EXPLORING HEALTH INFORMATION USING WAP TECHNOLOGY: MATERNITY AND CHILDREN GUIDE

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EXPLORING HEALTH INFORMATION USING WAP TECHNOLOGY: MATERNITY AND CHILDREN GUIDE

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Abstract

The present study attempts to investigate WAP based application for pregnancy and after the birth of the baby. The system highlights the development of the fetus to the pregnant mother and the required physical exercises that the mother should go through during pregnancy. The system also provides information regarding the child's immunization which can be stored for future reference or course of action. This entire information is made available to the mothers through their mobile devices throughout the process. The system is evaluated by enabling selected respondents to test drive the developed prototype. The findings show that the respondents consider the benefit, usefulness, and ease of use of the Maternity and Children Guide (MCG).

Acknowledgement

All Praise to ALLAH for helping me to accomplish this humble study. Also, my thanks to ALLAH who has seen me through to this level in my academic achievement,

I would like to seize this opportunity to extend my gratitude to Prof. Abdul Bashah Mat Ali and Dr. Mohd Syazwan Abdullah for kindly supervising this study. Their priceless instruction and gaudiness had great role in the accomplishment of this report, my evaluators for their suggestions and help.

I would like to thank my husband and my family for everything they did and the love they showered on me. Without their dedication and sacrifices, I would not have come up to this level in life.

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List of Abbreviations

AnC ..... Antenatal Care
ARIs ..... Acute Respiratory Information
ASP ..... Active Server Pages
BLS ..... Basic Life Support
CHF ..... Congestive Health Failure
ECG ..... Electrocardiogram
EMD ..... Electronic Miscellaneous Document
GMDS ..... General Methodology Design Science
GSM ..... Global System for Mobile communication
HDML ..... Handheld Devices Markup Language
HTML ..... Hyper Text Markup Language
HTTP ..... Hyper Text Transfer Protocol
ICT ..... Information and Communication Technology
IEC ..... International Engineering Consortium
IEHMS .. Integrated Emergency Healthcare And Medication Information System
IEEE ..... Electrical and Electronic Engineers
IT ..... Information Technology
MBTS ..... Mobile Based Bus Ticketing Service
MCG ..... Maternity and Children Guide
MIME ..... Multipurpose Internet Mail Extensions
MIDP ..... Mobile Information Device Profile
MMS ..... Multimedia Messaging Service
MOH ..... Ministry Of Health
PDAs ..... Personal Digital Assistants
PHC ..... Primary Health Care
PnC ..... Postnatal Care
RAD ..... Rapid Application Development
SMS ..... Short Message Service
TCP/IP ..... Transmission Control Protocol/Internet Protocol

TLS .....Transport Layer Security
UDP.....User Datagram Protocol
UML..... Unified Modeling Language
VPN..... Virtual Private Network
WAE .....WAP Application Layer
WAP..... Wireless Application Protocol
WBMP .....Wireless Bit Map Protocol
WDP.....Wireless Datagram Layer
WHO.....World Health Organization
WML..... Wireless Markup Language
WMLS.....Wireless Markup Language Script
WSE ..... WAP Session Layer
WSP .....Wireless Transaction Layer
WTE.....WAP Transaction Layer
WTLS.....Wireless Transport Layer Security
WTP .....Wireless Transection Layer
XML..... Extensible Markup Language

CHAPTER ONE
INTRODUCTION

The chapter presents the general explanatory view of the study. It introduces the topic of study and elaborates on the problem statement. It also includes the research questions and the study's objectives. This is followed by the significance of the study and the final part deals with the content organization of the chapters.

1.1 Introduction

The dynamic and significant development of Internet and communication technologies during the past two decades has transformed the lifestyle of human beings all over the world. People residing in urban and rural areas have similar access to lifestyles of high quality owing to the presence of communication technologies' improvement of education, health and economics of people residing in all parts of the world.

The number of mobile phone users in the world was recorded around 2.2 billion in 2005 and the number of Internet users was reported to be 1 billion (ITU, 2006). This development in the usage of phones has resulted in the development of mobile's reach to a wider population. Equipped with higher speed, easy usage and affordable rates, subscribers to mobile phones are enabled to acquire high quality pictures, multimedia content like movies and news and they are also enabled to connect to the Internet. Along the same lines, relevant and accurate information regarding pregnancy can be accessed through mobile phones at any time or place. The service

for such a program can be easily accessed even in the areas with limited transportation and medical services.

The creation of the Wireless Application Protocol (WAP) technology for the purpose of mobile phone Internet access has significantly impacted the way people apply to offices and in the way they order products, anywhere and anytime (Ab. Razaq & Halina, 2009). Owing to the internet connection and large memories of applications in mobile phones, recently a mobile application enabling users to access to health information anywhere, assisted by WAP has been developed.

In most developing countries, mothers are being neglected when it comes to technological developments that can assist in the preparation of the baby's birth (Human Resource Sector Working Group, 2009). This resulted in the development of the WAP application in the hopes of exploring health information in the form of the Maternity and Children Guide (MCG). It notifies pregnant mothers concerning issues of fetus development and after birth guidelines for both mother and baby.

Maternal health is considered under the umbrella of women's health during pregnancy, childbirth and postpartum period. Despite the fact that motherhood is a positive and fulfilling experience for those who have been mothers, it is more often than not, related to suffering, ill-health and in worse cases, death. Therefore, the Millennium Development Goals drawn up by the International Community at the United Nations Millennium Summit, 2000 included improving maternal health in the 5th of the eight specified goals (World Health Organization, 2010).

In addition, maternity and children guide can be a major method to provide pregnant women with the education they need about themselves and their children and to monitor the children's progress; thus, reducing anxiety and stress.

The maternity and children guide, from here on known as the MCG comprises of two parts – first, the relevant information provided to pregnant women and second, the information regarding children's health and development. Both these parts are made available on the mother's mobile phone enabling her to access the information in a timely and easy way wherever and whenever she needs it.

1.2 Problem Statement

Pregnancy and all that it entails can be quite a challenge to mothers particularly when it's their first time for motherhood. So much of the information that passes from one individual to another may be irrelevant and redundant that it may impact the pregnancy of a woman. The information is considered in accurate as each pregnancy is different from another. To make matters worse, most of this information is passed from generation to generation as a cultural taboo (Maniam, chin, & Chenapian, 2008).

Various books, journals and other printed materials have been dedicated to pregnancy and providing information that women require during their pregnancy and after birth. However, these materials are usually overwhelming and difficult to understand. The Internet provides relevant information in a timely and easy way so that pregnant women and mothers can access the information whenever they need it. Nevertheless, most of the information stems from what happens in the West and is

concerned with cases of pregnancies in the West. It has also been noted that very few information concerning pregnancy is accessible to women in other parts of the world particularly relating to healthcare for women who lack English language proficiency and computer literacy (InfoDev, 2006).

In the urban areas, women can easily obtain information and advice from doctors in clinics although this may cost them. On the other hand, in the rural areas, medical aid is few and far between (WHO, 2010).

Based on the study of Cho and Choi (2003), the maternal and childcare centers are currently providing consulting services, immunization and check-ups for pregnancy and fetal health. All the above information is noted down on a book that is provided to mothers to keep track of their next visit and their babies' immunization dates. This book is not very reliable as it can be lost and damaged or mothers may have more than one child entailing more than one book. Additionally, websites may be able to provide information regarding pregnancy and children development but they don't facilitate the saving of personal medical history just as in the book and moreover, computers are not always available when needed.

A major portion of the healthcare information in the current era is still paper-based or saved in standalone systems that are not Internet enabled, and are not connected to multimedia, wireless or real time technologies (Human Resource Sector Working Group, 2009). Moreover, there is a notable lack of policies in most developing countries concerning women empowerment and children development that encourage health education (WHO, 2004).

The main problem lies in the fact that information does not reach the expecting mother owing to the word of mouth passing of information. Such a problem is solved through the use of WAP whereby the mother is notified regarding the information she needs. The present paper attempts to tackle the issues which prevent the improvement of mothers' and their children's development and care.

1.3 Research Questions

The main research questions for Maternity and Children Guide System (MCG) are:

1. What are the requirements of MCG System?

2. How to design and develop the MCG System?

3. Is MCG System satisfied the users in terms of ease of use and usefulness?

1.4 Research Objectives

The main object of this study is to develop prototypes objectives of Maternity and Children in (MCG). In order to develop this project, these following objectives should be accomplished.

1. To identify the requirements for MCG System.

2. To design and develop prototype of MCG System.

3. To evaluate ease of use and usefulness of MCG System.

1.5 Significant of the study

The main rationale behind the present study is to attempt to provide pregnant mothers with the information they need through the use of WAP application systems that allows mothers to keep abreast of their pregnancy information through the use of a mobile phone. In other words, information concerning the baby's growth will be communicated to the mother through WAP applications and the mother will find this information invaluable for her and her child's needs.

1.6 Scope of the study

The study delves into WAP application system development that is used to monitor mother care and childcare during the pregnancy of the mother and after birth until the child is 6 years. It basically focuses on enabling the pregnant to have a smooth pregnancy and monitoring her child care. This entire information can be obtained from mobile applications offered with internet services.

1.7 Organization of The Report

The study is divided into six chapters all interlinked with each other. The chapters' organizations are;

Chapter one presents the study background, the problem statement, the significance of the study, the scope and the organization of the study. It basically contains the introductory view into the objective of the study and the reason behind it.

Chapter two deals with extant related studies review. This is discussed to highlight the hypotheses of the study.

Chapter three explains the study methodology. It mainly focuses on the detail the researcher has adopted to carry out the objectives of the study.

Chapter four explains the development of the system and the application's interfaces.

Chapter five contains the evaluation of the prototype of this study under its ease of use and usefulness.

Finally chapter six contains the study conclusion, recommendations for future research, study limitations and recommendations for future study.

CHAPTER TWO
LITERATURE REVIEW

This section presents a literature review on the area of research studied-WAP-based on Maternity and Children Guide system. It gives a theoretical review on previous works and existing applications that have been carried out in the same area. The section illustrates medical information, health care system in Iraq and maternal and child health services, also this chapter illustrates on the concepts of WAP, WAP architecture, design and tools.

2.1 Medical Information

Medical information is a huge amount of information that is a combination of different medical reviews that adds to its complexity. In fact, what makes the medical contents so heterogeneous is the diversity of it sources. According to Gregory (1996), online access to the patient's medical record accessed through pocket or hand-held tool will be an invaluable tool for healthcare professionals and to other medical applications in light of information delivery, and information access. Kendall (1996) states that these medical applications designed for information delivery and access have been designed on the basis of handheld computers. In the current world, technology is undergoing dynamic changes and people opt for handheld devices to access information from as opposed to PC or laptop owing to it mobile element (Erlandson, 1998; and Goto, 1999).

