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ADOPTION POSSIBILITIES AND USE OF RFID IN NIGERIA HEALTH SECTOR

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ABSTRACT

RFID technology has become one of the technologies that have gained popularity in different nations and industries in the global economy with impart on supply chain and logistics, education, production, security and protocol; hospitality and tourism; military and health. It has transcended identification and tracking with rudiment barcoding to become a first aid collaborative health gadget that has made health care delivery cum patients' information transfer correct, faster and accessible through its sophisticated communication frequency device. RFID, even though at an infantile stage of adoption in virtually all industries in Nigeria, the tremendous benefits accruable to the country's human capacity building and development through the RFID adoption in Health sector will last till the extinction or alternative.

The research study has served to investigate the inherent complexities within the Nigeria health sector's adoption perspective. It employed semi-structured interview method to find out the nature and causes of adoption of RFID in Nigeria health care delivery sector. The author carried out the research instruments on four hospitals (two private and two public or government managed hospitals).

The research engaged itself to investigate the internal, external and technical dynamics of Nigeria health care service as a sector and how the formers are necessary and contributory to the adoption of RFID thereby eliciting the level and direction (positive or negative) which it is taking in the economy. It also tasked the research study to identify and better understand areas where RFID adoption will be more beneficial to the Nigeria health sector.

The result showed that RFID adoption though assigned with low level of awareness; adoption capital recompense and infrastructural challenges in the Nigeria health sector in particular, also has high and great tendencies to thrive. The result of the second research question revealed that the Nigerian health care service delivery can harness the benefits of the IT solution system to function in its clientele servicing in forms like authentication and identification of personnel, patients' data and blood verification; drug dispensary among others.

However, among the varying importance of RFID technology, the most significantly identified in the research is the data solution service, which cuts through a wide range of interconnectivity between the primary health care giver and the secondary users and health administrators.

Keywords: RFID, adoption, technology, healthcare, hospital, sector, Nigeria, ICT

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LIST OF ABBREVIATIONS

EPC	Electronic Product Code
FCT	Federal Capital Territory
HF	High Frequency
HMOs	Healthcare Management Organizations
I/O	Input/output
ICT	Information Communication Technology
ID	Identification
LAN	Local Area Network
LASAMBUS	Lagos State Ambulance Service
LASEMS	Lagos State Emergency Service
LASUTH	Lagos State University Teaching Hospital
LF	Low Frequency
LUTH	Lagos University Teaching Hospital
MDG	Millennium Development Goals
NAFDAC	National Agency for Food and Drugs Administration and Control
PDA	Personal Digital Assistant
PPFN	Planned Parenthood Federation of Nigeria
RF	Radio Frequency
RFID	Radio Frequency Identification
RNCs	Reader Network Controllers
UHF	Ultra-High Frequency
UN	United Nations
UNDP	United Nations Development Project
UNICEF	United Nations Children's Fund
WAHC	West African Health Communities
WHO	World Health Organization

1 INTRODUCTION

1.1 Background of Study

Development experts have long recognized health as an important moral and social goal. Health is also a key component of a sound development strategy, along with education, economic growth and good governance. As a form of human capital, health is essential to a productive society. Furthermore, the Millennium Development Goals (MDG) project of the United Nations (UN) fully endorses the central role of health in development (Dr. L. G.Sambo, 2008). The importance of health for economic growth and reduction of poverty is reflected in the MDG. Three out of the eight goals refer directly to health. One additional goal refers to access to affordable drugs in developing countries.

The long heralding efforts and benefits harnessed from health service production and delivery cannot be distinctively separate from contributions of technologies to improvement of human lives. Radio Frequency Identification (RFID) technology is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders. An RFID system consists of a transponder, a reader, a database and a software application for processing the collected data (TelecomSpace Telecom Tutorials).

The application of RFID technology in healthcare has been showing great potential to improve patient safety, reduce medical errors, save costs and overall contribute to the quality of care delivered to patients. In addition, the efficiency of healthcare delivery may also benefit from RFID technology. It is expected that availability of the technology, both inside and outside healthcare, will grow quickly over the coming years (RAND Europe, 2009).

RFID can be adopted in Hospitals in Nigeria both public and private with the goal to enhance productivity, particularly, in emergency scenario. Such RFID systems are called “indoor positioning systems”. Apart from this, public hospitals can use active RFIDs for patient and personnel identification and location purposes before administrating medications (Akintola K.G., Boyinbode O.K., 2011).

Against this backdrop, adoption and implementation of the RFID system in healthcare has the potential to augment patient safety, decrease operational cost, enhance items, human tracking, and real time management of hospital equipment. Although advantage of such technology that has been deployed in countries such as USA and European countries. Despite the established potential benefit of RFID to address healthcare problems, rate of adoption in developing countries is still very low as compared to developed countries (Fakhr, 2011).

Research done to investigate the factors affecting adoption of RFID in health sector has revealed issues such as cost, return on investment, standardization, organizational, operational and environmental factors. Dong-Her Shih, et al., (2008), highlighted seven factors (Dong-Her Shih, 2008). They are operation efficiency, manufacturing efficiency and supply chain efficiency, organization context, investment cost, market environment, and technology characteristic. The existence of this cannot be underrated in the Nigerian health service delivery horizon.

It is also necessary to ascertain how users and regulators of new technology view the potential impact of RFID in the healthcare industry. Rising costs, inadequate healthcare coverage and healthcare mistakes have prompted the government to investigate ways to improve this industry. What is the likelihood that RFID could have an impact? What roles could RFID play and how might RFID change the major players in the industry (Karen Crooker et al., 2009)? These are questions from former research (es) in USA and would be considered for the Nigerian health platform.

Therefore, the onus placed on this research is to question the possibility of RFID improving health service delivery in Nigeria. It is also assigning the task to identify how the factors (hurdle and accomplishment) of RFID adoption in healthcare can be addressed to facilitate the adoption process.

1.2 Research Motivation

One general motivation for this study relates to the enormous development and betterment of human lives that are inherent in technological advancement and its contribution to health service delivery in developed and developing nations of the world.

The emergence coupled with the ranking of RFID as "*the tenth most innovative technology in the past 25 years*" has called for investigation into its adoption in different industries (S. P. Singh et. al, 2008). Although the technology has been around and has been implemented in developed and even some developing countries in healthcare sector, so far, one of the hospitals in Nigeria has adopted this technology.

The National Agency for Food and Drugs Administration and Control (NAFDAC), a Nigerian government agency under the Federal Ministry of Health recently presented an injunction to all organizations it is monitoring and working under its legal jurisdiction to adopt RFID technology in their operations and has started negotiation with RFID providers on the modalities and other technical information necessary for the adoption of RFID. (Swedberg, 2010)

All emphasized factors trigger off the need and zeal to conduct this research to investigate this phenomenon and answer the research questions.

1.3 Purpose of Study

The purpose of this study is for better understanding and identifying factors affecting the adoption of RFID technology in healthcare sector in developing countries in Africa such as Nigeria from perspective of healthcare top pyramid. The result of this study can be helpful for executives, decision makers and stakeholders of hospitals in developing countries. It is also an underlining rationale to peruse crucial areas or divisions that urgently need RFID technology in the Nigerian health sectors.

1.4 Problem Description

In the last few years' health care providers and health policy regulators are making tremendous efforts in using information and communication technology for improving health service delivery and in combating the myriad of challenges confronting the health divide of the world. However, the problems facing the health sector of many developing countries, especially the adoption of recent technologies useful for efficient and effective service delivery are many. Cost, technological adaptability, social and policy environment constitute to some extent.

In order to bring down cost and improve efficiency, intelligent systems (such as RFID) can play a significant role in providing intelligently processed and personalized information about patients to doctors, their health care staff (i.e., nurses) and health care administrators. The performance of health care management system is far behind compared to the service and manufacturing industries. Health care organizations nowadays are dealing with greater rank diseases, their cost, quality and delivery has essentially not improved significantly, and even the difference with the other industries seems to have increased (F. A. Correa et al, 2005).

The Nigerian health sector and pharmaceutical agents and regulators are also just waking up to the enormous importance and contributions of the RFID technology facilities to the health sector. It is, however, alarming that only one health care provider, Stars Hospital Ltd, Abuja, FCT, Nigeria known to have adopted RFID technology in its service delivery. The company deployed an RFID-based asset-tracking system to keep track of medical equipment (Swedberg, 2010). This has intensely aroused questions and concerns on the knowledge and adoption options for health service in Nigeria.

This research mainly focuses on RFID adoption in Nigerian hospitals based on previous theories and pays attention to likely and preferential areas where there is crucial need for the adoption of RFID in the Nigerian health sector.

1.5 Delimitation

This study is limited to investigating factors (hurdles and success) of RFID system adoption in healthcare from perspective of hospital managers and IT managers, who are parts of decision-making groups on adoption of new technology in healthcare. Only big and established hospitals are targeted for the research. Hospitals are chosen based on rank among public and private hospitals, richness of service delivery and wealth of hospitals among other hospitals because such hospitals have foundational-base for the adoption. Thus, result of study could be more general if more hospital and health centers were investigated. Moreover, this research does not involve technical problem of RFID system implementation in healthcare, because covering this issue needs actual implementation and it is out of context for this research.

1.6 Chapter Framework

In Chapter 1, we present the background, scope, motivation and rationale of study, as well as the disposition of the thesis. Chapter 2 addresses the research design: research questions, purposes, method, strategy, approach, actual data collection and analysis, and validity and reliability. In Chapter 3, we review the literature about RFID adoption, what factors affect the success or the failure and what factors influencing the adoption. An overview of each case organization is given in Chapter 4. Chapter 5, we go into proper case analysis of the RFID adoption characteristics in every case organization. The analysis structure is built on the two main research questions. The analysis part starts with the RFID adoption stage and incorporating process in each company, continues with the reasons for adoption, and ends with the factors surrounding the adoption process. Finally, in Chapter 6 and 7, we present the conclusion of the thesis, which includes a thesis overview, results from analysis, discussion, suggestions to top executives, limitations of the thesis, and further works.

2 RESEARCH DESIGN

According to Kerlinger, "*Research design is the plan, structure and strategy of investigation conceived so as to obtain answers to research questions and to control variance.*" The definition includes three important terms - plan, structure and strategy.

This chapter consists of research questions, purpose, approach, strategy, data collection, sampling, data analysis, validity and reliability and visualization method. In the following divisions and sub-divisions, methodology of research work is described in detail.

