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Information Science and School of
Public Health
M.Sc in Health Informatics programme
Information Support System for Maternal
and Child Healthcare**

By: OLI KABA

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DECLARATION

I declare that the project “*Information support system for maternal and child healthcare*” is my original work and has not been presented for a degree in any other university.

TITLE PAGE

AFFILIATION: Addis Ababa University School of Information Science and School of Public Health

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STUDENT: Oli Kaba Eba

DATE: June, 2016

Name and Signature of Members of the Examining Board

___ Dr.Rahel Bekele _____	_____	_____
Advisor	Signature	Date

Dr. Mirgissa Kaba _____	_____	_____
Advisor	Signature	Date

Dr. _____	_____	_____
Examiner	Signature	Date

_____	_____	_____
Examiner	Signature	Date

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ACRONYMS

AAU	Addis Ababa University
ANC	Antenatal Care
BHAMC	Better Health for Afghan Mothers and Children
CDMA	Code Division Multiple Access
CHWs	Community Health Workers
DFD	Data flow Diagram
EDHS	Ethiopian Demographic Health Survey
EID	Early Infant Diagnosis
EMR/EHR	Electronic Medical/Health Record
FEP	Federal Employee Program
FMOH	Federal Ministry of Health
FP	Family Planning
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System Mobile
HAD	Health Development Army
HEWs	Health Extension Workers
HRMIS	Human Resource Management Information Systems
HSDP	Health Sector Development Program
ICT	Information Communication Technology

IMR	Infant Mortality Rate
ISS	information support system
IT	Information Technology
IVR	Interactive Voice Response
MAMA	Mobile Alliance for Maternal Action
MDGs	Millennium Development Goals
MMS	Multimedia messages
MNCH	Maternal Neonatal and Child Health
MOTECH	Mobile Technology for Community Health
PDA	Personal Digital Assistant
PHCU	Primary Health Care Unit
PNC	Postnatal Care
SDLC	Software development life cycle
UK	United Kingdom
UML	Unified Modeling Language
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
WHO	World Health Organization

ABSTRACT

Using information technology to reach mothers directly with health information customized to their stage of pregnancy. Mobile phones applications are able to quickly and easily disseminate information that will inform women of ways to care for themselves during pregnancy, dismiss tradition and misconceptions, highlight warning signs, connect women with local health services, reinforce breast feeding practices, explain the benefits of family planning, and make new mothers aware of how best to care for their babies.

The aim of this project is to design information support system for maternal and childcare, to identify the current sources of maternal and child healthcare information and the need for a mobile based system, to design a prototype mobile application platform for providing maternal child healthcare information.

A software development life cycle (SDLC) methodology of object-oriented approach applied to the study of the design system. Interview and document review were used as a main tool to capture the system requirement along with observation. Unified Modeling Language (UML) development techniques applied in the process of requirements capture, modeling, system analysis and design. SPSS and Visio Software were employed in analysis and design models diagramming.

The results of this study show that an expectant women currently access maternal and child healthcare information from the media, brochure (or information sheet), Health extension workers (HEWs) and Health Development Army (HAD). The women in each development group are clustered in one of five networks. In developed countries, mobile phones are widely used to provide maternal and child healthcare information through mobile applications.

Accessing maternal and child healthcare information directly to by expectant women and new mothers is an innovative way to empower women to take action to improve their own health and the health of their children and families.

The researcher recommends the implementation of the design by Partnerships with health professionals , hospitals and healthcare NGO's to ensure the maternal and child healthcare information they provide, antenatal care clinic , health events and more can be informed the target population by means of mobile applications.

CHAPTER ONE: INTRODUCTION

1.1. BACKGROUND

In today's societies, the significant role of information in the overall national development process is being increasingly appreciated. The continued advancement in the information technologies has improved the ways and means of information generation, collection, processing and dissemination. "Today, as we are in an information society, the capacity to generate process, store, transmit and utilize productive information determines the social and economic development of a country. However, the use of productive information for health purposes is limited in developing countries. For instance, according to Africa Freedom of Information Center (AFIC) 2010, Healthcare information especially maternal, infant and child healthcare among Africa's most challenging health problems which requires mechanism required to provide a platform for accessing healthcare information cheaply and faster. For this matter, Mobile technology is one of the mechanisms well positioned to enhance the access to healthcare information to beneficiaries. Bringing a new life to the world is a wonder to everyone.

Regarding maternal and child healthcare, each pregnancy can be different from one pregnancy to the other and from one person to another (Zantey, 2006). In the field of maternal health, information system should be used to provide support during pregnancy (Eugenie et al, 2011). These systems can offer general health and health-care information to pregnant women, provide emergency-care tips and alerts, and supply post-delivery support. The same systems can also be used to offer information about antenatal care (ANC), postnatal care (PNC) and emerging risks to which women are frequently exposed and periodic reminders of the need for preventive care.

This project particularly relates to the case of Ethiopia which is the second most populous country in Africa. Projections from the 2007 population and housing census estimate the total population for the year 2015 to be 90 million. Ethiopia is the home of a variety of nations, nationalities and peoples with more than 80 different spoken languages. The average size of a household is 4.7. The pyramidal age structure of the population has remained predominately young with 44.9% under the age of 15 years, and over half (52%) of the population in the age

group of 15 and 65 years. The average fertility trend has shown significant decline in recent years from the 2000 level of 5.5 births to 4.1 births per woman (EDHS 2014).

It has a three-tier health care delivery system which is characterized by a first level of Woreda /district health system comprising a primary hospital (with population coverage of 60,000 – 100,000 people), health centers (1/15,000-25,000 population), and their satellite health posts (1/3000-5,000 population). A second level in the tier made up of a general hospital with population coverage of 1-1.5 million people; and the third a specialized hospital that covers a population of 3.5-5 million. A primary hospital and each health center with five satellite health posts form a Primary Health Care Unit (PHCU). The main health problems of the country remain largely preventable, communicable diseases and nutritional disorders, although the country is increasingly facing the double burden of diseases due to chronic health problems such as cardiovascular diseases, diabetic mellitus and cancers (FMoH, 2012).

In Ethiopia, the current methods through which information provided to women in the reproductive age group (15 to 49 years) are the media, brochure (or information sheet), Health extension workers (HEWs) and Health Development Army (HDA). The women in each development group are clustered in one of five networks. The one- to- five networks develop to each individual women in the network (HSDP IV, 2015).

Access to information through mobile phone can mean access to information about pregnancy, childbirth and the first year of life and empower women to make healthy decisions for themselves and their families. Using information technology to reach mothers directly with health information customized to their stage of pregnancy. Mobile phones are able to quickly and easily disseminate information that will inform women of ways to care for themselves during pregnancy, dismiss tradition and misconceptions, highlight warning signs, connect women with local health services, reinforce breast feeding practices, explain the benefits of family planning, and make new mothers aware of how best to care for their babies.

This project intends to improve the information service in the health sector through the application of modern information technologies by designing the information support system for expectant women. Improvement in the information support system (ISS) in health care contributes towards better medical service, patient care, and management of the resources of

the unit. The system can position itself as a major breakthrough approach to educate women on reproductive age group, create awareness, monitor their own and child's progress, follow up with medical checkups, critical updates and post delivery support through modern information technology. Women in rural and urban area can benefit through this system greatly by preparing for child birth and post delivery.

1.2 STATEMENT OF THE PROBLEM

According to WHO 2015 report, while great an important positive development have been made to reduce maternal mortality in the lead-up to reaching the Millennium Development Goal target year of 2015, 289,000 women are still dying every year during or around pregnancy and childbirth. The vast majority of these deaths (99 percent) occur in low income countries, primarily in sub-Saharan Africa and Asia. Moreover, while neonatal mortality has decreased, 2.9 million babies still die within the first month of life. Reductions in maternal and newborn mortality have been slower than those in other health areas. The main causes of maternal death hemorrhage, Pre-eclampsia and Eclampsia, sepsis, and unsafe abortion and obstructed labor are all largely preventable. Similarly, babies are also dying of mainly preventable causes, including sepsis, asphyxia, and preterm birth.

In Ethiopia most of maternal and neonatal deaths occur during delivery and post-delivery period. This indicates that there are still significant obstacles in terms of access to and provision of maternal care service such as antenatal and obstetric health care services, postnatal care (PNC), family planning (FP), and Immunization. There are several factors influencing skilled maternal health care utilization within the dimensions of skilled maternal care definition. These factors are: maternal education, parity, residence, awareness and perceptions related to the risks of pregnancy and skilled maternal services, previous experiences, women's decision-making power, household wealth and the availability, readiness, and quality of services as well as the type, competence and caring behavior of providers and the presence of low education coverage, geographical isolation, and high poverty rate in the community reduce access and utilization of skilled maternal services(FMoH 2012). Maternal deaths occur due to the three delays: delay in seeking appropriate care; delay in reaching an appropriate health

facility; and delay in receiving adequate emergency care once at a facility. Home delivery/ low utilization of service, lack of recognition of danger signs both in newborn and pregnant women (Vital, 2011).

MDGs progress report, in Ethiopia most of maternal and neonatal deaths occur during delivery and post-delivery period. This indicates that there are still significant obstacles in terms of access to and condition of antenatal and obstetric health care services, especially in rural areas (Menegesha, 2011). According to Sanda (2014) missed appointments in Antenatal care (ANC) services delivery are a major cause of inefficiency in maternal care delivery, with substantial monetary costs for the health system, leading to the three delays in diagnosis and appropriate treatment during pregnancy.

The under-utilization of Antenatal Care services (ANC) by pregnant women is borne out of the assumption that most of the pregnant women are not adequately exposed to health information. Study made by (Jongh et al. 2012) showed that frequent information system exposure, usage and awareness on ANC services can lead to a reduction in maternal mortality. Even where the women have access to the information, there seem to be insufficient educative programmes on health to make them attend ANC. Several studies have reported that inadequate antenatal care for pregnant women is highly associated with negative ANC consequences and poor results. And also insufficient antenatal care delivery including communication of health promotion advice among other factors was significantly associated with adverse pregnancy outcomes. Several factors such as illiteracy and poverty among others tend to limit women's information exposure and usage

Despite several attempts undertaken there is still a huge problem particularly on accessing information regarding maternal health services like family planning, nutrition, ANC, Immunization. Women still do not get information access on maternal healthcare on a day to day basis except the limited advice they get from the Health extension worker (HEWs) and Health Development Army (HDA) activities which include: indentifying and linking pregnant women and children under five with primary health care provider; promoting family planning services at neighborhood level; organizing and conducting various experience sharing and learning sessions such as pregnant women's conference, etc.

In Ethiopia despite a number of efforts have been made to support and enhance the maternal and new born child health care services using low cost mobile applications and others in most recent periods, there is lack of appropriate information support system in the health sector. So far, there is no adequate information support system for maternal and child healthcare. Therefore, this project tried to design information support system for maternal and child healthcare to improve the quality of health care information delivery and user satisfaction in the sector.

Access to relevant and accurate healthcare information will also empower women to exercise their right to maternal health. Lack of this information hampers women's ability to partake fully in safe motherhood initiative. This solution develops methods mobile technology can be used to enable access to information to reduce mortality rate and improve quality of maternal health.

1.3 OBJECTIVE OF THE PROJECT

1.3.1 General objective

The main purpose of this project is to design information support system for maternal and child healthcare.

1.3.2 Specific objectives

- To identify the current sources of maternal healthcare information and the need for a mobile based system.
- To design a prototype mobile application platform for providing maternal child healthcare information
- To suggest ways and means of implementing the proposed system.

1.4 SIGNIFICANCE OF THE PROJECT

The result of the project benefits women in reproductive age groups by creating awareness about the danger signs that can occur in mothers and their baby in each pregnancy trimesters

and postpartum weeks and by providing their ANC and PNC follow up visit schedule that can help women not to miss the health care she and her baby can get during follow up visit. In addition, it helps women health interventions in the reduction of maternal and neonatal morbidity and mortality. Using information support system to transmit health information in different languages through eHealth application can create awareness directly to mothers/families.

1.5 SCOPE AND LIMITATIONS

The study covered the limitations of current methods of disseminating maternal and child health care information such as midwifery books, and stories in terms of relevance, reliability and ease of access. The researcher designed a mobile application as a proof of concept that mobile phones can be used to improve access to maternal and child healthcare information. System design document were developed and documented. The implementations were not done because of time and resource limitations. The major activities that were done are studying the existing system, identify its gap, gathering and analyzing the requirements, designing the architecture of the system.

1.6 DOCUMENT ORGANIZATION

This project report is outlined as follows:

Chapter one presents the introduction, statement of the problem, significance and objective of the project, scope and limitations. Chapter two discusses literature review and related works on use of mobile application information support system for maternal and child healthcare. Chapter three presents the methodology used and chapter four discusses the result of the project which contains system analysis including business use case and system use cases, system design such as data modeling and sequence diagram.

CHAPTER TWO: LITERATURE REVIEW

2.1. INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

Information systems are combinations of hardware, software, and telecommunications networks that people build and use to collect, create, and distribute useful data, typically in organization settings (Car J, 2012). Similarly, Information systems explained by (Singh and Raja,2010) as an interrelated components working together to collect, process, store, and disseminate information to support decision making, coordination, control, analysis, and visualization in an organization.

Information Technology is a systematic and technological engineering technique used for capturing various information and its practicality and integration with social, economical and cultural related issues (Welukar, 2010). Communication Technology is a digital devices used for information exchange among individuals or groups. Mostly it creates an environment to ease information exchange between an interested groups or individuals who are not nearby or present at the same location or areas. Some of the major media used for communication are telephone, telex, fax, radio, T.V. and Video as well as recent and most commonly used digital devices such as computers based technologies, comprises of digital data interchanges and email. ICT is the bi-product of Information Technology and Communication technology. ICT consist of all the technologies that we have been using to collect, organize, process, send, retrieve and store information. It is the interconnection of different hardware and computer programs designed to perform a certain business or operations. The rapid development of technology and technology related creativities and presence of high technological market demands are deriving the ICT industry towards convergence. Because technological convergence has many benefits such as ease of data entry, flexibility, etc. encourage different service providers to come up with new business approaches, encourage competition, reduce cost of service, and widen the premises of services and technologies available to users (Singh and Raja, 2010).

Nowadays ICT is touching every part of social, political and economic relationships of any country. Many of these promising changes and developments were not difficult because of the availability of various policies and regulatory frameworks that facilitates investments,

liberalization, and competition in the ICT industry. The enthusiasm of market and technological advancement trigger a phenomenon called “convergence”. The convergence of ICT drives the current world to shift from landline communication and desktop based information sharing to hand held small sized devices called mobile devices which can support both communication and information sharing and tremendously benefits both developed and developing countries (Celebic,2011). The occurrence of ICT convergence phenomenon requires different aspects. Regard with technology level, convergence helps for the provision of multimedia communications across a range of network of networks that were working separately. This primarily changes the business of ICT: infrastructure, services, companies, content, and devices can now interact and work together in new, unprecedented ways, opening markets, challenging existing structures, and allowing innovative business models. At different level, we are observing the convergence across different sectors, whereby many social and business services are being rely on the rapidly growth of cellular network platforms such as mobile health, mobile education, mobile for agricultural industry, mobile banking, and so forth.