2.1.1 Health Care System

The healthcare system was confined to hospital-oriented, capital-intensive model of care that necessitates huge amounts of imports of medicines, medical equipment and even healthcare workers. The system's running was characterized as fairly well with little health service data that is important to effective decision making collected and hospitals only provide services to partially cover the population's health. Currently, the available number of human resources for health is still reported as insufficient particularly nursing professionals.

The World Health Organization has carried out the first ever analysis of the world's health systems. Their goals of the health care system are good health, responsiveness to the population expectations and provide fair financial contribution. According to WHO vision, France provides the best overall health care followed by Italy, Spain, Oman, Austria and Japan (WHO, 2000).

2.1.2 Maternal and child Health Services

Maternal and child healthcare and reproductive health services are offered in all levels of service (WHO, 2004). The following services are provided at the onset (PHC):

1. Antenatal Care (AnC): The aim of providing this service is to appropriate at least five visits during pregnancy. This period involves the preparation of the mother's file containing her history, and information regarding her health. Routine investigations are inserted within the file. The mother is prescribed with ferrous sulfate and folic acid tablets during her visits and she receives two doses of tetanus

toxoid if the vaccination is her first time. During this period, detection of risk factors are detected and tackled and if treatment is lacking within the healthcare center, then they refer her to antenatal clinics in hospitals.

2. Postnatal Care (PnC): The rationale behind the mother's check up in PHC centers at least once in a period of six weeks after the delivery of the child, is because the mother needs to make sure that she has a clean bill of health after the birth. Therefore, medicine and tablets are prescribed if needed. For instance, ferrous sulfate tablets are provided if the mother is anemic, complications from childbirth are detected and treated.

3. Growth Monitoring of Under-Fives (U5s): Prior to reaching five years of age, children have periodical check-ups to monitor their development and growth. In addition, they are presented with a routine immunization schedule. Children who weigh to be less than 2Z scores are provided with high protein biscuits and those below 3Z scores are referred to the Nutrition Rehabilitation Centers in Hospital that specializes in pediatrics. These services initiate during the first week after the baby's birth when he/she is brought to the PHC center for the purpose of vaccinations and scheduled examinations.

Other services include management of acute respiratory infections (ARIs) and diarrhea through the utilization of standard case management charts, promotion of breast-feeding through the provision of health education, schedules immunization (Table 2.1), and curative services to both mother and child.

Table2. 1: Child Immunization Schedule (WHO, 2004)

Age	Vaccine
First Week of life	BCG, OPV0, HBV1
End of second month of life	OPV1, DPT1, HBV2
End of fourth month of life	OPV2, DPT2
End of sixth month of life	OPV3, DPT3, HBV3
End of 9th month of life	Measles vaccine
End of 15th month of life	MMR
End of 18th month of life	OPV, DPT first booster
4-6 years (school entry)	OPV, DPT second booster
12 year old females	Rubella vaccine

2.2 The Rapid Growth of the Mobile Phone

Business activity and information distribution are increasingly impacted by mobile applications as they are being widely accepted owing to desires and wants of the consumers and the dynamic improvement of wireless communication devices and technologies. Various applications now enable the sending and viewing of mail, browsing the Web, accessing traffic and weather reports, watching moves and even accessing back-end database systems (Bhavnani et al., 2008).

Bhavnani et al. (2008) stated that there are certain facts that require to be highlighted with the increasing utilization of mobile devices:

- Affordability (from the Demand side): The mobile devices are affordable and have many choices even for low-income consumers.

- Affordability (from the Supply side): The establishment of mobile masts and turrets is reasonable in terms of cost while serving the large and rural areas as opposed to fixed telephone lines.

- Flexibility: The devices can be utilized by varying consumers in varying places and they provide applications to send messages, voice mail, videos, and other WAP applications. This makes these devices highly flexible when compared to both radio and TV.

- Low Barriers to Entry: The mobile device is currently viewed as the most effective and easily accessible device from external and internal use and even in rural areas. Their reasonable costs make it available even to poor consumers.

2.3 Wireless Application Protocol

Wireless Application Protocol or from here on referred to as WAP, is considered as wireless application protocol and standard specifications allowing mobile devices to connect with the web server used in the WAP browser. It then allows the content display on the screen of the mobile devices; in other words, it is the protocol that enables mobile devices to connect with the internet (Kustin, 2002a). According to the International Engineering Consortium (IEC), WAP is an application environment and a set of communication protocols for wireless devices created to allow the manufacturer, vendor and technology dependent individuals to connect to the internet and advanced telephony services (Steenderen, 2007).

WAP connects the mobile worlds together through the internet and has the ability to deliver unlimited range of mobile value added services to the subscribers regardless of their network, bearer and terminal (Taylor, 2006). The WAP adopted its features and functionalities from both the internet standard and the development of wireless services in wireless telecommunication (Bulbrook, 2001). Hejden (2000), on the other hand, defines WAP as a method of global wireless internet standards for communication. Hence, it does not serve merely as a language but also a platform enabling development and interconnectivity.

WAP is ever evolving and it facilitates the growth of mobile commerce markets. WAP devices allow the users to carry out business transactions including shopping, baking, making reservations among other activities. WAP is created by WAP Forum which is attributed to the development and specifications of protocols and guidelines to its application environment (infoloom.com).

2.3.1 WAP Application Architecture

The WAP Application architecture comprises of two components; bearers and other services and applications (Figure 2.1). Bearers consist of GSM, IS-136, CDMA, PHS, CDPD, PDC-P, and IDEX, while other services and applications include application layer (WAE), session layer (WSP), transaction layer (WTP), transport layer (WTLS), and datagram layer (WDP).

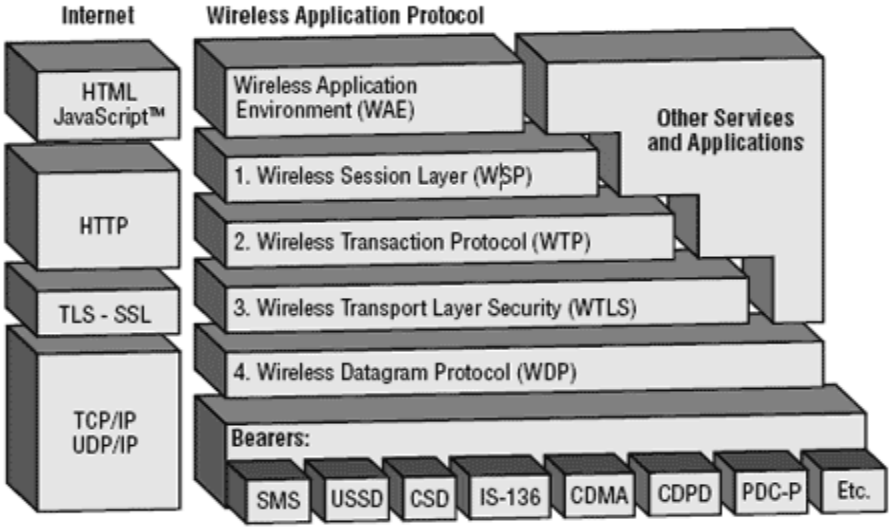


Figure2. 1: WAP Application architecture (Tutorialspoint, 2012)

Upon connecting to a wireless network to access the Web, a request is sent to the Website and it must support WAP. The mobile phone sends the request through radio waves to the nearest cell which then reroutes it to the Internet to a gateway server. The server proceeds to translate the request and transforms it into a Web format (HTTP) and sends it to the Website.

When the Website responds, it retrieves the HTML documents, through the gateway server which converts it into WML format and reroutes it to the nearest antenna. The antenna will in turn send the information through radio waves to the WAP device and eventually the micro browser will display the page. The working of the WAP Application Architecture is displayed in Figure 2.2.

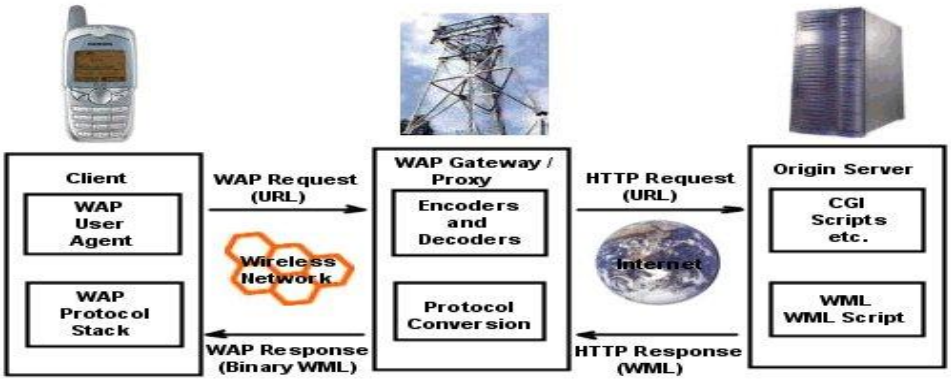


Figure2. 2 WAP Application architecture work

2.3.1.1 Bearers

There are various bearer services including short message, circuit switched data, and packet data that operates with the WAP protocols. Having the ability to handle throughput, error rate and delays in an effective manner, the bearers provide varying levels of service quality to the architecture. In addition, the WAP protocols are developed to tackle different levels of services. The WDP layer provides the convergence among the bearer services and the WAP stack and it facilitates their communication.

2.3.1.2 Application Layer (WAE)

Owing to its device specifications and content development programming languages (WML and WML Script), developers are attracted to the WAE. It is developed in the hopes of providing an interoperable environment enabling the creation of applications as well as the provision of services.

2.3.1.3 Session Layer

This layer has been developed by the WAP Forum, unlike HTTP, to offer timely connection suspension and reconnection.

2.3.1.4 Transaction Layer (WTP)

The WTP operates on top of a datagram service like User Datagram Protocol (UDP) and is considered as a part of the TCP/IP protocols utilized in the provision of a simplified protocol that is appropriate for low bandwidth wireless stations.

2.3.1.5 Security Layer (WTLS)

The WTLS includes security features on the basis of the established Transport Layer Security (TLS) protocol standard and data integrity checks, privacy, service denial and authentication services.

