

**KWAME NKRUMAH UNIVERSITY OF SCIENCE AND
TECHNOLOGY, KUMASI, GHANA**

**DESIGN OF AN E-HEALTH APPLICATION FOR MANAGEMENT
OF MATERNAL AND CHILD HEALTH: A CASE STUDY OF ATUA
GOVERNMENT HOSPITAL- LOWER MANYA KROBO
MUNICIPALITY IN THE EASTERN REGION OF GHANA**

BY

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DECLARATION

I hereby declare that this submission is my own work towards the Master of Science Degree in Information Technology and that to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University except where due acknowledgement has been made in the text.

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ABSTRACT

Following the numerous reports by several international organizations, it has become very clear that most developing countries including Ghana will not be able to meet the targets of Millennium Development Goals (MDGs) relating to maternal and child health. One of the major public health problems in Ghana is maternal, child and infant mortality outcome which is used to assess a country's socioeconomic performance and the citizens' quality of life. The Maternal Mortality Ratio (MMR) in Ghana is still very high in spite of numerous efforts and interventions by both the government and its developing allies. Evidences from several reports relating to maternal and child health outcomes show that a substantial number of women die yearly due to pregnancy related complications which can be prevented or reduced. The enormous promise that e-health solution possesses in improving the health of our communities particularly for people residing in the rural areas cannot be over emphasized. In this thesis, an outline on how to design an eHealth application in the health settings is provided. In order to gain the understanding of the application environment and also determine the functional requirement of the system, both the qualitative and quantitative methods of research were adopted. The qualitative method of research centered on observation of participants, background inquiry and focus group discussions helped gain more understanding into the research environment. The activities carried out included an analysis of workflow, documentation procedures, and documentation tools at the project study site. The study used Prototyping or Rapid Application Development (RAD) approach of system development; the development and testing of working models of the new application was carried out in an interactive and iterative process until the final product achieved. This work accordingly, resulted in the development of an artifact that was customized to address healthcare workers information needs and also improve clinical decision making which has the potential to improve patient outcomes and augment healthcare systems setup. The quantitative method of research was used to assess the healthcare professionals' perception on the dimensions of information system which included organization, management and technology perspectives. The major findings were that even though the health professionals indicated there was no problem with the work flow at maternal and child welfare clinic, the documentation tools

were problematic. The health professionals testified that eHealth application would facilitate data access, reduce problems associated with the documentation as well as enhance clinical decision making and promoting knowledge of work at maternal and child welfare clinic. Besides, the study showed that health professionals have either limited or no knowledge in information and communication technology usage. Although eHealth solution deployment could be a difficult task, it is evolving as one of the important means by which quality healthcare can be achieved. A well-functioning eHealth system ensures that midwives, community health nurses and other members of healthcare professionals can be assigned to definite homes where pregnant women children with risk factors as well defaulters can be closely monitored. In addition, a maternal and child comprehensive registry can be developed which can eventually enhance case management to improve health outcomes.



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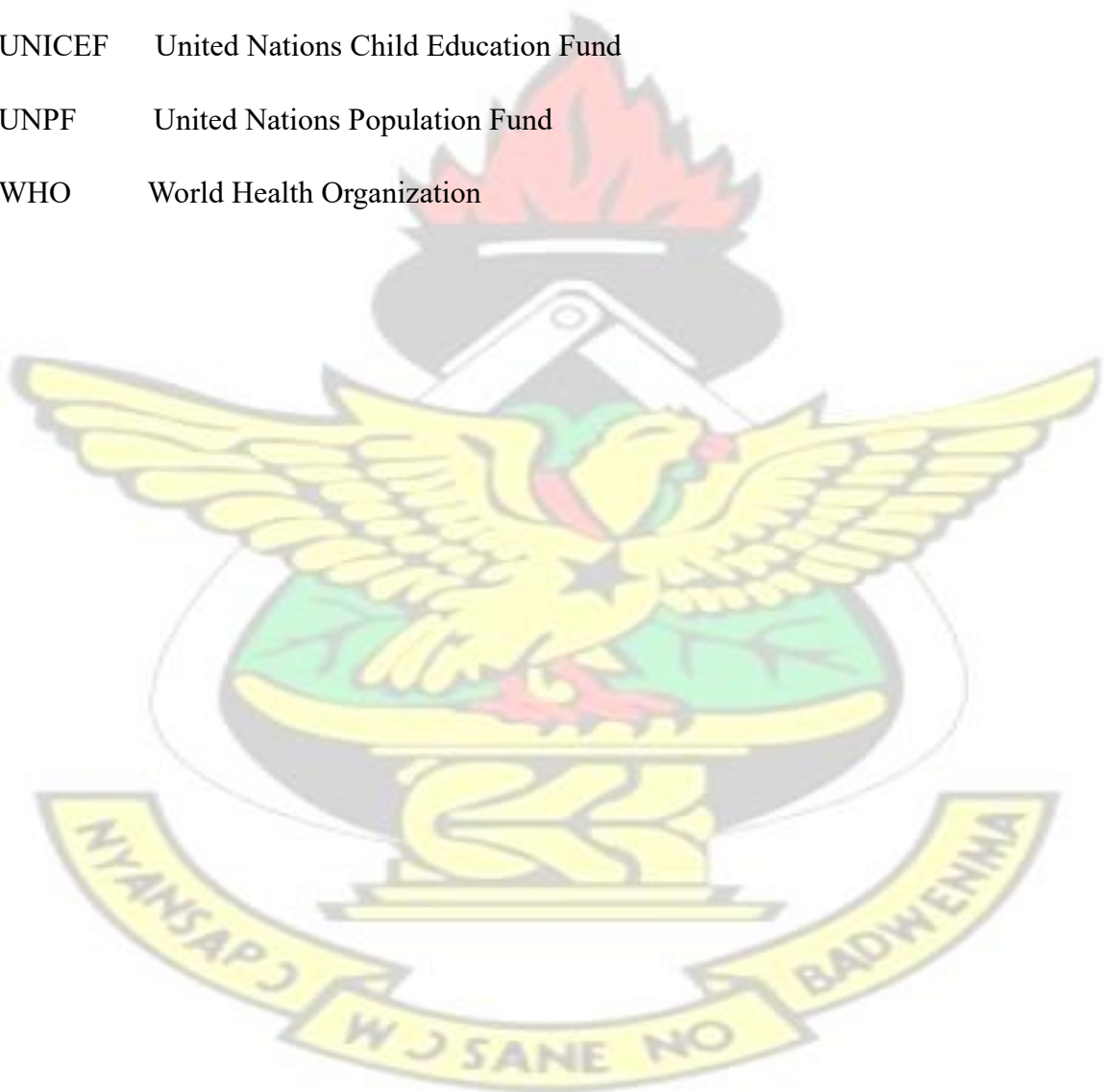
ABBREVIATIONS

ADB	African Development Bank
AIDS	Acquire Immune Deficiency Syndrome



ANC	Ante Natal Care
ART	Anti Retroviral Treatment
CHN	Community Health Nurse
CHR	Child Health Record
CHWs	Community Health Workers
CoIA	Commission on Information and Accountability
DHIMS	District Health Information System
EHealth	Electronic Health
EU	European Union
GHS	Ghana Health Service
GLSS	Ghana Living Standard Survey
GLSS	Ghana Living Standard Survey
HIS	Health Information System
HIV	Human Immunodeficiency Virus
HMIS	Health Management Information System
HMN	Health Metrics Network
HTML	Hypertext Markup Language
ICT	Information and Communication Technology
ITU	International Telecommunication Union
MAF-	Millennium Development Goals Acceleration Framework
MCH	Maternal and Child Health
MCHRs	Maternal and Child Health Records
MDGs	Millennium Development Goals

MMR	Maternal Mortality Ratio
RAD	Rapid Application Development
SDLC	System Development Life Cycle
SMS	Short Message Service
STI	Sexually Transmitted Infection
UNDP	United Nations Development Programme
UNICEF	United Nations Child Education Fund
UNPF	United Nations Population Fund
WHO	World Health Organization



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DEDICATION

I wish to dedicate this thesis to the glory of the most high God for his love and grace throughout this programme of study.



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CHAPTER ONE

BACKGROUND

1.0 Introduction

The maternal and child health mortalities continue to be a heavy burden for many developing countries. The failure of many developing countries to entirely embrace and integrate eHealth applications into the healthcare system have largely impeded the reduction of maternal and child deaths. According to Darrel (2015), maternal problems continue to be a serious problem in several nations. Report of African Development Bank (ADB) states that the high problem of disease burden in Sub-Saharan Africa is the main challenge to its economic and social development (ADB, 2014). The report further indicates that with just twelve percent (12%) of the world population from Sub-Saharan Africa, it accounts for forty nine percent (49%) of maternal deaths and fifty percent (50%) of children under five years mortalities worldwide (ADB, 2014).

According to the World Health Organization (WHO) report, when women have access to good and quality skilled delivery, it will enhance the reduction of maternal morbidity and mortality (WHO, 2004). The importance of the reduction of both maternal mortality ratio by seventy five percent and under five mortality by two-thirds (that is from 110-120 per 1000 live-births to 40 per 1000 live births) by the year 2015 is reflected in the Millennium Development Goals (MDGs) 4 and 5 (WHO, 2013).

According to the report by United Nations Development Programme (UNDP), a significant progress has been made by Ghana towards achieving the Millennium

Development Goals 5 yet falls short of attaining the target for 2015 (UNDP, 2015). The World Organization (WHO) indicates that the MDG 5 which aims at improving maternal health and reducing maternal deaths by three quarters between 1990 and 2015 as well as access to reproductive health has only resulted in the reduction of the mortality from 760 to 380 maternal mortality per 100,000 live-births between 1990 and 2013 (WHO, 2013).

Maternal Mortality Ratio (MMR) for Ghana according to the projections made by United Nations Development Programme, would be 358 per 100,000 live-births, which is still relatively higher than the mortality ratio of 190 per 100,000 live-births (UNDP, 2015). On the under-five mortality, UNDP states that despite tremendous gains attained from 1990, the set targets for infant as well as under-five year mortalities are not likely to be attained because although the under-five mortality rate improved from 122 per 1,000 live-births in 2012 but fell short of the MDG 4 target of 40 per 1,000 live-births (UNDP, 2015).

The problems that impede the achievement of the maternal and under-five year mortality ratios in developing countries are well known. According to the Ghana EHealth Strategy report, the challenges faced in addressing the maternal and child health issues are weak health systems, compounded by the challenges faced in improving and retaining the necessary human resource and the inability to obtain and integrate the required technology into healthcare have occasioned the present outcome in developing countries and that in most occasions the inability of developing countries' to implement the use of technology has been the major impediment (Ghana EHealth Strategy, 2013). In order to overcome the challenges faced in the delivery of quality healthcare, there is the need to adopt a faster and effective means to generate knowledge, where this knowledge is shared and translated into appropriate interventions that makes healthcare available and accessible to the vulnerable persons in our communities (Ghana EHealth Strategy, 2013). According to the

World Health Organization, a good foundation for meaningful decision making across the health sector settings requires a sound and reliable information which is important not only in the area of governance and practices but also for development and implementation of health systems, research, health education, development of human resources as well as financing and delivery of service (WHO, 2008). To address some of the challenges faced by the health professionals providing services relating to maternal and child healthcare, the deployment of Health Information System (HIS), will play a crucial role. According to Velez (2011), the integration of HIS can be valuable in tackling some of the challenges that midwives face in the rural communities in Ghana. An effective HIS allows healthcare professionals to function as knowledge workers, which enables them to integrate new knowledge into the healthcare system. Currently, the maternal and child health record booklets are kept in the custody of the clients which is practiced in several countries for many years. This record booklets help healthcare professionals to track clients with risk factors, conduct vaccinations and other health related issues on pregnant women and children.

Consequently, because the Maternal and Child Health (MCH) records' booklets are not automated, it do not enable healthcare providers to have a complete overview of clients' historical records to monitor antenatal visits, identify pregnant women and children with risk factors and danger signs and to make appropriate interventions. The integration of Information and Communication Technology (ICT) can contribute significantly in the improvement of the delivery of quality health services which include; the facilitation of surveillance, administration of data, sharing of data as well as enhancing vital statistics and registration of civil indicators.

To deploy ICT into healthcare to facilitate effective service, there is the need for the acquisition of computing and telecommunication devices. The International Telecommunication Union (ITU) report shows that access to computers, mobile-cellular technologies, fixed and mobile broadband, and Internet services is very important to expand to the reach of healthcare services and health information to remote and rural areas (ITU, 2013). The report further states that when these technologies are implemented well within the setting of national health strategy, it can be a useful tool in the health system, empower policy-makers, clinical workers and the patients to improve maternal and child health service delivery, that are provided in countries particularly for people living in the rural areas and remote communities and that wireless technologies are the best in terms of affordability among the broadband services, even though it possesses lower bandwidth capability relative to fixed broadband (ITU, 2013).

Considering the problems faced by the manual system used in managing the maternal and child healthcare, such as the inability to trace defaulters, inability to track antenatal and children under-five clients, poor case management among others, the introduction and integration of eHealth application into the health delivery system will greatly improve the quality of service and eventually reduce maternal and child mortalities.

This research aims at assessing the dimensions of organizational, technological and management perspectives of health information system. It also aims at evaluating and designing a web-based application as an early warning or alert system for tracking pregnant women and children with risk factors and tracing defaulters to improve upon maternal child health outcomes.

1.1 Problem Statement

The maternal and child mortalities continue to be one of the most serious health challenges in many developing countries including Ghana and these problems have been exacerbated as result of the country's inability to fully deploy eHealth applications into the healthcare system. According to the United Nations Development Programme (2015) report, although Ghana has put in several interventions and significant progress in reducing the maternal mortality, the country still falls short to reach the target of achieving 185 deaths per 100,000 live-births in 2015 (UNDP, 2015). In the view of the Millennium Development Goals Accelerated Framework (MAF), a substantial number of women die yearly due to complications related to pregnancies which could be prevented or reduced and that this maternal deaths represent nearly sixty five percent (65%) of maternal mortality worldwide (MAF, 2010).