2.1 Research Questions

RQ1: What factors contribute to the adoption of RFID in Nigeria Health sector?

Purpose of this research question is for better understanding and identifying of characteristics support factors of RFID adoption in healthcare sector of Nigeria.

RQ2: Can the adoption of RFID improve health service delivery in Nigeria?

Purpose of current research question is to better understand and identify areas where adoption of RFID technology is readily needed in the Nigeria healthcare service delivery.

2.2 Research Purpose

There are primarily three categories of research purpose, namely - exploratory, descriptive and explanatory research. The goal of explanatory research is to answer the question of why. Explanatory research attempts to go beyond what exploratory and descriptive research to identify the actual reasons a phenomenon occurs (Blurtit, 2011). Explanatory research also attempts to build and elaborate on theories and add to predictions and principles where possible.

Descriptive research is used to obtain information concerning the status of the phenomena to describe "what exists" with respect to variables or conditions in a situation. The methods involved range from the survey, which describes the status quo, the correlation study, which investigates the relationship between variables, to developmental studies, which seek to determine changes over time (James P. Key, 1997).

An exploratory study is undertaken when not much is known about the situation at hand or no information is available on how similar problem or research issues have been solved in the past. There are three primary ways to conduct exploratory research: a search of literature; interviewing “professionals” in the subject; and conducting focus group interview (Saunders et al., 2007).

An exploratory method is used for this research in order to gain more understanding about the circumstances surrounding Nigerian hospitals regarding adoption of RFID system or innovative technology, and to clarify, identify how the factor (hurdles and successes) can be described from perspective of hospital executive, core personnel and decision makers.

2.3 Research Approach

A research approach can be inductive or deductive. Inductive reasoning is moving from the specific to the general, while deductive originates with the general and ends with the specific. The choice of approach however is determined by the nature of information or phenomenon of study.

The deductive approach best complements this thesis. It exchanges information from broader generalizations to more specific observations and address the hypotheses. Deductive reasoning is a method of gaining knowledge, and therefore, supports the objectives of the thesis to applying theories in the real world in order to test and assess their validity (William M.K. Trochim, 2006).

2.4 Research Strategy

Research strategy contains clear objectives and should reflect why the particular strategy is chosen (Saunders et al., 2007).

Case study has been chosen as research strategy to carry out the finding of this study because the purpose of this study is to get deeper knowledge regarding the factors, which can facilitate RFID adoption in Nigeria's health sector. This was chosen knowing that case studies allow critical cross-examination and analyses. This means that the author of this research considers not just the voice and perspective of the actors, but also of the relevant groups of actors and the interaction between them (Tellis, 1997).

For this purpose, four hospitals has been chosen for investigation to determine what could be the factor (hurdles and successes) surrounding the adoption of RFID system from perspective of hospital administrators. Gathering data from each of these hospitals could be a clue to answer research questions and reveal the purpose of study.

2.5 Research Method

The aim of this study is to learn and understand the phenomena of RFID adoption within Nigerian health sector. The nature of adopting the RFID technology requires a method that is suitable to grasp the whole process, not only the factors influencing that. Therefore, this study employs the qualitative method, which enables us to study individual/organizational behaviors, the phenomena within their environments and reveal rich and complex processes.

Qualitative research seeks out the 'why', not the 'how' of its topic through the analysis of unstructured information – things like interview transcripts, open ended survey responses, emails, notes, feedback forms, photos and videos. It doesn't just rely on statistics or numbers, which are the domain of quantitative researchers. Focus groups, in-depth interviews, content analysis, ethnography, evaluation and semiotics are among the many formal approaches that are used, but

qualitative research also involves the analysis of any unstructured material, including customer feedback forms, reports or media clips (Ereaut G., 2011).

From the explanation given above, qualitative is the best choice, since this approach meets study's requirements to answer the research questions. The knowledge compiled from literature review helped to identify RFID adoption process, which comprised factors influencing the process. Information needed for answering the research questions were gathered from those who are currently working in the healthcare practice and regulatory environment, and are in strong position regards adoption of new technology. They have been in this field for long time to understand the behavior and reaction of staff, clients, executives and policy makers towards the adoption of new technology. After that, coding method was employed to categorize information extracted from the interviews. Finally, we analyzed the information in respect to the two main research questions, which help in deducing the conclusion and making recommendations.

2.6 Data Collection Methods

When appropriate research strategy is chosen, it is necessary to decide how to collect the data. Yin (2003) identified six kinds of data collection for case studies: documentation, archival records, interviews (by filling questionnaires), direct observations, participant-observation, and physical artifacts.

An interview can be classified as structured, semi-structure or unstructured interview. In other words, semi-structured interviews provides supervision, which allows interviews stay well within the motivation of the study, hitherto provide scope to explore new and relevant issues that surface during the interview process (Yin R., 2003)

To aid this case study research, semi structured interview type will be most appropriate. A semi-structured interview was subscribed to explore participants' experiences about the stage and process of RFID technology adoption in their organizations. The use of interviews can aid researchers to gain valid and reliable data that are applicable to the research questions and objectives. These interviews

enable the author to find out the influencing factors and not only the process as such.

The typical process of RFID adoption as revealed in related research works and literatures motivated to develop the semi-structured interview. A set of guide questions were been developed to inquire about the participants' experiences in the knowledge and adoption of RFID for their organizations. The questions were open-ended to encourage participants to define and describe a situation or event extensively and developmentally, as well as reveal their attitudes.

2.7 Sampling

According to Saunders et al (2007), based on research questions it is very difficult and sometimes impossible to collect data from all sources to answer the research questions, mostly due to lack of time, money and access restrictions. In order to lower the amount of data, various methods and technique have been purposed to help researcher to collect data from a sub group rather than all possible cases or elements (Ibid).

They also stated that data that have been collected from small number of cases are more detailed and accurate and it can help the researcher for better understanding and analyzing of captured data as compared to large amount of data and samples. Judgmental sampling is generally more appropriate for qualitative research than quantitative research (Picciano, 2011).

The use of multiple case studies ensures that credibility is the completeness of the data collection in order to affirm that accuracy of the conclusion is merited (Yin R., 2003). The sample selection criteria will be based on four hospitals (two public and two private hospitals). From these four cases, four respondents are chosen based on their involvement in hospitals' administration and pertinently knowledge as well as their influence and power regarding adoption of new technologies in their professional field.

Process of sampling are based on judgmental sampling because it is believed all of respondents have been in this field for so long and totally are aware of problems and possible barriers which hospitals are facing at the moment regarding adoption of new technologies and RFID system. Respondents have managerial and/or administrative background in their career and they have experienced previous technology adoption in hospitals.

2.8 Data Analysis Methods

When all data are collected, process of data analyzing will be started. Data analysis consists of examining, categorizing, tabulating, testing and recombining of both quantitative and qualitative data to achieve the purpose of study (Yin R., 2003). According to Yin (2003), analytical strategy should help the researcher to choose a method that completes the analysis of the research.

Analyzing data gives meaning to simple raw data by categorizing them in to proper classes that are related. Collecting data systematically help the researcher during analysis phase, because the researcher can identify patterns from the collected data and be able to do further explorations (Saunders et al., 2007).

The research was conducted first by reviewing previous works and literature on adoption of new technologies and RFID, then the interview was semi-structured to allow interviewee express their view on the adoption of RFID generally and as it concerns their organization.

First, case analysis has been conducted for each of the four hospitals case studies and then, cross-case analysis has been made to compare all the four cases. After the interviews and the theoretical reviews, the study came up with some relevant data, which were arranged into two main groups and five sub groups for each main group. Healthcare possible inhibiting factors group which consist of technological, environmental, organizational; privacy and security and other factors made the five sub groups. The second group, which consist of healthcare success or possible adoption factors group also features the same five sub group

components of the first group. These variables, which were chosen, are directly related to past research and literatures review.

Relevant information was categorized and used for within and cross case analyses. At first, case analysis of four cases was presented, and after that; cross case analysis was carried out between the four case studies. The results of both types of analyses were used to draw up conclusion. The real names of interviewees were given in this thesis in line with the privacy terms that were assured the respondents. The names were, however, denoted by the first letter of their respective names.

The interviewee were able to give their candid responses as the author gave them liberal but short period to intimate themselves with the basics of RFID technology as regards the healthcare service delivery. This was necessitated because first contact with them revealed very low knowledge of applicability of RFID to health care service delivery. Three of the interviewees appreciated the effort of the author to embark on this work and asserted to have benefited from the interview sessions.

2.9 Validity and Reliability

Validity is the extent to which a test measures what it claims to measure. It is vital for a test to be valid in order for the results to be accurately applied and interpreted while reliability according to Yin (2003) is how reliable and accurate the method to collect the data is.

- Validity

According to Zinkmund, validity is defined as "*The ability of a scale or measuring instrument to measure what is intended to be measured*". External validity refers to the extent to which the results of a study are generalizable or transferable. Most discussions of external validity focus solely on generalizability. A reference is included here to transferability because many qualitative research studies are not designed to be generalized (CSU Resources, 2011). Internal

validity refers to the thoroughness to which the study was conducted - e.g., the study's design, the action taken to conduct measurements, and decisions regards what was and wasn't measured (CSU Resources, 2011).

This thesis adapted the research structure of previous works and also consulted literatures to determine the inherent factors affecting adapting to change in technology and working conditions of health workers and also the various factors that are attendant to adopting RFID in health sector of similar developing countries like Nigeria.

- Reliability

The reliability of this work is ascertained as the interviewees have been informed beforehand and, therefore, they were more prepared for the questions. Each interviewee was assured of privacy and that the interview is aimed for academic research only. Each interviewee was allowed to freely express disposition to all items of the interview question. During the interviews session, the interviewees aren’t interrupted so that, they would use their own words rather than getting influenced by author’s words or saying whatever author wants to hear because, this could create a misleading situation. In the interview, guide questions were made clear to carry the interviewee along and also hint were given about the questions for ease of understanding and boost their confidence to address the questions.