Therefore, the convergence of ICT brought the following small sized devices which are very much common on the current ICT industry; 1) Personal Digital Assistant (PDA) is hand-held small sized computer. As the name implies, it is a device that fits in the user’s palm. Despite, the main purpose of having such device that is to assist the business function performed by users in mobile manner, it will not have high-tech capacity and computing power; 2) Mobile Phone is handy electronic devices used for communication among peoples at a distance or locating at different places. Recently mobile phones has transformed from simple communication device into a device that have many functions which can support various business operation of any sector. Those functions are Short Text Messaging (SMS), electronic mail, internet access, calculator, clock, alarm, audio/video recording, capturing and displaying photos, sending/ receiving multimedia messages (MMS), etc. has turned the mobile phone into an extremely useful device. A mobile device has been contributing a lot in the day to day activities of the modern society; 3) Smartphone is a device that combines the functional features of mobile phones, PDAs, and computers. Smartphone must use operating system to make it operate properly, which are the basis for application development. This mean that mobile applications will be developed based on the environment where it is going to be

installed, configured and operated. Some instances of Smartphone based operating system are: Google Android, Symbian, Blackberry, Palm Pilot, and Windows Phone (WHO, 2011).

The availability of timely, accessible, accurate and relevant information plays a key role in shaping knowledge, which in turn is a driver of health related change. Information also influences social norms and culture by increasing awareness about what other people are doing. In addition, information can create demand for health products and service (ITU, 2014).

2.2. M-HEALTH AND e-HEALTH

M-Health is a component of e-Health. M-Health or mobile health is termed as a medical and public health practice supported by mobile devices, mobile phones, patient monitoring devices, personal digital assistants (PDA's) and other wireless devices

M- Health and e-Health are inextricably linked, both are used to improve health outcomes and their technologies work in conjunction, for example, many e- health initiatives involve digitizing patient records and hence creating an electronic “backbone”. M-health programs can serve as the access point for entering patient data into national health information systems and as remote tools that provide information to health clinics, home providers and health workers in the field (WHO, 2011).

The expression is most commonly use in situation to using mobile communication devices, such as mobile phones, tablet computers and PDAs, for health services and information, but also to affect emotional states (Villani et al 2012). mHealth is a term used for the practice of medicine and public health , supported by mobile devices. mHealth applications include the use of mobile devices in gathering community and scientific health data, delivery of health care information to practitioners, researchers, and patients, real time scrutinizing of patients very important signs, and direct condition of care (Mourlas C, 2005).

mHealth in low and middle-income countries has been documented as a capable, creative, and potentially cost-effective intervention for health care workers addressing a number of diseases and creating a various array of interventions with varying degrees of efficacy and reproducibility (Loveday M, 2013).

The ease of use of timely, accessible, accurate and relevant information the stage a key function in shaping information, which in turn is a driver of health related change. Information also power social norms and culture by increasing awareness about what other people are doing. In addition, information can create demand for health products and services (Yvonne M, 2013).

Mobile applications are applications or services that can be pushed to a mobile device or downloaded and installed locally (Qusay, 2012). Mobile applications are classified into three: Browser-based (applications developed in a markup language), Native (compiled applications such as downloadable games), and Hybrid. Today's mobile devices are multi-functional devices capable of hosting a broad range of applications for both business and consumer use. Unlike from the perspective of developers, the process of coming up with a mobile application is complicated. First you have to come up with a compelling idea for the app (Todoros, 2011). There is a lot to consider when moving to the design of an application. According to Todoros (2011), first of all, one of the most frequently asked questions is whether to develop a native app or design around the mobile web.

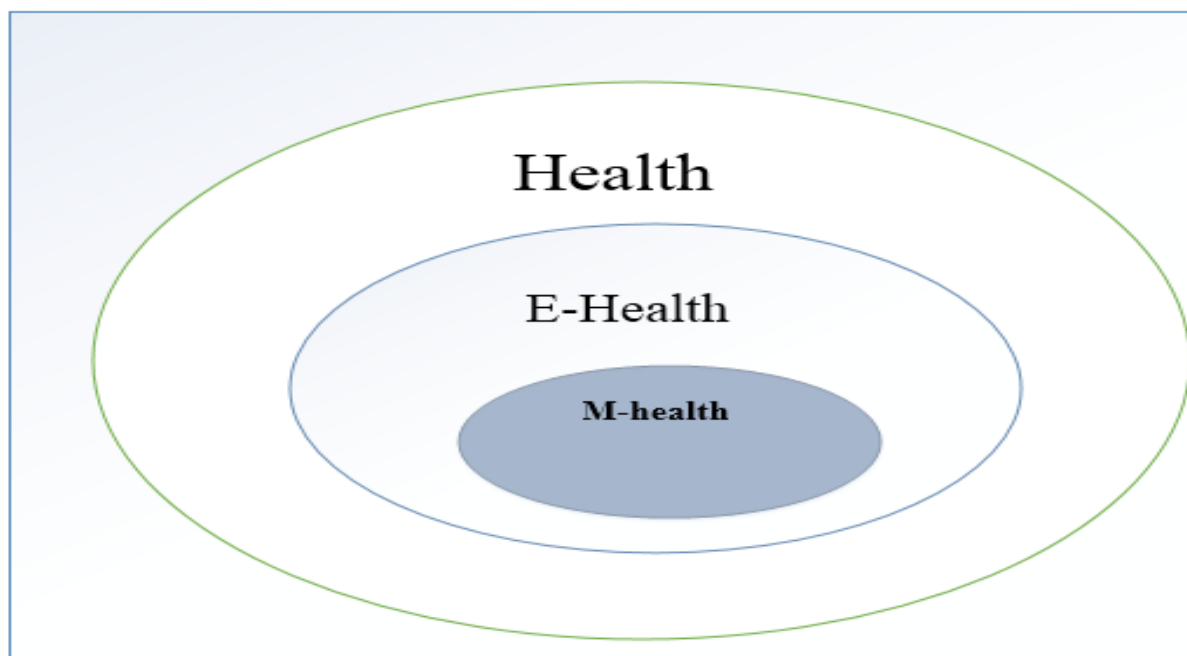


Figure 1: Relationship between Health, E-health and M-health (Odongo, 2010)

E-Health is a group name for all electronic systems that are working in the health domain of any country. Some of the major electronic applications that are implemented in Ethiopia and included in this group name are Electronic Medical/Health Record (EMR/EHR), Human Resource Management Information Systems (HRMIS), Mobile Health, and so forth.

2.2.1. Interactive Voice Response (IVR) in Maternal Information Delivery

IVR is 24/7, quick and easy access to specific data without the need to speak to a customer service representative or launching a mobile app. FEP IVR provides information for and about members of the Blue Cross and Blue Shield Service Benefit Plan also known as Federal Employee Program, or FEP (Federal Employee Program, 2008). It is based in Nevada, US. The FEP IVR offers providers and facilities the opportunity to obtain eligibility, benefits, claim status, including check information and ability to request copies of remits; also Pre-certification guidelines with option to be connected to the Pre-cert area and Anthem addresses by specific state (Wall Street Journal, 2008).

2.2.2. Mobile Alliance for Maternal Action (MAMA)

The MAMA 2011 project was aimed at empowering expectant and new mothers to make healthy decisions by harnessing the power of mobile technology. Many women around the world have limited or no access to basic health information required for them to have safe pregnancies and healthy babies. These women typically live in resource-constrained settings that lack the first-line providers of such information - nurses, midwives, and trained birth attendants. According to MAMA, 2011 only half of the 123 million women who give birth each year receive the antenatal delivery, postnatal, and newborn care they need.

Health information can be critically important during the period when women and their newborns are most at-risk. Each year, in the brief window of time between the onset of labor and 48 hours after birth, 150,000 women and 1.6 million give birth completely alone. Health information can increase understanding of proper nutrition for mother and baby and aid in recognition of warning signs that require clinical attention.

Over the past several years, there has been an explosion of mobile networks in developing countries. Mobile subscriber penetration has reached over 5 billion people worldwide out of a total world population of 6.9 billion and the UN estimates that by 2012, half the people living in remote areas will have one. More than 1 billion women in low - and middle - income countries own a mobile phone (MAMA, 2013).

2.2.3. Security and Privacy of Information in Mobile Health-care Communication Systems

The sensitivity of health-care information and its accessibility via the Internet and mobile technology systems is a cause for concern in these modern times. The privacy, integrity and confidentiality of all healthcare information are key factors to be considered in the transmission of medical information for use by authorized users. Mobile communication has enabled medical consultancy, treatment, drug administration and the provision of laboratory results to take place outside the hospital. Medical information sharing to expectant women is made possible through mobile phones, due to the implementation of Internet and Intranets. But the vital issue in this method of information sharing is security: the user's privacy, as well as the confidentiality and integrity of the health-care information system, should not be compromised (Kioko, 2012)

2.3. EXPERIENCES FROM MHEALTH PROJECTS IN MATERNAL AND CHILD HEALTHCARE

2.3.1. Wired-mothers project

The Wired-mothers project that uses of mobile phones was employed in Zanzibar to improve maternal and child healthcare. The projects were joined pregnant women to a primary health care unit through use of mobile phones receiving regular Short Messaging Services (SMS) reminders for care appointments and who can call the primary provider in case of sensitive or non-sensitive problems (Seif, 2014).

The place of this project put the pregnant women and Traditional Birth Attendants (TBAs) at the same level as both are in the same community. As TBAs considered being faster to pregnant women, they can suggest essential support in case of urgent situation. Moreover, the

channel of communication links the community to the referral level through Primary Health Care Unit (PHCU). In addition to that, the antenatal care (ANC) attendance through mobile phones intervention was made. The wired-mothers' mobile phone intervention significantly increased the proportion of women receiving health care during pregnancy and after delivery. Mobile phones applications showed constructive results towards improving quality maternal and newborn health care.

The “mobile midwife” program that was initiated in July 2010 in Ghana enables pregnant women and other care givers to receive text or voice messages that offer time-specific information about different stages of their pregnancy. According to the Cheers Report, MOTECH has two interrelated mobile applications aimed towards women and their children. These messages include alerts and reminders, advice and educational information in English and in the user's native tongue.

Moreover, Ghana tried to address Maternal and Neonatal mortality crisis through the use of website known as “MamaYe” which is an ‘Akan’ word meaning (Mother is Good), which was a digital platform for maternal and newborn health stakeholders to be well-informed, empowered, and integrated in their efforts. According to Hassan and Nyamawe, 2014 the website was powerful in delivering huge amount of information at per. arrangement and illustration of more lively information can easily be communicated through it. Moreover, website can be displayed in different platforms including; some of mobile phones and computers. Through daily information updating on website, women's can regularly build up their body of awareness concerning MNH, this would have positive impact in reducing MNMR

2.3.2. Programme Mwana

Programme Mwana is a mobile health initiative implemented by the Zambian MOH with support from UNICEF and collaborating partners to strengthen health services for mothers and infants in rural health clinics, with particular focus on improving Early Infant Diagnosis (EID) of HIV and improving post-natal care for mothers and their children.

Programme Mwana started on a pilot in April 2010 to reduce these delays in results transmission from the HIV test laboratories to rural health facilities via SMS message. The pilot had two main SMS components: Results160 and RemindMi. Staff to securely deliver infant

HIV results from the lab to the health clinics, while community health workers to remind the mothers to return to the clinics to receive their infant's results used RemindMi used Results160.

2.3.3. Increasing Healthcare Access

ZMQ Software Systems has developed in India which was a SMS application for women in villages to receive antenatal care. Once a women registers via SMS she will receive weekly tips on what to eat, what vaccines to get, and when to get check-ups. ZMQ develops innovative ICT solutions, software, and applications for empowering people and enabling sustainable development (Quraishi, 2010). Doornbos (2011) discussed how he worked with an organization that had a team that had a simple project that allowed midwives to text in questions to system that provided answers. According to him, this was a fascinating project but it had lots of problems in implementation. While over 80% of Haitian adults have access to mobile phones, less than 20% of Haitian woman have access to health care (Univcity, 2011). The goal of Univcity was to substantially increase health care access by creating a maternal healthcare network called DigiHealth. The DigiHealth network combines a support or call center, healthcare software and mobile computing with the brand, scale, and infrastructure of Digicel, Haiti's largest mobile carrier.

2.3.4. Development Initiatives Using ICT

The project known as "Better Health for Afghan Mothers and Children (BHAMC) "working with Dimagi's CommCare application was carried out in Afghanistan. The project designed a mobile phone maternal and newborn healthcare application to be used by community health workers as they advise community members. The phone application served as 1) a job aid for CHWs and informing mothers, 2) emergency call and referral and 3) reporting home visits (Lund et al 2014). As a job aid, the application reminded CHWs of key messages. It was a resource for CHWs to share information with mothers. CHWs talked with pregnant women regarding the need for antenatal care visits and delivering in a facility, planning and preparing for birth, danger signs during pregnancy, labor, delivery, caring for a newborn, and the need for facility birth with the family and facilitated related decisions. When a woman went into labor, the CHWs made a referral call and linked the woman's family with a skilled provider at the nearest facility. CHWs were able to advise families on available transportation, including

ambulances if available. It also helped communication with facility staff. The project manager was able to provide timely feedback to CHWs in the intervention area as the data was received in real time.

2.3.5. Healthy Pregnancy, Healthy Baby Text Messaging Service

In Tanzania there have been a number of widespread initiatives in developing mobile applications for providing pregnant women with health information for the safety of their own pregnancy and safety delivery. Expectant and new mothers receive SMSs for reminding them to visit clinics regularly and as well useful information relation to each and every phase of their pregnancy. Aligned to that, Mobile Alliance for Maternal Action (MAMA) in collaboration with other development partners launched a mobile based application “Healthy Pregnancy, Healthy baby text messaging service” in Tanzania. The project expected at delivering high quality antenatal care (ANC) information during pregnancy and 16 weeks after delivery. Information included proper nutrition and care and as well as signs of health complications (Nyamawe, 2014).

2.3.6. Mother is Good Mamaye which is an ‘akan’ in Ghana

Ghana tried to address Maternal and Neonatal mortality crisis through the use of website known as “MamaYe” which is an ‘Akan’ word meaning (Mother is Good), which was a digital platform for maternal and newborn health stakeholders to be well-informed, empowered, and integrated in their efforts. According to Hassan and Nyamawe, 2014 the website was powerful in delivering huge amount of information at per. arrangement and illustration of more lively information can easily be communicated through it. Moreover, website can be displayed in different platforms including; some of mobile phones and computers. Through daily information updating on website, women’s can regularly build up their body of awareness concerning MNH, this would have positive impact in reducing MNMR

2.3.7. Health Center by Phone

Health Center by Phone project was carried out in Malawi to address barriers to maternal, newborn and child health(MNCH) information and improve the coverage and quality of MNCH services by; (i) ever-increasing knowledge of facility and home-based maternal, MNCH practices, (ii) increasing use of facility and home-bases MNCH practices, and (iii)

increasing user fulfillment with MNCH facility services. The Information and Communications Technology equipment for Maternal, Newborn and Child Health (ICT for MNCH) Pilot Project in Balaka District, in southern Malawi, where its hotline and information and aide memoire services are together known as Chipatala Cha Pa Foni (CCPF), or “Health Center by Phone.” (Watkins et al. 2013).

2.4. RELATED MOBILE APPLICATIONS

2.4.1. My Pregnancy Today

It is a daily pregnancy application that guides women, from the baby due date given, gives answers and prepares for baby's birth (Baby Center, 2013). The versions available are for smart phones iPhone, iPod Touch and Android. This targets high-class and tech-savvy users who have the money to buy smart phones and pay for the data charges. My pregnancy app has other features like fetal development images these are images developed by expert medical illustrators. Pregnancy checklist is an interactive to-do list filled with activities and reminders to keep you on track with decisions; doctor-appointments; and more. A nutrition guide gives the tips and recipes to help eat well and manage cravings.

