to say:

"... for example some of the facilities have stopped reporting owing to one issue or the other so it is difficult to get a holistic picture and report on what is going on in a particular state as regards the issue of ante-natal attendance or under-five deaths or births....for example" (SO6)

".... Some facilities have stopped sending in their reports... others are sending theirs irregularly... it is difficult to monitor or look out for trends say from one month to another...this is making my work almost impossible..".(SO4)

With this being the case, it did not come as a surprise that this actor group had to by-pass the MADEX system and seek alternative means to get facility data that could enable them carry out their key task of monitoring key MNCH indicators and the preparing of quarterly status report for agency directors as well as other stakeholders such as the federal government who required this information for accountability purposes. The two alternative sources of data available to the senior data monitoring personnel were the manual register otherwise known as the paper based system which was still in place and running at the time, and the DHIS2 platform (district health information system Version 2). Just to give a quick overview of the DHIS2, it is a tool for the collection, validation, analysis and presentation of aggregate statistical data, tailored (but not limited) to integrated health information management activities. It is a generic tool rather than a pre-configured database application, with an open metadata model and a flexible user interface that allows the user to design the contents of a specific information system without the need for programming (www.dhis2.org).

Basically, the federal ministry of health (FMOH) adopted DHIS2 as the National Health Management Information System (NHMIS) across the federal, state and LGA levels. This platform which is online-based and takes advantage of many open-source software tools, frameworks and technologies, is also used for national health information reporting in Nigeria. It is important to mention that the effort to roll out DHIS2 by the HISP group is one that is still ongoing, and as at the time of conducting this field work, it was still been rolled out across the country. (Specifically, only about 15 out of the 36 states are fully compliant) and its availability at the facility level is limited owing to challenges like network availability considering it depends on internet technology.

From an ANT perspective, this "alternative data sources" could be referred to as competing networks because its presence, could be seen to directly or indirectly compete and challenge the stability of the emerging MADEX actor-network. (Gao,

2007) describes competing networks as occurring following conflict of interests among actors in a particular actor-network.

Suffice to say, the presence of these alternative systems caused senior data monitoring personnel at the NPHCDA, to boycott actively using and interacting with the MADEX system or even finding a way to address the issues it was facing. Consequently the presence of the alternative network, interfered in the ability of MADEX II to develop strong relations with the senior data monitoring personnel.

The paragraph below further explains this point;

"Now we have a situation whereby we are expected to make a report as part of our regular update to the federal government and other stakeholders, in order to show progress (or the lack of it) as regarding reducing maternal mortality rates in each of the states across the country. So what we do presently is to capture the required data from either the existing manual registers or the DHIS2 platform that is still being rolled out, to help meet our information needs as the data from the MADEX platform is just not usable" (SO 6)

Also, it is sufficient to say that prior to the data being collected from the MADEX platform becoming unusable, it acted as an intermediary as it was able to define the relationship between MADEX and the senior data monitoring operations personnel. As latour puts it, intermediaries such as text, have a specific power as it enables action at a distance Latour (2005).

As earlier mentioned, senior data monitoring officer, betrayed the adoption and implementation of MADEX by abandoning it and shifting to the use of other information systems such as the pre-existing manual system and the DHIS system. This not only weakened the MADEX system, but its ability to stabilise became difficult.

Still on the flaws that occurred within this translation moment, the focal actors failed to create a negotiation space for discussions around MADEX II especially as it concerned actors of the network. Some interviewees, drew attention to an important point which is that, although the focal actors had involved some actors such as senior personnel's of the NPHCDA in trying to promote MADEX, other actors like the M&E officers were not actively involved in this process. Thus in failing to capture the interest of a wider spectrum of actors, it came as no surprise that there was less acceptance and appreciation of this effort by certain actor groups of which affected its ability to establish.

Failed Mobilization of the network

Inherent issues particularly from the interessement and enrolment phase, made it difficult for MADEX II to mobilise. Basically, Callon argues that for mobilisation to be at least successful, exploiting minimum common interest between actors is important. With some level of common interest in place, it becomes possible for some actors to then speak on behalf of others. Overall, it can be said that, when allies in a network become successfully mobilised, the network is more than likely to achieve stability, indicating the institutionalisation and embedding of both the underlying network and roles. What this means is that the idea (network) is no longer seen as controversial, as it become taken for granted (Callon 1986).

Going by the above description, it could be said that the MADEX network was unsuccessfully mobilised, hence it failed to achieve stability and reach a point where it could become taken for granted.

Basically, mobilisation is about the acceptance of spokespersons, representing others in the setting up of the proposed network. In the MADEX case, state focal persons were appointed in each of the 36 states to act as representatives for all facility-in -charges and M&E officers responsible for capturing and reporting data within a particular state. In this phase of the project however, it could be said that this focal persons were 'out of tune' with the facility in-charges, and hence did not actively nor adequately represent their interests.

According to Callon, a representative of a silent majority must be convinced of the focal actor's action on behalf of those being represented. Considering that this effort was wide in scope being a nation-wide effort, the state focal actor were appointed as representatives for the LM&E officers in the state as they were the go-to person for the data reporting officers that is the facility in-charges, in matters arising from the use of MADEX. Basically, interview findings showed facility in-charges did not feel confident about the state focal person's abilities in speaking for them during regional workshops or generally for that matter.

"As one respondent put it, in order for the state focal person to effect change on our behalf, they must be able to actively exert the power given them to provoke an action from the other actors of which can positively address any problems that we may have that could be constraining the network. But this is not the case" (LM&E I8).

Another respondent had this to say:

"A large number of the issues we report to the focal actors don't get addressed. What we have most times is a situation where there are telling us why they are unable to do this or do that when we ask for some help... they are meant to be our voice...Sometimes we think their hands are tied..." (LM&E 22)

Also, regarding representation of the MADEX technology, it is sufficient to argue that the vendor consultancy called Dabar Objects, the company that won the bid for this project was their primary representative as they not only deployed the technology but it was their goal to see it do well as this will mean that as a company that provided mobile solutions, they can continue to partner with the agency and remain in business. Also in terms of their image, successfully pulling off a nationwide effort, will go a long way to boost confidence in the minds of prospective clients about their service delivery. Following their deployment of the MADEX system, they provided the list of actions that must be taken by the users in order to enter data correctly, as well as report the data on the platform. Further, although the day to day management of this application was taken over by the

operations personnel of the agency, the IT vendors provided expert leadership and advice on both the hardware and software aspects of MADEX from time to time.

For example, the IT vendors provided the IT operations personnel with support information such as steps on maintaining and managing the backend/server that was stationed in the operations room of the NPHCDA in Abuja in order to optimise the overall performance. However, from interview findings with their representative, it would emerge that sometimes these actions which were meant to be part of maintenance actions, were not carried out as at when they were supposed to and in some cases not carried out at all of which affected the working of MADEX. Below is a comment made by an IT vendor:

"We let the Agency know that it is important we make post implementation support a priority so that MADEX can function efficiently and effectively. But this has been very difficult, possibly due to reasons of leadership and finance. For example, we have informed them (the agency) of the need to deploy software updates to the server...we have been waiting for them to raise a request so we can act (come and do it)...Their inability to response promptly has led to the server shutting down and corrupting the data on few occasions." (IT Vendor)

From the above, it is clear that in their role as spokespersons, representing the MADEX application and the mobile devices, the vendors could not "exert power" and felt powerless as they could not implement the change they wanted to see. Clearly, what ANT posits, is that a representative must be able to exert power, and cause other actors to act in certain ways. Thus the inability of these representatives, that is, the vendor company and the state focal persons, to effectively act as spokespersons for their "silent majority" contributed in weakening the MADEX network.

5.2.3 MADEX II failure to embed

The findings discussed above show that the implementation and use of MADEX did not take place as it was initially expected by the focal actor. From an ANT viewpoint, three main issues accounted for the inability of MADEX to be

implemented and used in this context sucessfully: First, the inability of MADEX to grow; Second, the existence of competing actors; and third, betrayals in the MADEX network

These findings have shown that the inability of MADEX to evolve and develop, was due to the inability of the focal actors to gain the necessary financial resource to better support the implementation effort in terms of post implementation support and maintenance and the provision of regular incentives to those responsible for the routine reporting of data, that is the facility-in-charges and LM&E officers. Also MADEX was unable to evolve and "assert itself" because of the presence of the pre-existing manual system and the DHIS system. Basically, these alternative system or "competing system" were supporting the senior data monitoring personnel as they had the alternative to use them when MADEX failed to meet its objective.

Regarding betrayals in the MADEX network, we had series of betrayals that took place, provoking the collapse of this network. In ANT terms, betrayal simply refers to a situation when actants do not abide by the agreements (translations) previously made by their representatives, of which could cause failure of translation. To avert the possibility of a betrayal in a given actor-network, all actors must have a spokesperson to speak on their behalf (Callon 1986).

In the case of the MADEX actor-network, there were three main episodes of betrayal, the first being from the Nokia phones used in the first phase of this effort. Soon after MADEX I was launched, the mobile phones, that is, the Nokia phones used in the first phase of this effort betrayed its representatives, that is the vendors (an external IT solutions company called Dabar Objects responsible for the deployment of this ICT solution), as it could not perform optimally as the vendors had promised the senior officers and directors of the NPHCDA. This happened because the vendors did not comprehend the complexity of this deployment especially as this would be the first time they would be rolling out something this large within the public sector.

For example, if we recall, the Nokia handset used in phase I could only support a maximum of 160 characters. Consequently, this limitation in its feature compromised the data being received by the server. Basically, when reports exceeded 160 characters, this phone would transmitted the first 160 characters only. Also, the basic Nokia handset used in MADEX I had very poor signal strength, consequently, in areas were network connectivity was weak, this technological device was unable to fulfil the role assigned to it by the focal actor; that is, reporting of reliable information on key MNCH indicator in a timely manner.