2.10 Visualization Methodology

VISUALIZATION METHODS	
Research Purpose	
Exploratory	
Research Approach	
Deductive	
Research Strategy	
Case Study	
Research Method	
Qualitative	
Research Questions	
Q1	**Q2**
Data Collection Method	
Interview	**Questionnaires**
Sampling	
Judgment Sampling	
Data Analysis Method	
Coding	
Validity	*Reliability*
• **case study procedure**	• **various sources** • **series of facts**

Figure 1: Visualization methodology (adapted from literature)

3 RFID: ITS APPLICABILITY IN HEALTH SECTOR

This chapter discuss the technological overview of RFID and how this can be harnessed and utilized by hospitals and the healthcare sector of Nigeria and other concerned developing countries. The need for this endeavour is due to the yearning of RFID technology advocates that health sector should join the wagon of other industries that have adopted and are benefitting from ICT. The following section explains all in details.

3.1 What is RFID?

RFID is an short form for Radio Frequency Identification. The term RFID simply describes the use of radio frequency signals to provide automatic identification of items. RFID is part of the more general Automatic Identification systems (also known as Auto-ID systems) (Patrik Fuhrer et al., 2006). RFID is used as a direct replacement for barcode technology. The advantages it offers include 100% read accuracy, the ability to survive demanding environments, and the elimination of line-of-sight requirements (Shoewu O. and Badejo O., 2006). Added to its advantage over barcodes is the ability to change the stored data as processing occurs (Piasecki Dave, 2011).

RFID can be supplied as read-only or read/write, does not require contact or line of-sight to operate, can function under a variety of environmental conditions, and provides a high level of data integrity (Shoewu O. and Badejo O., 2006)

The mechanism of operation of RFID involve the use of radio waves to transfer data from an electronic tag, called RFID tag, attached to an object, through a reader for the purpose of identifying and tracking the object (Chikkala Kiran, 2011). The system is explained by Shoewu, O. and Badejo, O. (2006) as composed of tags, which carry the data in suitable transponders, and an RFID reader, which retrieves the data from the tags. Products that contain RFID tags embedded in them or fastened to them enable stored information to be transferred from an RFID tag to a remote reader through radio frequency waves of a specific wavelength.

In summary, a Radio-Frequency Identification system has three parts:

- A scanning antenna
- A transceiver with a decoder to interpret the data
- A transponder - the RFID tag - that has been programmed with information (Science Fiction, 2011).

3.1.1 RFID Tags

The main system of RFID is built around the tags which carries the information needed for identification or tracking of an object or person. RFID Tags can simply be described as a small object, such as an adhesive sticker, that can be attached to or incorporated into a product. RFID tags are composed of an antenna connected to an electronic chip and are thus basically contact-less smartcards (Patrik Fuhrer et al., 2006).

Most RFID tags contain at least two parts. One is for storing and processing information, modulating and demodulating a radio frequency (RF) signal. The second is an antenna for receiving and transmitting the signal (Jake George, 2010).

The main properties of RFID Tags are highlighted by Akintola K.G. and Boyinbode O.K. (2011). These are:

- RFID Tags do not require line-of-sight.
- RFID Tags can store far more information than barcodes.
- Some RFID Tags are writable, so information can be updated as time goes on or as the tag travels to different locations.
- Some RFID Tags have sensors that can record information. For example, a tag on a shipment of frozen foods could record the temperatures that the foods were exposed to.
- RFID Tags can go on all kinds of objects and even on living beings.
- Tags come in many shapes and sizes.
- There are two types of RFID Tags; these are active and passive tags.

Active tags require a power source — they're either connected to a powered infrastructure or use energy stored in an integrated battery. In the latter case, a tag's lifetime is limited by the stored energy, balanced against the number of read operations the device must undergo (Roy Want, 2006). Active tags contain an embedded power source. Passive tags are powered by the signal generated from the reader device. Passive tags can only transmit signals over a shorter range and can operate over longer periods of time. Active tags can no longer function once their embedded power source runs out, but can transmit signals over longer distances, up to 100 meters. Active tags also tend to have a higher accuracy of data transmission compared to passive tags (Karen Crooker et al., 2009).

However, Akintola K.G. and Boyinbode O.K. (2011) added that battery assisted tag to the other two basic tags. Battery assisted tags are just like passive tags (they use backscatter) but they have a battery to provide the power to the chip. This provides a big advantage, because the tag is not reliant on the strength of the carrier from the interrogator to provide the power it needs. Now it can use all the power from the battery and so is able to work at a greater distance from the interrogator.

RFID tags are typically categorized according to Tom Singer (Understanding RFID):

- ***Power source:*** Active tags have an internal power source or battery. Passive tags receive their energy from the transmission of an external reader. Active tags can transmit information at much greater distances than passive tags, but cost significantly more.

- ***Frequency:*** RFID tags are typically designed to transmit data on one frequency. The frequencies employed by tag vendors are generally classified as low (LF), high (HF), ultra-high (UHF) and microwave. In general, the lower the frequency the shorter the read distance and the lower data transfer rate.

- ***Encoding Method:*** Tag designs also vary in how information is encoded on them. These encoding methods can be categorized as read/write, write once/read many and read-only. Read/write tags allow information to be recorded multiple times. As the name suggests, write once/read many tags can only be programmed a single time. However, this encoding can occur on demand. Read-only tags are encoded with data during their manufacturing process. Read/write tags are the most expensive variety (Tom Singer, 2003).

RFID tags can be embedded in products, government-issued ID cards, credit cards, toll devices and even people with the aim of tracking the products or people with ease (Akintola K.G., Boyinbode O.K., 2011).

Figure 2: An RFID Tag (Source: Intermec RFID Tags)

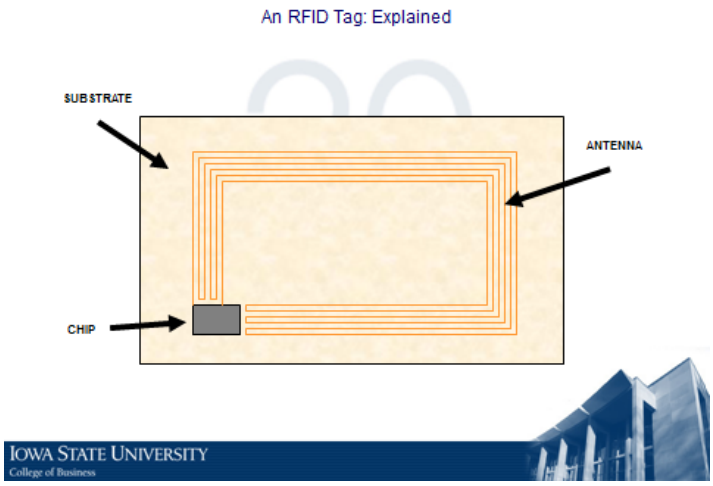

Figure 3: An RFID tag: Explained (Source: Brian E. Mennecke)

3.1.2 RFID Readers

RFID readers are querying systems that interrogate or send signals to the tags and receive the responses. These responses can be stored within the reader for later transfer to a data collection system or instantaneously transferred to the data collection system (Ing. B. Korteweg, 2007).

Readers have an antenna for sending and receiving signals and a processor for decoding them. The reader receives instructions and information from the antenna through the scanner, which is a part of the reader that examines analog output from the antenna. The scanner's information is then converted into a digital format by the reader, which the computer or processor can then use for data analysis, recording, and reporting (Shoewu O. and Badejo O., 2006). The information received can also be sent to a network. The computer or network accommodates the RFID software called the *middleware.*

3.1.3 RFID Infrastructure

The RFID infrastructure consists of the elements that manage the devices and tag data. Consumers of the data are the client network elements (typically end-user applications). The network elements between the tag and the clients form the conduit that transports tag data to the applications, and convey tag operational commands to the RFID devices. At a minimum, the RFID infrastructure comprises tags, readers, RNCs (Reader Network Controllers) and applications running for example, on enterprise servers. In addition, other devices could also be in the network such as RFID/bar code readers, I/O devices (such as electric eyes, light stacks and actuators), bar code/smart label printers and applicators (Krishna, 2007). It is needed to be said that the visible parts (hardware) of the RFID mechanism or infrastructure are the tags and readers; the communicative and management of data are basically software applications controlled.

The infrastructure comprises three interlocked communications paths: data processing (the Data path), device management (Management path) and device control and coordination (Control path).

3.1.4 How does RFID works?

The RFID operation work as an RFID tag passes through the field of the scanning antenna, it detects the activation signal from the antenna. That "wakes up" the RFID chip, and it transmits the information on its microchip to be picked up by the scanning antenna (Science Fiction, 2011).

Initially, data is written to the RFID tag enabling it to identify and characterize a product as a particular manufactured good with a determined application. At some later point, an RFID remote reader will scan and acknowledge the information once the tag is within range of an electromagnetic field activating the tag to perform a user defined function (Shoewu O. and Badejo O., 2006). Some of the components may be combined into one hand-held unit to allow user mobility. Also, many passive RFID transponders have antennas sealed with the tags to give them greater read-write abilities (Ibid).

A more comprehensive illustration was given by Jeffrey K. Brecht. He explained that RFID works as "*The microchip, attached to an antenna, picks up signals from and sends signals to a reader. Each tag contains a unique serial number, the Electronic Product Code (EPC). The antenna enables the chip to transmit the identification information to the reader; The reader converts the radio waves returned from the RFID tag into a form that can then be passed on to computers that can make use of it. Once the EPC is retrieved from the tag, it can be associated with dynamic data such as from where an item originated or the date of its production."* (GS1, 2011)

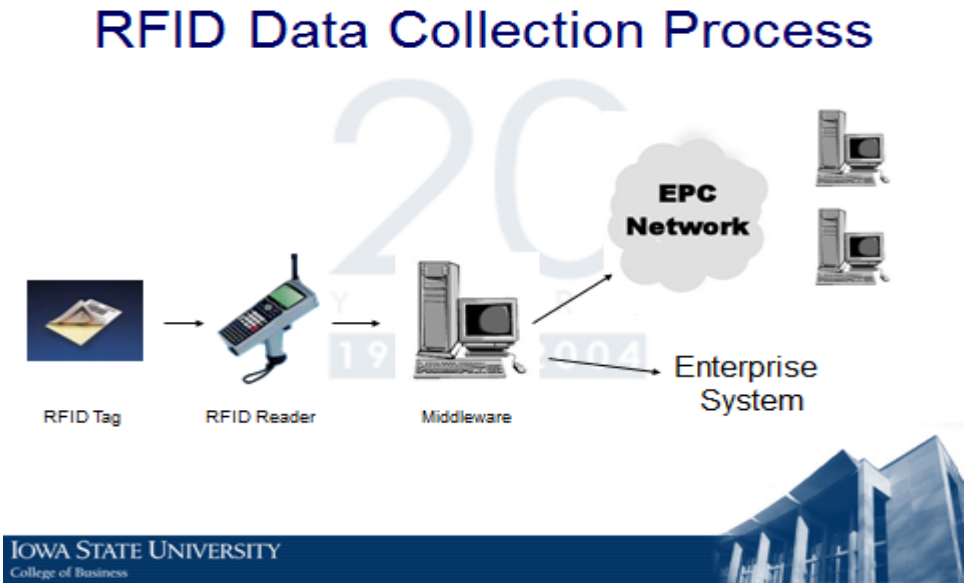

Figure 4: RFID Data Collection Process (Source: Brian E. Mennecke)