2.4.2. WawaNet

WawaNet uses text messaging via mobile telephones to enhance the health of mothers and infants by enabling them to receive customized advice on nutrition and potential problems during pregnancy (Cueto, 2009). This mobile solution seeks to solve the problems of maternal mortality in Peru, emphasizing that an improvement in the health of mothers and infants would also contribute to Peru's attainment of the Millennium Development Goals. However WawaNet is solely textual as its main focus is on rural women, it is more information based this makes the approach different to this research. Our mobile application for detecting risks during pregnancy will determine based on the expectant mothers' information whether she is at risk or not.

2.4.3. Mobile Midwife

In Ghana, there was a mobile phone-based health education program for pregnant women and recent parents which was sponsored by MoTeCH (Chib 2010) MoTeCH is a multi-part project that uses mobile technology to send antenatal (ANC) and postnatal (PNC) health information to Ghanaian's and allows community health workers to collect and share health data. Women register for the program and receive either SMS or voice messages with health information. The organization designed the messages to be applicable to both men and women, as they anticipated that both partners would listen to the messages (the report found that 99% of respondents chose to receive voice messages). The messages were designed to tell women what to expect during pregnancy, dismiss tradition and cultural practices, and provide general health information.

2.4.4. Text 4 Baby

Text4baby is a program designed to provide education to pregnant women and new parents regarding their baby. Text messages are sent three times a week with information on how to have a healthy pregnancy and a healthy baby (Center for Disease Control and Prevention, 2013). The text messages were timed to the pregnant woman's due date or the baby's date of birth. The free text messages provided tips on subjects including breastfeeding, car seat safety, developmental milestones, emotional wellbeing, exercise and fitness, immunizations, labor and delivery, nutrition, antenatal care (ANC), safe sleep, and stop smoking.

(Brian, 2010) has launched a mobile health initiative similar in aim and execution to Text4Baby for the more than 20 million expectant mothers in China, India, Mexico, Bangladesh, South Africa and Nigeria. Johnson and Johnson estimates that 1.1 billion women in those countries have a mobile phone today and are likely to sign up for its new program, Mobile Health for Mothers, which includes free mobile text messages on antenatal care (ANC), appointment reminders and phone calls from health coaches. This will have a great impact and reach to the users since all mobile phones are enabled to receive text messages; they are confidential compared to mobile applications as a way to provide maternal care information. Johnson & Johnson also launched its BabyCenter mobile campaign with mobile agency Velti in 2007, first in India (Sailesh et al, 2011).

CHAPTER THREE: METHODOLOGY

A phased development methodology of object- oriented approach was applied to the study of the design system. Interview and document analysis were used as the main tools to capture the business system requirement along with observation. Unified modeling language (UML) development techniques applied in the process of requirements capture the business system and system design. Visio Software was employed in design models diagramming.

3.1. STUDY SETTING

The study was conducted from Feb.2016 to June 2016 in Addis Ababa, Ethiopia. Ethiopia is a Federal Democratic Republic with 9 regions and two regions are the sit's of the federal government while the remaining 9 regions has their own regional city administrations These are subdivided into 817 administrative Woredas (districts) which are further divided into around 16,253 Kebeles. This study was conducted at selected health facilities in Addis Ababa.

3.2. SOURCE AND STUDY POPULATION

The population of the study was the health professionals working for more than two years at Maternal and child healthcare Directorate of Federal Ministry of Health and women of reproductive age groups from the selected public health centers. In Addis Ababa women who were either currently expectant or had given birth, each owing a use of phone. This qualification ensured that the participants understood the nature of the questionnaire and its use for access to maternal and child healthcare information, making the survey items easy for them to accomplish.

3.3. SAMPLE SIZE DETERMINATION

Due to routine work and other daily business operation it is difficult to get all the responsible health professionals and the end users for interview. Therefore, purposive sampling technique was employed to conduct interview and collect all the necessary information. The main reason for selecting purposive sampling is that it allows us to select a case based process that illustrate issues of interest in the research and where those features are likely to be present.

The study covered 15 expectant women and 5 health professionals currently working for more than two years at maternal and child healthcare Directorate of Federal Ministry of Health (FMOH). Some of the issues addressed during the interview were the source of current access of maternal and child healthcare information and the use of mobile phone for easily access the information.

3.4. SOFTWARE DEVELOPMENT LIFE CYCLE (SDLC)

A systems development life cycle is composed of a number of clearly defined and distinct work phases which are used by systems engineers and systems developers to plan for, design, build, test, and deliver information systems. An SDLC aims to produce high quality systems that meet or exceed customer expectations, based on customer requirements, by delivering systems which move through each clearly defined phase, within scheduled time-frames and cost estimates. To manage this level of software development life cycle, a number of SDLC models or methodologies have been created, such as "waterfall". The whole process of systems development goes further still.

3.4.1. Water fall approach

The total time given for the accomplishment of the project was about 5 months and also selected respondents from the study area, source and study population were not available all the time to collect the relevant information.

Therefore, for delivering the project within the specified time and due to the constraints of other resources Water Fall software development methodology is applied in the study. This method follows the following major phases in a sequential manner.

1. System Investigation phase
2. System Analysis Phase
3. System Design Phase
4. System Implementation or coding phase
5. System testing phase

6. System Deployment phase
7. System Maintenance phase

3.4.1.1. System Investigation Phase

Requirement Collection Instruments

Requirement collection instruments are used to collect detail and relevant information from health professional's experts who are currently working on maternal and child healthcare and expectant women. The requirements used to collect the functional, non-functional requirements and also development of the mobile application.

The requirement were collected using different types of instruments, including document review, observation, and interview. Interview was conduct for 20 peoples. It's used because through interview the feeling and opinions of the peoples can be understood easily rather than observation and documentation analysis. Interview and document analysis were used to know about how the existing.

Data/ Requirement Collection Instruments

Requirements for the project were collected from health professional's experts who are currently working on maternal and child healthcare in the institute, and expectant women from selected public health centers in order to gather facts and opinions through interview, observation and document review.

Interview

Interview can be conducted through face- to- face, telephone, Skype or any other latest technology application. Face- to- face interview were selected for this study. It allows a great deal of interaction between the interviewer and interviewees. Methods of interviewing can be open ended and semi-structured question as guides. The respondents were who qualified for the sample selection was currently expectant women or had already given birth. These criteria ensured that the participants understood the nature of the questionnaire and its use for maternal and child health care information system.

Observation

The current system, in general the ways of accessing information were observed in order to identify problems with the current system.

Document review

Some literature reviews, formats, guidelines of key actions to improving family health were reviewed to understand and define problems.

3.4.1.2. System Analysis Phase

The result of the system modeling that helps to understand the system models used for analysis of the system was done using tools like the use cases diagram, domain model diagram, sequence diagram and Data flow Diagram.

Models

A model is a representation of an important aspect of the real world. It is sometimes called an abstraction as it is used to separate out an aspect of particular importance. Data depiction were made using the following models

- System Use Case Description
- Domain model Diagram
- Sequence Diagram
- Data Flow Diagram &
- Activity Diagram

Tools

A tool in software development is software support that helps create models or other components required in the project.

The tools used for analysis and design in this project were:

- Microsoft Visio for drawing various modeling diagrams
- Microsoft Project for planning

Techniques

A technique in system development is a collection of guidelines that help an analyst complete a system development activity or task. The techniques used in SSADM are logical data modeling, data flow modeling and entity behavior modeling.

➤ **Logical Data Modeling**

The process of identifying, modeling, and documenting the data requirements of the system being designed. The result is a data model containing entities (things about which a business needs to record information), attributes (facts about the entities) and relationships (associations between the entities).

➤ **Data Flow Modeling**

The process of identifying, modeling and documenting how data moves around an information system. Data Flow Modeling examines processes (activities that transform data from one form to another), data stores (the holding areas for data), external entities (what sends data into a system or receives data from a system), and data flows (routes by which data can flow).

➤ **Entity Event Modeling**

A two-stranded process: Entity Behavior Modeling, identifying, modeling and documenting the events that affect each entity and the sequence (or life history) in which these events occur, and Event Modeling, designing for each event the process to coordinate entity life histories.

3.4.1.3. System Design Phase

In this phase the system and software design is prepared from the requirement specifications which were studied in the first phase. System Design helps in specifying hardware and system requirements and also helps in defining overall system architecture. The system design was done on the basis of the functional and non-functional requirements identified. Microsoft Visio 2013 was used to design the architecture of the mobile application

3.4.1.4. System Implementation

In this phase, the prototype of the system application was developed which address all of the functional and non-functional requirements which were identified in system analysis phase of SDLC. The android studio platform with integration of android development tool with java based programming language

3.4. ETHICAL CONSIDERATIONS

The project has been carried out after getting permission from the ethical clearance committee of Addis Ababa University and Medical Faculty through School of Public Health. Information sheet and consent forms were delivered along each interview and all interviewees have been asked their willingness to participate in requirement gathering; and informed verbal consent were also be obtained from all study participants and from every interviewee after the objective of the study informed. Besides, the convenience, confidentiality, privacy and comfort of the participants were of consideration

3.5. METHOD OF DISSEMINATION OF RESULTS

The results of the project disseminated by using informal report and formal report and presentation to Federal Democratic Republic of Ethiopia Ministry of Health, Addis Ababa University School of public Health, School of Information Science Health Informatics program and other respective health institute and other concerned and interested organizations.

3.6. OPERATIONAL DEFINITIONS

Actor - is a person, organization, or external system that plays a role in one or more interactions with the system.

Antenatal care - is care given for a mother with in her pregnancy period.

Danger sign - is signs and symptoms of health problems that can occur during pregnancy or postpartum period both in mothers and in babies.

Postnatal care - is care given for a mother after delivery until 42 days.

GSM- Global Systems for Mobile Communications

Mobile Application or Mobile App or App – This is an application developed for small hand held devices that come either pre-installed on phones during manufacture or downloaded by customers from various mobile software distribution platforms.

Mobile Health – The term used for the practice of medicine and public health supported by mobile devices such as mobile communication devices (mobile phones, tablet computers and PDA) for health services and information.

APP- Is short for “application” and refers to any software program that performs a specific function for a user or anther application

Interface – Gives programmers a formal set of routines to call on use underlying network services.

Architecture – How a system is designed; includes how the components are connected to and operate with each other.

Browsers – Client applications that access WWW servers.

Client/server Architecture – Network where some computers are dedicated clients (Workstations) and some are dedicated architectures.

Data – Information manipulated inside the computer in the form of bits and bytes.

Firewall – A barrier between a network and the internet through which only authorized users can pass; set of security policies to screen incoming and outgoing messages.

Graphical User Interface – Easy way of accessing applications with the use of pointing device.

Maternal health services – Various facilities and programs organized for the purpose of providing medical and social services for mothers and children. Medical services include antenatal and postnatal services, family planning care, and pediatric care in infancy.

Operating System – Interface between the application and the computer network.

Platform – The underlying hardware or software for a system.

Web application – Web apps live on a remote server and delivered to the users over the internet through a browser.

CHAPTER FOUR: ANALYSIS AND DESIGN OF THE SYSTEM

In this chapter, the data gathered from the sample group in relation to the study objectives is analyzed and interpreted. The ways of the study entails a detailed account of the demographic profile of the respondents. First, major business requirements were determined. Second, those requirements draw out using UML functional analysis model to support business process and data flows and use cases to describe the basic functions of the information system. Third, design models of the system use case descriptions, sequence diagram, domain model definition, system behavior, data flow diagram and architecture diagram were used in order to show the structural design of the system

4.1. SYSTEM INVESTIGATION

The ways of the study entails a detailed account of the demographic profile of the respondents.

4.1.1. Profile

The profile of the respondents is looked upon in terms of age, educational attainment and employment status.

4.1.1.1. Age of the Respondents

Figure 3 below shows the age range of the respondents. Sixty percent (60%) of the respondents were 25 - 35 years old. Thirteen percent (13%) of the respondents were between 36-45 years old. Lastly, there is twenty seven (27%) of respondents who are in the ages between 18 - 24 years old. The apparent diversity of the maturity of the respondents reflects several implications in the study's findings. In relation of the age bracket of the respondents, the researcher could presume that in the said percentage, a considerable number could be among the young adult members of the population. This population group is active in adopting use of mobile phones.

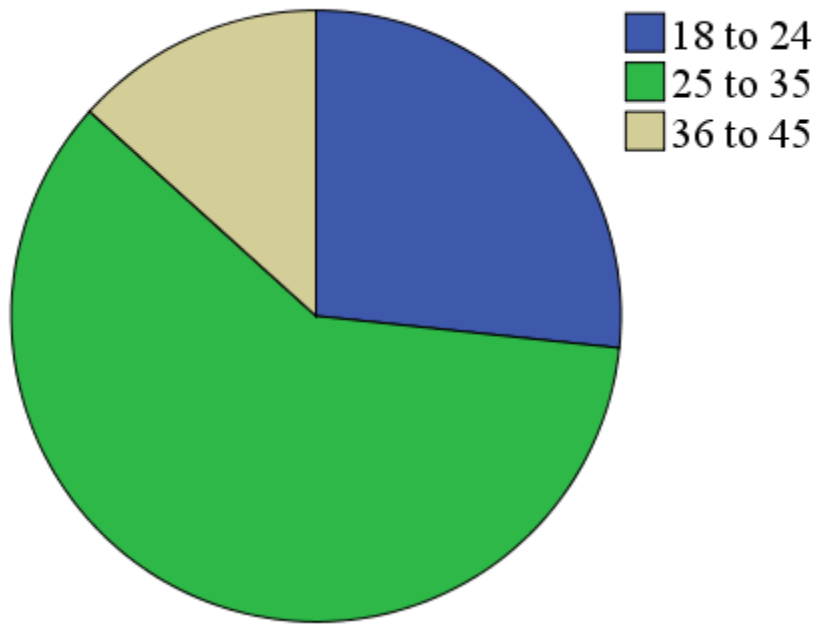


Figure : 2 Ages of Respondents

4.1.1.2. Employment Status

Figure 4 below shows the employment status of the respondents. 47% of the total respondents, which is the dominated response is employed. 33% of the respondents are self-employed. There was only 20% who are unemployed and house wives from the fifteen respondents. As the figure was interpreted, there is a little percentage of unemployed respondents.