2.3.1.6 Transport Layer (WDP)

The WDP or the Wireless Datagram Protocol enables the WAP to be independent of bearers through the adaptation to the transport layer that underlies the bearer. The WDP shows a consistent data format to the higher levels of the WAP protocol stack and thus enabling application developers' bearer independence.

Every layer provides a structured interface to the layer above it. In other words, the internal workings of each layer are transparent and are visible to the layers above it. This layered architecture enables other applications and services to make use of the

features offered by the WAP stack making its use invaluable for services and applications currently unspecified by WAP.

2.3.2 Mobile Application Technology and WAP

Accessing internet through mobile devices is becoming widespread. Most mobile providers also offer wireless network between the cellular phones and WAP gateway server. The mobile technology lies in the automation of business, streamlined business processes coupled with future-proof mobile applications which leads to enhanced productivity and decreasing operational costs. However, this necessitates a cautious and strategic method when extending business into mobile applications.

WAP services do not call for additional requirements to the service provider and a WAP site can be developed in a WAP server characterized as predictable. The developer requires HDML, WML, WMLS, WBMP, and MIME types to configure the server. For the dynamic WAP contents, languages like Java Servlet, PHP, Perl and ASP can be utilized.

2.4 WAP Registration Application

A mobile based bus ticketing service (MBTS) prototype was developed by Jimoh (2001) to enable bus passengers booking through mobile devices. The prototype was evaluated and the findings confirmed its usefulness for passengers as this would facilitate their easy, direct and successful transactions in any location and at any time. Jimoh's (2001) study was a pioneering success holds the basis for the development of a mobile based application system of blood donation.

In a related study, Stuart and Brian (2003) reported that a great benefit would result in both banking industry if bank customers are enabled banking transactions through mobile technology. This was in light of the development and introduction of WAP applications in mobile phones. Bank transactions are now carried out through the mobile phone with the help of WAP technology applications. As a result, bank customers are afforded a chance to check their bank account balances and to carry out other possible transactions that are similar but more convenient to do through online banking owing to the mobile element and the conformability in mobile technology.

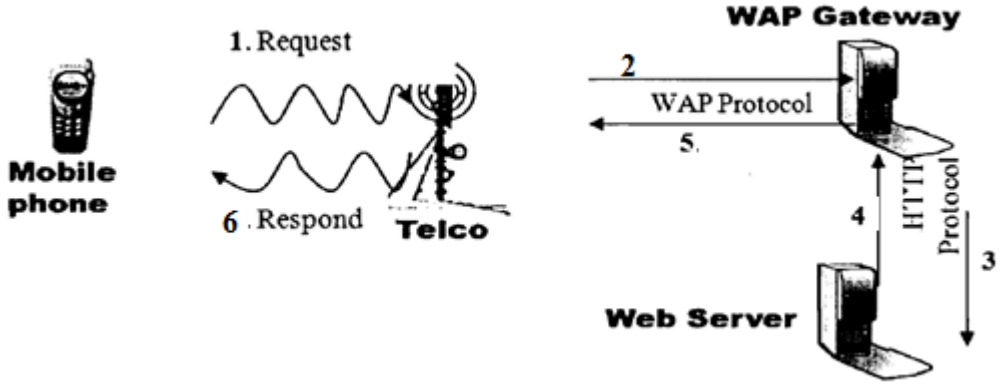
In another related study, Ondrus and Pgneur (2005) provided a description of the working of the WAP application in mobile payment and as a basic tool utilized to determine the throughput of the mobile payment application. In addition, various researchers have advocated the emergence of the mobile payment application in the mobile commerce and expectations of the mobile commerce are evident in the efficiency of WAP applications in mobile technology. These advocacy and recommendations also highlight the success of the mobile applications of blood donation since its benefits are plentiful and it is supported by the same WAP applications.

Moreover, the usefulness of the mobile technology in general and WAP in particular in the future has been elucidated by Mallat et al. (2004). This study became the basis of Ahmmed's (2007) study of WAP based applications for handicraft products manufactures in rural areas. The study attempted to develop a WAP based

application for tourists in rural areas to request, apply or buy handicrafts. This study has been reviewed to present the similarities of the proposed system.

Similarly, Yusuf (2008) developed a WAP based application to increase promotion and advertisement and to enhance sale processes and profitability of city business and brand innovations. This application enabled product promotions and advertisements and hence benefitting product producers, manufacturers and consumers. It facilitated the product and brands viewing on mobile phones and the advertisement and marketing of manufacturers of their new products and brands.

The WAP technology infrastructure was developed based on the WAP technology system that was developed before it. WAP technology necessitates WAP gateway for the performance of conversion and synchronization. The process flow of how the user connects to the Internet is presented in Figure 2.3 (Andersson et al., 2005).



- **The numbers represent the sequences of flow**

Figure 2. 3: The WAP Process Flow Ghani(2005)

2.5 Existing Medical Related Works and Applications

Many researchers (Steen and Hunskar, 2004; Abowd, 1996; ARC Group and the Wireless Advertising Association, 2001) have tackled the issue of patients seeking emergency care systems. These studies explored the way patients seek emergency care with special reference to the role of the list patient system. The patients were requested to complete a questionnaire exploring whether they are privy to the physicians whose list they were in, their assessment and accessibility to the said physician, their method of contact prior to coming to emergency care, their waiting duration, their reasons for emergency care necessity and their certainty in getting an appointment with the physician. The study distributed at total of 1504 questionnaires which were later analyzed and the findings reveal that patients did know the names of their physicians (84%) and were satisfied with accessing them. The findings also showed that three out of four patients do not inform their physicians prior to visiting the emergency center and half of them are willing to wait for their appointment. There is a huge potential for change in patient's behavior in the context of primary care emergencies in the context of Malaysia (Country Profile, Malaysia, 2006).

According to Cho and Choi (2003), the healthcare industry is faced with challenges in their provision of healthcare professionals' access to patient information at any time and place when it is required. The access has been suggested through mobile computing and several studies have tackled with Personal Digital Assistants (PDAs) or mobile to record healthcare services at the point-of-care. The studies revealed that documentation of healthcare interventions can be advantageous than its paper based

documentation counterpart. The advantages include efficiency, greater user satisfaction, increased visibility and recognition of staff work.

This finding is supported by Paradiso-Hardy et al. (2003) who reported that the WAP based data collection sheet facilitates standardized documentation and provides comprehensive and consistent reports. However, the time taken to record intervention was reported to be the same for WAP based and paper based systems. But an additional advantage of the former application is the ability to create reports from the data collected. However, there is limited view of data on the PDA or mobile (Paradiso-Hardy et al., 2003; and Cheverst, 2000)..

The trend in the present healthcare sector is to connect patients, physicians and hospitals together in one platform to provide the best healthcare possible (Britze, 2005; Doderon, Gianuzzi, Coscia & Virtuoso, 2001). In addition, preventive care may be provided as opposed to curative medicine which reduces the cost, enhances the treatment quality and promotes knowledge sharing among physicians.

In the framework study of InfoDev (2006), the health based web sites improvement of knowledge, and behavior leading to slow health decline among users have been highlighted. Studies in the context of Peru, Egypt, and Uganda report that the utilization of ICT has lessened maternal deaths. In the context of South Africa, mobile phones are used to provide timely reminders to patients suffering from tuberculosis (Infodeve, 2006).

Bental, Cawsey and Jones (1999) suggested another approach in which tailored information based on individual characteristics of a person is provided which is invaluable to patients with particular needs. For instance, for expecting mothers, during the pregnancy, there may be varying needs and varying types of health issues depending upon the mother's health and physical condition (CenterSite, 1995-2007).

Moreover, patients can be taught to keep track of their own health. In Cafazzo's (2000, 2004) study, diabetic patients are provided with the tool to measure blood pressure which is passed through mobile device to be recorded in the central data repository. The clinical rules engine then receives the data from the mobile device and reports to the physician in case of abnormal readings.

Mobile devices are useful in providing health information on the basis of geographical location of the patient. These devices are convenient for travelers to keep track of their illnesses in specific locations (Kamel, 2003).

In addition, Momeda, or Mobile Medical Data is basically a demonstrator that can be utilized through a PDA as it facilitates the access to electronic patient record data of the consulting physician. In addition, diagnostic information including radiological images and text and laboratory data is transmitted through a wireless pocket size terminal equipped with a user friendly multimedia format. This enables patients to access the specification of their medical information and their understanding of their medical problem. Information regarding the planned procedure, the lifestyle they should follow during and after their hospital procedure is accessible (Pavlopoulos et al., 1999).

Moreover, the University of Athens developed a project known as the ambulance project. For this project, they were required to develop a portable emergency telemedicine device displays real time transmission of critical bio-signals and still images of the patients through GSM link (Pavlopoulos, 1998).

In the context of Malaysia, Hameed et al. (2011) recommended an integrated emergency, healthcare and medication information system (IEHMS) for Malaysian hospitals. This information system facilitates a user friendly, efficient, and cost-effective we based system through the multimedia environment, real time and mobile technology. The IEHMS architecture is displayed in Figure 2.4. Its main features include, the creation of a virtual global community, the investigation and overcoming of weaknesses of the present medical emergency systems, the offering of real time communication between patients and physicians, SMS, MMS, live chat, and the development of real time agent based medical emergency system facilitated through multimedia, Web 2.0 and mobile technology.

The IEHMS also provides a user friendly web interface application for emergency centers and for hospital staff's interaction with the patient, up to date medical records of patients to the doctors, up to date information of related data and customized disease information to patients. it is developed in the web-based multimedia environment, and real time technology. It provides an integrated medical database providing stakeholders with medical information. The users can register and log into the system to access and to provide their medical information.

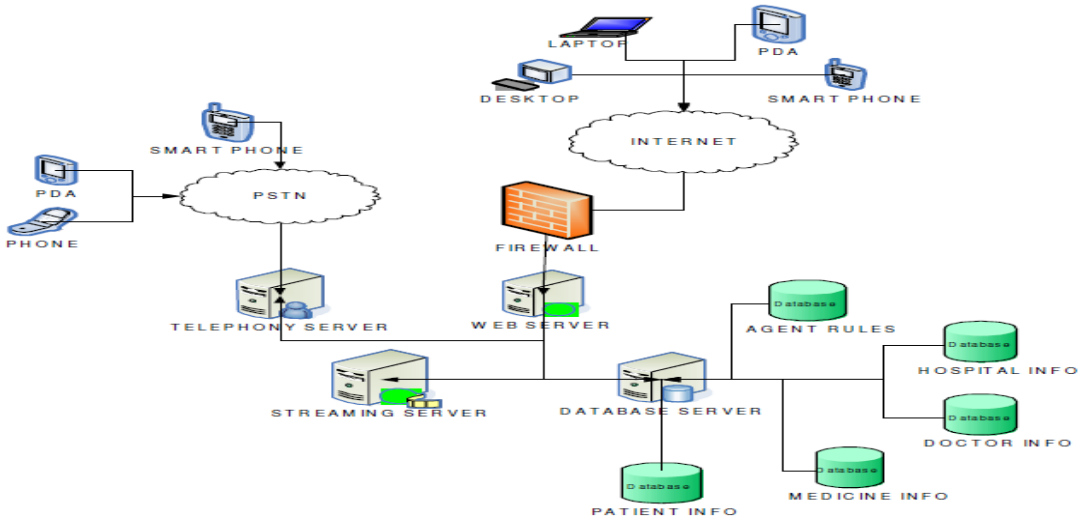


Figure 2. 4: IEHMS architecture.