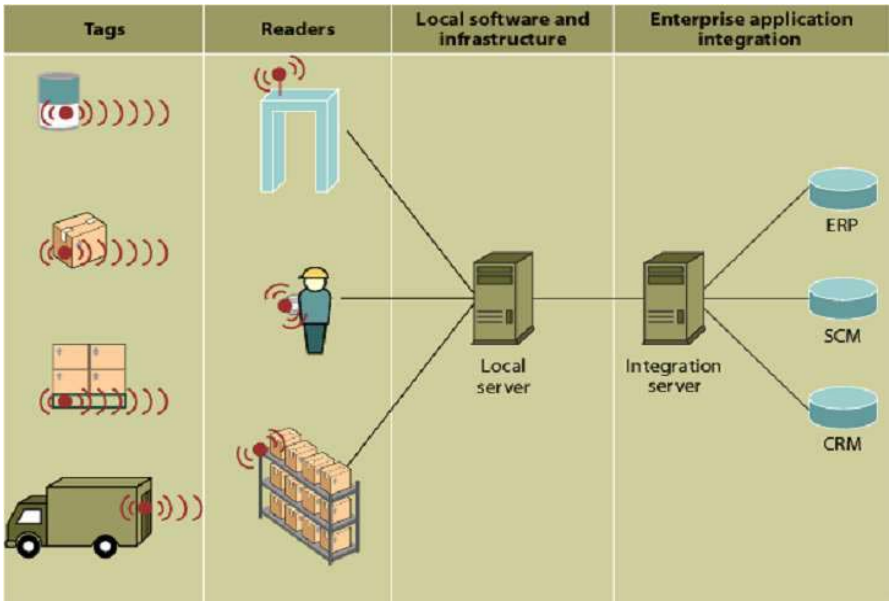

Figure 5: The Process in Context (Forrester Research in Brian E. Mennecke)

3.1.5 RFID Information Security

Many security issues and threat such as tag and reader communication capture, eavesdropping, interference, hacking, cloning etc. regarding RFID adoption have been outlined in earlier research (Azevedo, S.G. et. al, 2010). Hence, lack of security of a system can be a serious hitch regards adoption of the technology

(Yao, W. et al., 2010). This brings up the fascinating questions of positive versus negative disturbances. However, recognizing essential privacy or security threats of RFID system will help guide policy decisions regarding the responsibilities of RFID manufacturers and the privacy right of end users (Yue et al., 2008).

Government standards and regulation for privacy issues are extremely important for RFID adoption having learnt about RFID securities related issues (Yue et al., 2008). Government and its agencies should design a policy which explained "*why and how the data will be gathered, how long the data will be remained in their systems, how and in what way the data will be used, how the security of the personal data will be protected, and who is in charge of collected data*" (Alamgir, 2009). Against this backdrop, companies and individual will understand their privacy protection and can speed up the adoption of RFID application in their respective organizations (Yue et al., 2008).

3.2 RFID implementation in hospitals

The greatness of healthcare service offered by Hospitals all over the world cannot be overemphasized. It is nonetheless oblivion in the pursuit of the verses of the Hippocrates oath to shy away from what technological innovation offers to hospitals and health service delivery as a whole. RFID implementation in Hospitals has vast positive consequences from reduction of cost due to errors and theft coupled with counterfeiting and poor patient satisfaction to prompt tracking and verification of patients and medical products in the Hospitals. The adoption of RFID in the healthcare domain is still in its infancy but is rapidly becoming the standard for hospitals to track inventory and identify patients (Jill A. Fisher, Torin Monahan, 2008). We envision hospitals and medical facilities where using the identification technologies can improve the patients' care, optimize the workflows, reduce the operating costs, help avoiding severe mistakes (such as patients' misidentification) and reduce costly thefts (Patrik Fuhrer et al., 2006).

3.2.1 Tracking

A great deal of the benefit of RFID to hospitals lies in its ability to trace and track products, patients and health care provider. Many aspects of hospital service needs tracking due to the sensitivity of their service and operation. It will not be an interesting scenario for instance, if a corpse is missing in the mortuary or a murder suspect patient leaves the hospital without the knowledge of the hospital authorities. Amongst all the imaginable use cases, RFID is certainly best suited for tracking applications. The technology enables an automated and fast tracking of assets, animals or people. Efficient tracking in a hospital offers plenty of interesting perspectives (Ibid).

3.2.2 Identification and verification

Patient, blood, dugs, health professional and other type of identification in Hospitals will not only cut down operational errors but will enhance patients satisfaction and also reduce unwarranted cost attached to theft, dosage errors, etc. Many health professionals are concerned about the growing number of patients who are misidentified before, during or after medical treatment. Indeed, patient identification error may lead to improper dosage of medication to patient, as well as having invasive procedure done (Ibid). Hospital personnel identity verification, blood types and constituents verification are part of the many uses of RFID technology in Hospitals. Added to this is infant identification which is very much important in the case of infant health care.

A good illustration by Patrik Fuhrer and Dominique Guinard on how RFID can work in smart hospital: This chip stores a unique patient ID number and some relevant medical information such as the patient’s blood type, in order to speed treatment. The caregiver uses a handheld computer with an RFID interrogator (an RFID-enabled). In other projects the computer chips, which are about the size of a grain of rice, are designed to be injected into the fatty tissue of the arm, PDA to read the data encoded on the patients ID bracelets over a wireless LAN connection, the hospital staff can access the patient’s encrypted confidential medical history as well as treatment record and can obtain information on which

drugs and what dosages the patients will require. Patients will also be able to check their own records by scanning their wristbands using information terminals. Another identification usefulness in the hospital is blood identification and tracking of patients (Ibid).

3.2.3 Sensing

Sensing is another promising RFID-enabling function that has been identified. "*A RFID tag can be applied to collecting sensor-derived data and doing computation by extending the RFID, including integration with physical and chemical sensors for logistic data logging, and integration with gas sensors for food logistics*" (Yao, W. et al., 2010). According to Van Oranje et al (2009), sensing capability of RFID has an encouraging function in diagnosing patient's condition. This ability of RFID technology can be categorized as a part of e-health applications, which gives the hospitals and other related healthcare system the potential to manage the devices from distance (Van Oranje et al., 2009). Case studies have shown that RFID sensing functions are not just dedicated to patient monitoring application, but also for definite issue such as compliance monitoring (Ibid). For example, it can be used on personnel identity cards to confirm personnel compliance with basic hygiene rules process such as washing hands. Added function of RFID sensing is for the system access security purpose, for entering and exiting of staff based on their security level in the institution (Ibid).

3.2.4 Data collection and transfer

One importance of incorporating RFID into hospitals and healthcare service delivery is its ability to aid interdependency and data management (collection and transfer) in the healthcare sector. This can be illustrated from the diagram: Pooled interdependence for patient care delivery (Karen Crooker et al., 2009).

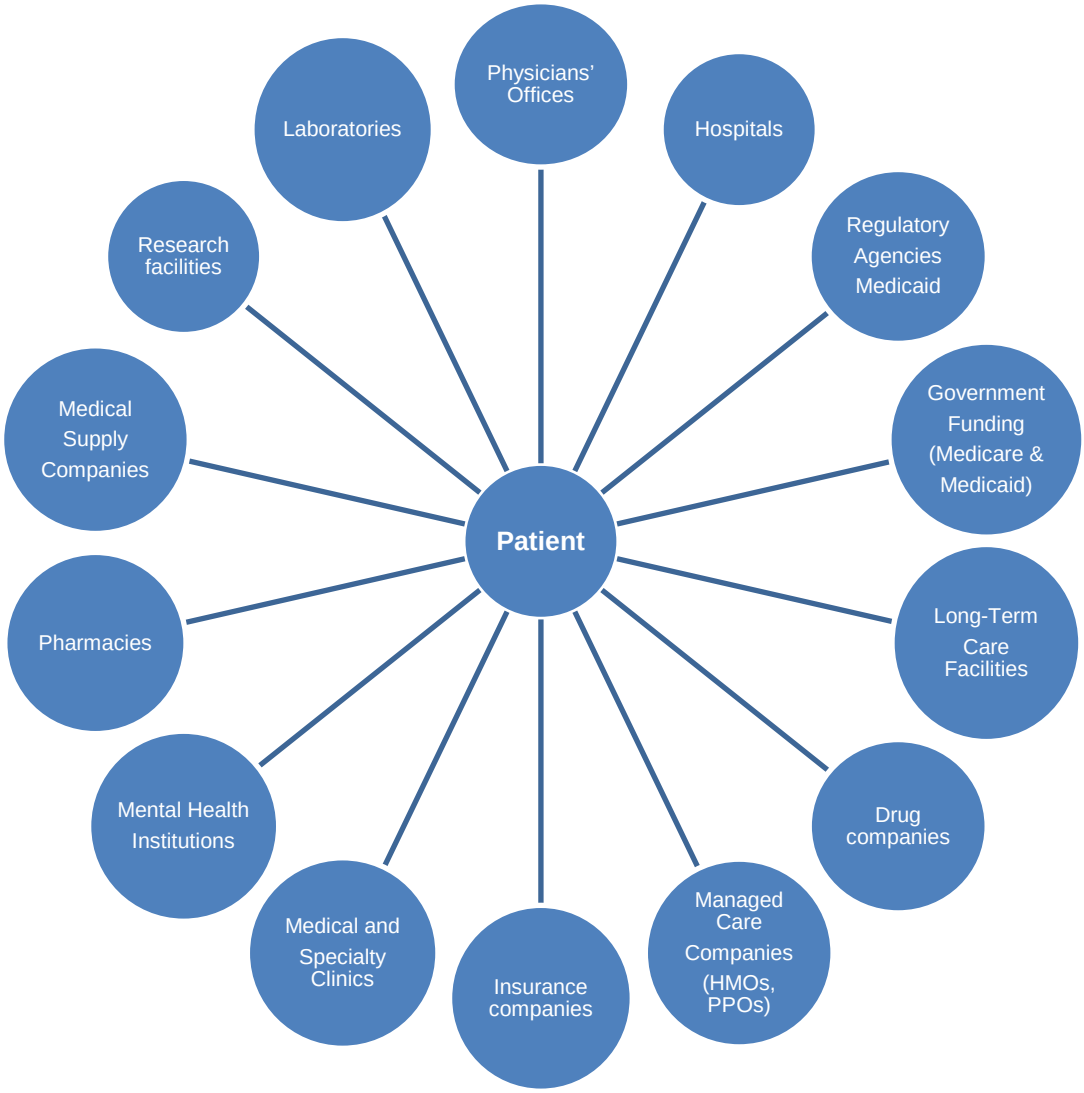

Figure 6: Pooled interdependence for patient care delivery - adapted from (Karen Crooker et al., 2009)

The diagram shows clearly how a patients' information can be collected and accessed for better services, likewise, it shows how different healthcare facilities can work with and within a comprehensive hospital's data management platform.