However, it is important to say that in the second phase of this effort in which smart phones were enrolled into the MADEX network, this technology performed well such that the vendors did not feel betrayed.

The second instance of betrayal, was few months after the launch of MADEX II. Basically, senior officers of the NPHCDA such as data monitoring officers who initially gave their support to MADEX, betrayed this initiative as a whole by abandoning MADEX and shifting to the use of other platforms, specifically the pre-existing manual system to address their information needs. While on the one hand, this officers were supporting the embedding of MADEX, on the other, they diminished its use by making a "detour" by getting the information they needed from the existing manual system and at other times, from the DHIS platform were possible. The existence of these competing actors, clearly contributed in diminishing the durability of MADEX.

The third instance of "betrayal" came from the sponsors of the initiative that is the federal government. The main issue that motivated this was the unavailability of an important device which is funds. Essentially, the inability of this actor to release sufficient funds promptly to support the various activities (such as making funds available to enable the focal actors fulfil their promise of providing M&E officers with monthly stipend) could be said to have impacted on the translation process negatively. Also the lack of sufficient funding made it difficult to take care of post-implementation issues that did arise. Ultimately, this contributed in undermining the performance of MADEX and ultimately contributed to its breakdown.

In sum, it is evident how processes of "betrayal" took place during the deployment of this effort and undermined it. Further, our analysis showed how the existence of competing actor, weak interessement strategies and lack of power on the side of the focal actors to gain resources from the government to further the development of this effort, provoked the collapse of this actor-network.

Thus, mid-2015, owing to the myriad of constrains and the inability of MADEX to meet its objectives, the focal actors called time on the MADEX project, closing the door to an opportunity for mobile phone innovations to become embedded and used in the management of health information in the public healthcare system.

It is important to say that, despite the initial enthusiasm of having quick and digitised MNCH information by introducing and using mobile phones for the first time within the public sector, the key focus here was making MADEX sustainable. Basically, the focal actors unambiguously expected that overtime, MADEX will be partly independent from the funds that was being received from the federal government as the respective thirty-six (36) state governments would have more input in this effort. However, the reality is that MADEX did not reach self-sustainability, hence compromising its ability to become embedded and integrated within the mainstream public health system in Nigeria.

In the light of these findings, this next chapter will discuss the value of using ANT in enhancing our understanding of this implementation effort. (RQ1). It will also explore how actors in this network, interact together and how circulating intermediaries among them plays a significant role in shaping their interaction and in defining their actions in the network (RQ2).

In summary, the diagram below is presented in order to shows the key aspects of the entire MADEX implementation. These aspects, provides an overview of this chapter and summarises it in seven broad categories.

Aspects	MADEX Systems Implementation
Goals and Objectives	➢ Increased information accessibility

	➢ Ensure global transparency and accountability in the area of maternal and child health statistics ➢ Promotion of m-health activities
Purpose of the system	➢ To enable the routine reporting of maternal health information from primary health facilities across the country up to the national level (NPHCDA). To enable regular monitoring, planning and setting of priorities.
Stakeholders/actors	➢ Technical working group (otherwise referred to as the focal actor) ➢ Senior data monitoring personnel ➢ Facility-in -charge, ➢ IT operations team, ➢ The federal government, ➢ MADEX IT vendor, ➢ Local M and E officers,
Methodologies prior the implementation	➢ Paper-based system/ fragments of computer-based systems
Key Requirements prior to the implementation (organisational and technical)	➢ Project plan developed (how the system will be rolled out, supported, and maintained) ➢ Identification of the roles of actors/stakeholders ➢ Selection IT/software vendor ➢ Budget planning

	➤ Decision to proceed the plan
Best practices/enablers	➤ Achieved a common understanding about the need for a mobile supported solution ➤ Reconstitution of the network to improve stability and durability ➤ Training of users on how to use the MADEX application ➤ A simple mobile innovation (MADEX solution) that could work easily and was easy to use
Key Problems / Barriers	➤ Technical glitches and limitations ➤ Financial considerations ➤ Issue of scepticism ➤ Diminished ability for MADEX to evidence its impact at the local level ➤ Political issues ➤ Presence of competing information systems "networks"

Figure 5-1: a summary of the key aspects of the MADEX implementation effort

5.3   What comes next?

In this chapter, the findings of this study were presented and key themes were presented from an ANT point of view. The next chapter will provide a discussion

on the value of using ANT in enhancing our understanding of this implementation effort. (RQ1). It will also explore how actors in this network, interact together and how intermediaries among them plays a significant role in shaping their interaction and in defining their actions in the network (RQ2).

Chapter 6: Discussion

6.1   Overview

Having presented the research findings in the previous chapter, this chapter in line with the research question, will provide a discussion on the value of using ANT in enhancing our understanding of the implementation of a mobile-phone based innovation within the government led public health system. However, before providing this discussion, the researcher with the help of ANT's theoretical concept, provide a brief summary, highlighting the failing that occurred during this implementation process.

6.2   The Failings that occurred during the Problematization

Taking a look at an important step within the problematization, that is, the problem definition and mapping out the solution, from the research findings, it came to light that the focal actor in the MADEX initiative, who were the main problematization protagonist, adopted a very top-down approach in terms of defining the proposed solution. Interview findings show that, the proposed solution to the problem emanated mainly from the focal actors as some actors attested to not having a say and being part of the decision and negotiation process that led to the creation of the proposed solution.

For example, some senior personnel's at the national office of the agency who's responsibility it was to of managing the incoming data, there was very little participation from actors like themselves in this process. Further, some senior personnel's of the agency admitted that, they were never really keen on MADEX. Basically, while they acknowledged its uniqueness as the first mobile platform within the public health system, some of them would argue that having multiple

platforms at the same time created a complex situation for both themselves and LM&E officers, as they found themselves being participants and members of multiple networks, that is the three data platforms namely: the DHIS platform, the manual system, and now the emerging system, that is the MADEX platform. Below is a quote to support this claim:

"We didn't have the opportunity to agree or disagree about key aspects of the project. Just like most efforts, the approach adopted was not democratic at all, as there was little input from key groups directly involved with this effort. Personally, I like the DHIS platform, even though it's not fully implemented in all thirty-six states, in those states where it is present, I can receive digitised data so I don't really see the need for MADEX. Personally, I feel it is a waste of money. (SO5)

Other participants also had this to say:

"...I am not familiar with the long term plan of MADEX...we don't even know how long this reporting will carry on...for now we just do what we are asked to do" (LM&E 11)

"It's all about reporting data to the NPHCDA... we don't see the benefit of this system for us facility in-charges" (Facility in-charge, 3)

The findings above, echo the argument made by Bryne and Sahay who argue that the task of designing and using an information system specifically within a healthcare context is very challenging owing to the complexities of health systems and as such, they advise for a participatory approach of the various stakeholders in the design, development, and use of such information system. They go on to support this position by stating that the development of an IS, should be viewed as a social process of negotiation among people's different needs, expectations, and views, so as to develop a shared understanding of their own and each other's interests, perceptions, roles and even obstacles. The reason they give for this, is that the process of deploying an IS can be considered as a highly political exercise that addresses issues of equity, power, information sharing, and social transformation Bryne and Sahay (2007). Thus they argue that effective negotiation among actors

during the deployment of an IS should form an integral part of its development and use.

Moving on, another flaw that was evident during the problematization process had to do with the focal actor framing the goals and obstacles of the actors. The process of identifying the needs, goals and obstacles of actors is very important at the start of any project. As was the case in Callon's (1986) case study of fishermen in St Brieuc. Bay, the focal actor identified the obstacles of the other actors as well as their interest in their own terms. Having identified actor's interest and obstacles, it is the responsibility of the focal actor to design strategies to align the interest of those actors with their own and also have However from the findings of this case study, it is evident that the focal actors lacked sufficient translation strategies to support the other actors in overcoming their obstacles and achieving their goal.

Suffice to say, the focal actor was faced with a situation whereby the expectations of the other actors were unrealised as their interest did not align with those of the other actors. This echo's the argument of Mahring et al. (2004), which states that, successful problematization is demonstrated by the focal actor's ability to established clear goals for all the actors within the network.

Overall, this flaw highlighted in the problematization moment points to an important theme which is the diverse as well as evolving nature of interests of actors within a given actor-network and how this can shape the outcome of the network. From the case study, it can be seen that MADEX was not an isolated actor, but an actor interrelated to other human and non-human entities such as the pre-existing manual system. Thus, its ability to be successfully embedded was shaped by the interests, motivations and perceptions of the actors related to the MADEX network. For example, senior data monitoring personnel who initially supported the use of MADEX, "betrayed" its adoption by opting for the use of other platforms such as the DHIS and manual registers to capture data to enable them perform their task in the absence of "usable" data coming from the MADEX platform. Thus, in not finding MADEX useful, this actor group disregarded the further use of MADEX. This action, further highlights another interesting point, which is, that the interests of actors are not always fixed or constant but can evolve and change owing

to the ever changing nature of actor-networks. Consequently the focal actors must constantly be involved in negotiations so as to ensure strong alignment of interest of both the focal actor and other actors.

Last but not least, another flaw identified during this moment had to do with the exclusion of relevant actor's that could have helped to make the network more durable. For example, the National Information Technology Development Agency (NITDA), which is the premier body in Nigeria responsible for Information Technology practices and activities nation-wide surprisingly was not included during the formation of the MADEX network. Basically, such an agency would not only have the experience to provide leadership to a project of this kind but also provide support and strategy of which some considered to be lacking in the MADEX effort.

For example, a senior personnel from the agency had this to say when asked what could have been done differently to make MADEX successful:

"...I believe that the IT leadership was not strong enough ....considering that MADEX is a nation-wide project and of a complex nature, it could have benefited from strategic leader from the country's foremost IT agency known as the NITDA....." (SO3)

6.3   Problems during the Interessement

Moving on to the interessement, from the study findings, it is sufficient to say that, although the focal actors managed to create interessement devices to draw actors around the main idea, the interessement stage was never realised completely. To this end, we have identified two main issues with the interessement device that contributed to this unfavourable outcome.