In Malaysia infant mortality is around 250, 000 in the year 2005 (UNICEF, 2005) and according to the Malaysian Health Facts, 2005 (MOH Malaysia, 2006), there is a total of 122 government hospitals, 6 Specialist Medical Institutions, 6 non-government hospitals and 222 private hospitals for both maternity and nursing homes. There is a total of 20, 105 doctors in Malaysia with a population ratio of 1 doctor to every 1300 patients.

Expecting mothers in Malaysia is often referred to hospitals to let them take advantage of accurate and better advice. In addition, in the urban areas, medical advice is also available through clinics but most doctors are medical practitioners and costs are high. The provision of medical aid and advice in the rural areas is difficult to find (WHO, 2010).

In Iraq, there is a total of 1924 PHC centers serving the total population and about half of the centers are managed by doctors. Iraqi doctors account for 15, 994 of the profession with the doctor population ratio of 6.2% per 10, 000 population. Owing to the security situation in the country from 2005-2006, a total of 3800 healthcare workers quit their jobs. The latest report and situation analysis in the country imply that Iraqi children and women are the most vulnerable group that are impacted by lack of PHC services with a child mortality rate of 41% per 1000 and maternal mortality rate of 84% per 100, 000 (UNICEF, 2011; and Jaafar, 2008).

Reduction of infant mortality and morbidity issues may be facilitated through the MCG systems and through the Internet. Through this system, an easy and simple way to communicate and deliver information is facilitated.

Kadri et al. (2007) designed and developed a mobile healthcare application to facilitate patients browsing. The study highlighted the feasibility of developing a mobile patient data management system through ASP Net technology. This will enable the freedom of medical personnel to retrieve, add and edit patient data anywhere. The system is backward and forward compatible which ensures its unlimited module expansion. The M-mobile patient data management system utilizing ASP.Net is shown in Figure 2.5.

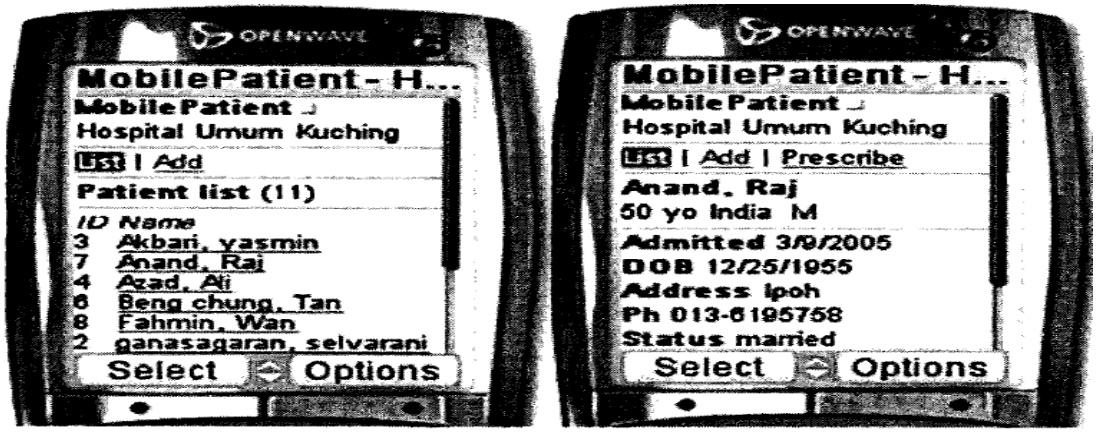


Figure2. 5: Mobile patient data management system (Kadri et al,2007)

Information is lacking with regards to using WAP application notification through the Web for pregnant mothers and children care. Most of the studies tackling with the use of applications in mobile phones as a way to communicate with pregnant women regarding their pre and post natal care and child care include studies such as the one conducted by Maniam, Ken & Chenapian (2008) involving the use of mobile phone based pregnancy support system. The system provides the pregnant women an opportunity to monitor their own and their child's progress, follow up medical check-ups, critical updates and post-delivery status report through mobile phone. In addition, a study was conducted regarding cognitive behavioral therapy used to treat depressed pregnant women in the context of Pakistan (Psaros, 2009) and another study investigated the use of deep tissue massage for pregnant women (Wahanda, 2010).

2.5.1 Mobile Phone Based Remote Patient Monitoring System for Chronic Disease Management

Cafazzo (2000, 2004) developed the remote patient monitoring system to enhance management of chronic diseases. The system makes use of commodity mobile phones and Bluetooth-enabled medical devices to send the patient's physiological information from the patient's home to the central repository where the generation and delivery of both alerts and reports are facilitated to the patient as well as the healthcare provider. The working of the Remote Patient Monitoring System is depicted in Figure 2.6.

Figure2. 6: Remote Patient Monitoring System

The health and social care systems in Canada faces a growing challenge in chronic diseases. Over 80% of the primary care visits and two thirds of the medical admissions into emergency sections of the hospital suffer from chronic diseases. Thus, the effective management of chronic diseases may lead to enhanced health outcomes and improved quality of life. For instance, controlling blood pressure for

people suffering from diabetes has been revealed to decrease the mortality rate caused by serious complications from renal and cardiovascular diseases.

2.5.2 Mobile Telemedicine System for Home Care and Patient Monitoring

A mobile telemedicine system for the purpose of home care and patient monitoring was proposed by Figueredo and Dias (2004) where the systems makes use of a serial port in new mobile phones to apply a generic interface for patient monitors and where telecom care services are developed on the basis of client-server architecture. A server application stores and facilitates the presentation of incoming vital signals from the clients. The client is responsible for taking data from patient monitors and sending them through the Internet. The systems schematic is presented in Figure 2.7.

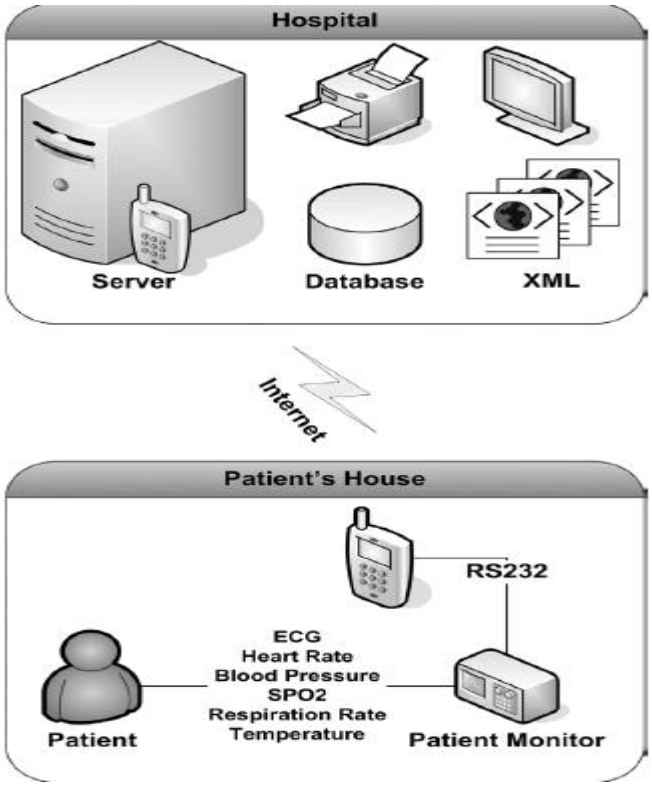


Figure2. 7: System Schematic(Figueredo and Dias,2004)

The patient is connected to the patient monitor at home to have the EMD record the vital signals including ECG, heart rate, blood pressure, respiration rate and temperature. The mobile phone is then connected to the monitor receiving the information through the RS232 interface. After the signals are converted into packets, they are sent to the server through the TCP/IP and/or UDP protocols. The server stores the data in the relational database in the hospital. This way, healthcare providers can monitor their patients and the signals can be sent through XML files or they can be printed.

On the client side, the client application along with the communication protocol works through the mobile phone and is implemented through the use of the Java MIDP (Mobile Information Device Profile). It facilitates the provision of the main application functionality that is needed in mobile applications such as the user interface, network connectivity, local data storage, and application lifecycle management – presented as Java runtime environment with a set of Java technology APIs (Oracle, n.d.). The client application should be user friendly as it is to use by patients and hence, its interface should be simple. In addition, the MIDP program was programmed to have a few commands and simple options. All the software is developed to be similar to the usual programs of the same caliber as the platform is a mobile phone. The client side comprises of four screens, the main, setup, equipment and connect. The screen displays the choice of patient monitor, his ID and the server connection.

Server Side: In the realm of telemedicine, the medical information is required to be distributed to medical doctors. Hence, the server side was designed with the receiving, storage, and distribution of the vital sign data from patients in mind. Moreover, it was designed based on Java technology reutilizing many classes.

The server comprises of a Java application along with a relational database. The application provides features such as, list of patients, personal information regarding patients, visualization of vital signs and data export. The healthcare provider in control of the server has several tools at his disposal to operate ECGs.

2.5.3 WEB-WAP Based Telecare

Two telecare applications were developed by DeLeo, Krishna and Balas (2002) on the basis of mobile telephony (WAP) and WEB. One of them can be utilized to request Basic Life Support (BLS) guidelines when needed through a WAP device and to guide people and non-professionals requiring healthcare emergency help. The other one is a WEB-WAP based mechanism that retrieves medical data at-home healthcare monitoring of ill patients who are chronically ill with congestive health failure (CHF) or diabetes.

The WAP application makes use of features used in the last generation of mobile phones like multimedia information presentations, greater capabilities of interactivity and improved ease of use. On the basis of these two applications, an effective platform is provided to develop applications in healthcare, home care, medical

monitoring and health education guaranteeing a continuous care. The system technologies' workings are displayed in Figure 2.8.