3.2.5 Alerts

Medical staff can instantly have access to patients current health information such as blood pressure, oxygen level, and even electrocardiogram images by wireless phone, equipped with RFID reader to send patients health information and emergency alerts.

3.3 Benefit of RFID in healthcare sector

The enormous benefits inherent in the adoption of RFID technology, which has been notified in manufacturing, supply chain and other industries, give a baton to the healthcare sector or industry. Many researchers and practitioners believed that RFID technology has great potential benefits for healthcare organizations and among members of healthcare supply chain. As seen in the last section, hospitals implementing RFID system can use it to improve their service delivery and save cost of operation. Healthcare systems are inherently complex in nature and address the needs of several stakeholders in healthcare management. Key stakeholders in healthcare industry include patients, physicians, nurses, hospitals, managed care companies, pharmacies, government regulatory and licensing agencies, and government funding agencies (Karen Crooker et al., 2009).

Healthcare facilities, in developed as well as in developing countries, are continuously facing a multiplicity of challenges including medical errors, lack of necessary resources, inefficient workflows, inefficient information management, process disparities, as well as a disintegrated healthcare logistics; affecting patient safety and contributing to a rise in current spending (E. Lefebvre et al., 2011).

Various areas of interest where RFID can improve healthcare sector range from anti-counterfeiting, patient information management and safety.

3.3.1 Anti-Theft

Hospitals make use of very expensive and delicate equipment and infrastructure that their theft might jeopardize the smooth running of the hospital. The tracking and monitoring components of RFID technology is very useful in combating pilferage and theft in hospitals.

3.3.2 Patient Safety and Satisfaction

With proper identification, verification and effective anti-counterfeiting of drugs needed by patients, errors reduced, the right treatments given coupled with efficient data collection and management all provided with RFID system patient safety and patient health care satisfaction is surely earned by health care providers.

3.3.3 Medical Process

Karen Crooker et al. (2009) explained how Medicare process can be improved through sequential, reciprocal and pooled interdependency. Sequential interdependence in a healthcare setting would be typified by the supply chain from pharmaceutical companies to distributors to retail pharmacies (including hospitals) to patients. With reciprocal interdependence, units can create contingencies for each other that have to be resolved before a product moves on, while pooled interdependence arises when individual units each contribute independently to a centrally located product. That the pharmacy cannot issue blood until it is ordered by surgery, and that surgery cannot proceed until the blood is received from the pharmacy illustrates reciprocal interdependence. Pooled interdependence is evidenced when various departments like the pharmacy, radiology, laboratory, dietetics, and physical therapy each independently provide care to a patient without necessarily coordinating efforts or sharing information. Pooled interdependence is also illustrated at a macro level when various entities collaborate together for patient care (Ibid).

3.3.4 Reducing Time and Cost

The implementation of several IT applications, including applications for digitizing medical records and clinical data have generated documented benefits, such as the reduction of operating costs, the improvement of operational efficiencies, the increased of productivity, the automation of processes, and elimination of waste and duplication (E. Lefebvre et al., 2011).

3.3.5 Improved Productivity

One of the motives of hospital/healthcare business is to at least, make return on investment and this can only be guaranteed with efficient service delivery through improved productivity. Imagining that all the medical histories (and other important documents) are tagged, it enables us to locate them through the use of an assets tracking application like the RFIDLocator. This fact can already help *reducing the medical files' losses*. In addition, using an assets tracking application within the infrastructure deployed for our smart hospital gives us the possibility to locate and trace staff members as well as patients efficiently. This can help *improving the workflow* of doctors, nurses and other caregivers. Additionally, being able to trace all the tagged equipment introduces an *efficient and accurate inventory system* (Patrik Fuhrer et al., 2006).

3.3.6 Improved Patient Monitoring

Intensive care unit patients and infants undergoing incubation cannot but enjoy the surrounding constituent of RFID sensory and alerting. It has been identified to be proper solution in cases when doctors want to have fast and automatic access to patient information and in particular when patients are not able to establish healthy communication (Korkmaz I. et al., 2010). Information of patients who come to the hospital is recorded in the system, a bracelet (See figure below) is worn by the patients which includes an RFID tag, and the relevant doctor who is assigned to the patients can read the tag in the bracelets with authorized access to an RFID card reader-supported PDA device, and, as a result of this definition, PDA device can reach the server and withdraw relevant health information from database and submit them to the doctor.

Figure 7: RFID bracelet: adapted from (Korkmaz I. et al., 2010)

3.4 RFID Adoption Success Factors and Barriers

Different factors herald the success of any technology adoption in the various industries of developed and developing nation of the world. Aside the glamour for RFID adoption in healthcare industries, the question of supportive and inhibitive factors contributing to its adoption comes up for consideration. Various factors have been identified to be determinant for adoption of RFID and are pointed henceforth.

Tornatzky and Fleischer (1990) stated that technological innovation adoption is influenced by three factors, which are technological, organizational and environmental factors. This was investigated by (Karen Crooker et al., 2009) in South African industries and found to be existent factors for adoption. Ashir Ahmed and Sugianto L. (2009) pointed out cost, implementation, privacy factor and locatability of RFID as inhibiting factors affecting adoption in emergency management (Ahmed A. et al., 2009).

According to Rachida Parks (2009), widespread adoption of RFID technology in the healthcare industry has been hampered by the lack of adequate privacy protection from RFID technology vis-à-vis the privacy provisions and relevant healthcare regulations.

Wang, Y. et al. noted *Rogers's* opinionating that *"innovations that are perceived by individuals as having greater relative advantage, compatibility, trialability, and observability and less complexity will be adopted more rapidly than other innovations"* (Wang Y. et al., 2011)

Wang, S. et al (2006), the reasons for failure include user (mostly physician) resistance and technical, clinical/professional, organizational, and implementation issues. These problems may affect the implementation and adoption of RFID in hospitals, even as the uncertainty of RFID in terms of technical aspects and application feasibility might invoke other concerns (Wang S. et al., 2006).

Evident from the points above, it can be said that the contributing factors to adoption of RFID can be classified in three main areas. These are:

1. ***Internal factors:*** these include the cost, management and implementation issues, user resistance and adaptability, etc.

2. ***External factors:*** these involve regulatory bodies and government position on adoption; privacy and clients view of adoption, competitive interplay by others organizations in the industry, etc.

3. ***Technical factors:*** this has to do with compatibility, usability, mechanical/electronic complexity of the RFID technology and so on.

4 CASE OVERVIEW

The main task of this chapter is to present a general synopsis of each of the organizations used for general exploration of the research questions and subject matter of research. As earlier stated, four (two private and two public) hospitals were used for the purpose of this research.

Each of the Hospitals is reputable in the State and the Nation at large. They are outstanding in their areas of specialty. The two public hospitals are also double as teaching hospitals. LASUTH is a Lagos State Government owned teaching hospital while LUTH is a Federal government hospital. The other two private hospitals are well-known and both offer consultancy services for state and federal hospitals and even collaborate with international healthcare service organizations.
In respect to modern technology adoption, each hospital subscribe to imaging, therapeutic and diagnosing machines that are rarely found in other Hospitals in the country. It is, however worthy of note to say that RFID as a technology is reckoned with in each hospital but presently unavailable due to reasons that would be discussed in the succeeding chapter.

4.1 Lagos State University Teaching Hospital (LASUTH)

Lagos State University Teaching Hospital generally referred to as the State General Hospital is situated in Ikeja, the capital of Lagos State in Nigeria, was commissioned for treatment of patients from Ikeja and its environs on June 29th 1955. It was originally a cottage hospital but later transformed to a full fledge General Hospital, with just about sixteen (16) departments. (LASUTH, 2011)

It is pertinent to note that the General Hospital has now been transformed into a Teaching Hospital of repute from 9th February, 1999. The hospital is now a multi-specialist hospital. The staff complement is 1686, 93 Honorary Consultants and 51 House Officers. (LASUTH, 2011).

The driving goal of the Hospital is to be in the forefront of modern and efficient healthcare in Nigeria. The mission statement of the state owned hospital is to

provide high quality health care services in a friendly environment where patients' satisfaction is the ultimate with the vision of becoming the center of excellence in health care delivery.

Some major departments in the Hospital are accident and emergency services: the Emergency Services Department of LASUTH is the 'eye' of the hospital (LagosIndicatorOnline, 2008). It has two arms - a Medical Section, and a Surgical and Trauma Section. The surgical section (LASEMS) also houses the control centre of the Lagos State Ambulance Service (LASAMBUS); and critical care unit: the critical care unit stood as one of the most effective life support facility in Nigeria. It is a centre incorporating a theatre for advanced surgery, an intensive care unit and an amenity ward facility (LagosIndicatorOnline, 2008)

Providing many health care services, it behooves on the hospital to have its own medical school to produce its own medical personnel in order to raise the level of health care in the state. In a bid to put the hospital in good stead for the greater challenge of a teaching hospital, the Lagos State Government and other philanthropists, corporate national and international organizations providing funds and grants are reported to have put in great financial and capacity development resources in the pursuit to transform service delivery and the educational development and research capacity of both personnel, medical students and the employed facilities in the hospital (LagosIndicatorOnline, 2008).