First, funding concerns impacted on the ability of the focal actor to successfully provide stipends to those responsible for capturing and reporting the data that is the facility-in-charges and LM&E officers. Specifically, the focal actors found it difficult to continue to provide the monthly stipend promised to those who were

sending the data as per their original agreement. Thus the interest of this actor group failed to converge and their alliance with MADEX began to weaken gradually.

Second, the information generated from the MADEX platform, which served as an interessement device for some senior data monitoring personnel at the NPHCDA national office, turned out to be unusable over time owing to issues such as technical limitations etc (the data was both untimely and incomplete as reporting rate started to drop). Thus the absence of usable data resulted in this actors aligning their interesting with the alternative networks hence severing its alliance with MADEX.

6.4   Disorder during the Enrollment

If we recall, enrollment implies a degree of acceptance of assigned roles on the part of actors. However, studies have shown that sometimes, actants may not fully assume the role assigned to them. Nevertheless, we know that in the enrollment, there is room for "group multilateral negotiations, trials of strength and tricks to be used in order to achieve acceptance (Callon 1986, p.211).

For the MADEX implementation effort, the disorder and flaws that resulted during the enrollment can be attributed primarily to the failings of the earlier two moments of translation i.e. problematization and interessement. Basically, from the case findings, it can be seen that the focal actor proved inept at maintaining stability of the MADEX network. For instance, with actor's such as the LM&E officers, the focal actor was able to convince them to join the network as data management officers (replacing the facility in-charges) with the promise of a monthly stipend (acting as the interessement device). However as soon as the focal actors realised that there was problems with government funding, of which would constrain their ability to provide this actor group with the incentive as agreed to keep them interested, they failed to engage in a re-negotiate process of which could have involved communicating with these actor group to find out what other maintenance strategies such as persuasion and simple bargaining (Nhampossa, 2005), could be introduced to help consolidate the roles assigned to this actor group and ultimately achieve alignment of interest. Notably, this view is consistent with the position of

(Madon, Sahay and Sahay, 2004) who argue that the negotiation skills of the focal actor can increase the likelihood of successful enrollment.

Also if we take a look at the relationship between the project sponsor and the focal actors, again it is evident that there was a failure of negotiations between both parties to get the necessary resources to support the activities of MADEX and ultimately to further its development.

Finally, based on Callon (1986) it can be said that the MADEX actor-network was not mobilised. The mobilisation process refers to when the actor-network achieves the set OPP. Essentially; this process is made possible via the surfacing of spokespersons. Basically, to put off betrayal in the actor-network, all actors should have a spokesman to speak on their behalf (Callon, 1986; Rhodes, 2004). However, in the MADEX effort, it could be said that the process of mobilisation was not completed as the objectives of this actor-network were not achieved. Therefore, this moment cannot be analysed in this chapter.

Overall an ANT examination of this case affords visibility in terms of revealing the particularities of the process such as how a lack of continuous negotiations, processes of betrayals, and competing networks, multiple membership of actors and insufficient interessement devices, just to name a few, contributed to the failure of MADEX to become embedded or institutionalised within the given context.

Further, this case illustrates an aspect that has been emphasized by other researchers—the important role played by technology (and other non-human entities) within an actor-network (Heeks, 2013). Specifically, an ANT perspective has been insightful for considering technologies as an active entity, rather than a passive and inert actor. (Robey and Holmstrom 2002), point out that while technologies are created within the social realm, they are also act back upon the social realm by regulating simple actions such as entering data into a computer or technological device. From the case finding, we can see how in the second phase of the MADEX effort, the smart phones had the ability to exercise control over and act back on some of the M&E officers. Specifically, the findings showed how the smart phones used in MADEX II possessed properties (such as email function and

connectivity to the internet) that were aligned to the interests of some M&E officers who were its primary users. Thus, it is sufficient to say that the technology enabled itself to become indispensable to this actor group, and therefore supported its own use. This goes to affirm ANTs recognition of both human and technical actors, possessing the ability to modify the state of things within a network, with the only difference being that the human are empowered with intentionality of course.

Further, the study findings reflected the competing and disruptive role the manual system and the DHIS system played when MADEX was introduced, of which is also insightful in understanding the active role played by other non-human entities in constraining the ability of MADEX to strengthen its relations with human actors in the network such as the senior data monitoring personnel.

Notably, within this context, because most times there is a pre-existing system (most times a paper-based system already in existence) alongside the emerging technological actor-network, the issue of competing networks or even actors becoming members of multiple actor-networks, can create a tricky situation whereby some actors find themselves in a difficult situation of deciding where to align themselves. For instance, bearing in mind that the M&E officers are the highest ranking data management officers at the lower level of the health system, while the were key players in the MADEX actor-network, they were also part of the existing DHIS network and also the manual system as they were responsible for uploading data on that platform too. This kind of situation, whereby actors have multiple membership at the same time in multiple networks causes them to possess what has been described as an "intrinsic uncertainty" (Singleton and Michael, 1993). Basically, this improbability can create a precarious situation, as it can be difficult to predict or control where such actors loyalty may lie.

Having highlighted the flaws with the implementation process using ANT's moments of translation, the next section will highlight the value of ANT in helping us understand this implementation effort.

6.5 How ANT was insightful in understanding the implementation of this mobile phone innovation (RQ1)

Mobile phone technology as an actor

ANT's conceptual framework has been insightful for considering technologies such as mobile phones as active actors, rather than passive actors (Heeks, 2013). Obviously, this stems from the principle of agnosticism, the most widely criticized tenet of ANT that advocates for a level playing field for all human and non-human actors and that basically seeks to see all actors treated with equal significance.

For example, from the study findings, we see how the smart phones used in MADEX II, was seen as a non-human actor subjected to control by the focal actors and the IT operations personnel in terms of using it to do their bidding which was basically to capture data and transmit it. However, we will see that at the same time, owing to internet technology capability and other software capabilities offered by the smart phones, it was able to exercise control over some of the LM&E officers, by enabling and motivating them to continue to actively recharge the phone at their own expense and create the commitment of sending off their monthly report on time, in other words enabling the performance of a specific action.

Proceeding from the principle of general symmetry, this example highlights' the contribution of non-humans to social processes. This echo's the argument of Latour (2005:17) who states that if an entity makes a difference in the course of some other entity's action, then we have an actor that is exercising agency (Callon and Latour 1992). Thus, what this perspective ask, is that in implementation efforts of mobile phone innovations, we must be open to the possibility that non-humans such as technology, documents, policies etc. can add something to the chain of event. What this simply means is that non-humans can also shape the interaction taking place within the network and as such falls under the general rubric of action and agency (Sayes, 2014).

Therefore in deploying mobile phone innovations, an ANT analysis demands that technologies must not be considered in isolation; rather their adoption must be seen as shaped by the relations they develop with other actors whether they be human or non-human (Munir and Jones, 2004).

Implementation of mobile-phone innovations involving political processes

ANT's conceptual framework has been helpful in demonstrating how implementation efforts of mobile phone innovations such as MADEX should be considered as a political process that requires lots of communication and negotiations, and also entail processes such as competition and "betrayals" Bearing in mind that political processes are characterised by constant communication, engagement and interaction between groups. In the MADEX case, it is evident that the lack of constant communication and re-negotiations affected the stability of MADEX. Specifically, the focal actors in some cases had just one strategy to align the interest of actors. Such that when that strategy or device failed, it was difficult to re-align the interest of such actors to MADEX. By having multiple strategies, the focal actor could have been able to re-negotiate with actors so as to ensure that their interest was aligned with the goal of MADEX.

Also in the MADEX case, there was evidence of processes of betrayals within the network and also completion among actors, both of which affected the implementation process adversely. Implementers of this kind of effort must be aware of this processes and its impact on the emerging network.

The dynamic nature of actor's interest

Actor-network theory has helped highlight the evolving nature of interests of influential actors, and how this can affect the implementation process of mobile-phone based innovations. For example, study findings highlighted how senior data monitoring personnel who were once optimistic about using MADEX, betrayed its implementation by opting to use alternative systems such as the manual and the DHIS system to meet their information needs when their interest was no more served (If we recall, the interest of this actor group was served by their ability to

access timely and accurate information from the MADEX platform). Thus, in not finding MADEX useful, they disregarded further interaction with MADEX.

The evolving nature of interest among actors, was also exemplified when some LM&E officers who were not motivated to support MADEX, owing to the non-payment of stipends and their inability to see the direct benefit of MADEX in their work practices, became motivated and committed to the implementation when the found out about how beneficial other capabilities of MADEX was to them. Specifically LM&E officers who found the internet capabilities of the smart phone useful, had their interest strongly aligned with the goals of the focal actor. Basically, this echo's the argument made by (Hanseth and Braa, 1998; Cho et al., 2008), they argue that while actors' interests can be mobilised and aligned to the interests of a particular network; there is a possibility that their interest can continuously shift as they become subject to ongoing translations. Therefore, focal actors or managers of this sort of implementation must pay attention to this and how it can impact the deployment process.

Importance of paying consideration to "network effects"

The theoretical resources from ANT highlights the importance of paying consideration to network effects. Taking a closer look at the MADEX case, it is clear that very powerful actors who could have strengthened the MADEX network were excluded from the network. Specifically the National Information Technology Development Agency (NITDA), which is the premier body in Nigeria, charged with the mandate of creating a strategic framework for the planning, development, standardization, application, coordination, monitoring, evaluation and regulation of Information Technology practices and activities in Nigeria, was not part of this network. One would expect, that since this effort was a nationwide effort and the first of its kind in terms of using mobile phones within the public sector, this agency should have played a major role and be part of the make–up of the network considering their responsibility of providing leadership to ICT efforts through human capital development and the provision of IT infrastructures.

Considering the role of this agency, it is possible that their inclusion in the MADEX network, would have afforded it more durability.