Distance monitoring technologies in the medical sector ensures better continuous care through the improvement of access and a clinician's support of activities coordination.

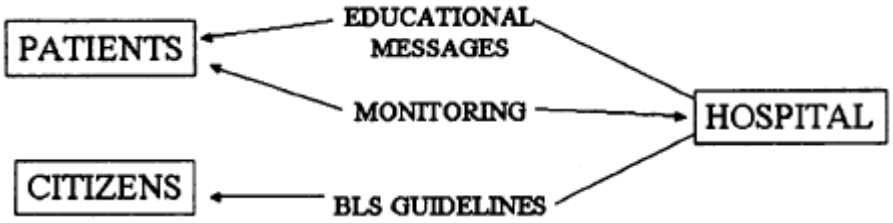


Figure2. 8: system technologies diagram(DeLeo,2002)

The system made use of NOKIA 7110 WAP device wherein scrolling up and down is supported well while the display width is fixed. Owing to the difficulty and time consuming elements of phone sized devices, list boxes are used to make the interface more easy to use. The systems are developed through a Windows 2000 environment with an Internet Information Server as Web server as well as Active Server Pages service (ASP). The latter is a viable technology to develop dynamic web content and owing to ASP's service side technology, it is suitable for the creation of dynamic WAP and WEB applications particularly in the database access. Through ASP, the generation of dynamic WML and WML Script is facilitated. Both the WEB and WAP connection in the system requires a web server using authentication module for the authentication and identification of users accessing the system and assigning particular privileges. They developed the system through the use of a personal

firewall product, an effective anti-virus product that has automated updates, and access control so that the user are only enabled to access authorized data and varying users are restricted to different access modes. The files and folders in which the data is stores in the database are encrypted and all links between the mobile host and the corporate network take place through a Virtual Private Network (VPN) ensuring secured communication channels. Security policies were adopted to protect the system but flexible enough not to disturb the user and to impact the productivity in a negative way. The system stores the logs and the modifications of the elements in the database. In the past, first aid guides can only be acquired through a telephone call or through reading materials in medical books. With the system, Resuscitation guidelines are provided. The BLS guides through WAP Device is depicted in Figure 2.9.

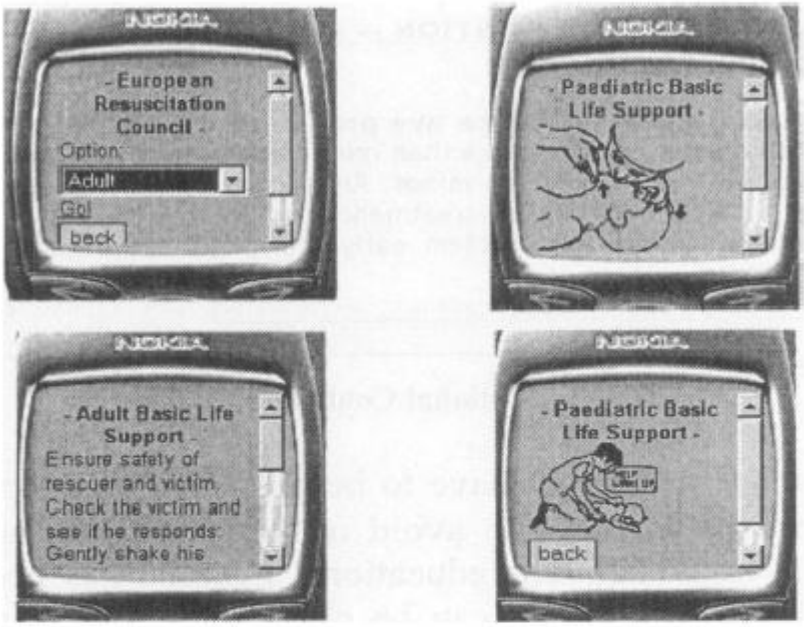


Figure 2. 9: BLS guidelines through WAP device.

Based on DeLeo, Krishna and Balas's (2002) study, WAP technology facilitates the visualization of text and low resolution images on a small screen which is already available for many users. The proposed system's core advantages are its flexibility and availability. WAP is located at the crossroads of two dynamic evolving network technologies; the wireless data and the Internet. The meaning of healthcare is evolving into care that is available when needed at any place, any time. Therefore, patients are free to move about and live anywhere with their diseases managed and understood.

2.6 Summary

The chapter discussed related extant studies concerning healthcare systems, maternity and child care system and mobile technology functionalities explaining mobile applications infrastructures and WAP. The next chapter deals with the research methodology.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The methodology of the study is plays an important role as it lays down a systematic way of solving the research problem and clarifies the tools needed to complete the research. It is considered as the methods and techniques utilized by the researcher to perform the research and it comprises of data collection method, data processing method and instruments.

In the present study, the design science research method is the method chosen for the study. When used in information systems, the design science research builds and evaluates IT artifacts to achieve health education needs. It deals with the process of artifact construction and end product design. For the system development, the research method is based on the general methodology in research design proposed by Hevner et al. (2004) and Vaishnavi and Kuechler (2008) depicted in Figure 3.1.

The present chapter explains the process of design science methodology utilized to develop the MCG system and to carry out the objectives of the study. The methodology comprises of the five following phases: awareness of problem, suggestion, development, evaluation, and conclusion. For this methodology consists of five phases are following:

Phase I: Awareness of problem

Phase II: Suggestion

Phase III: Development

Phase IV: Evaluation

Phase V: Conclusion

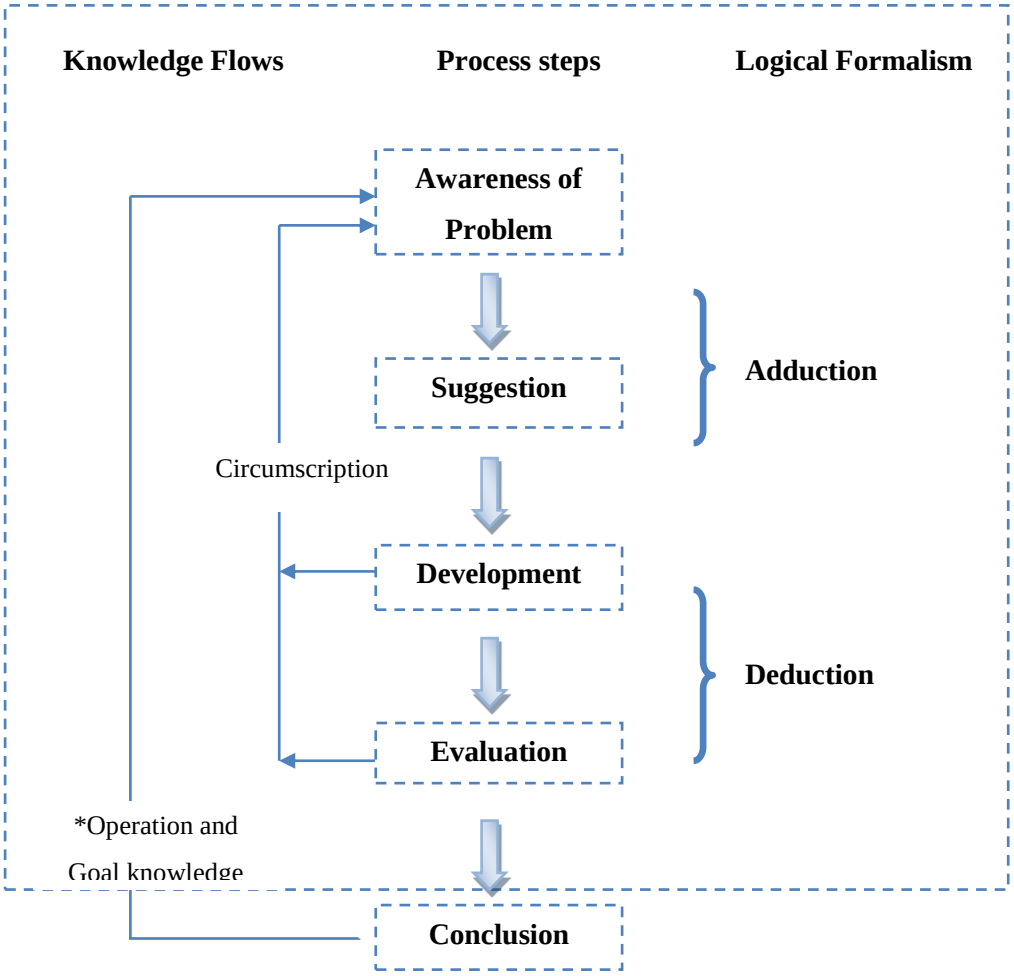


Figure3.1: General Methodology Design Science (Vaishnavi and Kuechler,2008)

3.2 Research Design

Generally, in the research methodology, awareness of the problem is where everything begins. This is followed by suggestions or solutions provided to the problem based on the extant knowledge. The implementation of the artifact follows next where further details are covered with the help of a diagram. The implementation is then evaluated based on the functional specification implicit or explicit in the recommendation. The implementation is then developed, evaluated and further suggestions are provided and frequent modifications are carried out. This modification is based on the stages of completion of the cycle back to the awareness of the problem as presented by the arrow in the diagram. This is finalized by the conclusion which signifies the termination of a specific design research. The detailed research design of the present study is presented in Figure 3.2.