4.2 Lagos University Teaching Hospital (LUTH)

The Lagos University Teaching Hospital and the Medical School Complex grew out of a Cabinet decision of April, 1961 to restructure the Federal Hospital to a facility for medical education and healthcare service provision. The objective was to train at least 100 Doctors annually in Medical Schools in Nigeria from 1975 onwards. The site on which the Mainland Hospital was built and now occupied by LUTH and CMUL was a ninety-two (92) acre field of bush and farmland. In the perennial circumstances of scarcity of funds, it was considered economical to adapt the finished buildings of the new Surulere Mainland Hospital to suit the needs of a Teaching Hospital/Medical School Complex (LUTH, 2011). The

energy and enthusiasm of the Minister of Health enabled this task to be accomplished in record time. (LUTH, 2011)

As a foremost tertiary institution of international standard, the public benefited immensely from its medical expertise in providing patient care, production of highly skilled medical and health work force and investigation of health related problems by applying the highest standard of promptness, comprehensiveness and effectiveness.

Lagos University Teaching Hospital is not an island on its own and in discharging its duties of rendering excellent medical services to mankind; it thus interacts and collaborate with other sister hospitals cum medical institutions, the College of Medicine of the University of Lagos use LUTH facilities to teach and produce highly skilled medical personnel while their lecturers are Consultants to LUTH in various areas of Medicine like Dentistry, Surgery, Obstetrics and Gynaecology, Paediatrics, Radiodiagnosis, Radiation Biology etc. Agencies like NAFDAC, PPFN, other Teaching Hospitals and Federal Medical Centres also collaborate with LUTH. Internationally, LUTH collaborates with WHO, UNICEF, UNDP, WAHC, etc in the areas of research, training and work force development. Public health is generally being protected through the diagnosis and treatment of patients, as well as supporting and participating in programmes and research that will benefit and improve public health. (LUTH, 2011)

Part of its technological, operational and institutional constraint, as a 40-year-old multi-billion Naira hospital, the Lagos University Teaching Hospital, is the problem of aging, which has set in on some of the equipment. Some of the medical equipment are unserviceable and need outright replacement. The hospital is seriously faced with inadequate funding and clinical supplementation to promote research, continuity, education of staff and provision of essential facilities to both staff and patients. (Madike, 2011)

Lagos University Teaching Hospital is designated a center of excellence in Dentistry and Teaching/Specialist Hospitals in the country. A major breakthrough of the successful conception and delivery of the first authentic test tube (In-Vitro-

Fertilization) baby was performed by the duo of Professor Osato Frank Giwa-Osagie and Professor Dapo Ashiru at the Lagos University Teaching Hospital. Other prominent healthcare services are provided in specialized areas of Medicine like Neuro-Surgery, Haemo-dialysis, Cancer treatment, Eye treatment, Urology, Paediatric Surgery, Maternal Health etc. LUTH is the hospital in Nigeria with the highest concentration of skilled medical and paramedical staff in different areas of medicine. This explains the reason why LUTH is always the focus when foreign countries, oil companies and even highbrow private hospitals in Nigeria are on recruitment drive for work force. LUTH has pioneered Small Incision Cataract Excision Surgery in Nigeria and has trained over 20 doctors from all over the country in the procedure in the past one year. The hospital has also commenced laparascopic gynaecologic surgery, which has dramatically reduced the duration of hospitalization after surgery. (LUTH, 2011)

4.3 Gold Cross Hospital

Gold Cross Hospital is a private hospital also situated in Lagos State. The Hospital vision is to lead in healthcare delivery by giving unrelenting attention to clinical excellence, patients' safety and to remain attentive to the health and well-being of those it served through innovative services, open communication and supportive environment. The mission statement of Gold Cross Hospital is dedicated to providing quality, excellent and compassionate healthcare services.

Gold Cross Hospital was established in 1989 to provide qualitative medical care, using state of the art medical equipment in a conducive and patient friendly environment. Over the last 21years, Gold Cross Hospital has risen to be one of the well-equipped private hospitals in Nigeria. As a hospital accredited by the National Health Insurance Scheme, Gold Cross Hospital has taken its excellent medical services by establishing business relationship with over forty Health Maintenance Organizations. Gold Cross Hospital was recently accredited as a referral center for the emergency services (Trauma, Gynaecology & Obstetrics) by the Lagos State Ministry of Health. The Hospital was recently invited to run maternal and child health centres by the Lagos State Government under its Public Private Partnership Scheme. This feat is attained by available state of art

equipment, a medical team that include some of the best and very experienced specialists (in all the major fields of medicine) complimented by a highly trained and motivated paramedical and administrative staff.

Some of the specialties of the Hospital in healthcare service delivery are Gynaecology, Accident & Emergency Services provided 24 hours comprehensively run by a team of emergency nurses and doctors. Anaesthesia, Cardiology, Endocrinology, General Surgery, Paediatrics, Imaging services: Radiology, Fluoroscopy (barium studies), Ultrasonography.

4.4 EKO Hospital

EKO is an acronym of the first letters of the founder's surnames in alphabetical order i.e. "E" for Eneli, "K" for Kuku and "O" for Obiora is a successor to Eko Hospital limited established in 1982 as a Joint Medical Practice patterned after both a teaching hospital as a Medical Center. (EKOCORP PLC., 2011)

Eko Hospital Limited was itself a successor to Mercy Specialist Clinic, which had operated successfully between 1977 and 1982. The practice has been growing in bounds due to the total commitment and dedication of the partners and staff and the high level of reputation and customer goodwill enjoyed. With a 40-bed capacity clinic situated at Ebute-Meta, Lagos in 1977, the company has grown into a multi-service and multi-location hospital with operations in Ikeja, Ikoyi, Central Lagos, Surulere, etc. to cover the entire Lagos area. (EKOCORP PLC., 2011). Today, there are two full-fledged hospitals located at Ikeja & Surulere in Lagos. The Ikeja facility is a private teaching hospital of 130 ends and state of the equipment. It is a tertiary institution with a wide range of therapeutic and diagnostic equipment. The Surulere hospital is a 40 bed secondary healthcare facility. A third hospital is currently under construction at the new Federal Capital Territory, Abuja.

The philosophy of the multi-hospital group is to provide excellent medical care at primary, secondary and tertiary levels. Today, the hospital has undergone significant transformation, as it is the only publicly quoted hospital business in

Nigeria Stock Exchange under the auspices of the name EKOCORP PLC. The company enjoys tremendous goodwill and occupies an enviable position as a market leader in private hospital market sector (EKOCORP PLC., 2011).

With the facilities EKO Hospital possess, it has acquired good reputation across the country, and this is evidence by the huge number of corporate retainership in excess of 300 (covering government parastatals, oil sector, banking sector, embassies and conglomerates).

A combined consultation of experts, in management and decision-making, offers the desired synergy and excellent opportunity for the treatment of the patient. Close collaboration with overseas centers as those in Addenbropke's Hospital at Cambridge, St. Mary's Hospital, of the Imperial College School of Medicine and Mount Vernon Hospital Cancer Unit, Northwood, Middlesex are maintained (EKOCORP PLC., 2011).

5 CASE ANALYSIS

This chapter is set out, after review of factors contributing to the adoption of RFID and analysis of case studies in the Nigerian healthcare sectors, to critically observe and analytically compare the case studies in relation to general technology adoption within themselves. It also exerted effort, as stated in the research objectives to compare the various identified adoption variables, which was reviewed in the third chapter.

The subsequent sections will reveal the result of the interview encounter with each of the interviewees and the aggregate situation of things as regard adoption of RFID technology in the Nigeria health sector.

5.1 Within Case Analysis

This section is to present summary of the individual responses of personnel in the case studies hospitals, which have been introduced in the previous chapter.

5.1.1 Case 1: LASUTH

Case 1: Dr. A Title: Departmental Head of Hospital

LASUTH is generally a medical and educational hospital. While this hospital performs patient care and other routine medical services, it also provides educational service to medical science students such as nurses and doctors training in the Lagos State University College of Medicine.

Dr. A is both a lecturer and medical consultant in the Department of Physical Medicine. He oversees the usage and maintenance of medical technology attached to the department. He belongs to the decision making board of the Hospital and partake in deciding whether to adopt; and also in determining the inherent ROI of a new technology. He has fundamental knowledge about what RFID is, and claimed to have been intimated with how RFID can be beneficial and aid efficiency in hospitals.

His knowledge about RFID was gathered from seminars and summits organized for doctors and also from medical journals and the internet. He also attributed better knowledge and the clamour for adoption to the moral suasion by NAFDAC in the recent times. He mentioned that RFID can be used for authentication and identification of personnel, patients' data and blood verification; drug dispensary and authentication among others.

He commented that the hospital and its key players are considering using RFID but the plans to use RFID is confronted by the challenge that the hospital is state owned and thus rely on government and donors for capital projects such as that of RFID.

Summarily, as shown in the table below, he identified the existing and possible inhibiting factors and support for adoption of RFID in Nigerian hospitals especially the case study hospital.

Table 1: Case 1 summary of inhibiting and supporting factors

Existing and possible inhibiting factors for adoption of RFID: Q1					
Factors	**Organizational**	**Environmental**	**Technological**	**Privacy & security**	**Other**
Summary of response	Low awareness, bureaucratic decision making process and long term advocacy for government to implement or provide resources for adoption.	Little regional and national glamour for the adoption. Clients also have little knowledge, thus zero demand for RFID usage. Medical practitioners and regulatory bodies give little order for hospitals to adopt because of the capital demand.	Less research on the usage. Seem more theoretical than applicable to the technology personnel.	No major privacy problems. On security, lack of proper surveillance culture may be an inhibition to proper usage when finally adopted.	Nil

Existing and possible factors that will support adoption of RFID: Q2					
Summary of response	Expert and complacent hospital personnel.	The Nigerian culture to welcome new and progressive innovations and technologies. The recent clamour by regulatory and medical profession bodies for health care service providers especially drug and blood banking organizations to embrace the opportunities in RFID.	The availability of IT solution providers will make adoption easier.	Detailed documentation, proper and conscientious monitoring and data management.	Collaborative effort with nations and hospitals that have adopted and are aware of the intricacies of RFID usage in hospital

5.1.2 Case 2: LUTH

Case 2: Dr. M Title: Physician

According to Dr. M, average knowledge of how the RFID works, and where are the promising points of usage of this technology. He showed fresh knowledge of RFID. He mentioned authentication and standardization of drugs, payment, drug inventory, patient safety as parts of the use of RFID to healthcare service.