On child health, the report of the Ghana Demographic and Health Survey (GDHS), indicates that one of the major public health problems in Ghana is the infant and child mortality indicators which are used to assess the country's quality of life and its socioeconomic condition (GDHS, 2014). The report additionally shows that the rate of children under-five years is projected to reach 60 deaths per 1000 live-births in 2014 relative to 40 per 1000 live-births target for 2015. This achievement of the decline of under-five year mortality rate is appreciable but the country still falls short of achieving 2015 target of 40 per 1000 live-births (GDHS, 2014). The current system of managing maternal and child health records is done manually. These maternal and child health records are in the custody of the clients and as a result, without the maternal and child health record books, the health information pertaining to the pregnant woman and the child, treatment and proper follow-ups become ineffective.

The manual system also invariably does not permit the pregnant women and the children with risk factors to be effectively and closely monitored to get the needed services. One key advantage of the electronic system is that the mother can be closely observed throughout her pregnancy period and the child can also be monitored till he or she obtains the age of five and this guarantees high quality healthcare for both. That is when the electronic health system is deployed into healthcare, it ensures the pregnant women gets all the required checkups throughout her pregnancy period, and the delivery will be safe and it also promotes good health for the baby. Apart from proper case management, the integration of the eHealth application into the health system will also greatly enhance tracking of pregnant women and children and the application can also be used as an early warning system or alert system to impact immensely on the reduction of maternal and child mortality outcomes. **1.2 Research Objectives**

1.2.1 General Objectives

The general goal of this research is to design an eHealth application that can be used to efficiently and effectively manage the maternal and child related health issues at Atua Government Hospital in the Eastern Region, Ghana, with the ultimate aim of expanding to cover the entire country.

1.2.2 Specific Objectives

The following are the specific objectives of this study:

- i) To evaluate the dimension (organizational, management and technology perspectives) of information system in Atua Government Hospital;
- ii) To assess and ascertain management support and preparedness towards the introduction of eHealth application into healthcare delivery system; iii) To develop an eHealth application as an alert or early warning system to tract pregnant women and children with risk factors and danger signs and trace women

- and children who default to come for follow-up; iv) To build eHealth application that can be used to educate pregnant women and parents of children under five years who come for weighing exercises through Short Message Services (SMS) on proper health lifestyles; and
- v) To assess and design an eHealth application that can be used to closely monitor pregnant women during the antenatal period and children from the time of birth until five years.

1.3 Significance of the Research

The researcher considers that, by developing an eHealth application for maternal and child healthcare, it is possible to build a comprehensive registry where the health professionals can closely monitor antenatal clients as well as children under the age of five to expedite targeted interventions. To do this, it is essential to understand the problems and opportunities to be addressed within the application domain, which consist of the people, technology, and organization that will interact with the artifact to be developed. One importance is that the artifact that is developed has the potential for reducing data collection and sharing inefficiencies in the application setting, improving the quality of data collected, and provide a means for collecting data for patient management.

The positioning of Information and Communication (ICT) into the health system can practically impact positively on every segment of the health sector. The deployment of eHealth application into the healthcare delivery system will encourage patients to take further responsibility of issues relating to their individual health needs which further leads to enhanced cost efficiency in the health segment. The use of eHealth application will

allow a jointly helpful collaboration and participation of pregnant women and underfive year's children and health professionals to ensure quality healthcare services.

1.4. Research Strategy

The purpose of this study was to design and test an eHealth application for use by healthcare professionals at the Atua Government Hospital in the Eastern Region of Ghana, with anticipation of expanding to cover the entire country. In this study, the qualitative and quantitative methods of research were both used. The qualitative method involved background enquiry, participants' observation and focus group discussion. This method helped to guide the understanding of the dimension or perspective of the information system in the health institution. The strategic components of an organization are the people, the structure available and operating procedures (Pabbi, 2011). Managers also play key roles in an organization because they identify challenges in an organization and come out with strategies to tackling the challenges, assigning the human and financial resources required to attain the agreed targets and goals (Pabbi, 2011). Participants' observation, background enquiry and focus group discussion guided or increased the understanding of application domain and also helped to determine the functional requirements of the system. It was based on these three dimensions (organization, technology and management) of an information system for which the product was developed. Additionally, the study used Rapid Application Development (RAD) approach of system development, where the development and testing of working models or prototype of the new application was carried out in an interactive and iterative process. The design and development cycle was repeated iteratively until a desired final artifact was achieved. This

approach included active participation and design input of stakeholders (health professionals) at the study site, Atua Government Hospital.

1.5 Research Questions

To achieve the overall objective of this research, the questions that were formulated in this study are as follows:

- How is the current workflow at maternal and child welfare clinic?
- Are there problems associated with the documentation tools?
- What are the requirements needed to develop an eHealth application for maternal and child healthcare?
- Are the healthcare providers conversant with ICT usage and what is their perception on the impact of technology on healthcare delivery?
- Are ICT tools available at maternal and child welfare clinic?

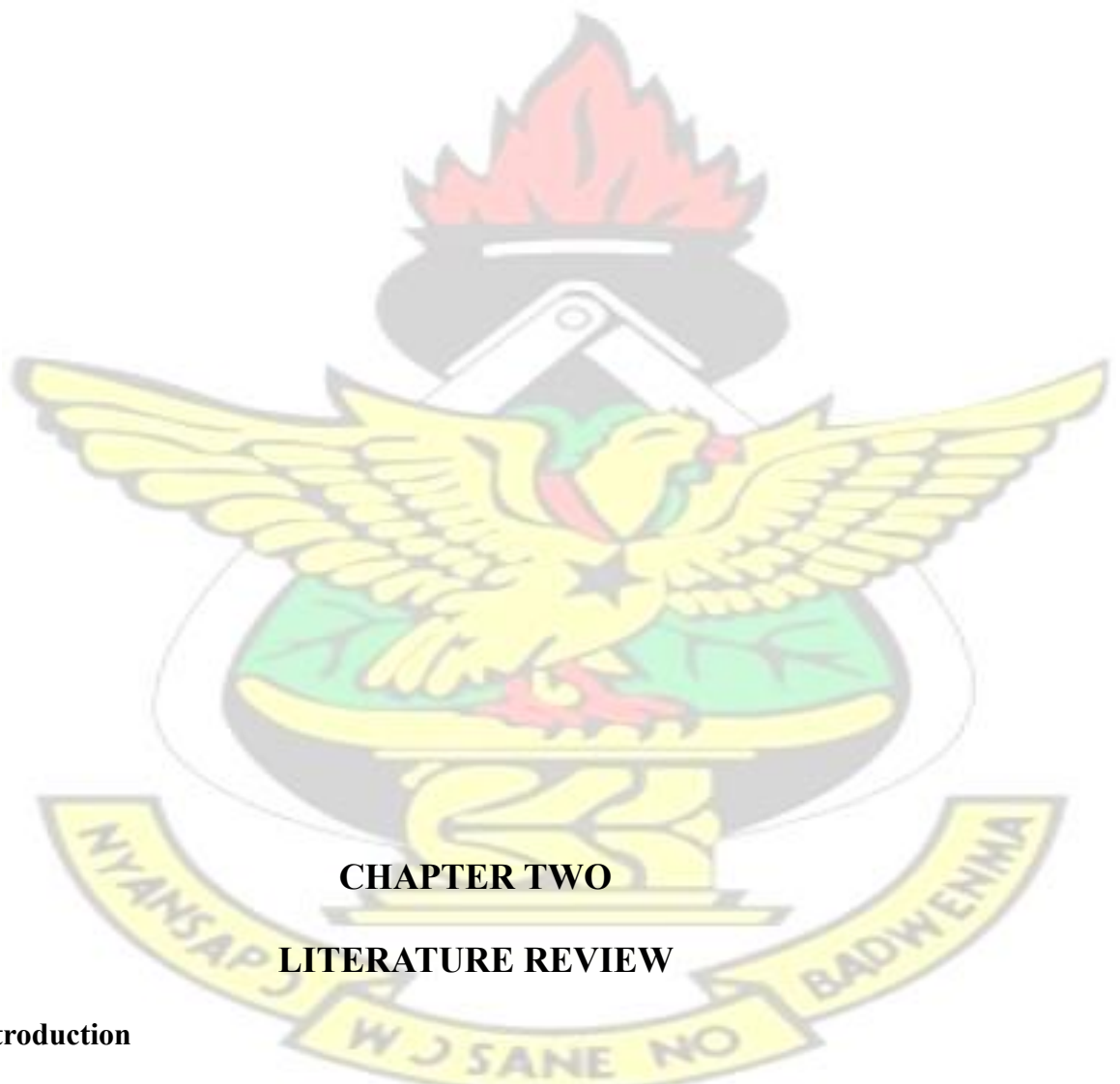
1.6 Scope and Limitation of the Research

This research does not delve into an integrated system of managing the health status of all patients in general but is limited to the development of an eHealth application for the management of maternal and child records. It is centered on the design of an eHealth solution for only pregnant women as well as children under five years.

1.7 Conclusion

EHealth offers a unique way for bringing health information system in developing countries particularly, Ghana. Healthcare providers require accurate, reliable and accessible data to provide quality healthcare to both patient and the general populace. The study applied Rapid Application Development (RAD) method of system development. This led to the development of a working model that could be used to address healthcare providers' information needs and also improve clinical decisions making and eventually improve healthcare indicators on maternal and child health.

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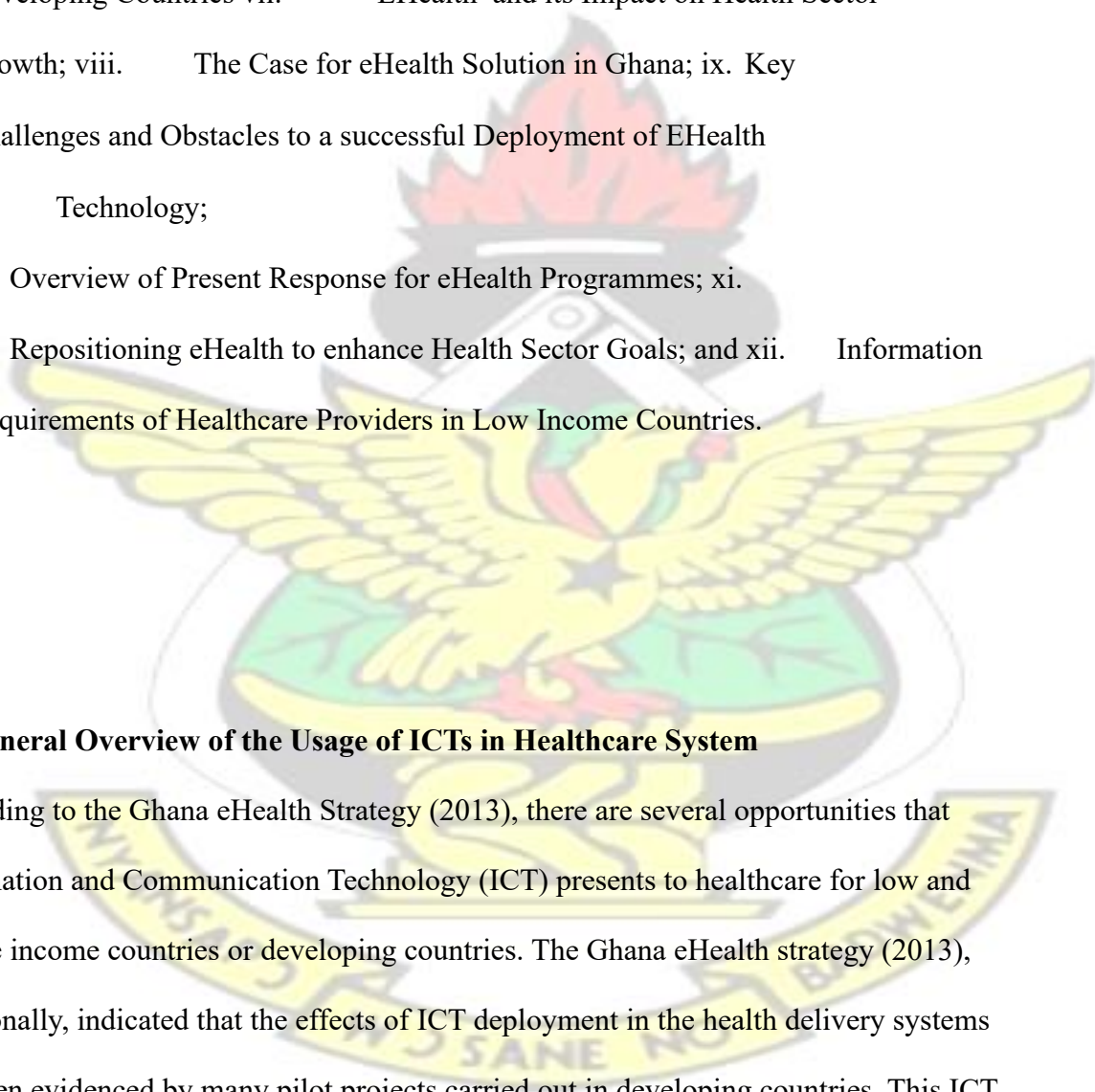


CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The chapter under consideration reviewed the literature relating to area of study. The information for the review of the literature was obtained from appropriate textbooks, web sites and other credible sources. The following were the topics reviewed for the study.

- 
- The logo of KNUST (Kwame Nkrumah University of Science and Technology) is a large, semi-transparent watermark in the background. It features a yellow eagle with its wings spread, perched on a green shield. Above the eagle is a red torch. The shield has a yellow star and a green leaf. The entire logo is encircled by a yellow banner with the university's name in Ghanaian and English.
- i. General Overview of the Usage of ICTs in Healthcare System; ii. The State of Maternal and Child Healthcare; iii. Essential Healthcare Initiatives Needed to enhance Child and Maternal care; iv. Health Information Systems in Low Income Countries; v. The Effects of eHealth Technology; vi. EHealth Deployment in Developing Countries vii. EHealth and its Impact on Health Sector Growth; viii. The Case for eHealth Solution in Ghana; ix. Key Challenges and Obstacles to a successful Deployment of EHealth Technology; x. Overview of Present Response for eHealth Programmes; xi. Repositioning eHealth to enhance Health Sector Goals; and xii. Information Requirements of Healthcare Providers in Low Income Countries.