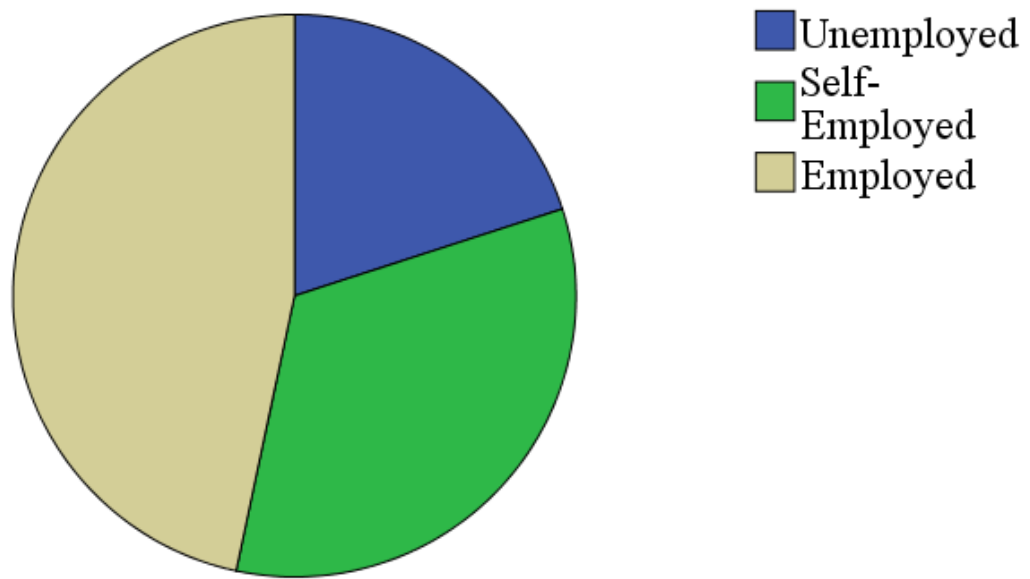


Figure: 3 Employment statuses

4.1.1.3 Educational Attainment of the Respondents

The respondents were asked for their educational attainment and the report shows thirty three 33% of them are graduates. The survey indicates that most of the respondents are high school graduates at forty six (46%). Twenty percent 20% are primary school graduates. Figure 5 below shows that majority of the respondents are literate.

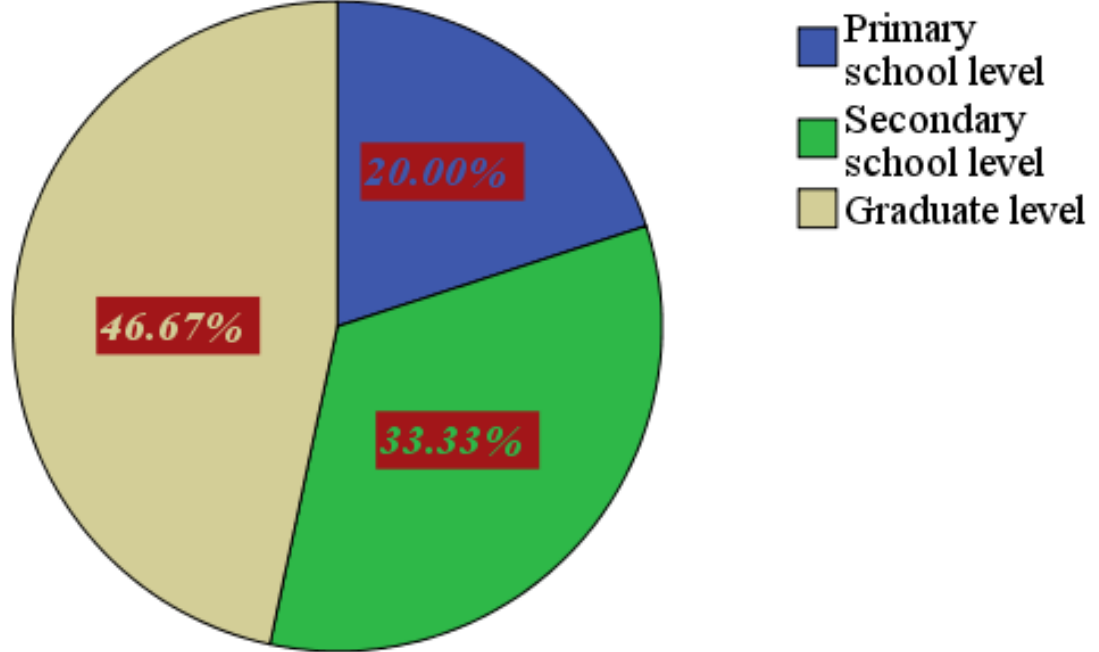


Figure: 4 Level of education

4.1.2 Presentation of the Data Collected

Interview

The following questions were asked with respective responses during the semi structured interview.

❖ Source of information on maternal and child health care

A requirement gathered through review of article documents and interviews. Currently maternal and child healthcare information are accessed through Health Extension works (HEWs), the traditional media, brochure (or information sheet), Health Development Army (HDAs) one- to – five network. Other sources available to the expectant women were health workers (hospitals and health center), neighbors and friends, community leaders and social gatherings among others. These sources and the information acquired to a large extent influenced the utilization of maternal services. Based on the data therefore, the researcher

concluded that the more of such sources available, the higher the utilization of the maternal and child healthcare services. Similarly, the more pregnant women obtained information on ANC, the higher the use of the ANC services.

The current sources of maternal and child healthcare information do not provide timely access to the information as women have to travel to obtain the information from these sources. This makes it difficult for women to make informed choices on maternal issues, infant baby care and pregnancy complications. The application is precisely what a maternal and child healthcare mobile application should provide; updated information, easy to read and understand, accessible anytime, anywhere at the users' easily.

This study has provided a concept that maternal and child healthcare applications can be accessed easily through mobile phones by the use of mobile applications. To achieve this, the researcher has proposed that mobile phones are able to quickly and easily disseminate information that will inform women of ways to care for themselves during pregnancy, scatter tradition and misconceptions, highlight warning signs, connect women with local health services, reinforce breast feeding practices, explain the benefits of family planning, and make new mothers aware of how best to care for their babies.

❖ Respondents Experience with Mobile Applications

The implementation and usage of a mobile health care application would be more successful if the target population has experience in using other mobile applications, e.g. games, social network applications, and other information oriented information, e.g. news. As per the collected data, 73% of the respondents had used mobile application. Figure 6 shows the distribution of respondents based on their experience with mobile applications.

This implies that the deployment of a mobile healthcare application among the respondents will have a positive reception. Also, because of their experience with other mobile applications, training them to use a mobile healthcare application will not need a large amount of effort.

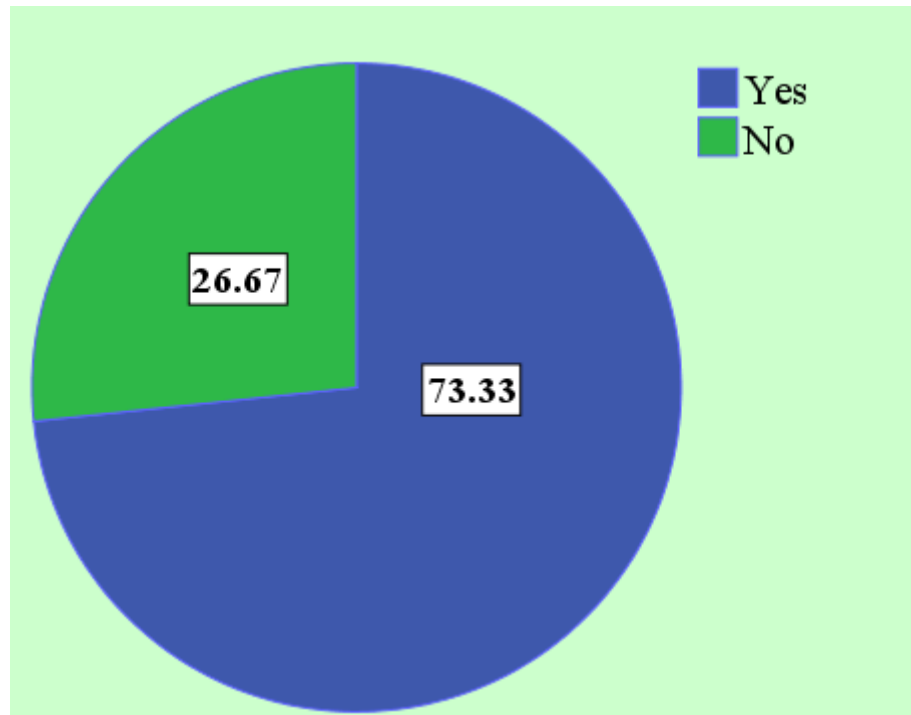


Figure: 5 Experience with mobile applications

❖ Mobile and Internet Service Provider Distribution in Ethiopia

Data obtained from Ethio-telecom shows that the number of Mobile phone subscribers reached 42.3 million, internet users 12.4 million and land line phone users reached 0.9 million in March 2016. It implies that the only service provider in Ethiopia, Ethio-telecom is accelerating the access to mobile phone across the country. Hence, the successful deployment and adoption of a mobile application depends on the mobile service provider, more users would experience better performance and cost effectiveness of the application on their mobile phones.

❖ Document Review

Family Health guideline document which was prepared by FMOH and other responsible stakeholders was the major source of information for this study. The major functional requirements of the study were taken from this valuable document.

4.2. SYSTEM ANALYSIS

4.2.1 Requirement definition

The requirements definition report usually called the requirements definition— is a straight forward text report that simply lists the functional and nonfunctional requirements in an outline format.

4.2.1.1 Functional requirements

Functional requirements define what the system does, namely, the functions (actions) of the system. They describe all the input and outputs to and from the system as well as information concerning how the input and outputs are interrelated.

The system should be able to provide the following main functional requirements of mobile based information support system for maternal and child healthcare information system.

- i. The system should capture, process and store maternal and child healthcare information.
- ii. The system should display information to respective users
- iii. The system users should be able to access maternal and child healthcare information.
- iv. The system should permit users to ask and contribute health information

Accordingly the functional requirements are describes as follows:

- The system record information about dangerous signs during pregnancy
- The system record information about preparation for birth
- The system record information about dangerous signs during labor
- The system record information about newborn care
- The system record information about dangerous signs at neonatal stage

- The system record information about postnatal dangerous signs
- The system record information about from birth to 6 months
- The system record information about immunization vitamin D and A
- The system record information about Family planning
- The system record information about when a child is sick
- The system record information about when a child has Dirrha
- The system record information about TB prevention
- The system record information about Malaria prevention
- The system record information about additional care giving action
- The system record information about sanitation and hygiene
- The system should be able to register new users account including its address

4.2.1.2 Non-functional Requirements

Nonfunctional requirements define the quality of the system. They include the description of the system's performance, usability, reliability, security, maintainability, portability, implementation, interface, operations packaging and legal obligations. . The ability to access the system using mobile phones would be considered a nonfunctional requirement. The non functional requirements correspond to the process of explaining the features, characteristics, attributes, and constraints of the information system used to limit the boundaries of the proposed solution. Non-functional requirements illustrate user observable aspect of the system that was not designated to the functional behavior of the system. The requirement includes from easy to use interface to view or display the information.

The nonfunctional requirements describe a variety of characteristics regarding the system:

The following were the non-functional requirements:

- i. The system is easy to learn and use by end users
- ii. The system is efficient so as not to waste system resources
- iii. The system is reliable because the application is standalone systems relying on database stored on a remote server
- iv. The system allows access to anyone of users
- v. The system should be designed to have the best quality.

- vi. The system should be available all the time 24 hours/day
- vii. The data output is accurate since the input data is validated
- viii. The system should be easily maintained by the developer as well as other authorized trained person.
- ix. The system is easy to maintain since it is modular and object oriented

4.3 Use Case Diagram

The use case diagram is the simplest representation of a users' interaction with the system. The use cases are UML (Unified Modeling Language) diagrams used during the analysis phase of project to identify and partition the system, their main functionality is to separate the actors and the use cases. It shows steps that form basis of interaction between various actors (User, Administrator and the system). Actors represent roles that could be played by users of the system. These users could be humans other computers, pieces of hardware, or even other software systems. The only criterion is that they must be external to the part of the system being partitioned into use cases.

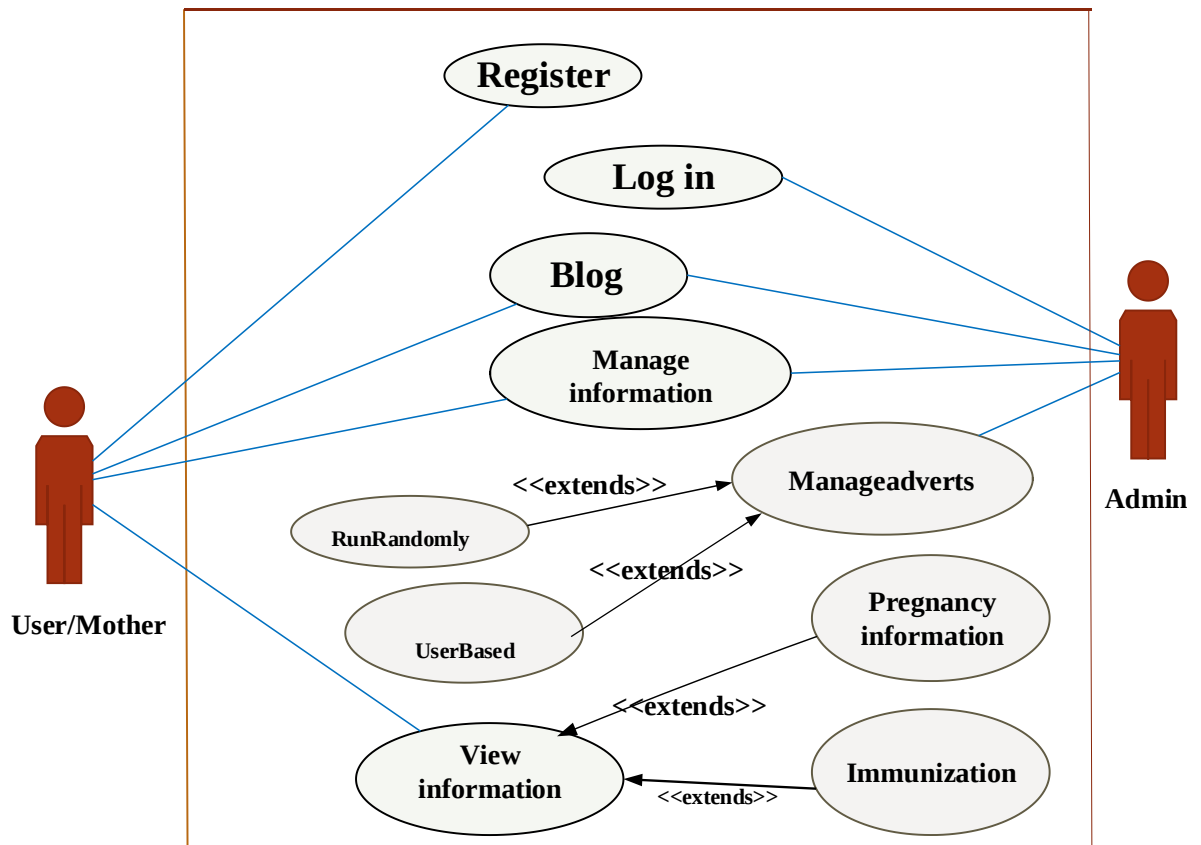


Figure 6: Use Case Diagrams

4.3. 1 IDENTIFIED ACTORS

Table 1: List of Actors and their goal

Actors	Description	Goal
Users/ Mothers	A users or mothers who access or use the information	To access or get the maternal and child healthcare information
Administrator	A person who is authorized to add, edit, and delete the data	To maintain or update the information
System	A machine used to display or view the information on a mobile application	To display or view the information

4.3.2 Identified Use Cases

1. Log in
2. Blog
3. View information
4. Manage information

4.3.3 System Use Case Description

Table 2 Log in Use Case Description

Use Case ID	UC_1
Use Case Name	Log in
Stakeholder And Interests	Want to log into the system
Primary Actor	Administrators
Pre-Condition	The administrator must have user name and password
Post-Condition	The administrator logs into the system
Process of Main Courses	1. The system displays the log in screen. 2. The administrator enters the username and password 3. The system verifies the information and set access permission. 4. The system will display the main screen. 5. Use Case Ends

Table 3: Blog Use Case Description

Use Case ID	UC_2
Use Case Name	Blog
Description	The information which are going to display to users are stored
Primary Actor	Administrators and Users
Pre-Condition	The system should have database to store information
Post-Condition	The information ready to display to the respective users
	1. Information should store or recorded in different language. 2. The database should ready to display 3. The system verifies the information and set access permission. 4. The system will display the main screen. 5. Use Case Ends

Table 4: View information Use Case Description

Use Case ID	UC_3
Use Case Name	View information
Description	Maternal and child healthcare information displayed the respective users/Mothers
Primary Actor	Administrators and Users
Pre-Condition	The users should have an android based mobile application
Post-Condition	Information should displayed or viewed to the right users
Main success scenario	1. The users should select the language 2. The users should select the information needed 3. The users view the information 4. Use Case Ends

Table 5 Manage information Use Case Description

Use Case ID	UC_ 4
Use case Name	Manage information
Stake holder and interests	The administrator wants to manage information of the system
Primary actor	Administrator
Description	This describes how the administrator manages the information.
Precondition	The administrator should register as an authorized administrator.
Post condition	The administrator manage information the system
Main success scenario	1. The Use Case starts when the administrator starts the application. 2. The administrator enters in to login screen. 3. The system display the login screen 4. The administrator enter user name and password 5. The System displays the account form. 6. The administrator performs create, edit, and update the information 7. The System validate the information which the Administrator enters 8. End the Use Case

4.4 Domain Model Definition

Domain model is a visual representation of conceptual classes of the proposed system. It is describing the various entities, their attributes, roles, and relationships, plus the constraints that govern the problem domain. Often the term 'Domain Model 'is used to refer to the class diagram that one finds in the Analysis model. Class Diagram shows the diagrammatic specifications of the software classes and interfaces in an application to be developed and implemented. It shows the definition of the software classes rather than the reflection of the real world concepts. Furthermore, it expresses the definition of the software classes as software components.