He readily agreed that adopting RFID in hospitals would be of immense benefits and pointed to areas like safer and smoother delivery of healthcare service in the country. He also advocated for organizations, especially the hospitals to sensitize and adopt RFID in their organizations as fast as possible and should continually strive to make it comprehensive to all departments, personnel and resources. He highlighted reduction in queues for registration and payment for service and drugs and thus patient or client satisfaction as the areas where RFID can improve healthcare service delivery in Nigeria.

On the readiness of LUTH to adopt RFID, he claimed there is no plan or budgetary consideration for RFID presently. He stressed that the possibility of given RFID adoption a trial in the hospital is very lean because of the managerial complexity of the hospital cum medical tutelage institution.

He identified as shown in the table below the existing and possible inhibiting factors for adoption of RFID.

Table 2: Case 2 summary of inhibiting and supporting factors

Existing and possible inhibiting factors for adoption of RFID: Q1					
Factors	**Organizational**	**Environmental**	**Technological**	**Privacy & security**	**Other**
Summary of response	Low awareness, logistics and work force	Low level of awareness of people and hospital personnel	Poor power supply (leads to higher cost of maintenance)	Not much serious issues except for security(fraud)	Standardization and censoring
Existing and possible factors that will support adoption of RFID: Q2					
Summary of response	Awareness and enlightenment of people	Uninterrupted power supply	Well trained work force	Proper censory bodies, appropriate legislation, proper enforcement of related laws	

5.1.3 Case 3: Gold Cross Hospital

Case 3: Dr. Az Title: General Physician

Dr. Az was interestingly ready to honour the interview but confessed the session was honestly tasking for him. The reason for this was the little or no knowledge of the usage of RFID in Hospitals. He said he had only witness its use at toll points abroad. He said after consultation and internet search he asserts that RFID is beneficial to Hospitals.

He identified that adopting RFID will help in proper patient identification and security, personnel identification and private ward pass clearance.

He affirmed that nobody in the whole hospital has been privileged to know about RFID usage in Hospitals and thus there is no plan at all to adopt RFID in the Hospital.

He, however, identified possible factors that are inhibiting and that can support the nearest adoption of RFID in Nigerian Hospitals and related health care service providers in the country. This is detailed below:

Table 3: Case 3 summary of inhibiting and supporting factors

Existing and possible inhibiting factors for adoption of RFID: Q1					
Factors	**Organizational**	**Environmental**	**Technological**	**Privacy & security**	**Other**
Summary of response	Lack of capital	None	none	None	
Existing and possible factors that will support adoption of RFID: Q2					
Summary of response	Organizational policy structure	Public private partnerships Good policy formulation and implementation	Technological intimation and upgrading	None	

5.1.4 Case 4: EKO Hospital

Case 4: Dr. P Title: Surgery Consultant

Dr. P is a renowned surgery consultant in EKO hospital and a meaning partner to different hospitals in the country. He displayed experience in the field of surgery and has long years of experience in paediatrics and community health heath in the nation. Surprisingly, Dr. P has proper knowledge of RFID and after second consultation hinged his awareness on cumbersome consultancy services he offers to medical patients across the country and other medical information gadget affiliations.

He displayed full knowledge of complacency of Medicare to the dynamics of RFID and lamented that adopting RFID will help in transforming healthcare service delivery up to a standard of electronic healthcare (e-health) provision and complementation in the West African sub region.

He however admitted that few medical practitioners could claim full interaction with the RFID technology aside the widely practiced doctors. He showed by describing how RFID can help a hospital client in furthering his or her observation and diagnosis in another part of the country to receive update collaboration with the healthcare giver in the referred region. He listed among many that HMOs, health insurance and medical research institutions as beneficiary of RFID data management facility. He asserted that if harnessed, RFID could multiply the effect of qualitative healthcare delivery in Nigeria health sector.

Dr. P at the long run tendered that RFID is like an “unseen wind of change that has come to stay”. He pointed and highlighted possible factors that are inhibiting and that can support the nearest adoption of RFID in Nigerian Hospitals and related health care service providers in the country.

Summary of factors Dr. P gave as possible inhibiting factors were as shown in the table below:

Table 4: Case 4 summary of inhibiting and supporting factors

Existing and possible inhibiting factors for adoption of RFID: Q1					
Factors	**Organizational**	**Environmental**	**Technological**	**Privacy & security**	**Other**
Summary of response	Lack of capital due to small scale outfit mode of many hospitals. Lack of trained staff.	Non collaborative effort of healthcare givers due to low level of awareness.	Little or no technical knowledge or expertise on the new technology	none	
Existing and possible factors that will support adoption of RFID: Q2					
Summary of response	Organizational expansion and finance sourcing.	Government and stakeholders' aids. Research and medical training centres as pilot health institutions to adopt the RFID technology	Training, technological transfer and collaboration	Existing regulatory and security bodies	

5.2 Cross Case Analysis

The cross case analysis engaged in comparing and contrasting the individual case study analyses. The four hospital cases are used generally first, for better understanding and identifying of inhibiting and support factors for RFID adoption in healthcare sector of Nigeria and secondly to help understand and identify areas where adoption of RFID technology is readily needed in the Nigeria healthcare service delivery. Subsequently these differences and similarities are shown in table forms to provide clearer picture.

Table 5: Inhibiting factors to adoption of RFID in healthcare

Description and comparison : organizational inhibiting factors				
Variable	**Case1**	**Case 2**	**Case 3**	**Case 4**
	Low awareness, bureaucratic decision making process and long term advocacy for government to implement or provide resources for adoption.	Low awareness, logistics and work force	Lack of capital	Lack of capital due to small scale outfit mode of many hospitals. Lack of trained staff.
Description and comparison: environmental inhibiting factors				
	Little regional and national clamour for the adoption. Clients also have little knowledge, thus zero demand for RFID usage. Medical practitioners and regulatory bodies give little order for hospitals to adopt because of the capital demand.	Low level of awareness of people and hospital personnel	None	Non collaborative effort of healthcare givers due to low level of awareness.

Description and comparison: technological inhibiting factors				
	Less research on the usage. Seem more theoretical than applicable to the technology personnel.	Poor power supply (leads to higher cost of maintenance)	None	Little or no technical knowledge or expertise on the new technology
Description and comparison: Privacy, ethics and security inhibiting factors				
	No major privacy problems. On security, lack of proper surveillance culture may be an inhibition to proper usage when finally adopted.	Not much serious issues except for security(fraud)	None	none
Description and comparison: other inhibiting factors				
	None	Standardization and censoring	None	None

Table 6: Cross Review of Cases Success Factors

Cross review: Organizational success factors				
Variable	**Case1**	**Case 2**	**Case 3**	**Case 4**
	Low awareness, logistics and work force.	Awareness and enlightenment of people	Organizational policy structure	Organizational expansion and finance sourcing.
Cross review: Environmental success factors				
	Nigerian to welcome new innovations and technologies. Medical professional bodies should embrace the opportunities surrounding in RFID.	Uninterrupted power supply	Public-private partnerships. Good policy formulation and implementation	Government and stakeholders' aids. Research and medical training centres as pilot health institutions to adopt the RFID technology
Cross review: technological success factors				
	The availability of IT solution providers will make adoption easier.	Well trained work force	Technological intimation and upgrading	Training, technological transfer and collaboration

Cross review: Privacy, ethics and security success factors				
	Detailed documentation, proper and conscientious monitoring and data management.	Proper censory bodies, appropriate legislation, proper enforcement of related laws	None	Existing regulatory and security bodies
Cross review: other success factors				
	Collaborative effort with nations and hospitals that have adopted and are aware of the intricacies of RFID usage in hospitals	None	None	None

6 SUMMARY AND CONCLUSION

6.1 Summary

The purpose of this study was to conduct an academic research for the adoption possibilities and use of RFID in Nigeria health sector.

RFID technology has become one of the technologies that have gained popularity in different nations and industries in the global economy imparting logistics, education, production, security and protocol, military and health. It has transcended identification and tracking to become a first aid collaborative health gadget that has made patients' information transfer correct, faster and readily accessible through its sophisticated frequency mechanism.

RFID, even though at an infantile stage of adoption in virtually all industries in Nigeria, the tremendous benefits accruable to the country's human capacity building and development through the RFID adoption in Health sector cannot be sidelined. The research study has served to investigate the inherent intricacies within the Nigeria health sector's adoption perspective. It employed semi-structured method (usually used in case study research) to find out the nature and causes of adoption of RFID in Nigeria health care delivery sector. The author carried out the research instruments on four hospitals, (two private hospitals and two public or government managed hospitals).

The research set out to find out how internal, external and technical issues surrounding Nigeria health care service delivery is contributory to the adoption of RFID thereby eliciting the level and direction (positive or negative) which it is taking in the country. It is also tasked to identify and better understand areas where RFID adoption will be more beneficial to the Nigeria health sector.

The rationale for the research study is to facilitate health workers and administrators with the knowledge, intricacy and field report of RFID and its efficacy to the Nigerian health care service delivery. It is also to corroborate past research work or identify divergence of the later to the present research results.

6.2 Results

6.2.1 RQ1: What factors contribute to the adoption of RFID in Nigeria Health sector?

The purpose of this research question is for better understanding and identifying of characteristic support factors of RFID adoption in the healthcare sector of Nigeria.

For the research question one (RQ1), the study investigated how the factors: organizational, environmental, technological; and privacy and ethical considerations already identified in literatures and past research works affect or contribute to the adoption of RFID in the Nigerian health care service industry.

The results are classified in relation to the aspect of the industry's units that are considered. These include the internal, external and technical factors. Under the internal dynamics factor, organizational, security and ethics issues are considered while for external factor, environmental and other issues constitute the classification. The technology aspects of the industries can solely be placed under the technical factor.

Organizational aspects, which affect the adoption characteristics, are basically, in knowledge, work force and financing. The study revealed that low level of awareness, logistics and work force coupled with lack of large capital that RFID adoption requires. Organizational policy structure also constitutes a great challenge to adoption especially in public hospitals. It is necessary to mention that the available work force is very receptive of new technology like RFID compared to other industries.

The problem of security and ethical considerations that has been identified in literature review seems to be of little significance to the adoption of RFID in the Nigeria health sector. The effort of regulatory bodies in the health sector is considerably firm and the meticulous feature of healthcare service providers

appears to be the safe landing, which the RFID adoption as regards security and ethical practices.