One participant commented by stating:

"*One of the thing the MADEX project is lacking is strong ICT leadership. This is a nation-wide government-led ICT project, yet the nation's foremost ICT agency (NITDA) is not part of the stakeholders. Their ability to provide policies and guidelines to support the implementation process could have improved the chances of MADEX to be successful*" (SO2)

The incorporation of relevant actors, both human and non-humans, creates what can be termed a strong "network effect" of which can make it difficult for an emerging network like MADEX to be dissipated or disbanded. Thus, considering that the implementation process of mobile phone innovations can be highly affected by the lack of enrolment of relevant actors (Walsham and Sahay, 1999). It is therefore important that the focal actor needs to involve all relevant stakeholders and gain their co-operation. By doing so, they might be able to steer the direction of things towards a greater likelihood of success.

In the section above, this research has examined the implementation process in terms of the moments of translation. However this alone, does not examine in enough depth the complexity inherent in the relationships that exist between the actors and particularly, relationships that bridge the divide between the material and social elements of the network.

Basically, through the concept of generalized symmetry, actor-network theory offers an alternative ontological perspective to view the relationship between the physical and the social. Specifically, this radical ontological perspective suggests that humans and non-humans are capable of being actors and defining the identity of the network. Thus the next and final section of this chapter sets out to demonstrate this, it sets out to examine some of the many alignments of actors. Specifically, it shows how different types of intermediaries connect the actors in the network.

According to the proponents of ANT, Intermediaries thus both order and form the medium of the network they describes" (Callon, 1991: 135). Callon goes on to identify four types of intermediaries namely: texts, which are also known as literacy inscriptions, human beings, money, and technical artefacts Callon (1991: 135).This discussion provided will be based on the findings of chapter 5 and will look at the role of each of this intermediary in connecting the different actors.

Texts (inscriptions)

Literacy inscriptions like texts, reports, manuals have an important effect in defining the role and the position of each actor in any network as they define the actions of their users. The findings of the fieldwork showed that there were many inscriptions that play an important role in shaping the actions of the actors and connecting them together to build the MADEX network.

The manuals and documentation of the MADEX technology creates a link between the IT operations personnel and the MADEX system. These manuals include facts about the system that can help the IT operations personnel to understand how it works in order to better support those actors that will be interacting with it such as the facility-in-charges at the health facilities. According to what they find out from these inscriptions, the IT operations personnel can plan their actions and activities. In other words, this inscription connected the two actors together and at the same time shaped the action of the IT operations personnel.

The primary health facility in-charges send their data on maternal health indicators via the MADEX form, to the IT operations room of the NPHCDA. When this report is received, it is passed on to senior data monitoring and evaluation personnel. If they detect any errors or misnomer in the data fields, they will notify the LM&E officer and IT operations personnel. Thus, this inscription connects the senior data monitoring personnel responsible for monitoring the data with the IT operations personnel who are responsible for managing the back end of MADEX (where the routine report is received) and also the facility-in-charges (who captures and transmits the routine data). Thus this report sent by the facility-in-charges to the IT operations personnel and subsequently to the senior data monitoring personnel is

able to shape the action of both actor groups. For instance, with regards to the senior data monitoring personnel, based on the report, their next action would be to prepare an action plan to show how they will overcome any problems that have been highlighted in the report.

The senior data monitoring personnel are connected to the MADEX system with another important inscription; the quarterly report as an output of the MADEX system. This report is the end product of the quarterly monitoring and evaluation of the maternal and child health statistics captured from the various health facilities across the country. Essentially, it is the method of communication between the senior monitoring personnel and the management of the NPHCDA and other stakeholders such as state governors and strategic partners. This quarterly report, as an inscription, has the features identified by Latour (1987: 219-232) that allow it to enable action at a distance, which are mobility, stability and combinability. The report permits action at a distance (Latour, 1987) as it helps the different users of the report to take decisions and to take different actions depending upon what is inscribed in the report although, owing to physical or even economic conditions, they are far-away from the place related to their actions. In other words, it enables stakeholders far away from the scene of activity, to have a window on what is taking place. It is also important to point out that the senior data monitoring personnel are connected to the management of the agency through other inscriptions such as other agency documentation such as work policy etc.

To sum up, inscriptions such as these that are circulated between the actors, play an important role in building their relationships and in defining their actions at the same time.

Human beings

This intermediary identifies the diverse relationships between human beings, resulting from position, job role and responsibility. If we recall, the findings (in Chapter 5) showed that the interaction and negotiation between the human beings in this network produce different relationships that help in shaping each actor while at the same time forming the network.

Difference in knowledge and skills between the IT vendor and the IT operations personnel has shaped their interaction and their role in the network. The IT vendor used their knowledge in deploying mobile technology solutions to justify their position in the network. Specifically, vendors have the knowledge that allows them to provide training to the IT operations personnel to teach them about using MADEX.

This knowledge and skill possessed by the IT vendors by default, awarded them the responsibility for overseeing the system and evaluating its performance so as to present the findings to the management of the NPHCDA. Further, the IT operations personnel had to seek the assistance and support of the IT vendors to perform various tasks with MADEX because of their knowledge in dealing with mobile phone technology innovations. Thus, for the IT vendors, they believed that the IT operations personnel relied on them in technical matters (in relation to the MADEX technology) because of the gap in knowledge and skills between them.

It is important to say that based on interview findings, over time, the relationship between both actors transformed from becoming a relationship of dependency (that is the IT operations personnel becoming dependent on the IT vendors), to becoming one of collaboration. With that being said, it is evident that the knowledge and skills of the IT vendors helped define their role in the MADEX network and ultimately defined their interaction with the IT operations personnel.

Technical artefact

Callon (1991) introduced technical artefacts as an intermediary that includes scientific instruments, machines etc. This intermediary, can be seen as structured groups of non-human entities which perform together certain tasks to connect the actors in the network and to shape it at the same time. In the MADEX network, the MADEX technology acted as an active intermediary as it participated in bringing different actors together. For example, the IT vendors and the IT operations staff at the NPHCDA are connected together through the MADEX technology to configure

how it will perform its expected tasks. In addition, the MADEX technology connects the LM&E officers during the training sessions provided by the IT operations personnel about the MADEX application and the MADEX system generally. It is imperative to point out that that the IT vendor keeps his relation with the MADEX system, after implementation, through its role of providing maintenance and technical support, in the event of any problems.

To sum up, it is evident that the above intermediaries played a vital role in connecting the human actors enrolled in the emerging MADEX network, it is sufficient to say that with the aid of circulating intermediaries, the actor's respective position in the network was defined, in addition, the intermediaries were instrumental in shaping the MADEX network.

Having looked at the role played by intermediaries in shaping the network, I will now examine in more detail the role of two non-humans in defining the MADEX network whose action constrained the emerging network's ability to embed.

The first of this is the pre-existing manual system and the second actor is financial consideration. Both actors were introduced by research participants interviewed. If we take a look at the case findings, it is evident that the pre-existing manual system as an entity could be viewed not only as a network but very much of an actor too (Heeks et al, 2013). In other to explain further how the manual system was awarded this ability we refer to the interview findings. Interview findings (see chapter 5) show that human actors in the network such as the senior data monitoring personnel were influenced by the pre-existing manual system. Considering that this system was also capturing data on the same key MNCH indicators as the ones captured on the MADEX platform, when the MADEX platform failed to produce usable data, the senior data monitoring personnel turned to the pre-existing manual system to meet their information needs. Thus, it is sufficient to say that, the ability of the pre-existing system to provide useable data for senior data monitoring personnel, influenced the way they acted and ultimately the relationship they had with MADEX.

The second actor introduced by interviewed participant was financial concerns. Basically financial considerations can also be seen to influence the way that the humans enrolled in to the network acted. For example, the ability to provide trainings was governed by cost. IT operations personnel could not provide regular trainings for users of the MADEX system owing to financial considerations. Interview findings did highlight how financial considerations affected other post-implementation tasks such as: providing funds to enable IT vendors buy new software to update the MADEX system to ensure that it functions optimally; addressing problems with the application on the smart phone used by LM&E officers; providing stipends to users of the phone to enable them recharge or top-up the phone to allow for the timely and regular reporting of routine information.

From the discussion provided above, it is evident that the non-human elements namely the pre-existing manual system as well as financial concerns played a major role in the implementation process. Specifically, the discussion has brought to light the way that they have both been able to influence the way that the human actors have behaved and at the same time directed the decisions that they have taken throughout this process.

6.6   Summary

This chapter discusses in more details the key findings of this study. Specifically, with the help of ANT's moment of translation, it describes in more depth the actions and inactions of the various actors as part of the implementation process. Further, it draws on ANT's principle of generalized symmetry, to examine the interaction between the material and the human element involved in this effort. The next chapter, seven is the concluding chapter, it presents the researchers reflection and conclusion in relation to the study.

Chapter 7: Conclusion

"The conclusion is the place where you get tired of thinking." - Arthur Bloch

7.1 Introduction

This final Chapter of this study, presents the researchers reflection and conclusion in relation to the research undertaken. In the first section of this concluding chapter, an overview of the study is presented alongside research findings. This is closely followed by section 7.3 and 7.4 which present the theoretical and practical contributions of the study respectively are discussed. Section 7.6 presents the limitations of the research and suggest areas for further research. This chapter concludes with a short personal reflection.

7.2 Thesis Overview and Findings

The purpose of this research was to understand situations of implementing mobile phone-based innovations within the broader government-led public sector with the help of a theoretical approach that is actor-network theory. By using this approach to study mobile phone innovation implementations, this study has been able to uncover the complex set of interactions that constitute this process. So, not only has this study used ANT's moment of translation to establish the story line of this effort and provide explanations regarding what happened and when, it has gone a step further by drawing on ANT's ontological perspective to trace the manner in which the different actors interrelate, in order to uncover the somewhat hidden complex inter-relationships between the human and material actors involved in the case.