Typically, this will include classes with attributes and operations, and will have related sequence diagrams. This reflects the views of the practitioners that the classes are created specifically for use with the current system. The responsibilities are already assigned to Attributes and operations.

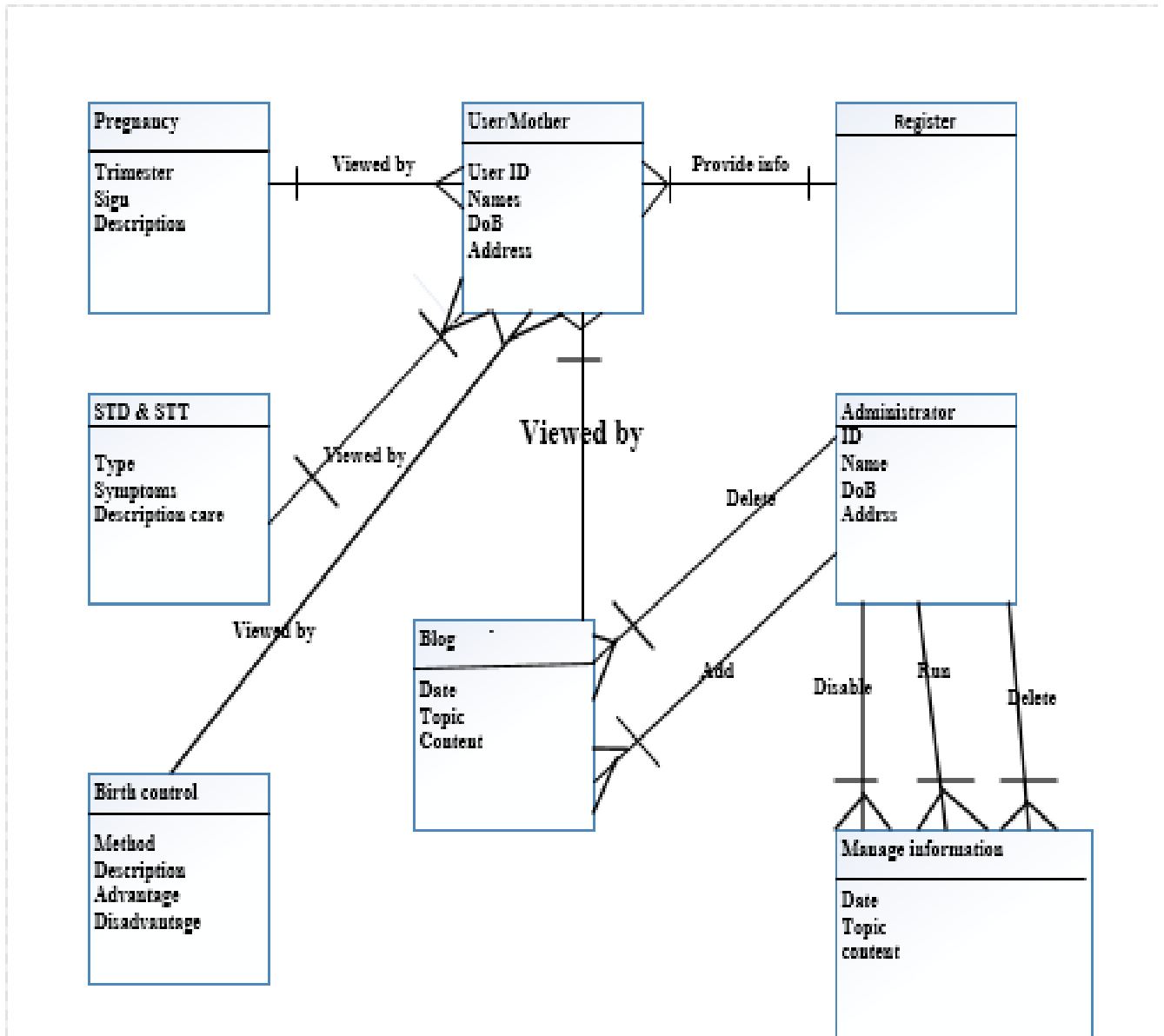


Figure 7: Partial Domain Model

4.4.1 System Behavior

Figure 9 shows a system sequence diagram for a process blog scenario that describes what the system does without explaining how it does it. It is a sequence diagram that shows the blog scenario of the use case in Figure 6. It is therefore a visual summary of the individual use case.

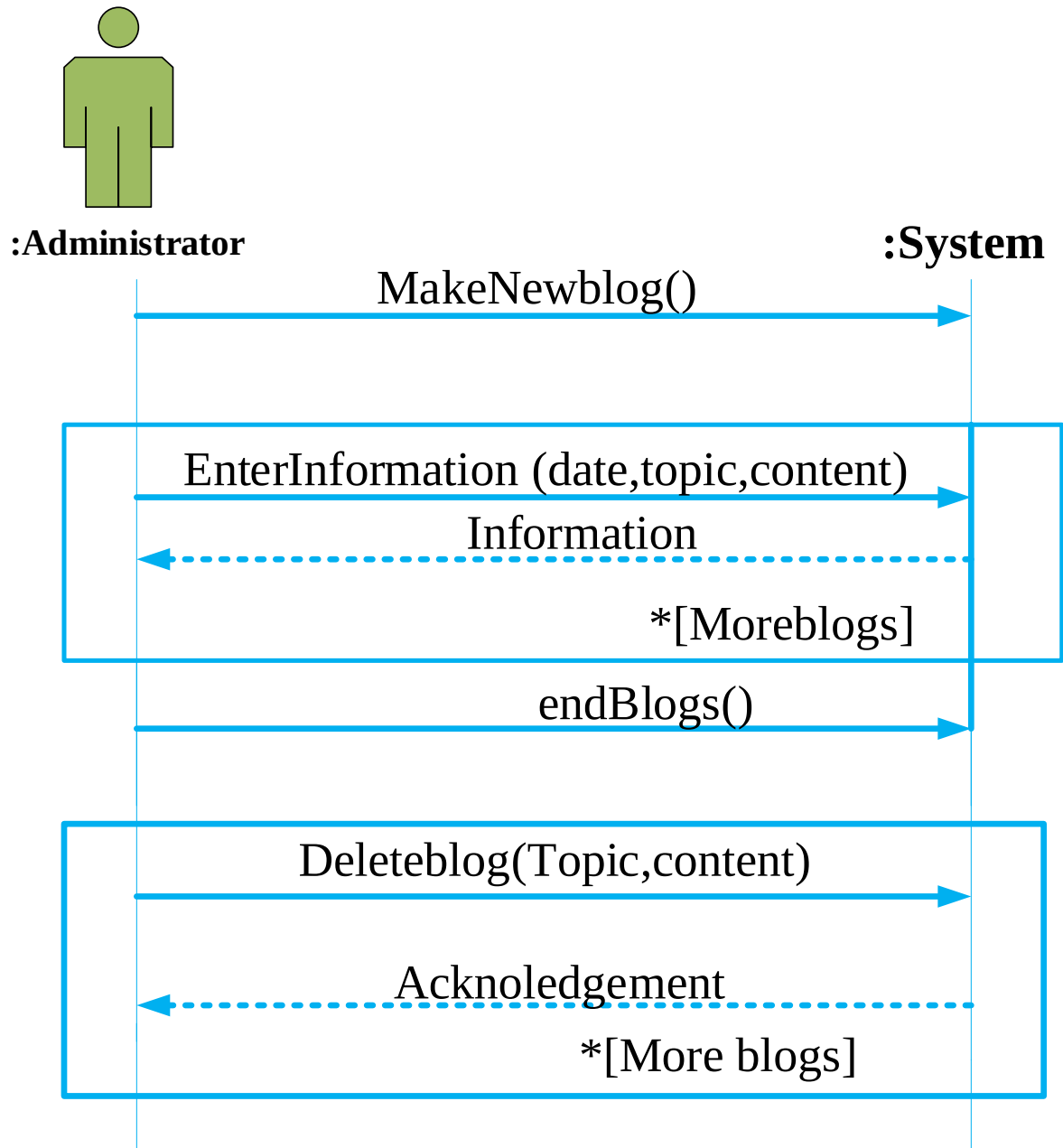


Figure 8: System Sequence Diagram for a process Blog Scenario

4.4.2 Sequence Diagrams

Sequence diagram is used to describe patterns of communication among set of object which are participated in the use cases. Communication between objects is represented by message passing between the objects. Objects are represented as columns with the vertical line to represent the life time of the object. UML provides a graphical means of depicting object interactions over time in Sequence Diagrams.

These typically show a user or actor, and the objects and components they interact with in the execution of a use case. One sequence diagram typically represents a single Use Case 'scenario' or flow of events. Sequence diagrams are an excellent way to document usage scenarios and to both capture required objects early in analysis and to verify object usage later in design. Sequence diagrams show the flow of messages from one object to another, and as such correspond to the methods and events supported by a class/object.

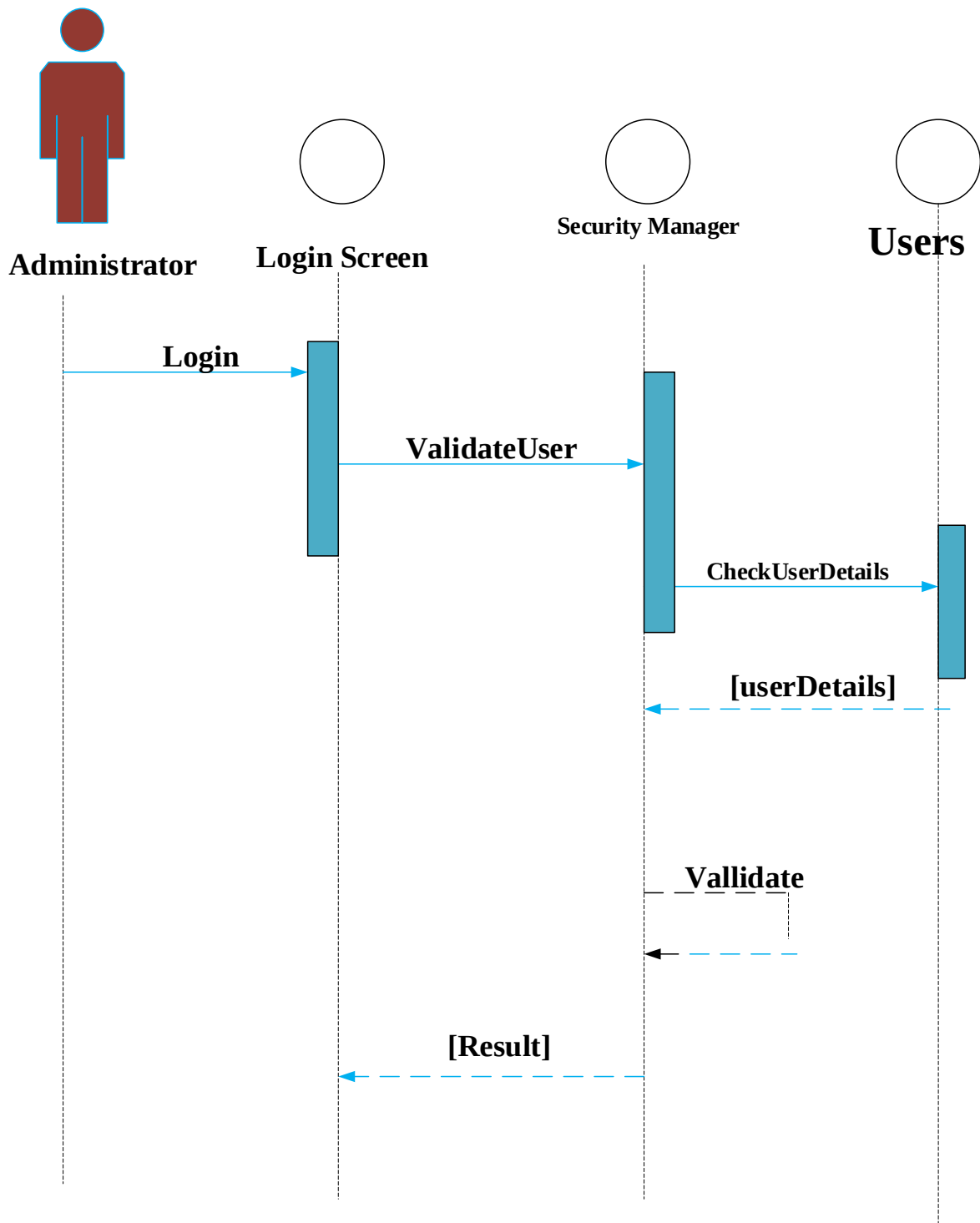


Figure 9: Sequence Diagram login

4.4.3 Interaction Diagrams

Figures 10, 11, 12 and 13 demonstrate how objects interact through information. They consist of a group of objects that are represented by lifelines, and the information that they exchange over time during the interaction. In other words, they show the sequence of information passed between objects. Additionally, they show the control structures between objects. The lifeline for the application scenario represents users and the administrator. They show the objects and classes involved in the different scenarios and the sequence of information exchanged between the objects needed to carry out the functionality of the scenarios. They are associated with use case realizations in the logical view of the application that was developed.