External or generally environmental factors identified are regulatory, policy and socio-cultural issues. The Nigerian socio-culture is friendly to new and progressive innovations and technologies. The recent clamour by regulatory and medical profession bodies for health care service providers, especially drug and blood banking organizations to embrace the opportunities in RFID is also a pointer to the tendering adoption platform for RFID. Power supply and public-private partnerships are however, areas that are somewhat unfavourable to adoption in Nigeria health sector. There is a high level of interrupted power supply and little capital intensive public-private partnership in Nigeria. Even though efforts are propagated to combat this, the cost effect on RFID and business as a whole is distressing.

The technical aspect of the adoption process is also a feasible one. With the availability of IT solution providers, access to collaborative technological transfer, the RFID adoption is bound to sail smooth in the Nigeria health sector.

6.2.2 RQ2: Can the adoption of RFID improve health service delivery in Nigeria?

The purpose of the current research question is to better understand and identify areas where adoption of RFID technology is readily needed in the Nigeria healthcare service delivery.

The responses of interviewees revealed that RFID can be used for authentication and identification of personnel, patients' data and blood verification; drug dispensary and authentication among others. It is useful for all first aid treatment systems as the readily available and accessible information about patients will accelerate and make service provision more efficacious.

Among the varying importance of RFID technology, the most significantly identified in the research is the data solution service, which cuts through a wide range of interconnectivity between the primary health care giver and the secondary users and administrators.

7 DISCUSSIONS

RFID applications have drawn attention and interest from various research groups in medical informatics, computer sciences, industrial engineering, etc. Innovative applications have been designed, implemented and accessed in laboratories and hospitals.

One setback in this academic research result is the lack of an existing actual implementation of RFID in hospitals. None of the case organizations has implemented RFID systems in their respective hospitals, thus their interview responses were based on their previous experience from the adoption of other technology. Further, the result would have hold more ground if the only hospital, in the federal capital territory of Nigeria that implemented an RFID based tracking system had been included to the case organizations but certain issues were faced during the collection of data.

However, the most widely adopted RFID application is asset and equipment tracking in hospitals, as it does not involve privacy and social concerns. On the other hand, applications such as patient tracking are on the contrary as it relates to privacy issues.

In addition to the factors which have been identified thus far, other factors such as political sanction, lack of cooperation and consultation between IT department and management, difficulties of hiring and firing personnel, particularly those personnel who are sabotaging and showing resistance of the implementation of RFID system, cause problems for hospitals during an adoption phase. Moreover, the enormous majority of studies in the literature consider that RFID technologies in hospitals are perfect and can be used to improve their service delivery and cost of operation.

7.1 Suggestions

The author's observation and research results have fashioned the following suggestions for the Nigerian health sector and its adoption of RFID technology.

1. To institutionalize the awareness and adoption of RFID in the nation's health care service industry.
2. The government should collaborate with private and international institutions to provide the infrastructural requirement for the adoption of RFID in every sector that deals with supply chain and data management of clients.
3. To also create a conducive environment for the regulatory aspect and issues surrounding the use of RFID in the health sector. This is because privacy and security have been identified to be a prominent threat to the full capacity contribution of the RFID technology to health service improvement.
4. The government needs to take into consideration number of policies to protect and promote the RFID application
5. IT solution providers need to fashion a SWOT analysis of the introduction and functionality of the RFID technology to West Africa and Nigeria industries especially the health sector.
6. Technological deficiency needs consideration. Several studies have shown technical downfall between RFID signals and medical equipment
7. A pilot adoption centre can be provided by the government in its public health service organizations to facilitate the formative evaluation of the adoption intricacies for the health industry.
8. Barcodes and existing wireless networks could be combined with RFID technology to reduce cost.

7.2 Further Research

This research work has opened avenue for other research into the adoption characteristics of RFID in other industries but also presents limitation that needs consideration. It is serving to recommend further research into the identified characteristics in the research work.

Research work is needed to determine the menu cost of changing or converting to the RFID technology from previous health data procession and storage.

Alternative area for future research could be an exploration of methods of protection of privacy and security of RFID data in hospitals by higher authorities. Their opinions about these issues should therefore, be paralleled between developed and developing countries. I anticipated that this paper would lead to a better understanding of the primary issues by creating awareness for both academia and practitioners in the healthcare industry, particularly in developing countries.

7.3 Possible Research Questions

1. How does a patient, medical staff react to RFID?
2. Does RFID adoption affect the relationships among the hospital, patients and medical staff, and if so, how?

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APPENDICES

Appendix 1

Semi-Structured Interview Guideline

Interview RFID Date:

Organization:

Name interviewee:

Function/Position:

This interview has two focus areas; one area is the strategic focus of your organization. The other area is the perceived use of RFID in your organization. This interview should take approximately 40 minutes. Information provided in this interview will be kept confidential.

A GENERAL ADOPTION CHARACTERISTICS

Healthcare professionals background knowledge of RFID

- Do you know what RFID is and how informed are you about it?
- Are you aware of capability of RFID for healthcare and how it is going to enhance the quality of healthcare process?
- What capabilities of RFID do you think are more suitable for healthcare practices?

Benefits and areas of benefit of RFID to improving healthcare delivery in Nigeria.

- Do you believe adopting of RFID in hospitals is going to be beneficial?
- What are the real benefits of the adoption and/or implementation of RFID system?
- How far and fast should companies change in order to embrace this technology?
- Which identified areas can RFID improve healthcare service delivery in Nigeria?

Defining Barriers

- How do you define the organizational barriers to adopting of RFID in healthcare? And why do you consider them as barriers in such context
- How do you define the environmental barriers to adopting of RFID in healthcare? And why do you consider them as barriers in such context?
- How do you define the technological barriers to adopting of RFID in healthcare? And why do you consider them as barriers in such context?
- How do you define the privacy, ethical, security barriers to adopting of RFID in healthcare? And why do you consider them as barriers in such context?
- What other barriers do you believe can prevent the adoption of RFID in healthcare?

Defining Critical success factors

- How do you define the organizational critical success factors of RFID adoption in healthcare?
- How do you define environmental critical success factors of RFID adoption in healthcare?
- How do you define the technological critical success factors of RFID adoption in healthcare?
- How do you define the Privacy, ethical, security critical success factor of RFID adoption in healthcare?
- What other critical success factors do you believe can facilitate the adoption of RFID in healthcare, based on your experience? Why?

B SPECIFIC ADOPTION CHARACTERISTICS

A. Are you using RFID in your organization?

If yes, what kind of RFID-applications are you using? And what are the prospects?

If no, do you have plans to use RFID in the future in your organization? What possible RFID-applications? What is the timeframe?

B. In which way is your organization working with RFID-applications?

a. Is there one person responsible for RFID?

b. What is the level of knowledge of RFID within the organization? Is it sufficient, and if not, what to do to overcome it?

c. Have you looked at case-studies or been overseas for RFID-knowledge?

d. Is there a budget for RFID-implementation? What is the budget?

e. What are the targets for RFID-applications?

C. What is your view on the following topics regarding the RFID-implementation process?

a. Do you think that there is a need for an assessment to determine ROI?

b. What kind of training is required?

c. Do you believe a pilot is important and what should be a preferable size and costs?

2. Related and supporting industries

a. Are you consulting organizations that can support you with your requirements or investigations regarding to RFID-applications?

b. What are your requirements for RFID-vendors / RFID-consultants, and have you find such a company?

3. Organization strategy and structure

a. In the process of implementing RFID, do you cooperate/ or willing to cooperate with trade partners?

b. What are the most important sources of information about RFID for your organization?

c. What are the most important improvement projects in your organization?

4. Innovation Characteristics

a) In which areas in your company are innovations important, and what kind of innovations are implemented in the past

b) How will RFID improve your current processes regarding to, reduction of operational cost, improved effectiveness/ efficiency/ reliability? *(perceived relative advantage*)

c) What constraints would you face when you implementing RFID? For example, understanding the technology, use of the technology, constraints in IT structure or organizational structure, the complexity. (*Complexity*)

5. *Environmental aspects*

We are going to mention possible issues that RFID is facing at the moment. Indicate in which way these issues are limiting you in the process of choosing for RFID, and if it's limited, how do you think you can overcome these issues.

a. Privacy Issues

b. Current cost of RFID

c. The lack of global standards

d. What other issues, please define

6. Opportunities

a) Is your organization receiving some incentive schemes from external organizations for innovation? Like RFID?

b) What is currently the most important trend in the national market in your opinion? (Demand)

c) What could you describe as an opportunity in the <u>current</u> situation of your organization? And in the near future?

Additional questions

1. The following refers to the external orientation of your company. Indicate in which way each is valid in your company.					
Our company pays a lot of attention on searching for opportunities, to be a step ahead on the competition.					
When searching for new ideas / solutions, external sources are important.					
Our organization needs reputable consultants for implementing RFID projects					
Our organizations needs training and workshops to learn more about what RFID can do for our company					
2. The following indicates the possible uses of RFID within your business processes. Indicate in which way each of these is of use in your company.					
RFID fits within the companies' culture and image we want to expose to our clients.					
RFID will be mandatory in the future by externals: clients/suppliers/government.					
In the company's image view, it is important to us that the RFID-application itself is visible to others.					

When a pilot project is implemented, it can improve my personal perception positively about the technology.					
RFID has to become more mature (cheaper, no privacy issues, global standardization, etc.), before my perception will change positively.					
3. RFID is an emerging technology that will be used in various sectors. Please answer the following regarding your company:					
The following issues regarding RFID are the perceived constraints for my organization:					
Current costs of tags					
Current costs of reader infrastructure					
Current costs of implementation					
Public opinion					
Safety					
Technical implications					
No standardization					
Not enough knowledge within the organization					
Privacy issues					

4. The reasons why I have/will implement RFID in the organization is: (driving forces)

Better traceability	☐	Increased access to more products	☐
Identification	☐	Improved security of prescription drugs	☐
My suppliers demand it	☐	Improved food safety and quality	☐
My customers demand it	☐	Provide potential savings to consumers	☐
Instant recognition of preferences	☐	Faster, more reliable notification of recalls	☐
Faster recovery of stolen items	☐	Faster checkout	☐
Prevent crime	☐	More control over employees	☐
Reduced counterfeiting	☐	Improved price accuracy	☐
Instant access to more product information			☐
Instant access to information on product availability			☐

If other specify:

5. Do you want to know more about RFID technology? Yes ☐ No ☐

Evaluation: Do you have any remarks or comments on this interview?

Thank you.