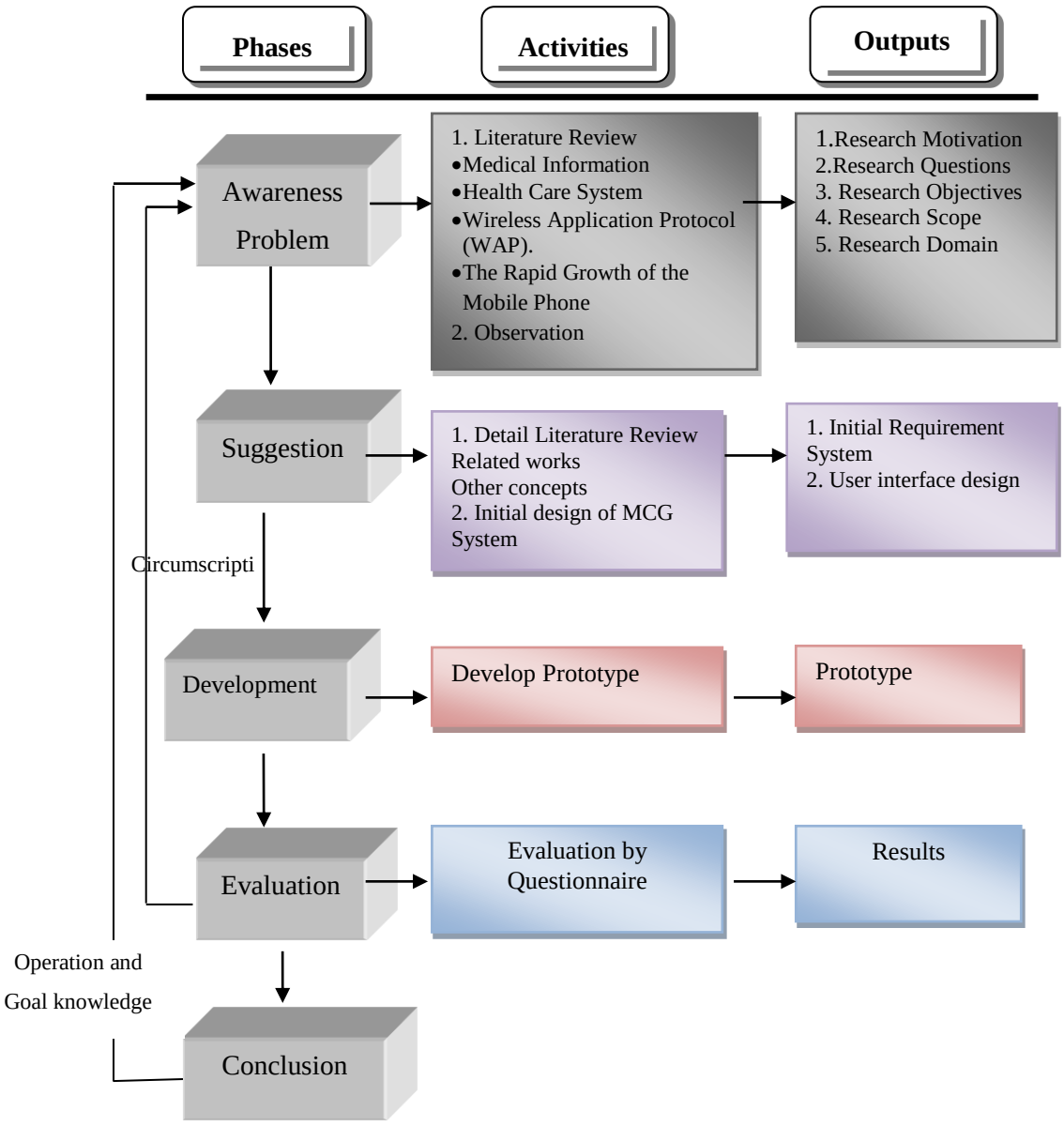


Figure3. 2: The Research Design Methodology Framework

3.2.1 Awareness Problem

This step involves the understanding of the objective and scope of the study. Data is collected to obtain more information regarding the research problem. Literature is

also reviewed regarding medical information, healthcare system and maternal and child health services. Data and information is then gathered from the activities in the health organizations. This phase of the research design is illustrated in Figure 3.3.

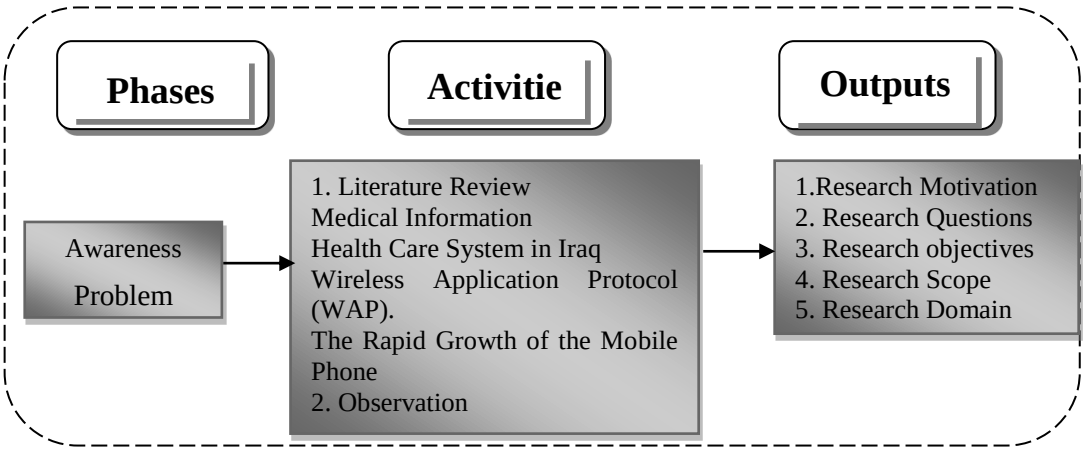


Figure3. 3: The Research Design Methodology Framework's First Phase

3.2.2 Suggestions

This step is the suggestions for the solution of problem that are inductively obtained from extant knowledge. Then an artifact implementation is attempted based on the suggested solution. To minimize the gaps of the research, many requirement were suggested to be achieved. Literature review of related works was used in this phase in terms of concepts and the development of the initial MCG system. This phase's output involves the identification of requirements and user interface design. The suggestion phase of the research methodology is depicted in Figure 3.4.

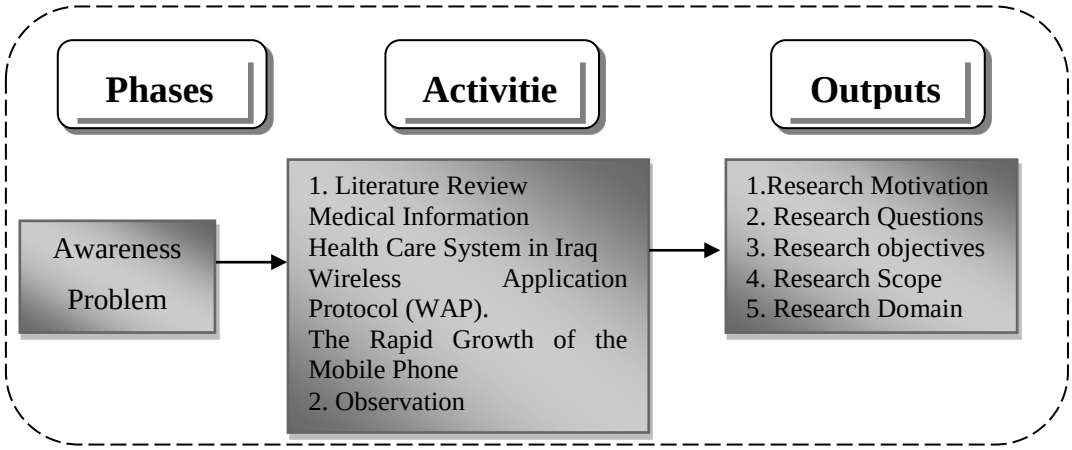


Figure3. 4: The Research Design Methodology Framework's Second Phase

3.2.3 Development

In this phase, the prototype is developed and implemented. The present research will make use of Rapid Application Development (RAD) methods to develop the MCG system prototype. This phase is depicted in Figure 3.5.

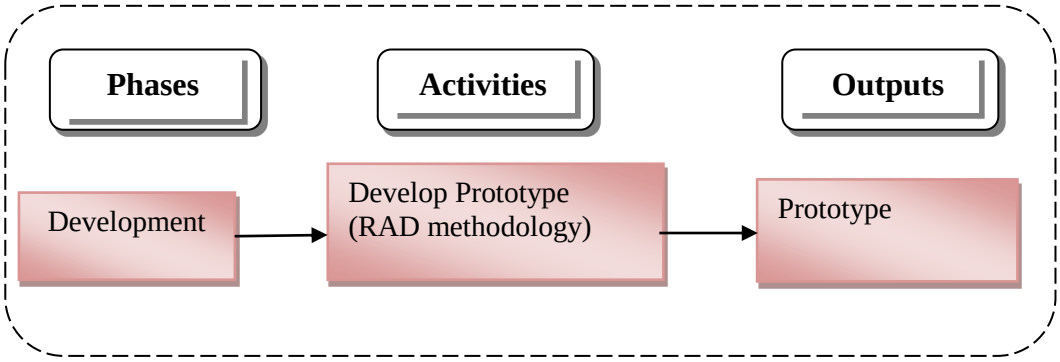


Figure3. 5: The Research Design Methodology Framework's Third Phase

According to Martin as cited in Daud et al. (2010) RAD is a development lifecycle designed to provide a short time in creating an application or in developing it and the results will be of higher quality compared to traditional lifecycle. The design is such that it obtains maximum advantage of powerful development software. There are four basic aspects of fast development namely, tools, methodology, people and management.

In the developed system, the expecting mother fills the required data into the system through her mobile and registers to the MCG system. The necessary information is filled and the patient proceeds to login into the system by using user name and password. She then proceeds to take the information needed for her or for her child. The proposed MCG architecture is depicted in Figure 3.6.

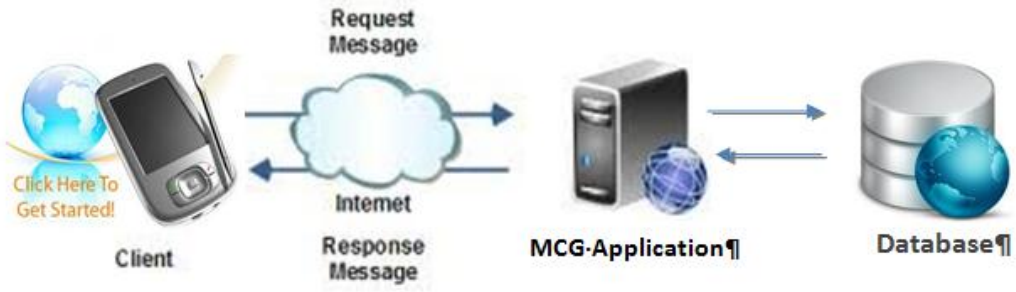


Figure3. 6: MCG architecture

3.2.4 Evaluation

According to evaluation phase is very important phase after system development. This phase will improve the quality of the software. In addition, one important thing that evaluates the software is testing. This prototype will test or evaluate by questionnaire, to evaluate ease of use and usefulness of MCG System. Figure 3.6 shows the phase 4 of research design methodology.