Thus this study has gone a step further from previous research on mobiles in developing countries that just seek for simple answers involving reliance on

properties of the technology to see why implementation of mobile phone innovations in LDC particularly within the broader government led sector has a specific outcome.

Thus, while, one may be tempted to argue that researching the application and use of mobiles is not a new area of study neither is it one that is under researched, it is clear that this research has gone a step further and indeed stands out from existing studies. Another reason that makes this study different, is that it seeks to understand mobile phone innovation implementation effort within the broader government led-public sector of LDC were there has been an increase in the number of mobile-phone based innovations implemented on a large scale, that is, beyond pilot. Bearing in mind that studies reporting on such efforts have been scarce, study does fill that gap in the literature.

In sum, while we know that mobile phone innovations such as MADEX, offer genuine possibilities for countries like Nigeria, and indeed other LDC (especially as the gap between the features of this technology and personal computers closes up more and more), the findings of this study does show that, the use of this technology, does not necessarily always deliver on the ambitious promises expected by implementers. Essentially, this study makes it clear, that there is no direct equivalence between using mobile phones in development areas and developmental benefits. In order words as much as development practitioners are enthusiastic about the possibilities this technology offers especially considering its suitability for use in less developed countries, it is only by appropriate usage and through proper consideration of socio-cultural and institutional influences within the wider context of which the mobile phone-based innovation is to be embedded (Avgerou 2003; Mitev and Bartis 2008), that people can come to reap the benefits that come with its implementation and use in development sectors with a LDC context. Thus those who make decisions about mobile innovation-related investments or the policy and regulatory environment within which M4D operates as well as other local or community stakeholders who may have some influence over mobile innovation efforts in developing countries must take heed.

Having provided an overview of this research, this section concludes by highlighting the key findings of this study. In an effort to provide structure, the researcher will highlight the findings in relation to each of the research question asked in the introductory.

RQ1 What do the theoretical resources from ANT reveal about the process of implementing MADEX within a LDCs setting?'

In relation to the first research question, the findings of this study reveal that:

Implementation efforts of mobile phone innovations are characterised by complex inter-relationships between the human and material actors involved in the effort.

Implementation of mobile-phone innovations involving political processes. Specifically, this study finds that such implementation requires lots of communication and negotiations, and also entail processes such as competition and "betrayals"

Mobile phone technology are very much actors within this implementation process.

Also this study finds that the interests of actors' in this network is not static but one that is dynamic and evolves owing to changing circumstances.

RQ2 What relations have emerged between humans and non-human and how do these relations enable and/or constrain their actions towards the implementation?

The study finding show that inscriptions such as text and artefacts circulated between the actors, play an important role in enabling and building relationships between actors. For example, study findings did reveal that the interaction and negotiation between the human beings such as the IT vendor and IT operations personnel in this network produce different help in shaping each actor while at the same time defining the MADEX network (see section 6.5).

RQ3 What are those factors that have been found to shape the implementation process of this new initiative?

The findings of this study show how factors such as technical limitation and glitches, issues of scepticism, political issues of the context and the multiplicity of membership of actors have shaped the implementation process of this mobile phone innovation. The findings also showed that pre-existing manual systems, which are more often than not already in existence in most developing countries can be an obstacle to the emerging actor network, that is the mobile phone innovation. On a positive note, this study findings showed how the smart mobile phone technology was an actor in this network and thus influenced the actions of the human actors.

7.3   Theoretical Contributions

The theoretical contributions of this study can be categorised into two areas: One is the unique application of actor network theory to the study of mobile phone-based innovations while the other is in enriching the body of work in mobiles for development "M4D" domain. Both the theoretical framework and findings of the study make claims in advancing the current understandings of the dynamics of implementing mobile phone-based innovations within mainstream government public institutions.

ANT approach and Mobile Phone-based innovations in LDC

One of the important issues that can be reflected upon is the suitability of adopting ANT to be the theoretical lens that guides this research in relation to understanding the process of implementing mobile phone based innovations in LDCs. This section will by way of discussion, reflect on the suitability of applying ANT for this study. Specifically, it will highlight on the achievements of adopting the ANT perspective in this study.

First of all, this study used ANT's moment of translation as a simplistic linear approach to help tell the story and provide a narrative of the chronological events

that took place as part of the implementation process. Specifically, the four moments of translations namely, problematization, interessement, enrollment and mobilisation were used as a lens to look at the key events that took place. Having established key insights on the implementation process based on this simple analysis with the help of the moments of translation, this study goes a step further by taking on a number of the key occurrences and relationships within the MADEX network and examines them from an actor-network perspective. Specifically, this study draws on ANT's concept of generalized symmetry, of which offered an alternative ontological perspective to view the relationship between the physical and the social. The insight provided by this second phase of analysis is discussed below.

Insights from using ANT's moment of translation

ANT was insightful in allowing us look at technologies as active actors with the capability to exercise control on others by constraining or enabling the performance of some actions but not others. From the case study, this was evident in the second phase of the implementation process whereby the smart phone, by virtue of their internet capability was able to closely align the interest of LM&E officers to the MADEX effort hence enabling them to lend more durability to the implementation based on their increased commitment.

Also, ANT's theoretical resource has been helpful in improving our understanding of the implementation effort as one that involves political processes. Specifically, ANT has helped in looking the implementation as a political processes where on-going negotiations between actors were required. Consistent with this line of thought, ANT helps understand how in order for MADEX to be implemented successfully, the focal actors who are in charge of the implementation process, needed to devise a variety of strategies such as regular meetings, incentives etc. to better align the interest of actors involved.

Last but not least, an actor-network analysis helped highlight the dynamic nature of the interests of important actors in the MADEX network. Simply put, the study gave insight into how the interest of most of the actors were not static, but changed over

time owing to changing circumstances and certain occurrences. In the MADEX case, the findings showed how the actors who initially backed the use of MADEX, "betrayed" its adoption by opting for the use of other information systems such as the manual system and the DHIS system, both of which could be described as competing against the interests of MADEX effort to become embedded. This changing nature of interests was reflected when senior data monitoring personnel's who initially used MADEX, but in not finding MADEX useful, disregarded its further use.

Insights from employing ANT's principle of general symmetry

This section will discuss the theoretical contribution of ANT based on the application of one of its fundamental concept, that is, the principle of general symmetry. The application of what Callon (1986) refers to as the principle of generalized symmetry, allowed actor-network theory the opportunity to make a contribution to how we view the process of deploying and using mobile phone – based innovations. Essentially, if we recall (please refer to chapter three), it is this radical ontological perspective (Whittle & Spicer, 2008) that suggests humans and non-humans are capable of being actors that the study set out to demonstrate. Basically, owing to its ontological relativism, ANT does not produce its own decision about what phenomena are to be studied neither does it create its own discriminations and boundaries; rather what ANT does is that "it removes from itself any terms and conditions that might serve to exclude others" (Lee & Hassard, 1999). By so doing, it allows researchers to see the world from different perspectives as they embark on the research without a clear picture of what sort of actors they will encounter during their research; basically they will " have to follow the actors" and make a list of those actors who make up the network under analysis.

Further, an essential characteristic of ANT which was considered while conducting this study is that of ANT's symmetrical assumption of the social and the technical. Essentially, the proponents of ANT declare their commitment to anti-dualism with regards to the traditional separation of human and non-human. Such equality allowed the researcher brings together non-human actors, in addition to the human

actors, into the frame of analysis while preparing the list of actors involved in this study.

"Following the actors" a phrase from ANT's theoretical approach, allowed the researcher to clearly see that the MADEX network constituted from hybrid human and non-human, micro-level and macro-level actors, who interact together through the help of various different intermediaries such as texts, human beings and technical artefacts all of which have an impact on the implementation process.

Overall, it is sufficient to say that, the research demonstrated that the implementation process of a mobile phone innovation is not just a technical process; it is a combination of many socio-technical aspects that comes from the interaction between different actors. For example, in the MADEX case, this interaction is evident through the association between the IT vendors who had the responsibility of deploying the system, the smart phones which was a tool for communicating and transmitting this information, the internet software which enabled LM&E officers use the phone to browse the internet, training provided by the NPHCDA IT operations personnel to the LM&E officers as well as the training provided by the IT vendors of the MADEX system for IT operations personnel, the pre-existing manual system and other actors that impacted the implementation process.

The non-essentialist ontological perspective adopted in this study, highlighted a key finding which is that, the implementation of mobile–phone innovations such as MADEX, are not purely a matter of technical considerations only, rather it is understood as a network of these heterogeneous social and technical, micro level and macro-level actors that are brought together into alliances for the purpose of making the network becoming stronger and durable (Latour, 1987). Thus, an important lesson to emerge from this is that all the actors, humans or non-humans, have an important role to play in the process of implementing mobile phone innovations.

Also, as regards ANT symmetrical assumption between humans (e.g. the focal actors, vendors of the MADEX system) and non-humans (e.g. the paper-based system, the mobile phones), it is important to make clear that ANT does not deny

the differences between them. Basically, as the proponents of ANT argue, the primary aim of this symmetrical assumption is to create the network. Callon's & Latour's specifically address this by stating that "Our general symmetry principle is thus not to alternate between natural realism and social realism, but to obtain nature and society as twin results of another activity...network building, or collective things …" (Callon & Latour, 1992).

To sum up, the non-essentialist ontology of ANT provided an alternative way of thinking about, and explaining, the implementation process of a mobile-phone based innovation. Specifically, it helped us to understand this implementation effort from a holistic perspective beyond "what happened and when" and gave us the chance to gain insights of the main hidden actors and intermediaries that are involved in the emerging network and how they interact with each other to shape the network.

7.4   Contribution to practice

This study contributes to practice by offering useful advice on high level strategies and interventions to project sponsors responsible for implementing mobile-phone intervention in mainstream government-led public sector of LDCs.

Key implications for practitioners based on the findings that emerged directly from the data.