2.1 General Overview of the Usage of ICTs in Healthcare System

According to the Ghana eHealth Strategy (2013), there are several opportunities that Information and Communication Technology (ICT) presents to healthcare for low and middle income countries or developing countries. The Ghana eHealth strategy (2013), additionally, indicated that the effects of ICT deployment in the health delivery systems has been evidenced by many pilot projects carried out in developing countries. This ICT positioning in the health sector are largely due to the availability, affordability and easy-to-use equipment and systems which has added to a lot of initiatives targeted at enhancing

the efficacy of health professionals and managers as well as healthcare consumers (Ghana eHealth Strategy, 2013).

According to the World Health (WHO) and International Telecommunication Union (ITU), all segments are embracing the usage of ICT globally to improve the delivery of service and to have competitive urge (WHO & ITU, 2012). WHO and ITU (2012) further indicated that apart from ICTs being able to change how healthcare is carried out as well as how the health systems are run, it also plays important functions in strengthening the healthcare through the capability of gathering, analyzing managing and exchanging information in all aspects of health and that through ICT usage, the required information is delivered to the right person at the appropriate time to precise person at the actual place in a secure and electronic form to augment the quality and usefulness of the delivery of healthcare (WHO & ITU, 2012).

2.2 The State of Child and Maternal Healthcare

The achievements made in reducing the maternal and child mortalities worldwide has been tremendous but most countries particularly the Sub-Saharan Africa countries continue to lag behind in the attainment of MDGs 4 and 5 (Child and maternal goals respectively).

The World Health Organization (2011) stated that maternal and child health issues in developing countries remain a major problem and worldwide, and 358,000 pregnant women as well as a projected 7.6 million children under-five years, die every year. The women and children's health play important roles in national growth. The report of Ghana Demographic and Health Survey (GDHS) indicated that health issues relating to women in the country are mainly aligned to reproductive health, nutrition and family planning, which reproduction is the basis of most health related problems for Ghanaian women (GDHS, 2003). The report of the Ghana Living Standard Survey (GLSS) also stated that

on modern forms of contraceptives, 94.6% of women testified that they or their partners were utilizing it (GLSS, 2008). The statistics on contraceptive usage is quite significant as according to Amposah (2011), the high contraceptive usage has a major importance in decreasing the spread of Human ImmuneDeficiency Virus and Acquire Immune Deficiency Syndrome (HIV and AIDS), that presently affects two hundred and sixty thousand people (260,000), which comprised one hundred and forty thousand (140,000) women and twenty seven thousand (27,000) children in Ghana. In this vein, the Ghana Health Service 2007-2011 reproductive health strategy plan is an initiative aimed at improving the women's health in Ghana, which is focused on maternal morbidity and mortality, family planning and contraceptive usage services (GHS, 2007).

The vibrant and adequate health workforce particularly midwives and community health nurses is crucial in efficient management of maternal and child health issues. The report of United Nations Population Fund (UNPF) published a report on 58 countries on the state of the world's midwifery data and policies regarding maternal and newborn deaths

(UNPF, 2011). The report of UNPF (2011) indicated that there are 5 midwives in every 1,000 live-births and the lifetime risk of death for pregnant women is 1 out of 66.

The report of Ghana Millennium Development Goals (2015) projected that Ghana's maternal mortality ratio in 2015 would be 358 per 100,000 live-births as compared to UNPF (2011) figures of 409 and 549 deaths per 100,000 live-births in 2008 and 1990 respectively. For children under-five year mortality rate, UNPF (2011) stated that the rate was 72 deaths per 1000 live-births and 39 for neonatal deaths as percentage of under-five years. WHO (2014) indicated again that the risk of dying before attaining the age of five years was 95 deaths per 1,000 live-births which is highest in the WHO African region, with

the under-five mortality rate in WHO African Region still above 100 per 1,000 livebirths. There is also disparities of under-five year's mortality rates between low income countries and high income countries. For example WHO (2014) said the mortality rate of under-five year children in low income countries was 82 per 1,000 live-births which was thirteen times more than the average rate of 6 per 1,000 live-births recorded in high income countries.

2.3 Essential Initiatives Needed to Enhance Child and Maternal Healthcare

2.3.1 Enhancing Continuum care

The United Nations Children Education Fund (UNICEF) report indicated that provided pregnant women have contact to necessary and primary healthcare, then 80% of maternal mortality can be prohibited (UNICEF, 2009), but most often, women lack the means and authorization to travel for antenatal services and on the other hand, services do not have means to provide quality care. According to UNICEF (2009), enhancing continuum care encompasses all stages of maternal, newborn and child health promoting integrated healthcare delivery during pregnancy period.

2.3.2 Promoting Care during Pregnancy and child birth

The promotion of healthcare for children under-fives years and pregnant women is very important part in ensuring the pregnant mother and her baby health status are improved. For example, UNICEF (2009) indicated that during the antenatal service, women are educated on safe birth and the necessary steps to take during emergencies, proper diet intake, provided with micronutrients supplements (Vitamin A, Iron, zinc and iodized salt), malaria medicines are given for areas with high malaria prevalence and worm treatment given if needed. Besides, pregnant women are examined, diagnosed and probability treated with Sexually Transmitted Infections (STIs) and in case a woman is diagnosed

with HIV and AIDS, Ante Retroviral Treatment (ART) is provided to prevent the mother from transmitting the virus to the child (UNICEF, 2009). According to Camielle (2009), the WHO endorses a minimum of four antenatal visits for every pregnant woman during pregnancy phase.

2.3.3 Encouraging Postnatal Care and child healthcare

As stated by Camielle (2009), about 40% of child mortalities happen within 28 days after delivery and majority of these deaths occur within the first seven days and a projected total of four million (4 million) babies die within the first week. Camielle (2009) further added that virtually these estimated 4 million mortalities occur in developing countries and the major causes are due to infection, preterm and asphyxia. Most women often die as a result of infection whilst most neonatal mortalities can be avoided if both the mother and babies receive postnatal service where the appropriate doses of antibiotics are provided (Camielle, 2009).

2.3.4 Enhancing Technology Usage

In the view of Krasovec (2004), besides continuum care, care during pregnancy, child health and postnatal mother and child care, there is the need to enhance technology usage in the maternal and child healthcare services, because it has the potential to improve the quality and services utilization. Krasovec (2004) again stated that if communication and transportation systems are improved, coupled with the availability of health services, maternal mortalities can be reduced tremendously and a strengthened communication system reduces delays in identifying health problems and taking appropriate interventions. According to ITU (2013), the increased use of ICTs together with fast positioning of mobile cellular telephony, have sustained the growth of eHealth applications and

amenities in the world. The enhanced access to and the use of information and communication technologies and eHealth systems has given the Commission on Information and Accountability for women's and children's health (CoIA) in the seventy-five priority countries great prospect to attain the targets set and accordingly meet MDGs 4 and 5 (ITU, 2013).

2.4 Health Information Systems in Low Income Countries

With the declaration that “primary healthcare is essential healthcare” it is needful that at the international and national levels, immediate and vigorous steps be taking to cultivate and implement principal healthcare worldwide, most especially in the low income or developing countries, due to the Alma-Ata conference in 1978 which established a way for development of the health information systems which are seen in the developing world (WHO, 2014). According to WHO (2008), the essential foundation for decision making in the health system settings is the availability of sound and reliable information, and this is important for governance and regulation, growth and implementation, development of human resources among others. The WHO (2008) stated that the importance of the implementation of health information system was demonstrated when it hosted and spearheaded the Health Metrics Network (HMN) aimed at strengthening health information systems in the developing countries and this helped to identify major segments and criteria of a nation's health information system (WHO, 2008). In Ghana for example, the Ghana Health Service (GHS, 2013) has worked in partnership with the University of Oslo, to come out with a software named District Health Information System (DHIMS2) which is a complete Health Management Information System (HMIS) used for reporting and analyzing data for information needs at health facilities, districts, regional

and national levels. The DHIMS2 software uses a data warehouse standard, centralized, online deployed and an integrated structure which can be customized to meet the requirements of any health related system (GHS, 2013).

2.5 The Effects of eHealth Technology

The WHO and ITU (2012) have stated that there has been increasing and quick expansion of Information and Communication Technologies to augment national health services and this is especially important at this time when the healthcare systems are facing tough economic problems and high calls to deliver top quality healthcare services to the most needed people in our communities.

In the view of the WHO & ITU (2012), when information and communication technology is appropriately applied to health services, it will not only increase the efficacy, but also increase quality of life and unravel innovations in the healthcare system. The eHealth is defined by the WHO as the utilization of ICTs for health and in comprehensive way, it is associated with improving information flow, by electronic means in order to back health services delivery and health systems management which offers important benefits in attaining health sector goals and showing what has been achieved and at what cost (WHO & ITU, 2012). WHO (2012) intimated that the adoption of ICTs has been demonstrated for more than a decade but has been difficult for health sector in several countries to applied eHealth technology from basic level to core tactical health planning. With the world increasingly moving to digitalization, backed by advances in technology, investments in economy and changes in social and cultural settings, there is an increasing recognition that ICT must be integrated into the health sector for service delivery.

2.6 eHealth Deployment in Developing Countries

According to the WHO (2011) and ITU (2008), there is unparalleled growth in the number of internet and cell phone users along with the decrease in the prices of services and devices. This enabled several programme implementers in health as well as policy makers to discover the level at which eHealth can solve the challenges confronted by limited resources in health system in connection with the availability, quality and how to finance healthcare (ITU, 2008). This has been shown by the increasing amount of measures and literature centered on eHealth such as the Savings Lives at Grand Challenge held to address eHealth challenges in developing countries and the survey undertaking by WHO on the usage of the mHealth through its member countries (WHO, 2011).

The advance in eHealth and mHealth applications is fast gaining impetus (ITU, 2013).

Accordingly, some of the examples of eHealth projects in developing or low and middle income countries include the *eDistricts*, a tool used for registration of births and deaths in Kapurthala district in India, which is an integrated electronic service supported by automation workflow, backend computerization, and data digitalization; *MOVE-IT*, a mobile-based application for registration of pregnancies, recording of births, deaths and cause-of-death, using text messaging system being used in the three district in the northern region of Ghana; *Project Mwana*, Mobile application based on Rapid SMS, used by community health workers (CHWs) to register new births and monitor community health events related to malaria, diarrhoea, and immunizations in children under five years old and expectant mothers in Malawi and Zambia; *Childcount+*, a mobile application based on Rapid SMS to monitor children under five years old in Kenya for data collection for community-based healthcare (ITU, 2013). Consequently, the examples

highlighted are only a few of the many solutions that are already improving the health of women and children globally, and which could be replicated in other CoIA and low income countries in order to save lives (ITU, 2013).

Schenker (2008) stated that in spite of the improved interest in eHealth initiatives in both low income and middle income countries, the field of eHealth is still blossoming. This was corroborated by Otto (2012) who indicated that it is only few eHealth programmes that have been scaled up and the operation has classically been disjointed and not well coordinated. According to Schenker (2008) and Otto (2012), hitherto, eHealth literature in low income and middle countries has mainly comprised articles and this describes solely technology uses, whilst Gerber et al (2010) and Crean (2010), stated it contains hypothetical deliberations and recommendations relating to the application of eHealth programmes and strategies and only few talks about the comprehensive landscape of these programmes. According to Lamaire (2011), the only exemption is a paper ordered by the Advanced Development for Africa (ADA) which talks about a sequence of researches and elaborates on the way forward by experts in health. The WHO (2011) corroborated that a research conducted for its member countries on 'utilization of mhealth' offers a methodical details of health programmes, notwithstanding the research depended so much on local government awareness which was incomplete because eHealth deployment were taking place in private sector as well.

2.7 eHealth and its Impact on Health Sector Growth

According to Robert (2008), a lot of health information system are insufficient as a result of the current prototypes that are being implemented in the reform initiatives, besides, the momentum that is being experienced by other sectors in acceptance of technology has not been replicated in the health sector. The African Development Bank (ADB) stated that as in

the developed countries, ICT can as well provide remarkable solution to resourceconstrained countries in Africa (ADB, 2014). Besides providing the platform for further transparency and accountability in the delivery of service, it improves error reduction, proof-based practice, increases diagnostic accuracy and shifts tasks down which helps address shortages in skills and eventually reduces cost by rationalizing processes, waiting time and improving data accuracy (ADB, 2014).

2.8 The Case for eHealth Solution in Ghana

According to Afrikumah (2014) the healthcare system in Ghana and that of other developing countries seems to be similar where access to healthcare delivery by people in isolated communities is very restricted. Currently, the health system is struggling to tackle the growing cost of service as well as responding to equally growing pressure to expand services to bridge imbalance gap that exists between the urban and rural communities, the southern and the northern parts of the country as well as the rich and the deprived (Ghana eHealth Strategy, 2013). Some important elements needed in every health institution is the adoption of reliable and effective communication which has a great potential in monitoring and fighting disease, educating the public and healthcare in general.

According to Afrikumah (2014), because of the importance of eHealth, the Government of Ghana has launched its country eHealth strategy, whilst a lot of international organizations have also started many pilot projects which has helped to disseminate and collect data, health education and improving telemedicine, in addition to the dedication by other institutions and organizations aimed at promoting eHealth and a number of webbased health consultancy initiatives.

Robert (2008) indicated that to derive the complete profit of information and communication technology implementation in multifaceted environments, it is essential to

have a clear defined goals and operational partnership among shareholders. According to ITU (2013) the Motorring of Vital Events through Innovations including Information Technology advances (MOVE-IT), eHealth application which is operational in comparatively underprivileged three districts in the northern of Ghana. MOVE-IT employs community-based agents-known as surveillance and health cadres- to report the occurrence of vital events (WHO, 2012). Competent technical persons follow up these events, confirming their occurrence, and capturing the relevant details in records in community folders and through computers linked to the national system of vital events recording. This initiative aims at promoting the analysis of data collected, as well as the use of the system at the local and national levels (WHO, 2012).