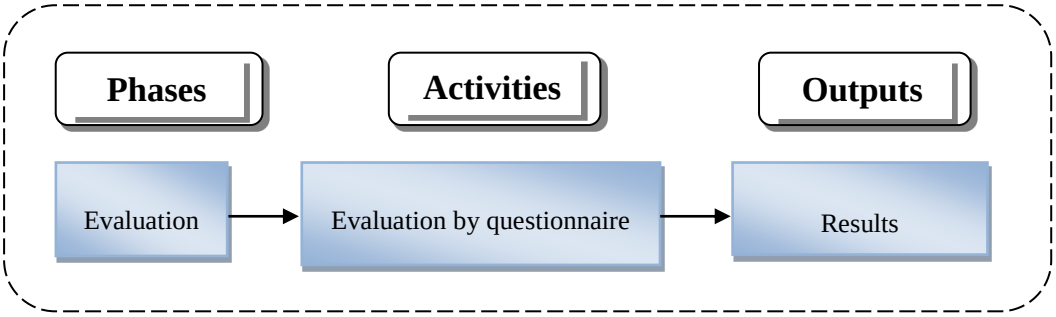


Figure3. 7: The Research Design Methodology Framework's Fourth Phase

3.2.5 Conclusion

The resulting research is depicted in the Maternity and Children Guide (MCG) prototype which facilitate easier interaction between users and technicians

CHAPTER FOUR

REQUIREMENT GATHERINGS, DESIGN AND PROTOTYPE DEVELOPMENT

4.1 Introduction

The prototype's design and development for the purpose of testing is presented in this chapter. A prototype has similar functionality with the final system but it is a scaled down version of the latter. The development process was discussed in the previous chapter (Chapter three) through a three step process: designing, modeling, and prototype development. The system comprises of two models; the first concerns pregnancy and the second being children care. The study made use of the Unified Modeling Language (UML) to design and model the system. UML is a standard language used to specify, visualize, construct and document artifacts of software systems and for business modeling and other non-software systems. UML represents a set of best engineering practices that is successful in modeling of large and complex systems. The design diagrams of UML are discussed in the present chapter.

4.2 Maternity and Children Guide (MCG) System Requirements

A requirement according to the Institution of Electrical and Electronic Engineers (IEEE, 1998) is defined as the conditions of the capability required by the user to carry out an intended purpose. The MCG user requirements are defined and divided

into two main categories which are the non-functional requirements and the functional requirements.

In the priority column, the following were used:

M - Mandatory requirements (something the system must do)

D - Desirable requirements (something the system preferably should do)

O- Optional requirements (something the system may do)

4.2.1 The MCG Functional Requirement

The main purpose behind this section is to explain what a functional requirement is. It is the definition of the system user requirements and the determination of the types of non-functional requirements.

Bennett (2002) defines the functional requirements as the required system components with their features in the hopes of achieving a successful outcome. The entire system components should be determined at the system requirements collection step (Dennis et al., 2005). The following table lists the MCG system requirements.

Table 4. 1 : MCG list of the functional Requirements

Requirement ID	Requirement Designation	Priority
MCG_01	**Log In**	
	By this function the woman has the ability to sign in the system, and manage her pages (the system requires a correct username and password)	M
MCG_02	**Create New Account (Register)**	
	This function of the system allows the woman to be a member of the system by permits her to create new account.	M
MCG_03	**Reset**	
	Through this function user can reset the user name and password to fill it again	M
MCG_04	**View Profile**	
	By this function women can view their profile	M
MCG_05	**Update Account**	
	Women can update their account by this function	M
MCG_06	**Add Babies**	
	By this function Mother can add her children (their name and age of each one)	M
MCG 07	**During Pregnancy**	
MCG_07_01	**Fetal Development Week by Week**	
	By this function pregnant women can see the development of fetal week by week	M
MCG_07_02	**How baby acquire skills before birth**	
	This function contain the information about the way to learn fetal inside her mother and a multimedia file from the holy Koran	M

MCG_07_03	**Depress Test**	
	This function content ten question after finish answering them the system give her the result of her situation This test is called the Edinburgh Depression Scale (Murray and Cox, 1990)	M
MCG_07_04	**Exercises**	
	This function contain what kind of exercises the pregnant woman can do	M
MCG_07_05	**Main Page**	
	By this function the woman can return to the main page	M
MCG_08	**After Pregnancy**	
MCG_08_01	**Immunization Schedule**	
	Through this function mother can see the immunization schedule according to the age. this schedule according to the National schedule	M
MCG 08_02	**Baby development**	
	This function provide information about the development of children in three levels according to their age (what most children can do, half of children can do and a few children can do).	M
MCG 08_03	**Address book**	
	By this function mother can add, view and update the notes that she add about her children. This function helps mother to remember the health history of her children.	M

MCG 08_04	**Baby growth chart**	
	This function provide information about children growth depend on the age (the system requires child age and child weight or height)	M
MCG 08_05	**Sleeping Schedule**	
	Through this function the mother can know how many hours her child needs to sleep according to his age.	M
MCG_9	**Log out**	
	By this function women can log out from her account and return to the log in page.	

4.2.2 The MCG Non-Functional Requirements list

The role of the non-functional requirements of the system in software engineering is to present and clarify a pragmatic and systematic method to develop quality into software systems. Systems require software that measures quality attributes such as security, accuracy, modifiability and performance (Chung, Nixon, Yu & Mylopoulos, 1999). Details are listed in the Table 4.2.

Table 4. 2: The MCG Non-Functional Requirements

Requirement (II)	Description	Priority
MCG_01	Reliability issues	
	The information must be reliable and the system must be able to bear the big amount of users.	M
MCG_02	Usability	
	MCG system must be easy to use it so must design best interface for user, for example all nested screens contains 'back key" to return to main screen	M
MCG_03	Security	
	The system must maintain the secrecy of members' information and the health details. The system doesn't give a chance to know about their members both personal and health details. This is maintained by using user id and passwords	M
MCG_04	Maintainability	
	The MCG code source should be in a good structure so that make it easier to developer to maintain and extend the system or feedback.	M

4.3 System Architecture

On the basis of the research, the solution provided the guide for the system building process. The prototype is designed on the basis of information collected in the previous phase. The MCG system infrastructure is depicted in Figure 4.1. Pregnant women or mothers are enabled access into the MCG System through their mobile devices with the help of a

wireless network. They are also enabled to access the service through Wi-Fi access points and GPRS network through WAP provider.

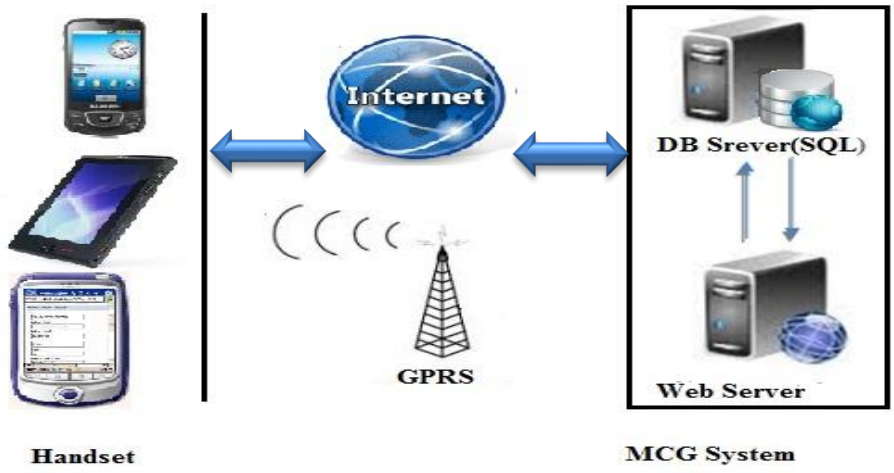


Figure 4. 1: MCG System Architecture

4.4 Analyze and Design System

This section describes the system analysis and design methods. The Unified Modeling Language (UML) is made of to design the MCG. Based on Barclay and Savage (2004), the Unified Modeling Language is a standard language used to specify, visualize, construct and document artifacts of software systems and for business modeling and other non-software systems. It represents a set of the best engineering practices that are successful in modeling large and complex systems. It is crucial in developing objects oriented software and in the software development process. It mostly utilizes graphical notations to present the design of software projects. UML diagrams produced by visual modeling tools are case diagram, sequence diagram and class diagram.

4.5 Summary

The chapter presented the design science research (GMDR) that is the research method followed by the present study and it explained the research design methodology stepwise in light of the objectives of the research. The design comprises of five phases with each phase classified into activities and output. The design methodology is adapted from Hevener et al. (2004) and Vaishnavi & Keuchler's (2008) design.

4.5.1 MCG Use Case Diagram

Use case diagrams present the system's role from the observer's point of view and the focus is on what the system is capable of doing instead of how it does it. This type of diagrams is related to scenarios. A scenario is defined as an example of events depicting someone's interaction with the system. It is a review of scenarios for a single activity. Meanwhile, an actor is the one who initiates the events in the scenario (Martina and Kendal, 2000). The MCG use case diagram is depicted in Figure 4.2.