Specifically, by adopting an ANT framework in this study, of which assumes an intermediary position that systematically avoids the dualism between the technical and the social, the findings of this study was able to reveal various socio-organisational factors ranging from political issues, infrastructure limitations, to cultural elements such as scepticism of which impacted on this implementation process.

 In effect, this study suggests that often taken-for-granted socio-cultural aspects of societies have a lot to offer in terms of how such implementation process playout.

To this end, this study reinforces the importance of examining not only the organisational context but also the wider socio-economic context when deploying mobile phone based innovations within the broader government led public sector (Mitev 2005; Mitev and Bartis 2008).

Based on these findings this study presents the following key considerations for sponsors and project managers of mobile phone-based innovations:

First, In relation to addressing socio-cultural issues such as scepticism among employees within the government–led public institutions, this study identifies the need for a nationwide sensitization and awareness effort of public sector employees to encourage an attitude of trust and optimism towards government-led ICT innovations projects, in order to address the issue of a sceptical attitude within the workforce. When employees are more trusting towards this kind of effort, they not only tend to be fully motivated to support such effort but they also become committed and active participants within such projects of which increases the ability of such innovations to succeed.

Also, in addition to sensitization efforts, sponsors of this kind of effort should ensure that mobile phone based innovations provide clear demonstrable benefits particularly to end users. This will not only increase their participation but also their acceptance towards deployment efforts of ICT innovations within the public sector.

Also, to better manage future initiatives of mobile-phone innovation within the government-led public sector, sponsors of this kind of effort need to put in place a robust policy to assist with the governance and management of such effort. Basically, such policy, should provide in detail, the approach that should be taken by all stakeholders involved in the project.

Further, while this policy should be based on established best practice methodologies carried out in similar settings, it should also be tailored to best fit with the resource availability and the requirements of the specific project.

In sum, it is sufficient to say that it is not enough, however, for a new technological innovation such as mobile phone-based information systems to simply be perceived

as useful and compatible based on its unique properties such as its cost-effectiveness, portability, but, mobile phone-based innovations like MADEX must also be perceived to add value especially to the end users. Further, sponsors and practitioners must take into account the important role of social and institutional context in facilitating or hindering the process of deploying and using mobile phone innovations.

Key implications for practitioners based on the findings from the analysis of the translation moments

Also, based on the findings from the analysis of the translation moments, of which brought to light key issues during the different moments of translation, this study presents key implications for project sponsors and practitioner. These implications are as follows:

Being pragmatic in the Problematization Process

Considering that the problematization is where the focal actor initiates the idea, devises a solution and identifies the actors and mechanisms of their alliances, it is important for the focal actor to be very realistic in terms of what is achievable and do-able, as the success of the other moments, is very much dependent on how well the problematization is thought out. For example, as this case study demonstrated, the strategies devised by the focal to support the actors in overcoming their obstacles (see table 5-1) in the actor-network were found to be insufficient.

If we take a look at the users of the mobile phones as an example, that is the M&E officers and facility in-charges, the focal actor showed little concern about their involvement in the design and planning process. Basically, their perspective were not reflected on or discussed at any meeting. Basically, it could be seen that the focal actors, viewed these actors as passive actors in the actor-network. Over time, this would impact on their commitment and cause them to be ambivalent about their support for the MADEX network.

Basically, focal actors need to think through the implementation process very thoroughly, by properly weighing the benefits of each main actor and their capacity,

ensuring that they can meet the task given to them. One way to do this, would be to bring in all the actors at the start of the project so that they can take part in the debating, negotiations, planning and setting of goals and objectives. However this was not the case in the MADEX project as it took a very top-down or what we might call autocratic approach, whereby other actors had to adhere to the commands of the focal actor. Not only does this kind of approach leave little or no room for negotiations, and active engagement of those at the bottom of the pyramid, it most times tends to create tension in the network of which increases the chances of failure.

The importance of multiple devices in the Interessement Process

A key recommendation of this thesis is that the focal actor must pay attention to the issue of creating multiple or different devices of interessement for various actors in an actor-network. In the MADEX project, it seemed an easy thing to "lock" main actors in the actor-network. However, on looking closer, this was not the case. For example, if we recall from the case study, most of the actors in the emerging network were also actors in the pre-existing paper-based system, such that in the absence of a strong interessement device, their allegiance to the MADEX network was short-lived as it was easy for them to shift back to the paper system. Thus when implementing mobile-phone based interventions as part of new ways of working, the focal actor must make certain to create devices or tools that could be used for locking in the interest of actors into the emerging actor-network, as it more than likely that efforts within the government led public system will include actors already members of the pre-existing system on ground. Like in the MADEX case, most of the actors were already part of the DHIS system and the manual system.

Paying attention to the role of pre-existing organisational norms and work practices

A key implication that can be drawn from this study is that, while paying attention to the motivations and interest of the actors as proposed by ANT, this study findings draws attention to the importance of also paying attention to pre-existing norms and work practices of actors as these can also shape the outcome of this kind of effort.

This study shows that pre-existing work practice such as the tradition of managing data via the use of a paper-based or manual system is one that is ingrained in the public healthcare system of most LDC. As such introducing technology as part of the work practices of these actors can be challenging (as can be seen in the MADEX case) and also met with scepticism especially in a country like Nigeria, where previous efforts to introduce technology in the public sector, have met with little success and basically have been short-lived.

Thus a transition from manual reporting of data to technology-enabled reporting, on the part of a wide range of primary-level M&E officers or even facility in-charges, would be a major social change for actors involved.

One M&E officer responded to an interview question on this issue by making the statement below:

"This is not our culture (that is the routine use of information technology to capture and send information)....from the beginning we have been keeping manual files and registers...it seems to me that we are trying to adopt a foreign culture here...I really doubt we have what it takes to pull this (implementation effort) off. You cannot just introduce something like this "overnight" but let us watch and see how things go". *(LM&E 4)*

From the above, it is sufficient to say that actors bring their own ideas, norms and existing practices (such as training and previous work experiences) with them into emerging actor-networks. Thus, implementers need to bring these aspects to the fore, so as to understand how such past norms and organisational culture may shape actors engagement with mobile phone interventions.

Recognizing the effect of multiplicities on the emerging network

Basically, an ANT analysis brings to light the issue of multiplicity and its effect on emerging actor-networks like MADEX. Basically, human actors from the MADEX network, were part of the existing national health information system (that is, the paper based system). Further, these actors, such as senior data monitoring officers and the M&E officers at the local level were also members of the DHIS-2 actor-

network. So basically, Like the DHIS-2 network, the emerging MADEX actor-network was a sub-system of the pre-existing paper based system, and, the human actors in the MADEX network such as, the senior data monitoring officers and the M&E officers, could be said to have 'multiple membership' as they were actively involved in all three networks.

Singleton and Michael, (1993) in their study on the UK Cervical Screening Programme (CSP) that was analysed using the lens of ANT, warn that such actors with multiple membership, tend to be endowed with what can be described as an "intrinsic uncertainty". In the MADEX network, this attribute could be identified among actors with multiple membership.

For example, in the MADEX network, it was evident that actors with "multiple network memberships" such as the senior data monitoring officers quickly switched allegiance from the MADEX network to the paper-based network and the DHIS network, when the MADEX network stopped serving their interests in terms of providing them with usable data. Overall on the issue of multiplicity, Star (1990), points out that people can inhabit many different domains at once ... and the negotiation of their identities, within and across networks, can be an extraordinarily complex and delicate task.

Therefore practitioners would have to think of how best to incorporate and manage actors that possess multiple membership. An important strategy would require the focal actor of emerging networks, to ensure that the interest of such actors are properly "locked in" the emerging network so as to prevent them from making a "detour" as it were hence abandoning the emerging network.

Being mindful of competing Actor-Networks

An ANT analysis also sheds light on the role of competing or "counter" networks on the emerging network. These networks could be seen as intruders that can act as an obstacle to the alliance the focal actor is trying to create within the emerging network. If we recall, in the scallop case at St Brieuc Bay (Callon 1986), in which external forces otherwise referred to as "enemies forces", such as starfish, parasites

and sea currents invaded and destroy the scallops, this situation seems similar to the case herein.

The findings, of this study showed that when the reports coming from the health facilities started to drop, of which resulted in the inability of MADEX to provide useable data as expected, other "networks" (specifically the DHIS network as well as the pre-existing manual system) already in place were used as an alternative source for collecting data. In this way, the DHIS-2 network and the manual system played an active role in constraining the ability of MADEX to strengthen its relations with other actors in the MADEX network.

With that said, it is important to mention that most mobile-phone based systems implemented within the public sector will most likely have to contend with an existing system such as the traditional system otherwise known as the manual system. Also, bearing in mind that most of the actors in the emerging network may also belong to the pre-existing manual system as was the case in the MADEX case, it is almost impossible for the focal actors to isolate actors from the pre-existing network. Therefore the focal actors need to be careful and ensure that such pre-existing system don't act as a competing system to the emerging network. To achieve this, the focal actor needs to employ sufficient interessement devices and introduce strong enrollment strategies to align the interest of all actors involved in the emerging actor-network. Also strong policies and guidelines will also have an essential role to play in ensuring that the pre-existing network does not act as an obstacle to the emerging network.