2.9 Key Challenges and Obstacles to a Successful Deployment of EHealth

Technology

E-Health programs according to Reichertz (2006) provides the capability for greater influence by which even the traditionally underserved populaces, at comparatively minimal cost, scalability, time effectiveness and the potential to tailor and customize for different healthcare consumers. The Ghana eHealth Strategy (2013), indicated that upon all the benefits that a country could derive from deploying an eHealth system, there are yet some barriers that impedes its effective implementation. Reichertz (2006), stated that because there are multiple stakeholders that are providing health services in the health sector, from geographical areas and the existence of such various stakeholders from public to private creates an appearance of a disjointed healthcare service. Because of the diversity of ownership of healthcare service, with divergent ideological basis, it has been difficult to successfully manage and bring into line information systems in the previous

and this could hinder the implementation of eHealth applications in the future (Ghana eHealth Strategy, 2013).

According to Tan (2005) and Mbanaga (2006), in spite of the possible benefits of eHealth solutions, there are hindrances to its complete implementation, as such the restrictions to access, literacy on health and technology and effective actions need to be addressed.

It was viewed by Reichertz (2006), eHealth solutions have enormous potential to change the health sector, but the threat of impairment exists, therefore policy-makers, clinicians and other stakeholders need to be aware of this risk.

2.10 Overview of Present Response for EHealth Programmes

The Ghana's health sector is categorized into various management divisions which are functioning and producing huge quantity of information which are stored in different silos and this makes it difficult to share information and this has played a major role by which the sector is unable to successfully show performance (Ghana EHealth Strategy, 2013).

According to the European Union (EU) report, by adopting eHealth solutions, national and regional health systems are anticipated to properly deal with increasingly high demands for improved health services and cost-efficiency which permits nations to attain a better and elongated life for its citizens (EU, 2009).

2.11 Repositioning eHealth Solutions to Enhance Health Sector Goals

The increasing positive effect that eHealth solution is bringing to bear on the healthcare delivery worldwide currently, coupled with how it is making healthcare system much resourceful and proactive to meet the expectations of the people is reasonably enormous (WHO & ITU, 2012). The advances in technologies as well as economic investment among others are backing the actualization that the health sector needs to integrate eHealth solutions in carrying out its functions. According to WHO and ITU (2012), the effective

day-to-day transaction of health generally depends on information and communication technology at all levels of healthcare, therefore all countries need to give the adoption of eHealth solutions serious consideration.

2.12 Information Requirements of Healthcare Providers in Low Income Countries

According to Pakenham-Walsh et al. (2009), healthcare providers in developing countries do not have basic and practical information to help them provide safe and effective healthcare and many healthcare providers depend on observation, colleagues' advice as well as building knowledge experimentally from their personal treatment success and failures. In the view of Pakenham-Walsh et al. (2009), a gross absence of experience by health professionals on the basis of diagnosis and management of common diseases could be seen in some areas of health sector in some countries which is a dangerous healthcare practice. If this level of understanding by healthcare professionals is symbolic, it seems that health system at the basic level has generally been unsuccessful for the most of the populace in the world (Pakenham-Walsh et al., 2009).

According to the Global Health Workforce Alliance (2010), healthcare information is needed by health professionals in order to learn how to diagnose and provide the required healthcare to patient and for patient education. Healthcare information for instance serves as the clinical reference and educational resources for critical delivery of safe, suitable and proactive healthcare and such information are needed to be available in the local language and at the educational and technical levels that is suitable to the consumer (Global Health Workforce Alliance, 2010). In the views of Godlee et al (2004), health information requirements are relative and differ in place and time based on various healthcare

providers, clinical situation and healthcare consumers are growingly demanding for safe, suitable and proactive services.

Summary

Undoubtedly, eHealth solutions around developing countries is growing, and this point cannot be denied. Although such solutions could be extremely difficult job, the eHealth solutions are evolving as the effective means by which quality healthcare could be achieved. According to the UNICEF (2009), whilst more than half a million pregnant women die per year from pregnancy and even additional develop pregnancy related disease, and besides, to this mortality of women, millions of babies die within the first month after delivery. The women, most especially those in developing countries are vulnerable when pregnant due to their limited access to healthcare services that are proactive, although life- saving care are associated with health services which are inaccessible. According to Camielle (2009), there are two interwoven causes of limited access of women to life-saving service which include the position of women in developing countries and the shortage of qualified healthcare professionals in developing countries. The women in developing countries are normally less educated and are residing in rural and remote communities, have limited participation in decision making as well as inadequate nutritional status. Camielle (2009), the less education, poverty and limited participation in decisions making relating to their health limit their rights and also prevent the women from accessing quality health services. Improvement the rights of women, dietary status and access to effective health service delivery can save their lives. UNICEF (2009), indicated that new methods are required to enhance the status of women, including their access to quality healthcare services and as such, one of the methods is to institute the involvement of males or women partners in maternal and newborn healthcare and the second is to improve communication systems in the area of health by enhancing technology usage.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

Prior to the system development, the proposed system was studied to know the requirements needed and to identify functional requirements. The System Development Life Cycle (SDLC) approach was used to help develop information system solutions to meet organization's opportunities. The SDLC is made up of five major phases namely, Feasibility Studies, Systems Analysis, Systems Design, Construction and Implementation, and Operations and Maintenance.

The model driven and object-oriented analysis approaches that highlights the design of illustrative system models to document and authenticate present and or the anticipated system and also incorporates data and process concerns into construct were used. The eHealth application uses PHP and MySQL at the server backend and HTML and JavaScript at the client part.

3.1 Research Methods

The qualitative and quantitative methods both were used in this research.

3.1.1 Qualitative Method

With regards to qualitative research, field study and participant observation were used to gain more insight into the system domain to help determine the functional requirements of the system. The study design was carried out in two phases. The first part involved a

requirements analysis, followed by development of functional requirements based on the outcome of the first phase. The activities carried out included an analysis of workflow, documentation procedures, and documentation tools at the project study site.

3.1.2 Quantitative Method

The study also used quantitative research technique to look into the dimension of computer-based information system which includes organization, management and technology perspectives. A questionnaire was designed and respondents were interviewed to ascertain their opinions on certain issues relating to dimensions of an information system.

3.2 Sample Selection and Requirement Gathering

The focus group discussion was carried out to help gained more understanding of current workflow and documentation procedure and tools in order to ascertain the functional requirements of the system. With regard to focus group discussion, six health workers comprising three midwives at Antenatal Clinic, two community health nurses at the Child Welfare Clinic and a Medical Officer (Medical Doctors) at the health facility were selected using purposive sampling technique because the sampling units were selected based on the discretion or judgment of the researcher and issues relating to the maternal and child welfare were discussed. In relation to requirement analysis, the study was concentrated on gathering qualitative data through user-centered design methods such as observation, background enquiry and interviews to help understand the studied context and users' needs. In relation to background inquiry the selected workers of the health facility were asked to describe the tasks they are performing and further questions were asked for clarification. For pregnancy related issues, the midwives were observed for two hours to really understand the tasks they perform. The pregnant women maternal record books were checked to familiarize with the data elements or indicators in the booklets and

field notes were taken accordingly. In the second phase, observation, enquiries, and interviews were carried out on the child welfare associated issues. A community health nurse was observed for two hours and field notes were used to record observations. To obtain data for the quantitative aspect of the research, a questionnaire was administered to some staff at the health facility to ascertain information on the dimensions of an information system. In this vein, thirty (34) workers of the health institution were chosen by means of convenience sampling technique because these health workers were directly involved in provision of maternal and child healthcare services or provide resources needed for the running of the clinic. The category of respondents comprised twenty three (23) midwives, two (2) community health nurses and nine (9) management members.

3.3 Review of Maternal and Child Health Records (MCHR) and Loopholes

One important aspect of the review exercise was analyzing current documentation tools by comparing existing data collection tools with the national standard tools. Initially, analyzing documentation tools was done by comparing study site maternal and child health booklets with a poly-clinic nearby (Somanya Poly-clinic). These maternal and child welfare booklets were then compared with the national standard tool. With the child welfare book, the two health facilities were using the same documentation tool. These activities were done together with a Medical Officers, three midwives and two community health nurses. A sample of maternal health and child welfare data collection tools are shown in appendixes B to F.

During the focus group discussion, the tools use for data collection (that is, MCHR), were assessed to ensure the completeness of the needed data elements. As shown in appendix D data elements on the medical investigations were Haemoglobin, Sickling test,

HbElectrophoresis, blood group, Rhesus factor, HIV status, Antibody screen, HBsAg, stool

RE, urine RE, ultrasound which excluded DNA test.

In general, the various entities derived from the revised of the maternal health records were: personal history which contains data attributes such as registration number, name, health insurance number among others; medical history entity with data elements for instance major risk factor, chronic disease among others. The rest are physical examination entity with the attributes; date of visit, weight, height, BP, Pulse and so on; medical investigations entity which contains attributes such as date of investigation, Haemoglobin, Sickling status, Hb-Electrophoresis, blood group and so on; Antenatal progress records entity, which comprises attributes such as date of visit, weight, gestational age (in weeks), fundal height, fetal heart among others; and delivery records entity that comprises data elements such as where delivered, delivery date, place of delivery, sex of baby and so on .

With respect to child health booklet, the various entities derived were: child's personal information which contains attributes such as registration number, name, gender, date of birth among others; child's medical investigations which was added to the child health records, with attributes such as date of investigation, weight, sickling test, G6PD status, blood group, DNA test, HBsAg and name of investigator; and child's progress records that comprise data elements such as date of visit, weight, immunization and vitamin A details among others.

3.4 Ethical Considerations

I first sought permission from the management of the health institution to carry out the research. After the approval was giving, I then gave the participants the chance to sign a consent form on their willingness to participate in the research or not. All the thirty four

participants agreed to take part in the research and therefore signed the consent form. To ensure anonymity, respondents were asked not to write their names on the questionnaires. The participants were assured that the data collected will not in any way be used for anything but for this study and publication of results.

3.5 Data collection and Analysis

This study employed a structured questionnaire towards gathering data for analysis. The data gathered was explored by means of Statistical Package for Social Sciences (SPSS) version 17 software in descriptive form. The questionnaire was in three thematic areas: the first part dealt with the organizational perspective of an information system; the second part touched on the management perspective of an information system; and the third part tackled the technology dimension of an information system.

3.6 Development of Functional Requirements

The functional requirements of the system were developed based on the data collected through background inquiry, observation, workflow, documentation procedures and focus group discussion. The data was gathered through the maternal and child records' booklets being used by the health institution. In addition, this method also took into consideration end-user's needs.

Based on goals determined by the healthcare providers through background inquiry as well as through maternal and child records' booklets and other associated sources, various entities and requirement specifications were developed. Entities derived from the maternal health records book were; Personal history, medical history, physical examination, medical investigations, Antenatal progress records and delivery records.

Whereas entities derived from the Child Health Records included; Child's personal

information, Child's medical investigations, immunization and vitamin A details, and child's progress records.

Workflow observations through the existing system at the maternal and child welfare clinic guided how and when data would be entered into eHealth application. Use cases were then developed based on data from background inquiry and workflow observations.

3.7 Design of Database Tables

Tables were created for both maternal and child health records. The tables were then subjected to normalization. The normalization which is a data analysis method that organizes data characteristics in such a way that they are assembled to form nonredundant, steady, and adaptive units was used.

3.7.1 Normalization of Tables

To prevent the structured tables to produce redundant data to potentially suffer from update, inserting, deletion and modification anomalies, entities were divided into entry forms based on the following criteria:

- First Normal Form (1NF)

For Tables or entities containing pregnant women details, there were no attributes in the tables such as investigation, med_history, physical_exam, antenatal_progress_record, delivery_outcome that might contain more than one value of a single occurrence of the entities and therefore were classified under 1NF. However for personal_history table, it was realized that, attributes such as facility_details, district_details and region_details in the table that might contain more than one value of a single occurrence of the entity and hence those attributes

were separated to form its own tables or classified into 2NF. For entities containing children details, there were no attributes in the tables such as cimmunvia, cweight_progress, cmed_history, and cinvestigation that might contain more than one value of a single occurrence of the entities and therefore classified under 1NF.

There were however, in cinfo and csiblings tables, attributes (siblings_details, child_certification_details, facility_details, district_details, and region_details) that might have more than one value of a single occurrence of the entity and therefore those attributes were separated to form its own tables or classifies into 2NF.

- Second Normal Form (2NF)

The attributes in the personal-history for pregnant woman details which might contain more than one value of a single occurrence of the entities were separated to form its own tables and these tables were, facility, district and region as shown in appendix L. For child health, entities such as cinfo and csiblings were having some attributes that could cause data redundancy and those attributes (siblings_details, child_certification_details, facility_details, district_details, and region_details) were also separate form its own entities. These entities in the 2NF were, csibling, certification, facility, district and region) as shown appendix M.

3.7.2 Entity Relationship Diagram (ERD)

The ERD that is a graphical depiction of data as entities and their relationships in the database structure in this research are shown in appendixes L and M for maternal and child health entities respectively.

3.8 Design System Interface

Once the database was created and a prototype of the system built, I worked closely with the system users to develop input, output dialogue specification. The end users inputs, outputs, ideas and suggestions especially regarding format were carefully sought. Their ideas and opinions were sought regarding on easy-to-learn and easy-to-use dialogue for the new system.

3.9 System Implementation

The system application, is the transfer of the system into production- that is day-to day operation. In the implementation aspect of the system, the parallel conversion approach which involves running both the old system and the new one for a period of time was employed to implement the proposed system. The implementation phase of the application involved; hardware specifications and software requirements, installation and documentation, training, system maintenance and support.

3.9.1 Hardware Specifications and Software Requirements

The following hardware specifications were used for the application to function effectively and efficiently:

- ✓ **Computer Type:** Desktop, Laptop and Tablet computer;
- ✓ **Random Access Memory (RAM) Capacity:** Must have at least 1Gigabites of memory;
- ✓ **Hard Disk Drive Capacity:** A minimum of 100 Gigabytes;
- ✓ **Processor speed:** a processor speed of at least 1 Gigahertz;

✓ **Application Software Requirements:** A web browser;

✓ **Operating system:** A minimum of Windows 7 operating system; and ✓

Internet availability: A Modem or a robust internet infrastructure.

3.9.2 System Installation

MySQL Database server, PHP application server, Apache web server and a web browser were installed.

3.9.3 User Registration (Adding a New User)

Users were registered by the administrator and assigned individual passwords for access.