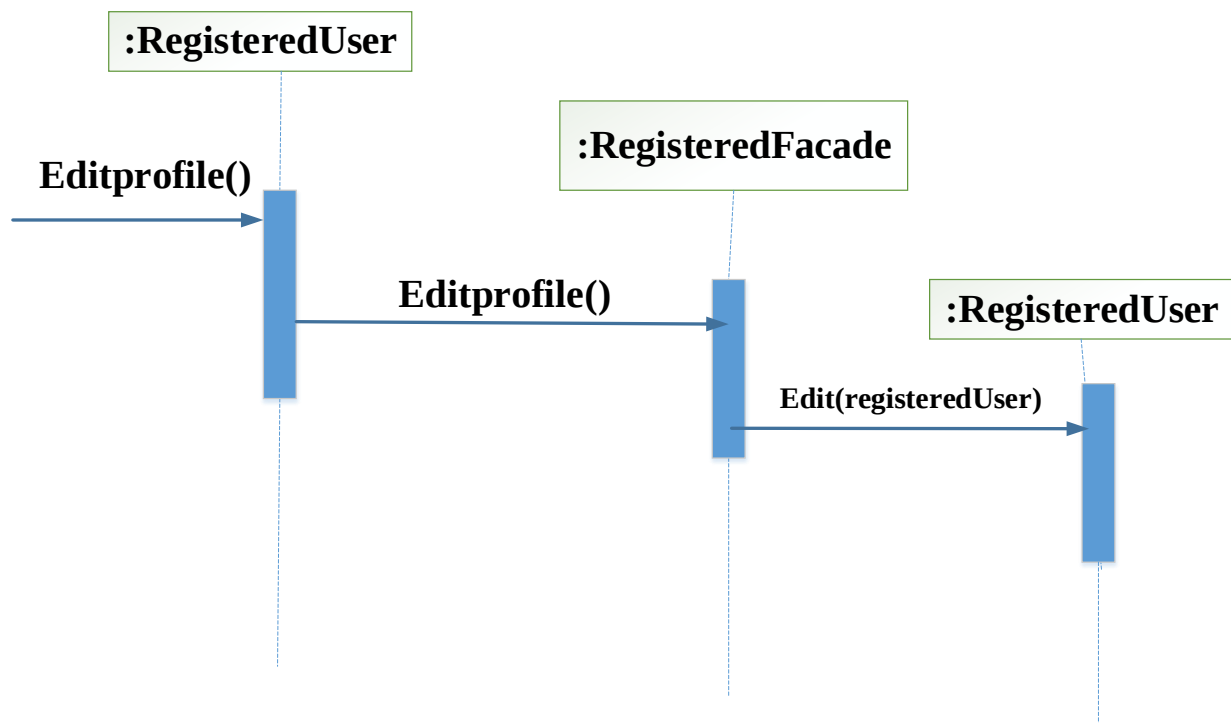


Figure 10: Sequence Diagram for a Process edit profile

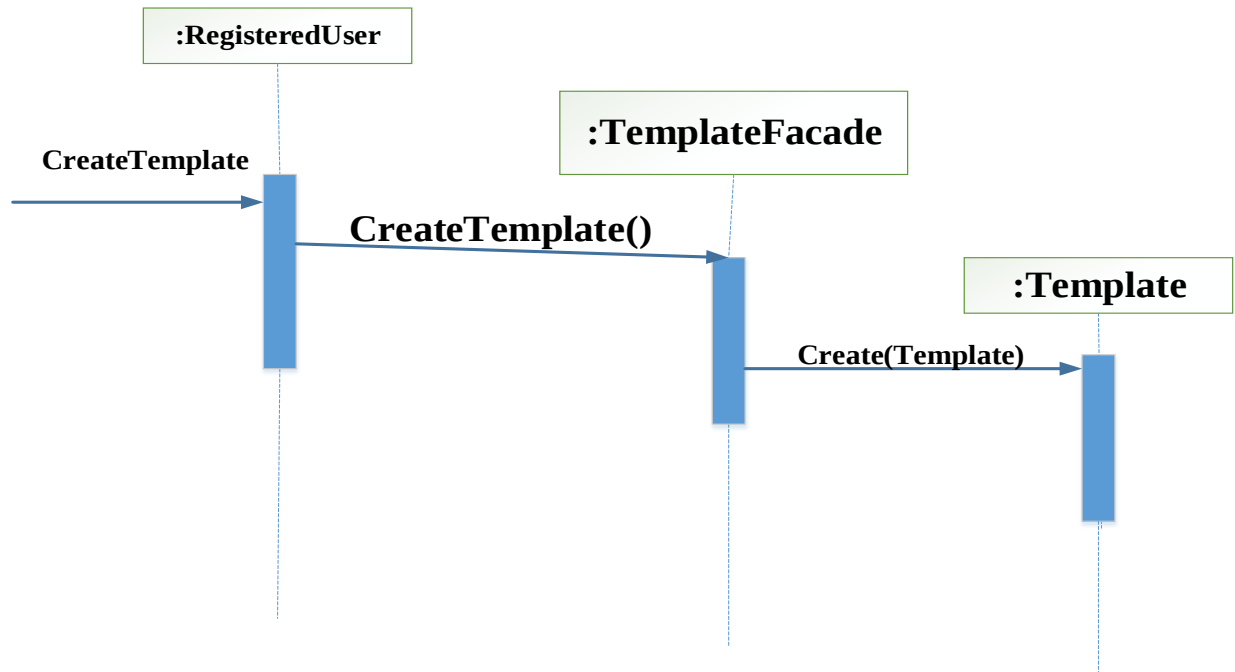


Figure 11: Sequence Diagram for a Process Create

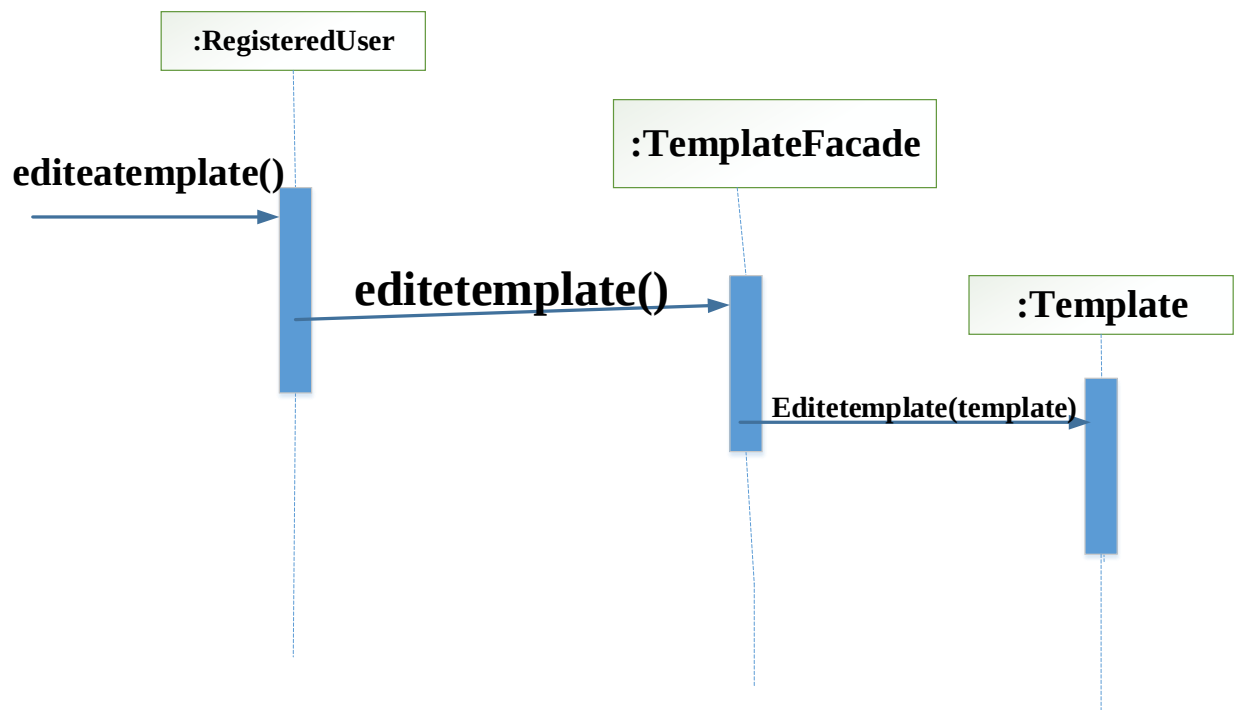


Figure 12: Sequence Diagram for a Process Edit

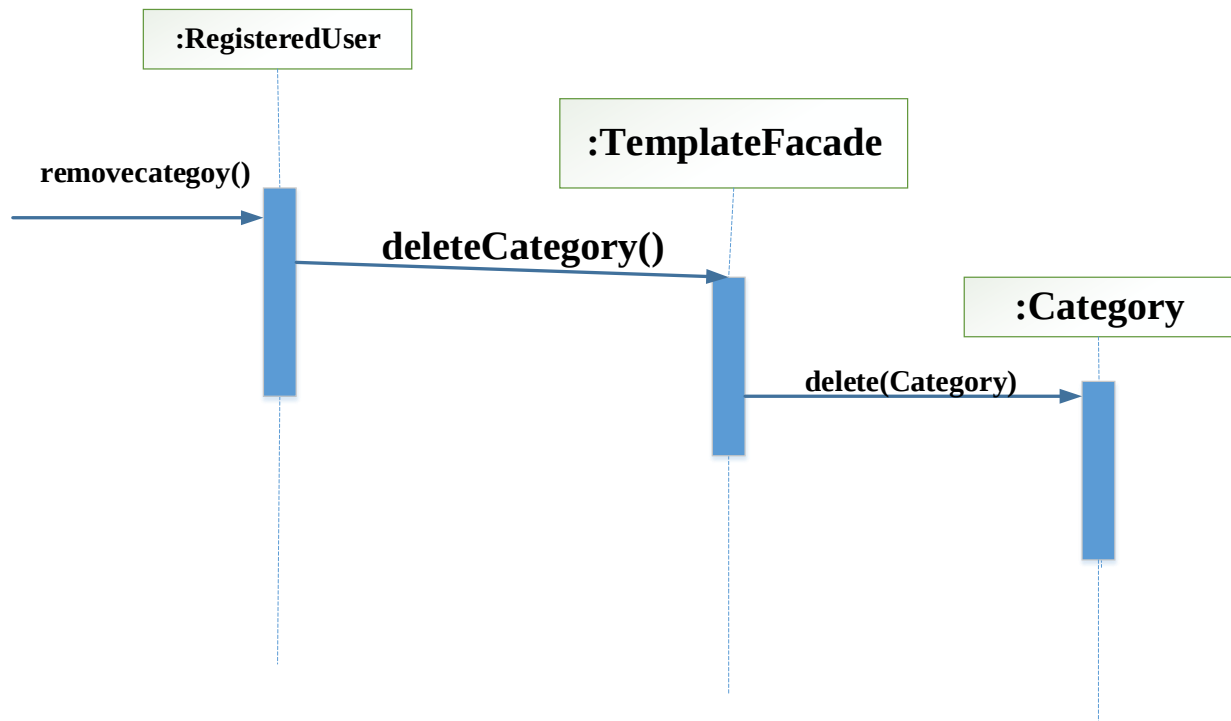


Figure 13: Sequence Diagram for a Process Delete

4.4.4 Data Flow Diagram

Figure 14 explains the process model of the system. It sought to explore the processes and information flow of the system. This was a preliminary step to create an overview of the application which can later be elaborated. The diagram (Figure 14) shows what kinds of information would be inputted and outputted from the application, where the data would come from and go to, and where the data would be stored.

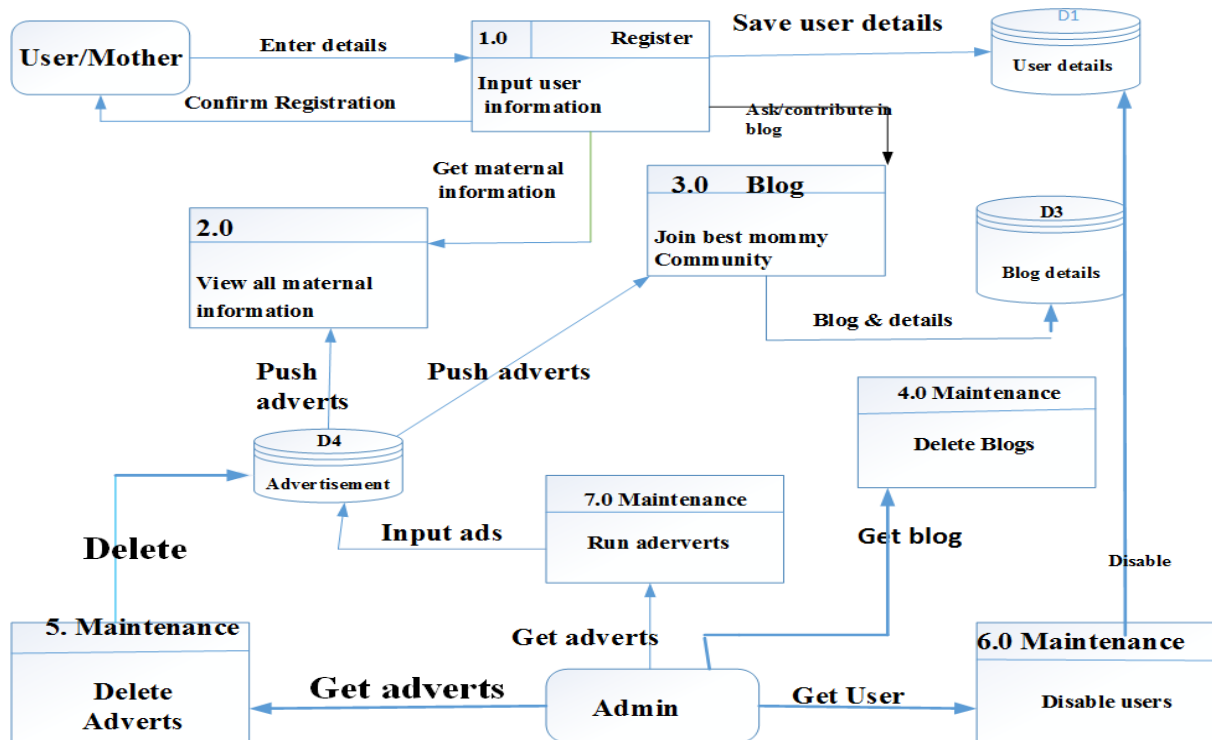


Figure 14: Data Flow Diagram

4.4.4 Activity Diagram

Activity diagram is unified modeling language (UML) diagram which are used to model sequential (possible concurrent) steps in a computational process. It is used to model the flow of an object as it moves from state to state at different point in the flow of control. This emphasizes the flow of control from activity to activity.