Contribution	Area of contribution	Justification
Theoretical contribution	Empirical examination of the implementation of mobile phone –based innovations within the broader government-led public sector. Enriching the body of work in the mobiles for Development (M4D) domain.	➢ The unique application of actor-network theory's radical ontological perspective that suggests humans as well as non-humans are capable of being actors. ➢ Exposes the previously hidden complex interdependent relationships between the human actors and non-human actors involved in this process. ➢ The actor-network approach allowed the process of implementing mobile phone based innovation within the broader government-led public sector, to be considered in a way that brings to light the complex interdependent relationships between the physical and the social dimensions. ➢ Enables readers appreciate the influence's at work in deploying mobile phone innovations within development areas such as health within the government–led public sector.
Practical contribution	Offers advice on high level strategies and interventions within mobile-phone intervention deployment in mainstream government-led public sector. Offers insight into the important role of social and institutional context in facilitating or hindering the process of implementing mobile-phone based innovations.	➢ This study identifies the need for project managers and sponsors to recognise socio-institutional actions and influences that shape the implementation process of mobile phone-based innovations in mainstream public sector. A notable influence being the pre-existing manual system already in place within such institutions. ➢ This study identifies the need for project managers and sponsors to address socio-cultural influences alongside techno-managerial issues. A notable influence is the issue of scepticism towards ICT interventions in mainstream public sector. In relation to addressing socio-cultural influences such as the issue scepticism, this study identifies the need for nationwide sensitization of public sector employees to encourage an attitude of trust and optimism in order to address the issue of a sceptical attitude toward government-led ICT innovations. This thesis suggest the development of policy and procedure to guide mobile phone-based interventions especially within the broader government-led public sector.

Figure 7-1 Contributions of the Study

7.5 Methodological Reflection

Having presented the theoretical and practical contribution for this study, I will also briefly reflect on a few difficulties encountered while conducting the field work

which took place within the Nigeria government led- public health sector. During the field work, I experienced an unexpected hindrance, as regards the interviews, which slightly altered the planned interview process and made it somewhat challenging.

Bearing in mind this was a nationwide effort, within the public health setting, interviews were scheduled to be conducted with a lot of participants across multiple levels of the health system, of which implied that interviews would need to be conducted in different locations. Basically, I set out with the intention of tape recording the interviews (for ease and convenience), to help save time, with the consent of the potential interviewees. However to my surprise, a large number of participants did not wished to be tape recorded as they found this practice quite suspicious. This meant that the interviews took longer as I had to write down everything by hand. In other cases, when the interviewee couldn't spare so much time, I was unable to ask all the prepared interview questions, since I spent most of the time typing the answers on to my laptop. Basically, because there are very few research conducted to evaluate public sector IS projects in Nigeria, some people were unwilling to share their experiences, and in some instances were "economical" with information, even after providing information sheets, explaining in detail the purpose of the study as well as reassuring them that this is an independent research, that will provide one hundred percent anonymity to participants.

Looking back, I would argue that, the government needs to encourage more evaluation of IS projects. Considering that the NPHCDA, is a government parastatal with a research and development department, one would expect this department to have actively conducted a thorough evaluation of this effort, and make such information available in the public domain, however, this has not been the case. Until government realises the importance of being transparent and possibly accountable to citizens about public ICT initiatives, people who work within the public setting where such efforts are deployed, will be less welcoming of research exercises such as this, and will generally fail to see studies such as this, as an important and necessary process, that can provide feedback to improve ongoing projects and also provide lessons that can inform future projects. Hopefully, this

will encourage more people to become more open and share their experiences with external researchers.

A second reflection concerns the difficulty of finding resources either as archived document or as online resource on the MADEX project. Considering that the MADEX project was a nation-wide public sector effort, again, one would expect that archived documents or online resources providing a neutral account of the MADEX project from its inception till its eventual collapse will be available for the public, either as archived material that is accessible or as online resource, but this was not the case. If we take the NPfIT programme in the UK as an example, information about its roll out, up to its eventual failure is the public domain, making it possible for researchers to easily conduct a well-informed review or analysis on this project from multiple perspectives.

One of such document is the 2013 House of Commons Committee of Public Accounts report tiled the "The dismantled National Programme for IT in the NHS" amongst so many others. Basically, this kind of transparency that makes information about a public sector IS effort available, is still lacking in the Nigerian setting. Such lack of transparency, makes it difficult for researchers to get the much needed information to evaluate such effort effectively, even more so, from a non-bias point. However, government's transparency about public sector efforts, will allow researchers, practitioners and citizens have access to key information about such projects. Also, when such information is out in the public domain, lessons can be learnt which could better inform similar efforts both in Nigeria or elsewhere in the future.

Overall in hindsight, due to these issues, I would say, that a study of this scale would have benefited from being carried out as an action research as I feel that there is still more to be told about this project considering its scope that I was unable to capture owing to these issues. Basically, by being partly immersed in the project as an action researcher, the researcher over time gets to be viewed as part of the team, of which will result in people becoming more open and comfortable about sharing information and their personal views. Also, I would have had the opportunity of observing and encountering certain things myself over an extended period of time.

This means that, my analysis would not have been dependent solely on the account provided by agency personnel, but also dependent on my own neutral assessment of events, in other words, affording me that privilege to first-hand information.

7.6   Research Limitations and Future Work

Owing to limitations of time and resources, this research was unable to investigate thoroughly the wider network in which MADEX was situated. This could have help to add more depth to our understanding of how this effort failed, from a broader perspective and also offer enrichment to the study findings. Therefore, future research analysing this case study, could seek to extend the study for example, to bring into the analysis, other actors that were seen to be excluded from this network (such as external institutions such as the national IT agency in the country-NITDA) could have shaped the implementation effort of MADEX. For instance, this research would have been able to investigate if the involvement of NITDA as an actor, would have made the network more durable.

Also, the case study for this research was an implementation effort that took place within the public health system. Notably, ICT interventions within the health system, specifically health information systems tend to be extremely complicated, as it normally includes many forms of data and requires multiple actors across different level of the health system.

Therefore, it will be interesting to see if mobile phone innovations in other areas of development such as agriculture or education, will face similar challenges or not. Still on that note, comparative studies that seek to analyse implementation efforts in different regions outside of the sub-Saharan African context (for example countries such as China or Brazil) can generate some interesting findings which would be of value to the field and further it's development.

Lastly, as pointed out in the methodological reflection section, conducting this research as an action research can offer enrichment to the study as it allows the

researcher to become fully immersed in the context and over time build relationships and rapport with participants, of which will make it easier to get access to information.

7.7   Post Script

Studying for a PhD has in more ways than one, been a journey of self-discovery for me. Basically, I have come to realise that this journey, is not just about gaining academic achievement, but one that questions and tests a person's values, morals, strength and principles. Having come close to the end (I hope), I also have become aware of its implications on my personality, my behaviour, way of thinking and my way of life in general.

Professor David Avison, would say in that first research methods class, during my first few weeks on the doctoral program, that a pertinent question we must try to answer early on, is the reason for doing a PhD. He would go on to argue, that this reason will help you stay focus and will also be a motivation for completing the thesis eventually.

However for me this would not be the case. Few months after returning from the field work, my dad had an accident that was life changing, not just for him, but for the rest of the family. This tragedy created a huge void in my life and suddenly I started to question everything I believed in. Consequently, I would take time off the program as I struggled to cope. Also, over time I would gradually lose the motivation and lack the will to carry on with the research.

Watching my dad fight everyday just to stay alive and knowing that he wouldn't want me to quit, gave me the much needed motivation and would be the reason for me to struggle to complete my study. Looking back, with regards to the Lecture of Professor Avison, I would argue (through the lens of ANT) that, like the "interests" of actors in the MADEX network, the reason to complete a PhD does not always remain static, as it has an evolving nature, and can change with time as a result of events and changing circumstances. So basically, the reason you set out with from the onset, may just not be sufficient motivation to complete the programme of study.

Overall, my experience throughout the duration of this research, has helped me develop a deeper sense of appreciation towards other researchers and their work, especially those who have had to face immense challenges and overcome obstacles while trying to accomplish such a great feat. Lastly, I would like to believe that this journey, has equipped me with the knowledge as well as the skills I need, to go out and become a better person and hopefully excel at whatever I choose to do next.

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Appendix A

Letter of Approval from NPHCDA

National Primary Health Care Development Agency

— Office of the Executive Director —

Plot 681/682 Port Harcourt Crescent,
Off Gimbiya Street,
Area 11,
P.M.B. 367, Garki, Abuja
Tel: 09 - 670 - 1778
Tel/Fax: 09 - 314 - 3630
E-mail: nphcdaabuja@yahoo.com

Ref No ....

Date .... 30 May 2012

Chioma Ezenwa
School of Information Systems, Computing and Mathematics
Brunel University, Uxbridge
Middlesex, UB8 3PH, UK

**STUDY ON THE INTERACTION OF MIDWIVES WITH THE MOBILE APPLICATION
DATA EXCHANGE SYSTEM (MADEX)**

With reference to your letter of 9 May 2012 on the above subject.

This is to convey management approval for you to conduct a research on the use of
Information and Communication Technologies within primary healthcare in Nigeria
(specifically the MSS Project), as requested.

You are required to provide regular updates to the Director of Planning, Research &
Statistics and share the findings with the Executive Director/CEO, Director of
Planning, Research & Statistics and Director of Primary Health care Systems
Development at the end of the mission.

Best regards.