3.9.4 Training and Experiment

Ten users were trained by the administrator on how to use the software. Experiments were also conducted on the existing and the new systems. Ten new pregnant women and children each were chosen to measure the time spent to capture their details using the existing (manual system) and the proposed system (electronic system) by eight midwives and two community nurses.

3.9.5 System Maintenance and Support

After installation, the system was put under regular monitoring and evaluation.

CHAPTER FOUR

RESULTS

4.0 Introduction

This chapter looks at the findings of each of the data gathered from the staff of Atua Government Hospital.

4.1 Results of the Maternal and Child Health Records and Loopholes Observed A visit to Somanya poly-clinic revealed that a piloted or a revised maternal health record booklet for the pregnant women was used as compared to Atua government hospital, where the old or different booklet was used. This showed a discrepancy in the maternal booklets used in these health facilities. It was also observed that the DNA test which establishes whether a woman is the biological mother of the baby or not was excluded from maternal health record book. With respect to child health records, it was detected that although both health facilities were using the same booklet, no medical investigations were conducted for children under five years except when a child was sick. Some basic medical investigations such as child's sickling, blood group, Hepatitis B and DNA tests were proposed, accepted and added to the new eHealth application. The health professionals including the medical officer involved in the focus group discussion endorsed that those medical investigations be conducted for children. According to the participants in focus group discussion, those basic medical investigations were so much important to the management of a child's health and could not understand why it was not initially part of the requirement in the child's health booklet.

4.2 Outcome of the Design of Database Tables

The importance of a well-designed database cannot be over emphasized. A well-planned database enhances management and becomes a prized information creator for an organization. The tables created regarding maternal issues based on the entities identified were: personal history, medical history, physical examination, medical investigations, antenatal progress records and delivery records as shown in appendix L. In relationship to the child's health records, the tables created were; child's personal information, child's medical investigations, immunization and vitamin A details, and child's progress records as indicated in appendix M.

4.3 Results of the Dimension of Information System

4.3.1 Organizational perspective

The result of the age categories of the staff is presented in table 4.1.

Table 4.1 Age category of staff

Age groups	Frequency	Percentage
20-29	9	26.5
30-39	9	26.5
40-49	9	26.5
50-59	7	20.6
Total	34	100.0

Source: Field data

Respondents were requested to specify the category of staff they fall within. The outcome of staff category is shown in table 4.2.

Table 4.2 Staff Category of respondents

Staff Category	Frequency	Percentage
Management Members	9	26.5
Non-Management Members	25	73.5
Total	34	100.0

Source: Field data

Respondents were further requested to give their opinion on whether there was a problem with the current workflow. The essence of this question was to ascertain whether there was any problem with the current workflow at the MCH clinic. The result is illustrated in table 4.3

Table 4.3 Opinion on whether there is a problem with the current workflow at MCH clinic

Response	Frequency	Percentage
No	32	94.1
Yes	2	5.9
Total	34	100.0

Source: Field data

Respondents were further asked whether there is any problem with the documentation tools being used at the MCH clinic. The result of the question is displayed in table 4.4.

Table 4.4 Problem(s) with documentation tools at the MCH clinic

Response	Frequency	Percentage
No	1	2.9
Yes	33	97.1
Total	34	100.0

Source: Field data

Respondents again were asked to state or chose the problems associated with the documentation tools at the MCH clinic. This question was a sub-question to the previous question. The importance of this question was to allow respondents make better clarification. The result of this question is illustrated in table 4.5.

Table 4.5 Problems associated with documentation tools

Problems	Frequency	Percentage
Cumbersome Documentation Tools	7	21.2
Duplicated Documentation Tools	20	60.6
Inconsistent Documentation Tools	6	18.2
Total	33	100.0

Source: field data

The respondents were asked to express their opinion on how to improve upon the documentation tools or process to enhance the quality of work. The result is displayed in table 4.6.

Table 4.6: How to improve upon documentation process

Response	Frequency	Percentage
Improve the manual system	6	18.2
Introduce an electronic or a computerized System	17	51.5
Organize Training on documentation tools	10	30.3
Total	33	100.0

Source: field data

4.3.2 Technology Perspective

Respondents were further requested to rate their ability to use ICT tools. The relevance of this question was to find out how easy it would be to integrate eHealth application into health care delivery system. The result of this question can be seen in table 4.7.

Table 4.7: Respondents knowledge in ICT

Response	Frequency	Percentage
Knowledgeable in ICT	0	0
A little high Knowledge in ICT	4	18.2
Limited Knowledge in ICT	13	38.2
No Knowledge in ICT	17	50.0
Total	34	100.0

Source: field data

Respondents' age category with respect to their knowledge in the use of ICT was looked at and the result is illustrated in table 4.8.

Tale 4.8 Age category of respondents in relation to knowledge in ICT use

Age category	A little high Knowledge in ICT	Limited Knowledge in ICT	No Knowledge in ICT	Total
20-29	7 (53.8%)	1 (25%)	1 (5.8%)	9
30-39	5 (38.5%)	2 (50%)	2 (11.8%)	9
40-49	1 (7.7%)	1 (25%)	7 (41.2%)	9
50-59	0	0	7 (41.2%)	7
Total	13	4	17	34

Source: Field data

The study looked at the category of staff in relation to knowledge in the ICT use. The result is displayed in table 4.9.

Table 4.9 Staff category in relation to knowledge in ICT use

Staff Category	A little high Knowledge in ICT	Limited Knowledge in ICT	No Knowledge in ICT	Total
Management Members	7 (53.8%)	0	2 (11.8%)	9
Non-Management Members	6 (46.2%)	4 (100%)	15 (88.2%)	25
Total	13	4	17	34

Source: Field data

Again, respondents were requested to indicate whether there were ICT tools such as computers, modems and so on at MCH clinic. Table 4.10 shows the result of the question.

Table 4.10: ICT tools availability at the MCH clinic

Response	Frequency	Percentage
No	34	100.0

Source: Field data

In addition, the respondent were asked to know whether in their opinion the introduction of an electronic system will improve upon the management of maternal and child health. The outcome is displayed in table 4.11.

Table 4.11 Opinion on the improving the management of maternal and child health through introduction of electronic system

Response	Frequency	Percentage
No	2	5.9
Yes	32	94.1%
Total	34	100.0

Source: Field data

Checks were also conducted at the health facility to ascertain whether telecommunication operators in Ghana (MTN, Tigo, Vodafone, Airtel, Expresso and Glo) that provide internet

services were having network signals. The signal strengths were not stable but fluctuating from time to time. Table 4.12 shows the result.

The table 4.12: Various networks signal available and signal strength picked up during the time networks were monitored

No.	Network Name	Signal Picked up	Signal strength
1	MTN Ghana	EDGE/WCDMA/HSDPA	Medium-High: (70-96%)
2	Vodafone Ghana	EDGE	Medium-High: (70-90%)
3	Tigo Ghana	EDGE	Low-High: (50-80%)
4	Airtel Ghana	EDGE	Low-High: (50-80%)
5	Glo Ghana	EDGE	Low-Medium: (50-70%)
6	Expresso Ghana	CDMA/EVDO	Low-Medium: (50-70%)

Source: Field data

4.3.3 Management Perspective

Respondents were asked to indicate whether management was prepared to provide human resource required for an electronic system. Both management members and nonmanagement members were asked. The outcome of the question is shown in table 4.13.

Table 4.13 management preparedness to provide human resource to support an electronic system

Response	Frequency	Percentage
No	10	29.4
Yes	24	70.6
Total	34	100.0

Source: Filed data

The study also assessed staff category in relation to their opinion on management preparedness to provide support in terms of human resource with an introduction of an electronic or a computerized system at the MCH clinic. The outcome is shown in table

4.14.

Table 4.14 Staff category in relation to management preparedness to provide human resource

Staff category	No	Yes	Total
Management Members	1 (11.1%)	8 (88.9%)	9
Non-Management Members	9 (36%)	16 (64%)	25
Total	10	24	34

Source: Field data

Again, respondents were entreated to indicate whether management was ready to provide ICT tools such as computers, modems, credits among others for an electronic system.

Management members and non-management members were both asked this question.

The result is shown in table 4.15.

Table 4.15 Management ready to provide ICT tools to enhance work delivery at MCH clinic

Response	Frequency	Percentage
No	9	26.5
Yes	25	73.5
Total	34	100

Source: Field data

Again, staff category with respect to the acceptance of introduction of an electronic or a computerized system was tackled as the result is displayed in table 4.16.

Table 4.16 Staff category in relation to acceptance of introduction of an electronic or computerized system at MCH clinic

Staff category	No	Yes	Total
Management Members	0	9 (100%)	9
Non-Management Members	2 (8%)	23 (92%)	25

Total	2	32	34
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Source: Field data

This study examined staff category in relation to their opinion on management readiness to provide ICT tools such computers, modems, credits among others to facilitate health service delivery at the MCH clinic. The result is presented in table 4.17.

Table 4.17 Opinion of staff category in relation to management readiness to provide ICT tools

Staff category	Management ready?		Total
	No	Yes	
Management Members	1 (11.1%)	8 (88.9%)	9
Non-Management Members	8 (32%)	17 (68%)	25
Total	9	25	34

Source: field data

4.4 System Testing

The system testing and evaluation was conducted in both simulated and real environment. The system was tested using the existing system (manual system) and the proposed system with data supplied by the hospital. The testing was carried out together with the eight midwives and two community health nurses rather than with stimulated test data to measure the time spent in capturing the pregnant women and the children details. The results of the testing are shown in tables 4.18 and 4.19 for both maternal and child health system.

Table 4.18 Result of testing of maternal health registration tool.

Observation number	Time spent in minutes		Outcome
	Existing System	Proposed system	
1	15	16	Data captured/documentated

2	14	14	Data captured/documentated
3	14	14	Data captured/documentated
4	13	13	Data captured/documentated
5	14	10	Data captured/documentated
6	12	10	Data captured/documentated
7	13	12	Data captured/documentated
8	12	11	Data captured/documentated
9	13	12	Data captured/documentated
10	12	12	Data captured/documentated

Average time spent per entry (Existing system): 13 minutes

Average time spent per entry (Proposed system): 12 minutes

Table 4.19 Result of Testing of Child health registration tool/form

Observation number	Time spent in minutes		Outcome
	Existing System	Proposed system	
1	12	15	Data captured/documentated
2	13	12	Data captured/documentated
3	12	13	Data captured/documentated
4	13	12	Data captured/documentated
5	11	12	Data captured/documentated
6	12	12	Data captured/documentated
7	13	11	Data captured/documentated
8	11	10	Data captured/documentated
9	14	11	Data captured/documentated
10	12	12	Data captured/documentated

Average time spent per entry (Existing system): 12 minutes

Average time spent per entry (Proposed system): 12 minutes

4.5 Use Cases

Use cases were developed based on workflow, observation, interviews carried out at the health facility. The tables below show samples of some textual or tabular descriptions of the use cases.

Table 4.20 Use case for user registration form

Use case description: User Registration
Actor: System's Administrator
Scenario: <ul style="list-style-type: none">i. Administrator validates midwife/CHN/Doctor;ii. Administrator registers midwife/CHN/Doctor using the following data elements: <i>Password ID, User name, Password, Privilege, Staff ID</i>;iii. Administrator saves client's records and client record is uploaded to the server.
Output: New midwife/CHN is registered into the system.

Table 4.21 Use case for maternal health registration form

Use case description: Maternal Client Registration

Actor: midwife

Scenario:

- iv. Midwife validates client's data;
- v. Midwife creates record that captures the following data about the pregnant woman: *Registration number, Registration date, Surname, Other names, Health Insurance Number, Expiry date, Date of birth, Age, Home address, Occupation, Marital status, Mobile Number, Name of husband/partner, Occupation of Husband, Occupation of husband, Address of husband, Mobile number of husband, Next of kin, Mobile of next of kin*; vi. Midwife saves client's records and client record is uploaded to the server.

Output: New maternal client is registered into the system

Table 4.22 Use case for maternal client health investigations form

Use case description: *Maternal client's health Investigations*

Actor: midwife

Scenario:

- i. Midwife verifies if client registration details exist in the system;
- ii. Midwife enters results of client's health investigations results that captures the following data elements: *Registration ID, Investigation ID, Investigation date, Hb level, Sickling test, HbElectrophoresis, Rheusus factor, Antibody screen, VDRL/PRP, HBsAg, Stool R/E, Urine R/E, HIV status, DNA test, Ultra sound* iii. Midwife saves client's records and client record is uploaded to the server.

Output: Maternal client health investigations captured into system

Table 4.23 Use case for child health registration form

Use case description: **Child Registration**

Actor: Community Health Nurse (CHN)

Scenario:

- i. CHN validates client's data;
- ii. CHN creates record that captures the following data about the child: *Child ID, Surname, Other names, Gender, birth date date, birthplace, mother's name, educational level of mother, Mobile number of mother, Address*
- iii. CHN saves client's records and client record is uploaded to the server.

Output: New Child record registered in the system

Table 4.24 Use case for Child's progress records form

Use case description: Child Progress Records

Actor: Community Health Nurse (CHN)

Scenario:

- i. CHN verifies if client registration details exist in the system;
- ii. CHN enters child's progress records that capture the following data elements: *Progress ID, Date of attendance, Weight, Age, Remarks, Name of Midwife/Doctor, Next appointment.*
- iv. CHN saves client's records and client record is uploaded to the server.

Output: Child's progress records captured into system

CHAPTER FIVE

DISCUSSION, CONCLUSION RECOMMENDATIONS AND

FUTURE RESEARCH

5.0 Introduction

In this chapter, the results of the data that was gathered in this study as presented in chapter four are discussed here. This chapter also touched on the conclusion, recommendations and areas of future research. The study analyzed certain characteristics which has direct influence on the dimension of the information system. The chapter also highlighted the details of the results of the review of the maternal and child health record booklets emanating from focus group discussion and background enquiry.