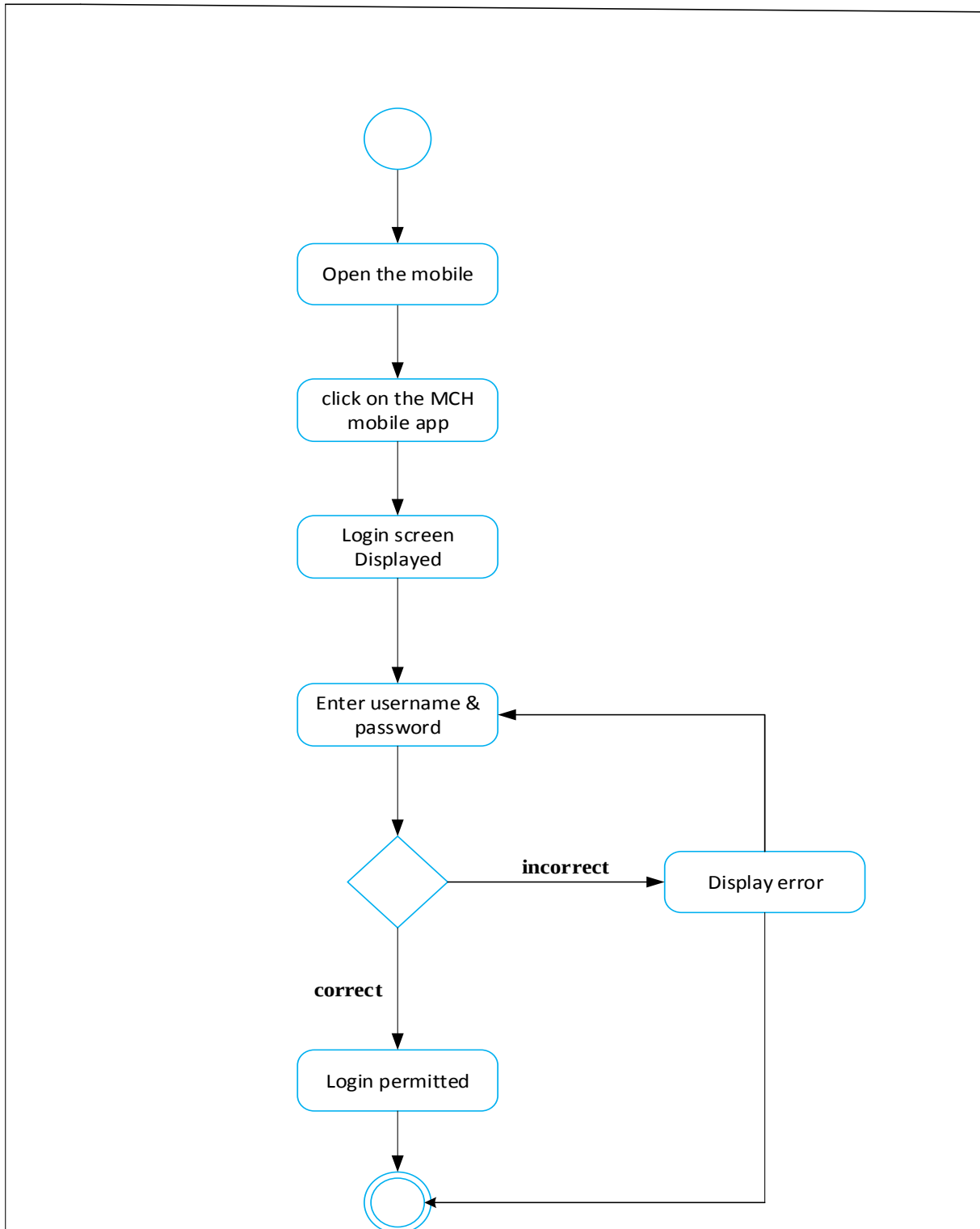


Figure 15: Login activity diagram

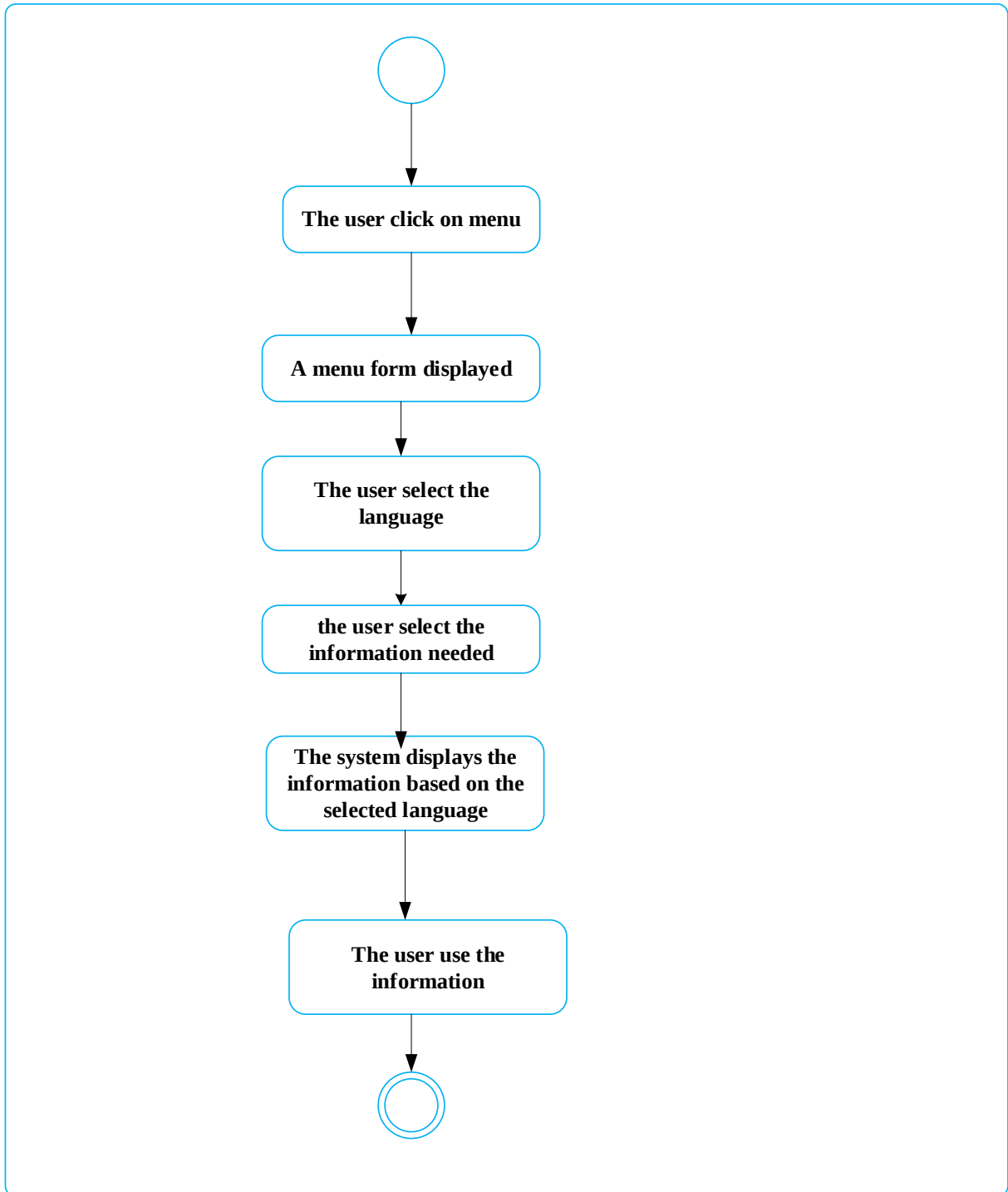


Figure 16: View information activity diagram

4.4.5 System Design

System design model is one of the formal ways of designating the data that are used and created by any business system. This shows the objects or people, the places, or things about which information is captured and the relationship among each other's.

4.4.6 The Prototype

The prototype has a very noticeable screen which is the first screen to load when the application is started. Once the application is fully loaded, the main menu of the application is presented Figure 18 This screen has custom information that welcomes you to the application. There are six main modules on this screen: All maternal information, Birth control methods, STDs and STIs, HIV AND AIDS, Immunization and Dangerous Signs.

4.4.6.1 Login

A first time user will be prompted to register with her details in the application. The user enters her username and password to login.

4.4.6.2 Home

Once logged in, the user is presented with all maternal information, birth control methods, STD and STIs, HIV and AIDS, Immunization, and Dangerous signs application settings.



Figure 17: Login Menu

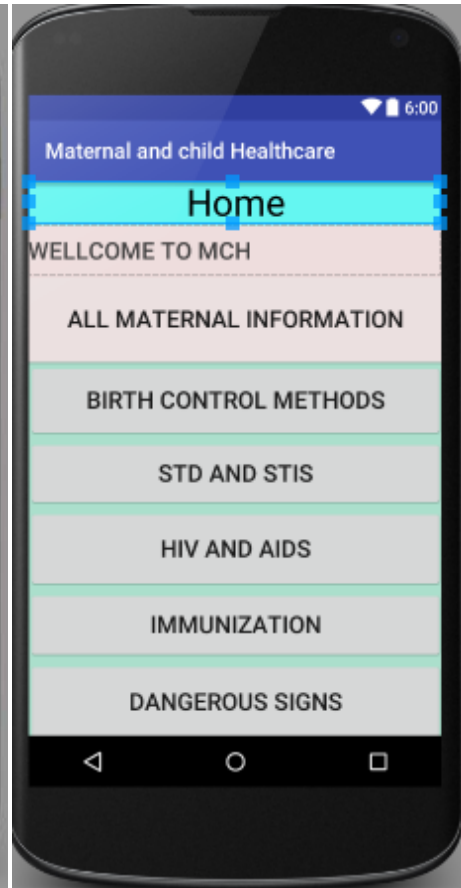


Figure 18: Main Menu



Figure: 19 Menus for maternal Information

Figure 19 shows the kind of information that can be accessed under all maternal information modules. This includes key pregnancy signs, stages of the development of the baby in each and every trimester, caring for the baby, common complications related to pregnancy, giving birth process, dietary requirements during pregnancy etc. These categories open links to the information centre which has detailed information regarding pregnancy. A sample of information in the category of pregnancy signs is shown in Figure 19.

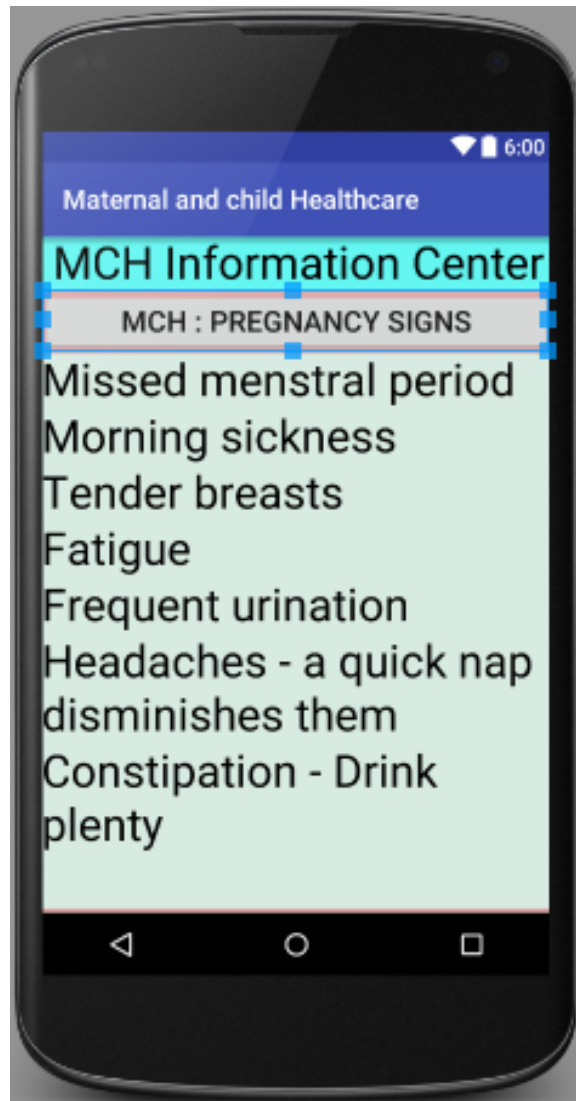


Figure 20 Menu for information Centre

The birth control methods module lists 8 different methods of birth control (Figure 20). These methods include abstinence, cervical cap, Female sterilization, male condoms, female condoms, pills etc. Also given are the chances of not getting pregnant.

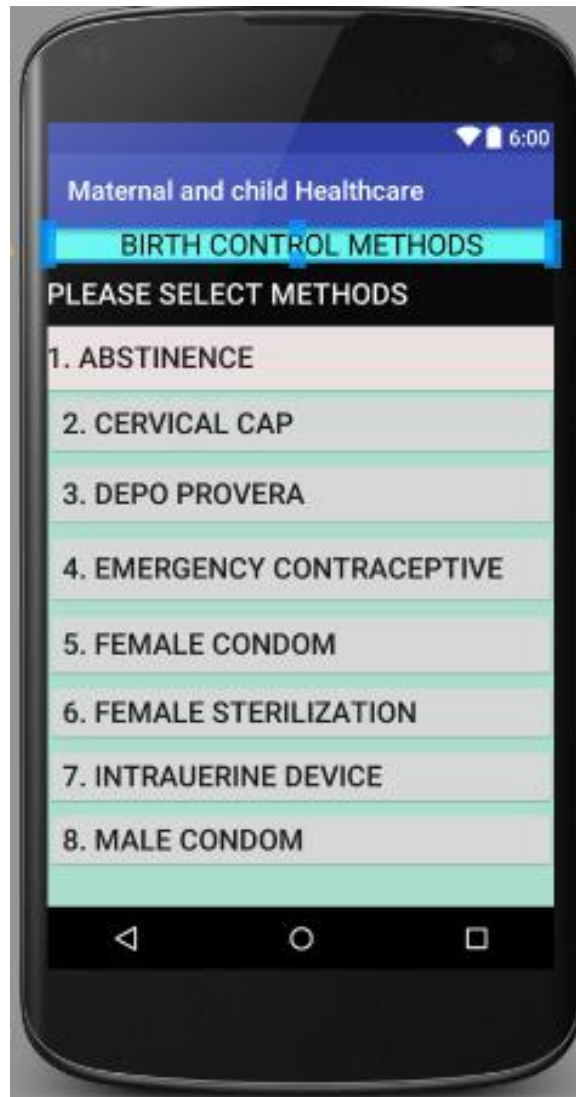


Figure: 21 Menus for Birth Control Methods

Under the STDs and STIs module, a list of these infections and diseases is presented as shown in Figure 21. Such diseases include gonorrhea, syphilis, genital warts, herpes etc.

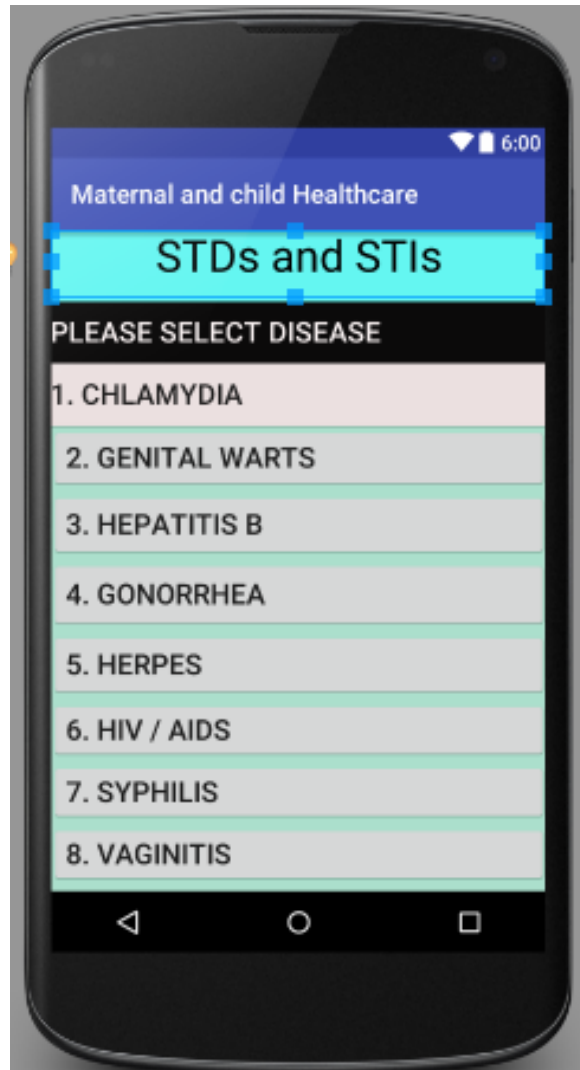


Figure: 22 Menus for ST D and S TIs

The eight modules are the HIV and AIDS module that provides information on the origin of HIV and AIDS, what it is the primary and secondary means of transmission, tests and prevention (Figure 22).