Dr Emmanuel Odu
Director of Planning, Research & Statistics

FOR: Executive Director/CEO

*To develop a Sustainable Primary Health Care Service System which is equitable, affordable & qualitative through the participation of all
Nigerian people, in partnership with all levels of Govt. And NGOS*

I

Appendix B

List of interview questions

List of interview questions for Facility in-charges & LM&E officers

Interview questions	Interest
1. Thank you very much for agreeing to be interviewed. I am keen to find out your perspectives on what has been happening so far in regards to the MADEX initiative and I would like to know more about it from your perspective. 2. Do you mind if this conversation is recorded? 3. Can you tell me a bit about your role and how you got involved with the MADEX project? 4a. What is your opinion of the MADEX project in general and would you say that the objectives and visions of this project is clear to you? 4b. Is this project beneficial for addressing the issue of maternal and child health mortality?	Opening statement and background information
5. What has been your experience so far in terms of using mobile phones in this project and engaging with the MADEX application? 5b. Do you have any forms of interaction with other groups of people involved in this effort such as the IT personnel etc? 5c. How would you describe that interaction?	Interaction and experience Formation of the network Interresement /Enrollment process
6a. Overall do you have any concerns as to how MADEX has been implemented or how it is being used?	Issues and challenges

6b. What challenges have you faced in using MADEX as part of your work practice? 6c. What in your opinion is the best solution to question a and b above?	
7. What benefits/values would you say this system has provided? 8. Are there any other ways you would like to see MADEX add value? 9. In your opinion, was this project successful or did it fail to achieve its objectives? If yes, could you explain in more details why? 10. Do you have any other comments about this project?	Rounding up the interview process

List of interview questions for Vendors and NPHCDA personnel

Interview questions	Interests
1. Thank you very much for agreeing to be interviewed. I am keen to find out your perspectives on what has been happening so far in regards to the MADEX initiative and I would like to know more about it from your perspective. 2. Do you mind if the conversation is recorded? 3. Can you tell me a bit about your role and how you got involved with the MADEX system? 4. What was the motivation for initiating this project?	Opening statement and background information

5. Who was the main initiator of this project? 6. How/why did the initiators start this project? 7. What other bodies/institutions/arm of government were involved in this project? 8. What were the objectives of this project? 8b. In your opinion, what did you think about the project objectives? 9. What were the responsibilities of your agency in this project? 9b. in your opinion did those responsibilities suite your organisational capacity? If not, why?	
10a Can you tell how mobile phones have been introduced and used in this project? 10b. Can you tell me what other "actors" have been enlisted or assembled together to become part of this project, what role did each of them play in this process? 10c.What strategies have been used to enlist them? And have these strategies been successful? 10d. Were there people who needed to be included who were not included? If yes, is there any reason why they were excluded? 11. Do you have any forms of interaction with other groups involved in this effort? If yes, how so?	Interaction and experience Formation of the network/translation Interresement /Enrollment strategies

12. Overall you tell me of any issues or difficulties that MADEX is facing? 12b. how did the agency solve them/or how does it plan to solve them?	Issues and challenges
13a. Taking an overall look at the entire process, would you say that this project was implemented smoothly from the beginning? Or do you have any concern about the process of implementing and using MADEX? 13b. In your opinion, is this project successful or not? If yes, could you explain in more details why? 14. Do you have any other comments about this project?	Rounding up the interview process/final comments

Appendix C

Sample themes, related ANT concept & supporting quotes

SAMPLE THEMES AND RELATED FRAMEWORK ELEMENTS	SOURCES	CODED EXCERPTS FROM TRANSCRIPT
Theme: Implementation of mobile-phone innovations involving political processes such as negotiations, betrayals etc. **Related Framework Element**: interessement (moment of translation)	**Source:** Coding of transcripts	*"At the moment, owing to funding issues, we are unable to deliver on the promise of monthly stipends, we will need to come up with strategies to persuade the LM&E officers to carry on with their routine reporting, otherwise we start losing their commitment over time"*
Theme: Mobile phone technology are very much actors within this implementation process **Related Framework Element:** Principle of general symmetry.	**Source:** Coding of transcripts	"*I can use the MADEX smart phone to browse the internet because it has internet capability, I can also check and send emails. So am happy to continue recharging and topping-up the phone with my own money to enable me send my monthly report*"
Theme: The interest of actors' are not static but dynamic and evolves owing to changing circumstances. **Related Framework Element:** Interessement (moment of translation)	**Source:** Coding of transcripts	*"In the beginning the MADEX platform was able to produce usable data to assist me with my work, but over time, with all the challenges faced the reporting rate has dropped making the output unusable. Presently I rely on the dhis 2 platform or the manual register to meet my information need"*
Theme: mobile phone-based innovations are characterised by complex inter-relationships between human and material **Related Framework Element:** Principle of general symmetry, actor-networks.	**Source:** Coding of transcripts	*""In the beginning the MADEX platform was able to produce usable data to assist me with my work, but over time, with all the challenges faced the reporting rate has dropped making the output unusable. Presently I rely on the dhis 2 platform or the manual register to meet my information need"*

Post-define themes that emerged from the data

THEMES	SOURCES	CODED EXCERPTS FROM TRANSCRIPT
Theme: Technical limitations and glitches	**Source:** coding of transcript	*"Sometimes I want to send my report via SMS but because of weak signal and connectivity problems I am unable to do so. Sometimes I have to wait a while this can result in me sending my information late"* *"The simple Nokia phones can only accommodate 160 characters so reports that exceed that number will not be able to be sent"*
Theme: Political issues	**Source:** Coding of transcript	*"The on-going political crises in northern Nigeria has posed a big problem to this effort. We are unable to capture data from some of the facilities in this area because the GSM network used to send the routine report has been affected"*
Theme: Scepticism	**Source:** Coding of transcripts	*"We don't have much confidence in what they (focal actors) are doing. Look around within government what you have most times is incomplete projects. Will this one be any different?? Why can't we get it right like other countries?"*
Theme: The effect of multiplicity	**Source:** Coding of transcripts	*"As the senior data monitoring personnel, prior to MADEX, I have been responsible for monitoring and evaluation of the data from the manual register, also I support the analysis of data from the DHIS 2 and now the MADEX system, since the MADEX system's output at the moment is poor, I have to make use of the data coming from the manual system to help me to do my work"*

Appendix D

Example of the Interview Transcript

(This interviewee is a health facility-in-charge personnel)

1. Thank you very much for agreeing to be interviewed. I am keen to find out your views on what has been happening so far in regards to the MADEX initiative and I would like to know more about it from your perspective.

2. Do you mind if this conversation is recorded?

"No"

3. Can you tell me a bit about your role and how you got involved with the MADEX project?

"Well I am the facility in-charge of this health facility. Early this year, a number of us (Health facility-in-charges) within the region were invited to attend a regional training about MADEX organised by the NPHCDA. When we attended we were briefed about MADEX and then we were told we will be the primary users of the mobile phone which we will use to enter information every month and send off to the national office of the NPHCDA in Abuja. We were told that we will get a monthly stipend to buy credit for the phone so that we can send the monthly report via SMS. So far, I have been doing what they want us to do. Every first week of the month, I use the MADEX phone to send my monthly report"

4a. What is your opinion of the MADEX project in general and would you say that the objectives and visions of this project is clear to you?

"I don't have an overall picture of the whole project but what I can say is that here at the local level, we are doing what we have been told, to do, that is, to enter the data on key MNCH parameters and send it off to them at the national office via SMS. Am believing by doing my own bit here and others doing their own bit as well the project should achieve its objective".

4b. is this project beneficial for addressing the issue of maternal and child health mortality?

"We were told that when we send our information on time, those senior data officers at the national office in Abuja can quickly look at it to analyse it and detect any problem. I believe this can help make things better with maternal mortality".

5. What has been your experience so far in terms of using mobile phones in this project and engaging with the MADEX application?

"The training provided is sufficient for me to be able to use the application but sometimes I have difficulties sending my report because of poor mobile signal strength. Sometimes I get a call saying my report has not been received so I have to resend it. Other than that, the only thing I would like to say is that the monthly stipend we were promised has stopped coming. This is not good. The work we do is important, so we expect them to keep to their promise".

5b. Do you have any forms of interaction with other groups of people involved in this effort such as the IT personnel etc.?

"After the initial training I have not had any other interaction with those at the national level. But we have been given a number to contact them in the event of any issues. I have not really had any issues so far that requires their attention. But from what I have found out from some of my colleagues who are having problems with their phone or the application, sometimes it takes a while before someone from the IT team comes to resolve their problem. This could be because of the distance from Abuja where the national office of the NPHCDA is located to the south east were we are".

5c. how would you describe that interaction?

"As I said, apart from my encounter with the senior officials at the national office of the NPHCDA, during the initial training, which lasted for half a day and mainly was about how we will use the MADEX phone to capture data and a brief

explanation as to why we are doing so, there has been no other interaction between myself and other personnel on this matter".

6a. Overall do you have any concerns as to how MADEX has been implemented or how it is being used?

"Yes. So for something such as MADEX that its success is mainly dependent on us as we at the local level are the key users and also the beneficiaries that is mothers and young children are also at the local level, there has been very little consultation with us. In fact, we know very little about this, we have a lot of questions and even ideas but it does not seem to count. Everything seems to be happening from at the top".

6b. what challenges have you faced in using MADEX as part of your work practice?

"The application is simple to navigate and use so in that regard I have not faced any problem. The only challenge I face sometimes is sending my report. So when there is poor network sometimes it is difficult to send my report by SMS. But when I get a wave of good mobile connectivity, I quickly forward my report by SMS to those at the IT control room at the national office of the NPHCDA".

6c. what in your opinion is the best solution to question a and b above?

"I think consultation with us would have been good. We have questions and suggestions so we would like those at the top to be interested in what we have to say as this will go a long way to help this project".

7. What benefits/values would you say this system has provided?

Here at the local level, I can't see any direct benefit. For instance, this application collects information about stock. One of the medication we administer here at the facility to the expectant mothers is misoprostol medication, the problem is, while some facilities have excess stock some other facilities don't even have at all. For those facilities with excess misoprostol, after a few weeks they have to throw away the stock since this medication cannot be preserve longer than two weeks at the facilities. This is wasting and it is not good. This continues to baffle us and is proof

that the information captured may not be guiding decisions relating to stock. This makes us inclined to question the purpose of the MADEX application capturing stock information".

8. Are there any other ways you would like to see MADEX add value?

"Yes, it would be nice for us to use it at the local level to inform stock management right here at the local level. Also since the data is digitised, it would be nice to have a chart of performance or any pictorial representation of the maternal health indicators. We can put that on the wall as a poster every quarter. The women can see at a glance how for instance their attendance of antenatal is helping reduce mortality rate and so on. Also the local government officials can see what is going on here at the facility by looking at this poster".

9. Do you have any other comments about this project?

"I would like to know where this is going. You see, most of this projects were the government introduce one technology or another does not last long. Most times, they will raise our hopes and make so much promise but after a while all our effort will go down the drain. The problem most times that makes them to discontinue such project is most times the management strategy and the issue of finance. At the end of the day we fall back to our traditional way of capturing and keeping data".