5.1 Discussion of the outcomes

5.1.1 Outcome of the Review of Maternal and Child Records' Booklets

The review of the maternal health record book during the focused group discussion revealed that even though medical investigations such as Haemoglobin, Sickling test, HbElectrophoresis, blood group, Rhesus factor, HIV status Antibody screen, HBsAg, stool RE, urine RE, and ultrasound were part of the requirements, DNA test was excluded. DNA test assists in paternity testing, which establishes whether a woman is the biological mother of a baby or not. There are common questions that are often asked relating to paternity during pregnancy. Looking for responses to these questions and making a decision has physical, emotional and financial benefits for both parents and the child. Presently, there are series of missing or allegedly stolen babies in the health facilities in the country, it was imperative that paternity testing be incorporated into maternal and child records. The establishment of the paternity of a child is important to his or her welfare. Apart from protecting child's future, determining the biological relationship is important for so many reasons. Among the

reasons are that it provides an accurate medical history for the child, gives healthcare providers additional insight during diagnosis and in managing the child's health; strengthens the bond between biological individuals, such as a father or mother and the child; and also establishes legal and social benefits, together with social security and inheritance remunerations. The review of the child record booklet also revealed that some basic laboratory test such as sickling, blood group, Hepatitis B and DNA were suggested during the focus group discussion and added to the functional requirement of the eHealth application to improve upon child healthcare delivery.

5.1.1.1 Analysis and Evaluation of Experimental Results

Experiments conducted using the designed eHealth application to capture ten pregnant women details by the midwives revealed that 12 minutes on average was spent in completing the registration process using electronic system whilst 13 minutes was spent on average to register ten pregnant women using the manual system as shown in table 4.18.

On the children, ten children details were also captured by the community health nurses and it revealed that an average of 12 minute each were taken to complete the registration process using both the proposed system and the existing system respectively as illustrated in table 4.19. Relatively, there was only a minute difference between the overall mean time spent in completing registration details of pregnant women using both the manual system and the proposed systems. The difference in time spent using the manual and electronic system was not much. Notwithstanding, overall mean time on the registration could improve with time since the eHealth application was new to the midwives and the community nurses. Besides, it was observed that the main advantage of

the new system over the existing system was the dependability characteristic of the eHealth application which include system reliability, security and safety.

5.1.2 The Dimension of the Information System

The discussions on the dimension of the information system was focused on three thematic areas of a computer-based information system, namely; organizational, technology and management perspectives.

5.1.2.1 Organizational Perspective

There were a total of thirty four (34) respondents made up of a medical doctor, twenty three (23) midwives, two (2) community nurses and nine (9) other health professionals. The age range of respondents was 20 to 59 years. As shown in table 4.1, almost 80% of staff were less than 50 years. This is an interesting result as much of the workforce are quiet younger.

There is a perception that elderly workforces are more delicate. That is, they are not up to date technologically and slower to learn and may be less productive than the younger ones.

The younger ones age, the faster one's ability to learn how to use technology. Aged workforces are thought to be less productive compared to the younger ones.

Once more, it was found that 73.5% of the staff interviewed were non-management members whilst 26.5% were management members as illustrated in table 4.2. One critical function is that managers identify problems in the industry and device organizational tactics to tackle challenges as well assign human and financial resources required to solve the problems. Quite a substantial number of management members were interviewed which has direct impact on the successful implementation of eHealth application at the MCH clinic. Management involvement is therefore crucial as their much needed support is

required in the provision of ICT tools such computers, modems, credit among others including the provision of requisite human resource at the MCH clinic.

Table 4.3 shows that 94.1% (32 out 34 respondents) interviewed indicated that there was no problem with the current workflow at the MCH clinic. However, majority of staff (33 out 34, representing 97.1%) overwhelmingly said there were problems with the documentation tools as indicated in table 4.4. As also shown in table 4.5, 60.6% (20 out of 34) of the respondents said the documentation tools were duplicated, followed by 21.2% (7 out of 34) respondents indicated the documentation tools were cumbersome, whereas 18.2% (6 out of 34) respondents noted the documentation tools were inconsistent. This calls for urgent need to revise or simplify the documentation tools.

Table 4.6 illustrates the opinion of respondents on what should be done to improve the documentation tools at the MCH clinic. Those who wanted an introduction of an electronic system scored 51.5%. This was followed by organization of training on documentation tools, 30.3% and finally, 18.2% voted for the improvement of the manual system. This reveals the respondents' general acceptance of ICT as a better means of improving documentation and overall quality work delivery at MCH clinic.

5.2.2.2 Technology Perspective

To strengthen health information systems, it is believed that spending resources on the capacity building of workers' knowledge yields a better profit, compared to solely

spending in technological solutions. Interestingly, table 4.7 revealed variation in workers knowledge with respect to ICT usage. It was discovered that half of the workforce interviewed (50%), indicated they have no knowledge in the use of ICT, 38.2% however said they have limited knowledge in the use of ICT, whilst 18.2% noted they have a little knowledge in ICT. Table 4.8 had revealed that there is a variation in the workers knowledge in the use of ICT as we move across the age categories. Whereas quite an impressive number (53.8%) of the workers in the age category of 20-39 years have a little high knowledge in the use of ICT, their counterpart in the age category of 40-59 years (7.7%) have a little knowledge in the use of ICT. Relatively, as we move down the age categories, the level of workers knowledge with respect to ICT usage increase (41.2% each for 50-59 and 40-49 age categories respectively, 11.2% for 30-39 years and 5.8% for 20-29 years with no knowledge in ICT use) as shown in figure 4.8.

Information and Community Technologies in workplace this times are essential and effective use of technology is important to upsurge productivity and improvements. Building the capility of workforce in ICT training is highly effective and it represents a real and speedy profit on investment for organizations. If employees are trained in ICT usage, there is a possibility for them to work faster and also helps them make less errors. As revealed in figure 4.9, most of the management members interviewed (53.8%) have a little higher knowledge in the use of ICT. As discovered in the table 4.9, fifteen (15) of non-management members interviewed, representing 88.2% had no knowledge in the use of ICT. Comparatively, 7 out of 13 workers (53.8%) that said they have a little high knowledge in ICT were management members while 6 out of 13 (46.2%) staff were nonmanagement members.

As illustrated in table 4.10, all workers interviewed indicated that the MCH clinic does not have ICT tools such as computers, modems among others for its daily transaction.

According to the workers, there was no single day ICT tools were used for daily transaction at the clinic; all daily activities were done manually. ICTs are one of the many tools available for dealing with change in the health delivery system.

As indicated in table 4.11, a total of thirty-two (32) health staff interviewed (representing 94.1%) expressed their opinion that the introduction of an electronic system at the maternal and child health clinic will greatly enhance the management of service delivery.

On the other hand, 5.9% (only two) of the respondents stated that the introduction of a computerized system will not in any way have positive outcome on the quality of work delivery at maternal and child welfare clinic.

Interview of workers at the health facility showed that apart from the MCH clinic not having or using computers for its daily transactions, there was no robust internet infrastructure apart from modems that were used in some few offices in the hospital that use computers. As indicated in table 4.12 checks conducted also at the health facility indicated that all telecommunication service providers (MTN, Tigo, Airtel, Vodafone,

Glo and Espresso) were having network signals. Some of the networks were 3G while other signals available were General packet Radio Service (GPRS) and Edge among others. The signal strengths were not stable but fluctuating from time to time. As indicated in figure 4.12 apart from MTN Ghana and Vodafone Ghana networks that the signal strengths were from *Medium - High* (that is 70-96% and 70-90% respectively), other signals picked during the monitoring at the health facility were from Low-High. Airtel, Tigo, Glo and Espresso networks signals ranged between 50-80% (Low –High) respectively.

5.1.2.3 Management Perspective

On the management perspective of a computer-based information system, 70.6% (24 out of 34) respondents said the management was prepared to provide human resource needed to support an electronic or a computerized system, whereas 29.4% (10 out of 34) respondents expressed different opinion as shown in table 4.13. The opinion of the staff on the preparedness of management to provide human resource to support electronic system based on staff category varied but did not vary so much. Relatively, whereas 88.90% of management members thought they were prepared to provide human resource, 64% of non-management members interviewed also believed so as shown in figure 4.14. It was also found out that 73.5% (25 out of 34) of the health workers interviewed said management was ready to provide ICT tools such as computers, modems among others to enhance work delivery at MCH clinic whilst 26.5% thought otherwise as indicated in figure 4.15. There was a little variation among category of staff but the opinion did not vary so much. Whereas table 4.17 revealed that 88.9% of management members said the management was prepared to provide ICT tools, 68% of non-management members believed that the management was ready. The successful implementation of a computerbased information system is dependent on management's involvement; acceptance, allocation of resources and any other support that may be required. The provision of ICT equipment such as computers, internet facility and other computing devices play an important role for effective operation of a computer-based information system.

5.2 Conclusion

The conclusions drawn from this research are as follows:

- Even though respondents indicated there was no problem with the current workflow at the maternal and child health clinic, notwithstanding, there were problems with the documentation tools. Among the problems identified were; duplicated documentation tools, cumbersome documentation tools and inconsistent documentation tools;
- Interestingly, a significant number of the health workers expressed confidence that the introduction of a computerized or an electronic system will significantly improve upon the documentation process at the maternal and child health clinic. Even though eHealth is instrumental in addressing problems relating to the documentation process, considerate design was important for successful implementation and sustainability.
- The limited knowledge of ICT usage by the healthcare providers has the potential to impede effective and efficient implementation of the eHealth application. For the system to be successful, the end-users must reach a certain level of technical self-efficiency. This usually entails training not necessarily related to the actual system, such as word processing or internet search skills, in addition to training on the software being implemented;
- Technology, particularly with regards to infrastructure, will remain a limitation to the deployment of the eHealth application. The need for the managers of the health services to provide ICT tools such as computers, modems and among others as well as offer human resource required to support an electronic system at the maternal and child health clinic is therefore very essential;
- The eHealth application makes it easier to develop and maintain a comprehensive maternal and child registry that facilitate the ability to implement targeted

interventions. The system has also shown that deploying of eHealth application can increase the level of accountability of midwives and community health nurses while enabling the health team to better manage maternal and child healthcare;

- The SMS based approach, using a system like eHealth application can lead to improved maintenance of maternal and child historical records which in effect can help monitor a community's health;
- Overall, this research has shown that with a working eHealth healthcare system, with midwives and community health nurses assigned to specific homes, it is possible to begin to build a comprehensive maternal and child registry where every pregnant woman and child is counted. This registry can then be used to help closely monitor pregnant women and children with major risk factors, thereby empowering the midwives and community health nurses with the knowledge to begin to track clients;
- One of the initial core functions of the eHealth application is the alert system that facilitates the sharing of pregnant women and children's status among healthcare professionals and the follow up alert system that is used to help prompt midwives and community health s to check up on sick pregnant women and children. The important focus moving forward will be to introduce functionalities that help monitor and improve the treatment of care once a pregnant woman or child has been diagnosed with an illness. The system will also be extended to allow the care giver to signal when there is a problem or check on a client's status; and
- The dependability of an eHealth application is one of the critical function in the provision of quality healthcare. One major advantage of the eHealth application

over the manual system noticed is the dependability characteristics which include but not limited to reliability, security and safety.

5.3 Recommendations

It is noteworthy to state that at the end of this study, there are important challenges that required to be attended to. The following recommendations were made to address those challenges;

- i. There is the need for implementation of eHealth system for management of maternal and child health at the clinics. This should be put into operation to significantly reduce the cost of health care, improve quality of healthcare delivery as well as increase productivity;
- ii. There should be periodic staff development programmes such as in-service training, workshops or seminars to update the health workers knowledge in the area of application of ICT usage; iii. There should be workshops with multiple stakeholders groups addressing issues of knowledge building on the critical role that ICT can play in the provision of healthcare, alleviation of fears around ICT and also clarifying the technology behind ICT introduction as an important tool in solving complex information and planning problems in the healthcare delivery system. iv. The provision of technological infrastructure is another critical area that needs to be addressed. Managers of healthcare provision should ensure that the technological tools such computers,

internet facility among others are available for workers to discharge their duties effectively and efficiently.

5.4 Future Research

Future research on this project will include this project to build a more integrated and reliable patients' records management system. These areas include;

- ✓ Integrated Out-Patients and In-Patients management system;
- ✓ Health Insurance patients Billing system;
- ✓ Health Surveillance and control systems;
- ✓ Human resource management system; and
- ✓ Inventory Control system for the hospital's store.

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APPENDICES

Appendix A: Questionnaire

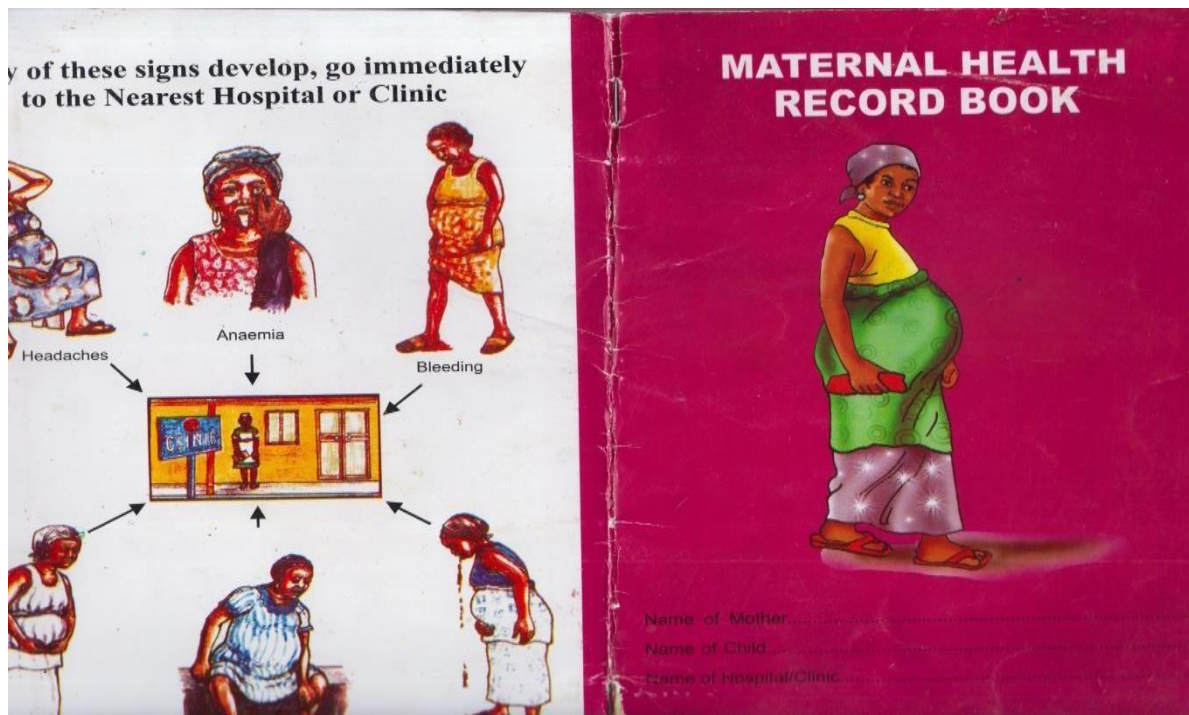
QUESTIONNAIRE ON THE DESIGN OF E-HEALTH APPLICATION FOR MANAGEMENT OF MATERNAL AND CHILD HEALTH: A CASE STUDY OF ATUA GOVERNMENT HOSPITAL- LOWER MANYA KROBO MUNICIPALITY IN THE EASTERN REGION OF GHANA.