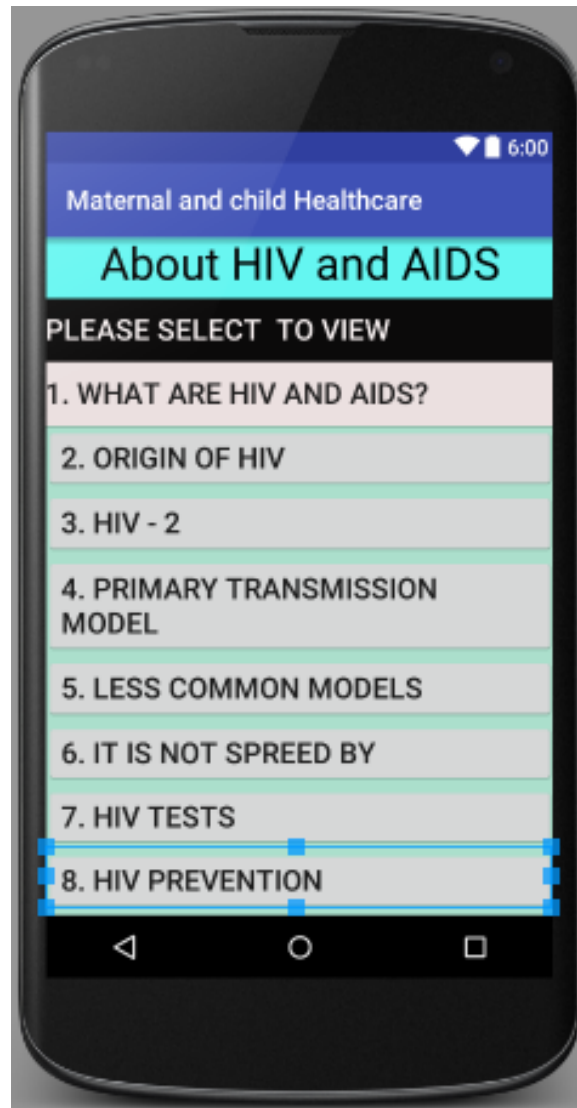


Figure:23 Menus for HIV and AIDS



Figure: 24 Menu for Dangerous signs during pregnancy Figure: 25 Menu for ANC Visit

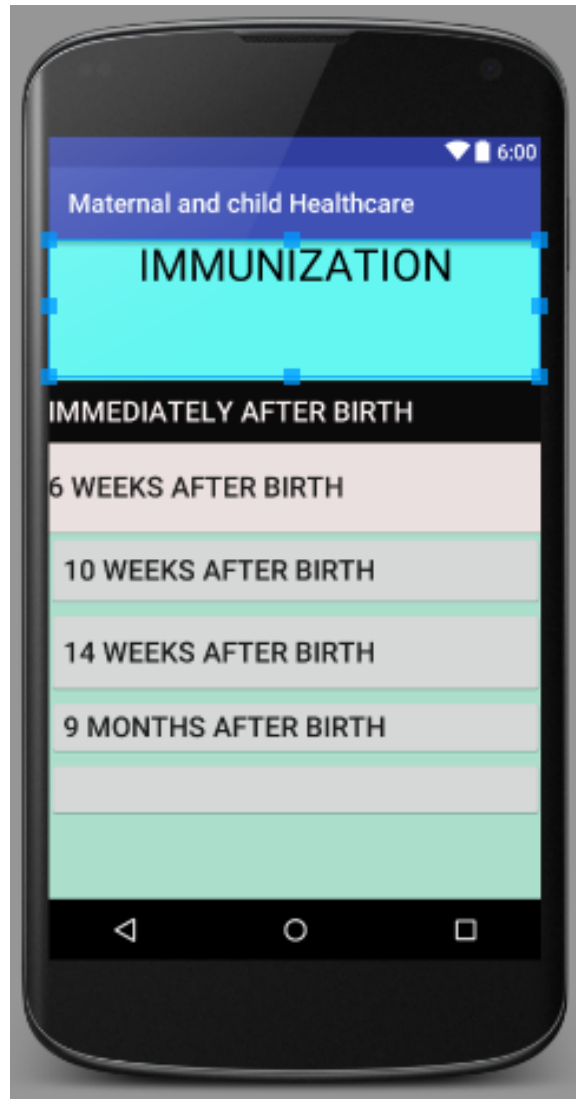


Figure: 26 Menus for Immunization

4.4.6.3 MCH Administrator Backend

The information in MCH mobile application is managed from the backend as shown in figure 27. One of the functionalities of the backend is to add, edit, and disable users registered. The information accessed in the mobile application can be added, updated and deleted by the administrator from the dashboard in figure 27.

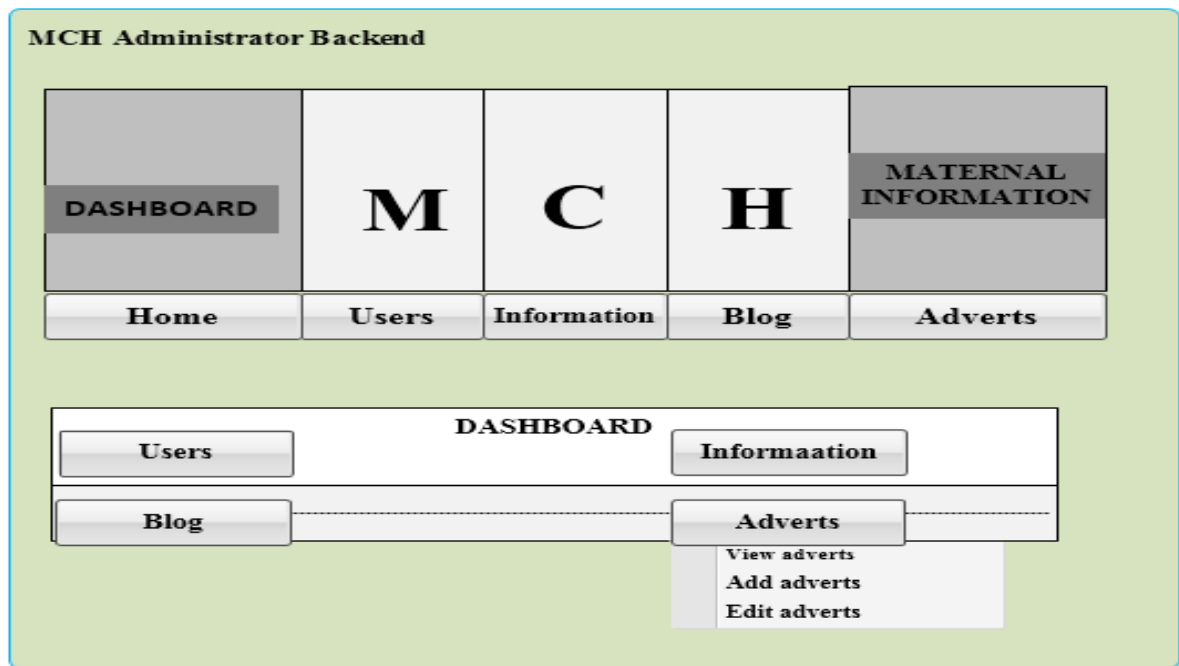


Figure 27: Home page of backend

4.4.7 System Architecture

The proposed system works on mobile phones and computers through a mobile communication networks in line with the requirements of end users. The system display information about maternal and child healthcare. This system is an integration of several modern embedded and communication technologies. To provide location and time maternal and child healthcare information anywhere in the world, Global Positioning System (GPS) "built in the Android" is commonly used as a space-based global navigation satellite system. The mobile phone which fetches the GPS location communicates with the server using General Packet Radio Service (GPRS).

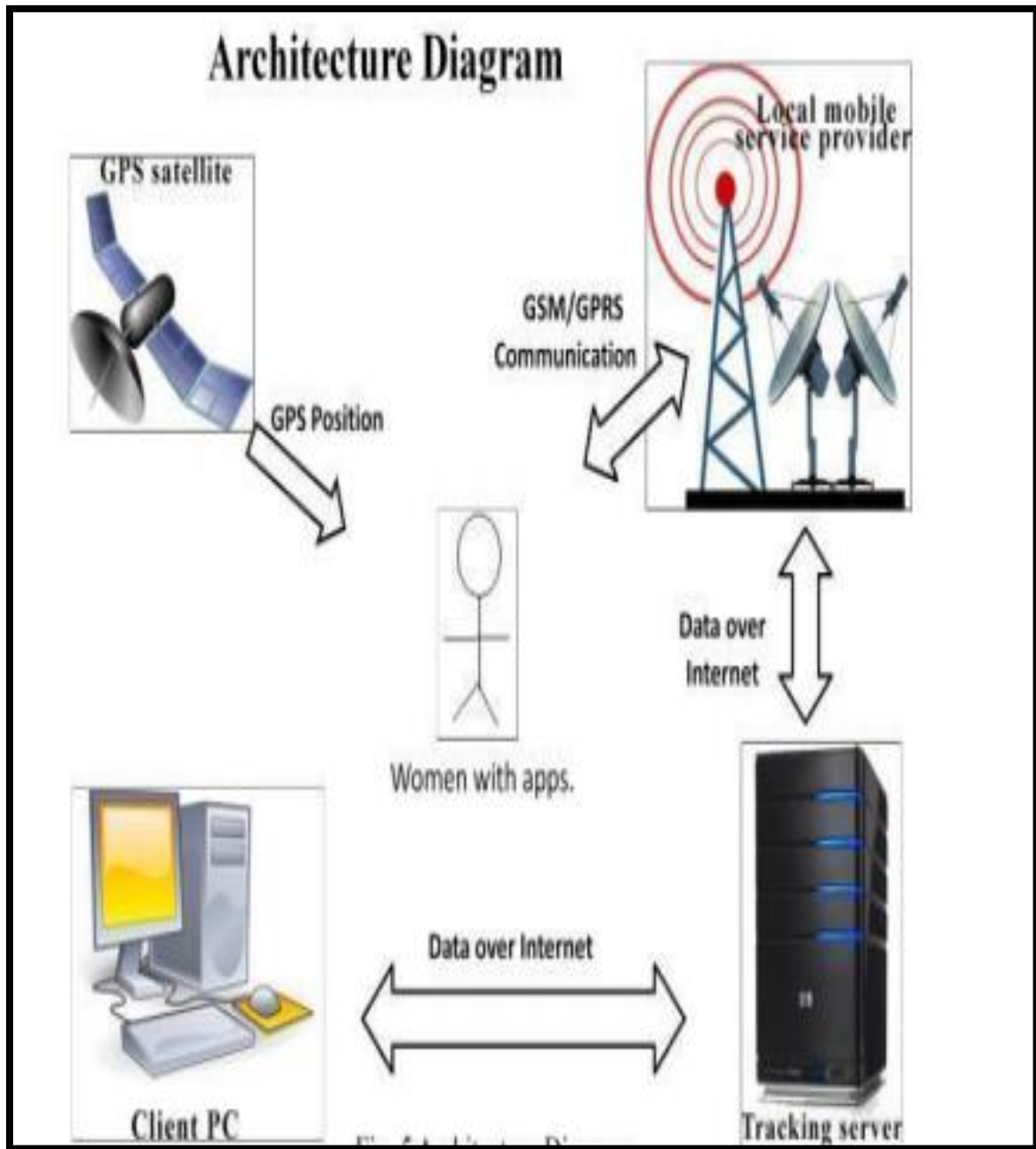


Figure 28: Architecture Diagram

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1. CONCLUSIONS

Using information technology to reach mothers directly with health information customized to their stage of pregnancy. Mobile phones applications are able to quickly and easily disseminate information that will inform women of ways to care for themselves during pregnancy, dismiss tradition and misconceptions, highlight warning signs, connect women with local health services, reinforce breast feeding practices, explain the benefits of family planning, and make new mothers aware of how best to care for their babies. Accessing maternal and child healthcare information directly by expectant and new mothers is an innovative way to empower women to take action to improve their own health and the health of their children and families. The explosion of mobile networks and the growth in mobile phones ownership offers a revolutionary way to deliver timely information to improve awareness of critical Maternal and child healthcare issues and reinforce health behaviors.

The study show that an expectant women currently access maternal and child healthcare information from the media, brochure (or information sheet), Health extension workers (HEWs) and Health Development Army (HAD). The women in each development group are clustered in one of five networks. This makes it difficult for women to make informed choices on maternal issues, infant baby care and pregnancy complications. Considering the requirements identified mobile based information support system was analyzed and designed. The models used use case narration, use case description and use case diagram to describe the basic function of the system to illustrate detail description of activities and functions running in the system.

In developed countries, mobile phones are widely used to provide maternal and child healthcare information through mobile applications. It is easy for the literate expectant women to read the maternal information and understand it. For the illiterate, it is difficult especially when the information is in English language. They prefer the information in local language or explained to them by another person.

5.2. RECOMMENDATIONS AND FUTURE WORK

FMoH, Partnerships with health professionals , hospitals and healthcare NGO's should be done to ensure the maternal and child healthcare information they provide, antenatal care clinic , health events and more can be informed the target population by means of mobile applications. To reach the semi-literate expectant women with maternal and child healthcare information easy to understand, local language should be used in the channels providing the information.

In future, partnerships with NGO's, medical institutions should be done to identify new ways of providing the information through mobile technologies to the most remote areas.

A centralized database should be developed and managed to store all the maternal and child healthcare information required. This will save users the suffering of wasting time, effort and money to obtain this crucial information. The mobile phones should be used more to disseminate this information.

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Annex A

Interview questions

Purpose: the interview question will help to assess the current system and design the current information support system for maternal and child care.

General information

Interviewee: _____

Name of Health facility: _____

Date _____

Part 1: Profile

Specific questions for women's in reproductive age group indicating important determinants regarding maternal and child care.

	Question			
1	Select your age bracket	18-24	25-35	36-45
2	Select your employment status	Unemployed	Self-Employed	Employed
3	Select your level of education	Primary school level	Secondary school level	Graduate level

Question 4 Is the sources of maternal and child care information easily accessible or available?

a) Yes

b) No

Question 5 Are you satisfied the method you have got the information of Maternal and child care?

a) Yes

b) No

Question 6 Do you prefer and other media or application?

a) Yes

b) No

Question 7 If yes, what application do you prefer for easily accessing maternal and child care information?

Question 8 Do you use the mobile healthcare application?

A) Using

B) Not Using

Question 9 Do you have experience with mobile application?

A) Yes

C) No

Question 10 Data capability of the mobile phone?

A) Data Enabled

B) Not Data Enabled