This work is a Master's Degree research and is purely for academic purpose. Any information received hitherto will be treated with confidentiality. Respondents are assured of anonymity. Cooperation of respondents is therefore highly anticipated.

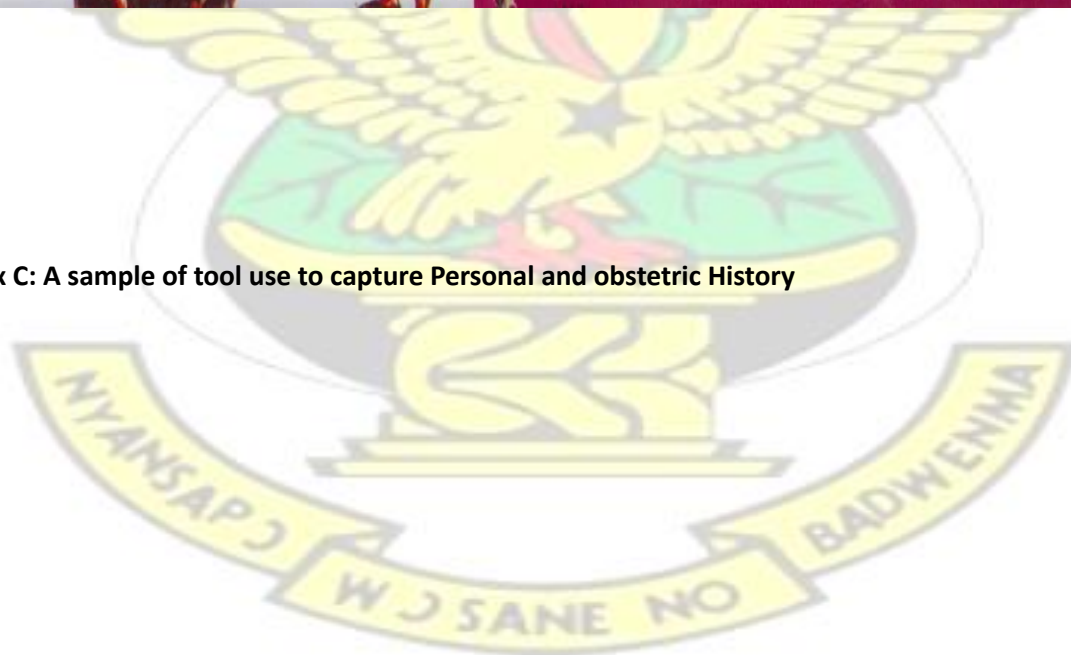
No	Item	Score
	ORGANIZATIONAL PERSPECTIVE	
1	What is your age category? 20-29= 1, 30-39 = 2, 40-49=3, 50-59=4	

2	What category of staff do you fall within? Management Member=1, Non-Management Member=2	
3	In your opinion, do you think there is a problem with current workflow at Maternal and Child Health (MCH) clinic? No=1, Yes=1	
4	If yes, what are the challenges of current workflow?	
5	Do you have any problem with the documentation tools at Maternal and Child Health (MCH) clinic? No=1, Yes=2	
6	If yes, what are the challenges? Duplicated documentation tools=1, Cumbersome documentation tools=2, Confusing documentation tools=3, Inconsistent Documentation tools=4, Others (Specify).....	
7	In your opinion, what do you think can be done to improve upon documentation tools? Improve upon the manual system=1, Introduce computerized system=2, Organize training on documentation tools=3, Others (Specify)..... =4	
	TECHNOLOGY PERSPECTIVE	
8	What is your level of knowledge in the use of ICT? No Knowledge in ICT=1, Limited Knowledge in ICT=2, A little high knowledge in ICT=3, Knowledgeable in ICT=4	
9	Is Maternal and Child Health (MCH) clinic having ICT tools such as computers, modems etc? No=1, Yes=2	
10	Do you think an introduction of electronic system will improve upon the management of maternal and child health at the MCH clinic? No=1, Yes=2	
	MANAGEMENT PREPAREDNESS	
11	In your opinion, do you think management is prepared to support a computerized system in the area of human resource at the MCH clinic? No=1, Yes=2	
12	In your opinion, do you think management is ready to provide ICT tools such as computers, modems etc for a computerized system for staff at Maternal and Child Health (MCH) clinic for their daily activities? No=1, Yes=2	

Appendix B: A sample of Maternal Health Record Book



Appendix C: A sample of tool use to capture Personal and obstetric History



MOTHER'S RECORD

PERSONAL HISTORY			
Name:		Hospital Number:	
Age:		Date of First Visit:	
Address: House No:		Name of Midwife/Doctor:	
Educational Status:			
Street Name/Landmark:			
Location:			
Telephone No:		Major Risk Factors:	
Occupation:		Grand multiparity	
Single: Not Married:		Previous C/S	
Name of Husband/Partner:		Previous PPH	
Occupation of Husband/Partner:		Myomectomy	
Next of Kin (if different from partner):		Sickle cell disease (AS, SC, S-Btal)	
Relationship to next of kin:		Other (Specify)	
Address: Telephone:		Menstrual History:	
Home Address: House No:		Duration of Menses:	
Street Name/Landmark:		Number of days between menses:	
Location:		Last Menstrual Period	
		Expected Date of Delivery	
		Number of weeks of Pregnancy at Booking	

OBSTETRIC HISTORY

Gravida: Para: Abortion: Spont: Induced:

Past Pregnancies

	Place of delivery/ Pregnancy Loss	Date of Delivery	Problems during pregnancy	Outcome: live birth, still birth, premature, multiple pregnancy loss	Sex: M/F	Birth weight (kg)	Labour/ Postpartum complications	Condition of child
1								
2								
3								
4								
5								
6								

Appendix D: A sample of tool use to capture *investigations*

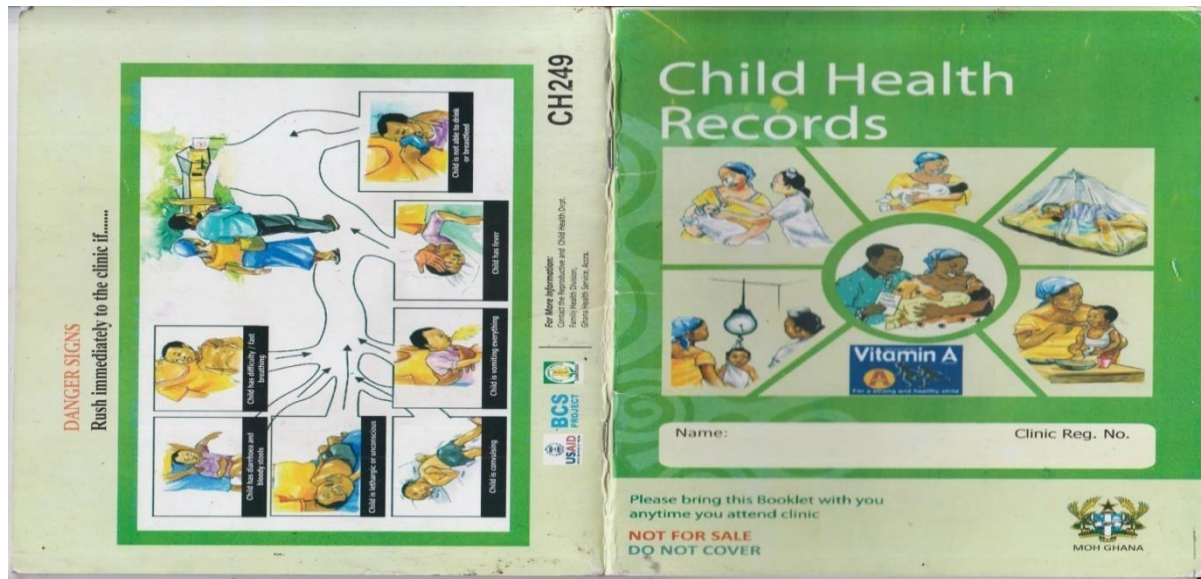
INVESTIGATIONS

Type	Result	Date	Other Investigations		
Haemoglobin			Ultra Sound Scan	Result	Date
Repeat Hb			Gestational Age		
Repeat Hb			Placental Position		
			Liquor Volume		
Antibody Screening			EDD		
VDRL/PRP			Others		
HBsAg			Ultra Sound Scan	Result	Date
HIV Test			Gestational Age		
Repeat HIV Test			Placental Position		
			Liquor Volume		
Stool RE			EDD		
Urine RE			Others		

Topics for Individual Client Education


Topics	Date Discussed	Topics	Date Discussed
Diet/Nutrition/Anaemia		Labour and Delivery	
Personal Hygiene and Environmental Sanitation		Tour of the Labour Ward, Lying - in Ward and Theater	
Rest/Exercise		Baby Care	
Medications (Immunization)		Breastfeeding	
Husband/Support Person Involvement		Usage and Importance of Insecticide Treated Nets	
Birth Preparedness and Complication Readiness		Iron Folate Supplementation (Counseling)	
STI Prevention/Condom Use/Safe Sex		Family Planning Motivation	
Mother to Child Transmission of HIV		Harmful Practices in Pregnancy	
Danger Signs in Pregnancy		Malaria Prevention (ITNs and IPT)	

Appendix E: A sample of child health records booklet



Appendix F: A sample of Child health tool use to capture child's personal Information

PARENT'S PLEDGE



We, the parents of Baby _____, will apply the actions included in this health booklet and do our best so that our child is healthy, grows and develops well.

Parent's Signature/thumbprint

2

CLINIC/HOSPITAL: _____

CLINIC REG NO.: _____

Child's Personal Information

Child's Name: _____

Birth Registration No. _____ Sex: ☐ F ☐ M

Date of Birth: _____ Birth Weight: _____ Kg.

Place of Birth: _____ Date First Seen: _____

Sickle Cell Status: _____ G6PD Status: _____

Mother's Name: _____

Education: ☐ Nil ☐ Primary ☐ JHS ☐ SHS ☐ Tertiary

Father's Name: _____

Education: ☐ Nil ☐ Primary ☐ JHS ☐ SHS ☐ Tertiary

Address (Where family lives): _____

House No./Description: _____

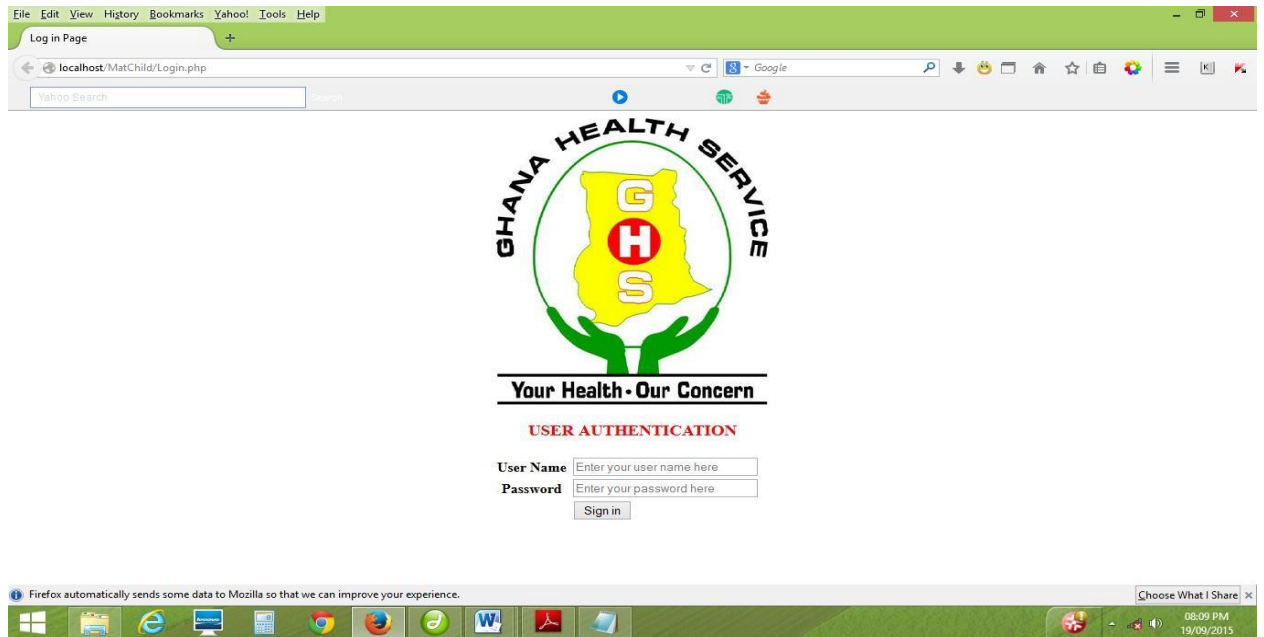
Town/Village: _____

Sub District: _____ District: _____

Region: _____

3

Appendix G: a sample form of User Authentication



File Edit View History Bookmarks Yahoo! Tools Help

Log in Page

localhost/MatChild/Login.php

Yahoo Search

GHANA HEALTH SERVICE

GH

Your Health - Our Concern

USER AUTHENTICATION

User Name

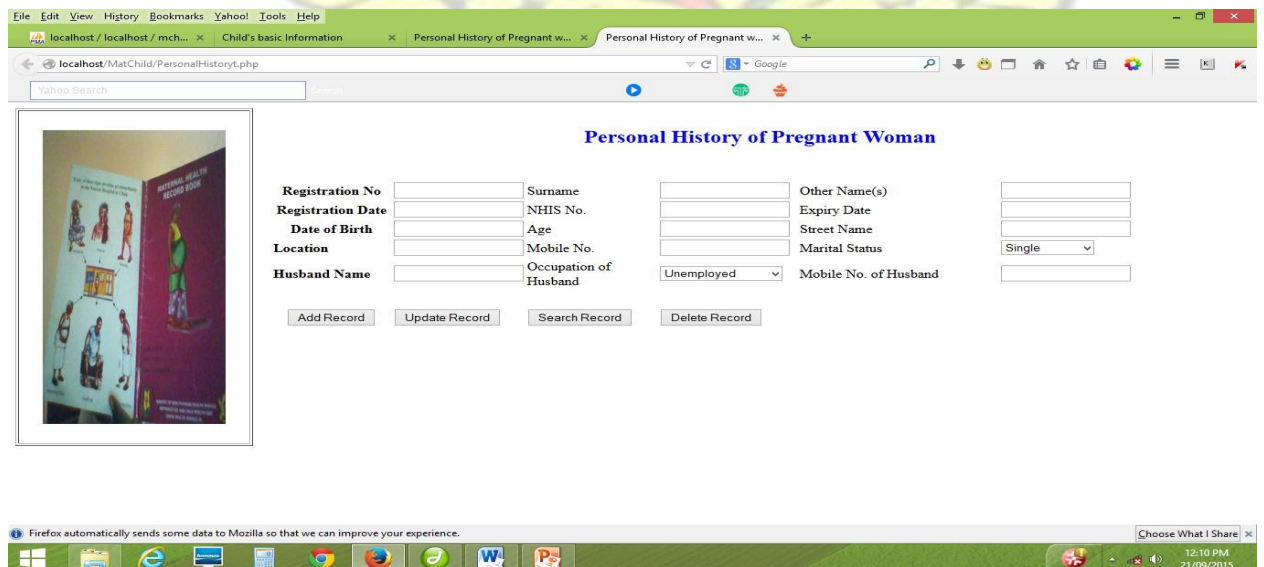
Password

Firefox automatically sends some data to Mozilla so that we can improve your experience.

Choose What I Share

08:09 PM 19/09/2015

Appendix H: a sample registration form of history of pregnant woman



File Edit View History Bookmarks Yahoo! Tools Help

localhost / localhost / mch... Child's basic information Personal History of Pregnant w... Personal History of Pregnant w...

localhost/MatChild/PersonalHistory.php

Yahoo Search

Personal History of Pregnant Woman

Registration No Surname Other Name(s)

Registration Date NHIS No. Expiry Date

Date of Birth Age Street Name

Location Mobile No. Marital Status

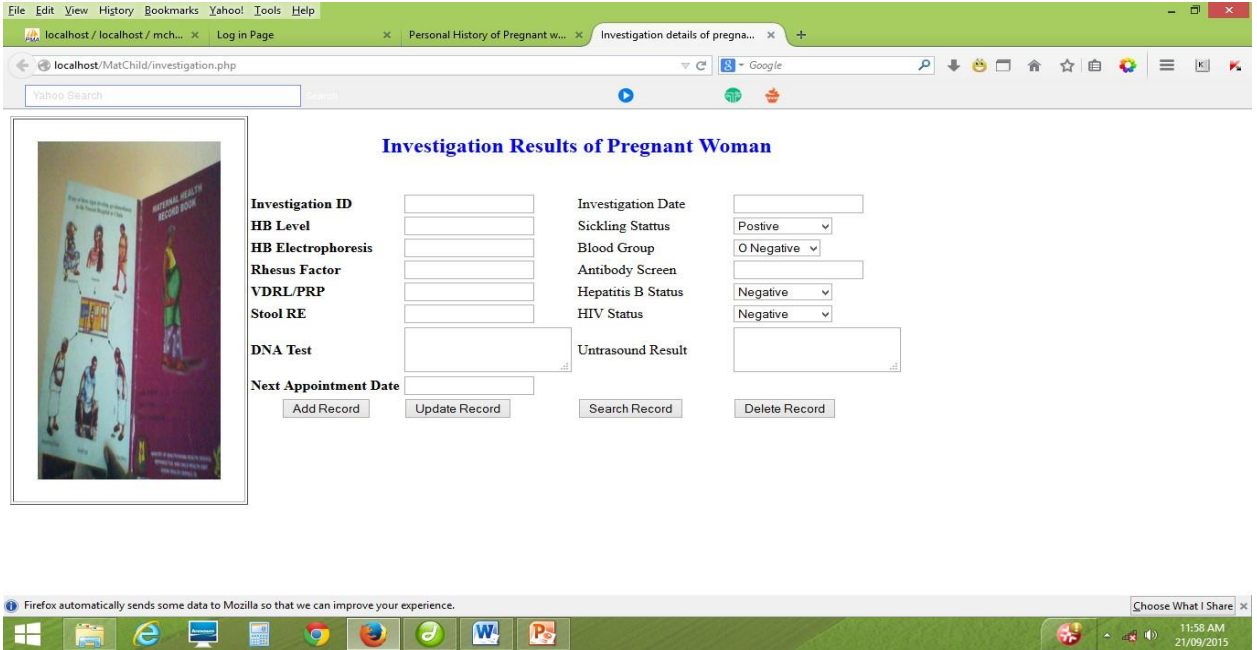
Husband Name Occupation of Husband Mobile No. of Husband

Firefox automatically sends some data to Mozilla so that we can improve your experience.

Choose What I Share

12:10 PM 21/09/2015

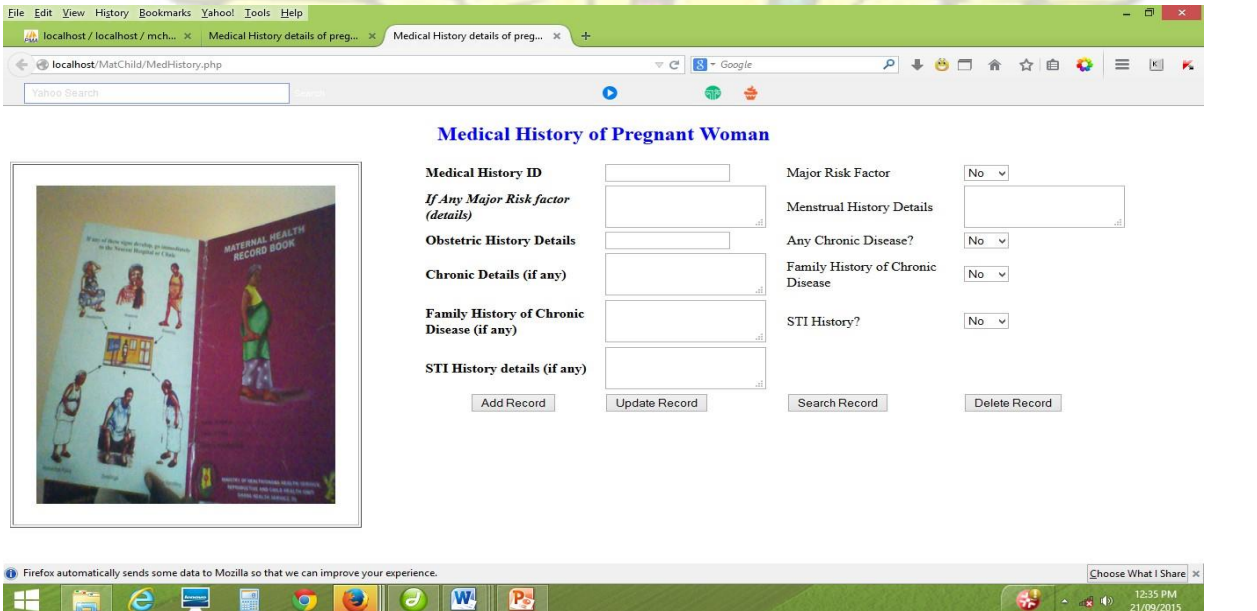
Appendix I: a sample form of investigations of pregnant woman



Investigation Results of Pregnant Woman

Investigation ID	<input type="text"/>	Investigation Date	<input type="text"/>
HB Level	<input type="text"/>	Sickness Status	Positive <input type="text"/>
HB Electrophoresis	<input type="text"/>	Blood Group	O Negative <input type="text"/>
Rhesus Factor	<input type="text"/>	Antibody Screen	<input type="text"/>
VDRL/PRP	<input type="text"/>	Hepatitis B Status	Negative <input type="text"/>
Stool RE	<input type="text"/>	HIV Status	Negative <input type="text"/>
DNA Test	<input type="text"/>	Ultrasound Result	<input type="text"/>
Next Appointment Date	<input type="text"/>		

Appendix J: a sample form of medical history of pregnant woman



Medical History of Pregnant Woman

Medical History ID	<input type="text"/>	Major Risk Factor	No <input type="text"/>
If Any Major Risk factor (details)	<input type="text"/>	Menstrual History Details	<input type="text"/>
Obstetric History Details	<input type="text"/>	Any Chronic Disease?	No <input type="text"/>
Chronic Details (if any)	<input type="text"/>	Family History of Chronic Disease	No <input type="text"/>
Family History of Chronic Disease (if any)	<input type="text"/>	STI History?	No <input type="text"/>
STI History details (if any)	<input type="text"/>		

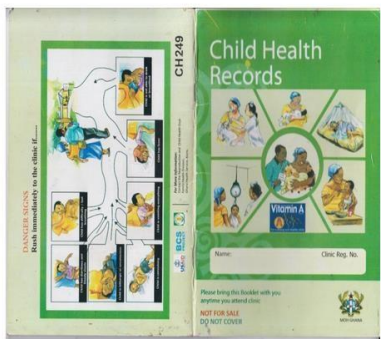
Appendix K. A sample registration form of Child's basic information

File Edit View History Bookmarks Yahoo! Tools Help

localhost / localhost / mch... x Medical History details of preg... x Child's basic Information x +

localhost/MatChild/Child_Info.php

Yahoo Search



Child's Basic Information

Child Registration Registration date

Surname Other name(s)

Date of birth Place of birth

Child mother's Name Child Mother's educational level

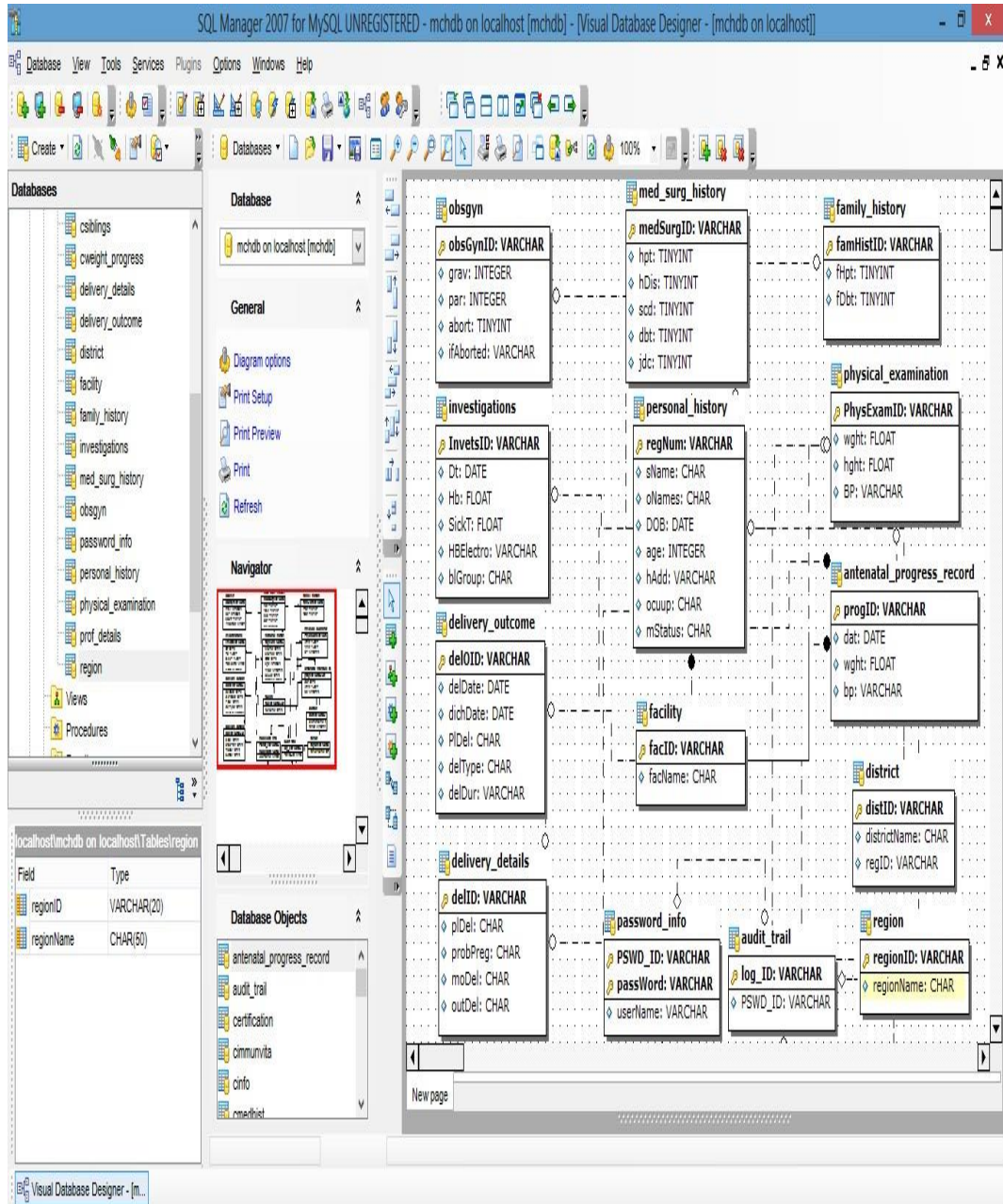
Child Mother's Mobile No. Child Father's Mobile no.

Address (Where family lives)

Add Records Update Records Search Records Delete Records



Appendix L: Entity Relationship Diagram (ERD) for maternal health records



Appendix M: Entity Relationship Diagram (ERD) for child health records