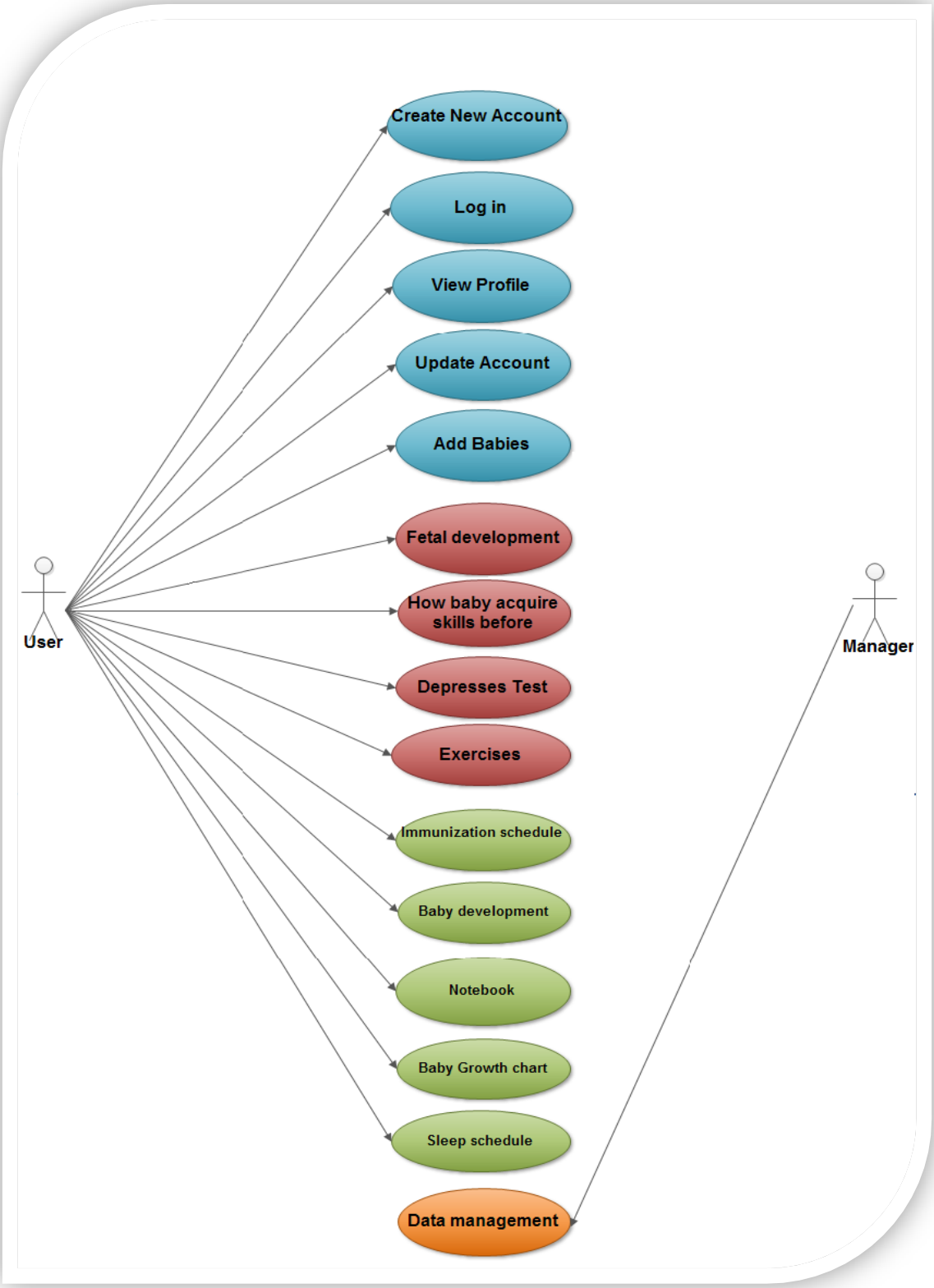


Figure 4. 2: MCG Use Case Diagram

4.5.2 MCG Use Cases Description

The MCG application use case descriptions are shown in Tables 4.3 to Table 4.10 respectively

Table 4. 3: Log in MCG Use Case Description

Use case name	Log in
Actor	Woman(Pregnant Woman or Mother)
Short Description	This use case describes how user can log in function ensures that only authorized users gain access to the system databases. An authorized user is a user who has an account on the system. The systems' users should key-in a valid password and username to gain access to the system
Entry condition	The woman has Account in the system.
Exit condition	User click close website. Current page is deleted. System shut down.
Major Steps Performed	The woman types her username and password. The woman clicks login button. The system shall verify and validate the entered information and displays main page if it is correct.

Table 4. 4: Create New Account MCG Use Case Description

Use case name	Create New Account
Actor	Woman(Pregnant Woman or Mother)
Short Description	This use case describes how user can create a new account in the system
Exit condition	User click close website. Current page is deleted. System shut down.
Major Steps	The woman clicks on sign up link

Performed	The system will display registration form Fill up the Registration form fields (Name, username, password, pregnant date). The woman click on submit button to complete the registration

Table 4. 5: Update Profile MCG Use Case Description

Use case name	Update Profile
Actor	Woman(Pregnant Woman or Mother)
Short Description	This use case describes how user can update her information. Same information may change so this function helps her to correct it.
Entry condition	The woman has Account in the system. and she already logged in the system
Exit condition	User click close website. Current page is deleted. System shut down.
Major Steps Performed	The woman press on update profile button The woman change her information the woman click on update button The system will update the information

Table 4. 6: Add Baby MCG Use Case Description

Use case name	Add Baby
Actor	Mother
Short Description	This use case describes how mother can add her child by give his or her name and age
Entry condition	The woman has Account in the system. and she already logged in the system
Exit condition	User click close website. Current page is deleted. System shut down.
Major Steps Performed	The woman fill the baby name text The woman select the baby's age the woman click on submit button The system will add the baby information

Table 4. 7: Fetal development week by week MCG Use Case Description

Use case name	Fetal development week by week
Actor	Pregnant woman
Short Description	This use case describes how mother can see the development of fetal week by week. this function contain images of fetal week by week to

	knew how her fetal will be looks like
Entry condition	The woman has Account in the system. and she already logged in the system
Exit condition	User click close website. Current page is deleted. System shut down.
Major Steps Performed	The woman click on Fetal development week by week link The system display the first image of fetal 4week of age the woman can browsing the images The system will display image of fetal from 4 weeks of age until 41 weeks of age

Table 4. 8: Depresses Test MCG Use Case Description

Use case name	Depresses Test
Actor	Pregnant woman
Short Description	This use case describes how pregnant women can know about her psychological state by provide depress test. This test about ten scientific question , she can do it every week to be insure about psychological state This test is called the Edinburgh Depression Scale (Murray and Cox, 1990)
Entry condition	The woman has Account in the system. and she already logged in the system

Exit condition	User click close website. Current page is deleted. System shut down.
Major Steps Performed	The pregnant woman click on depress test link The system provide ten question The woman select one of the suggested answer for these question The system show the result depend on the woman selected.

Table 4. 9: Address Book MCG Use Case Description

Use case name	Note Book
Actor	Mother
Short Description	This use case described how the mother can save her notes about her child health information or change some information that she save it before.
Entry condition	The woman has Account in the system. She already logged in the system. She must register her child in the system.
Exit condition	User click close website. Current page is deleted. System shut down.
Major Steps Performed	The mother click on address book link. The mother select add or update or view

	The system shows the mother children. The mother selects the child that she wants to add or update his information. The mother adds her notes.

Table 4. 10: Baby Growth MCG Use Case Description

Use case name	Baby Growth
Actor	Mother
Short Description	This use case described how the mother can monitoring her child Weight and Height
Entry condition	The woman has Account in the system. She already logged in the system.
Exit condition	User click close website. Current page is deleted. System shut down.
Major Steps Performed	The mother click on Baby Growth link. The mother select Weight or Height. The mother also should select the age The mother writes her child weight / length. The system give the ideal length / weight in the same age and what supposed to be next month

4.5.3 MCG Sequence Diagrams

Johan (2004) stated that the sequence diagrams present the time sequence of objects that take part in the interaction. This comprises of the vertical dimension depicted as time and the horizontal dimension depicted as the various objects.

Sequence diagrams primarily present the objects' behavior in a use case through the provision of the objects description and the messages they pass. The diagrams are read from left to right in a descending manner. The diagrams below depict the interaction between the MCG objects.

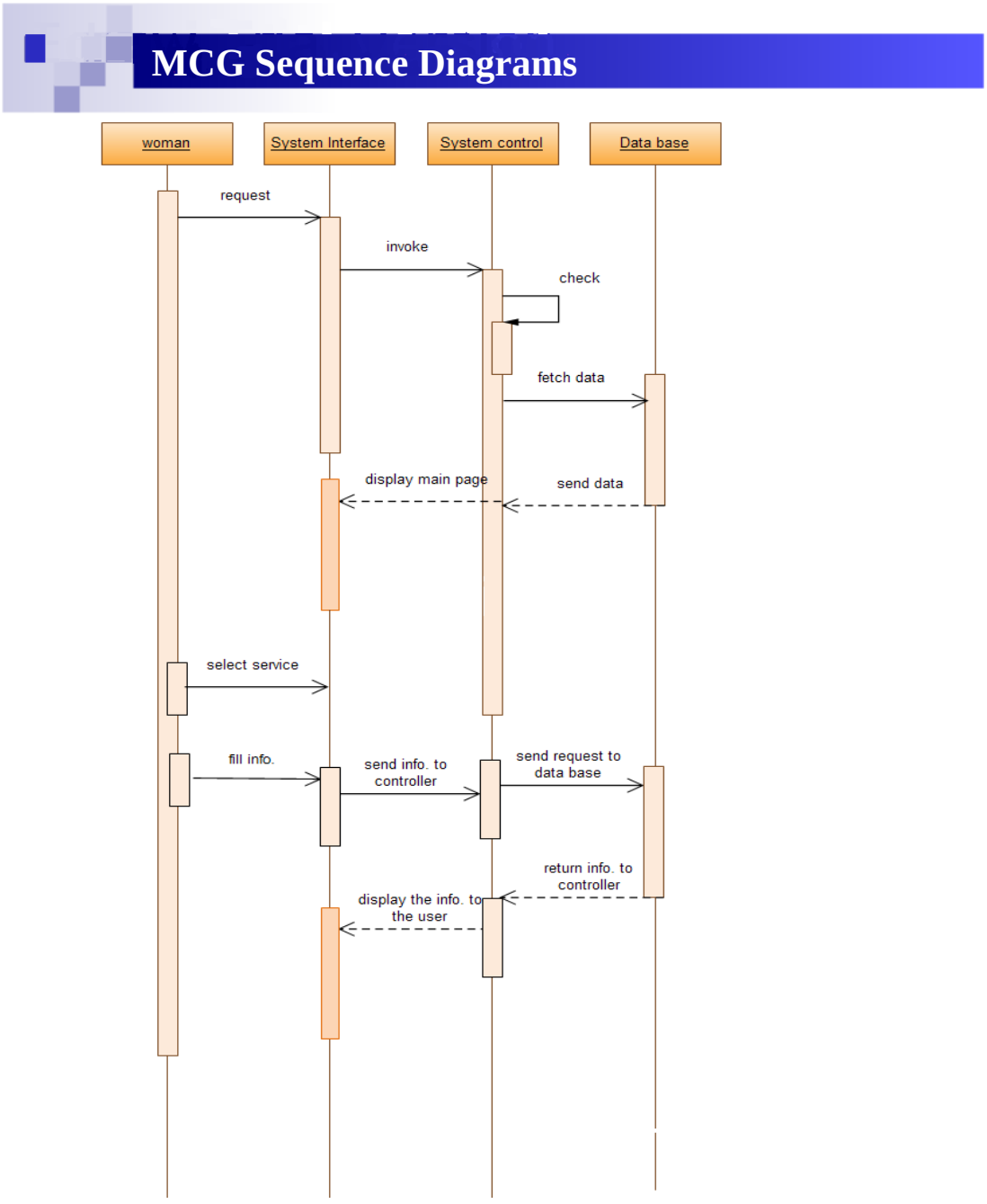


Figure 4.3 :MCG Sequence Diagram

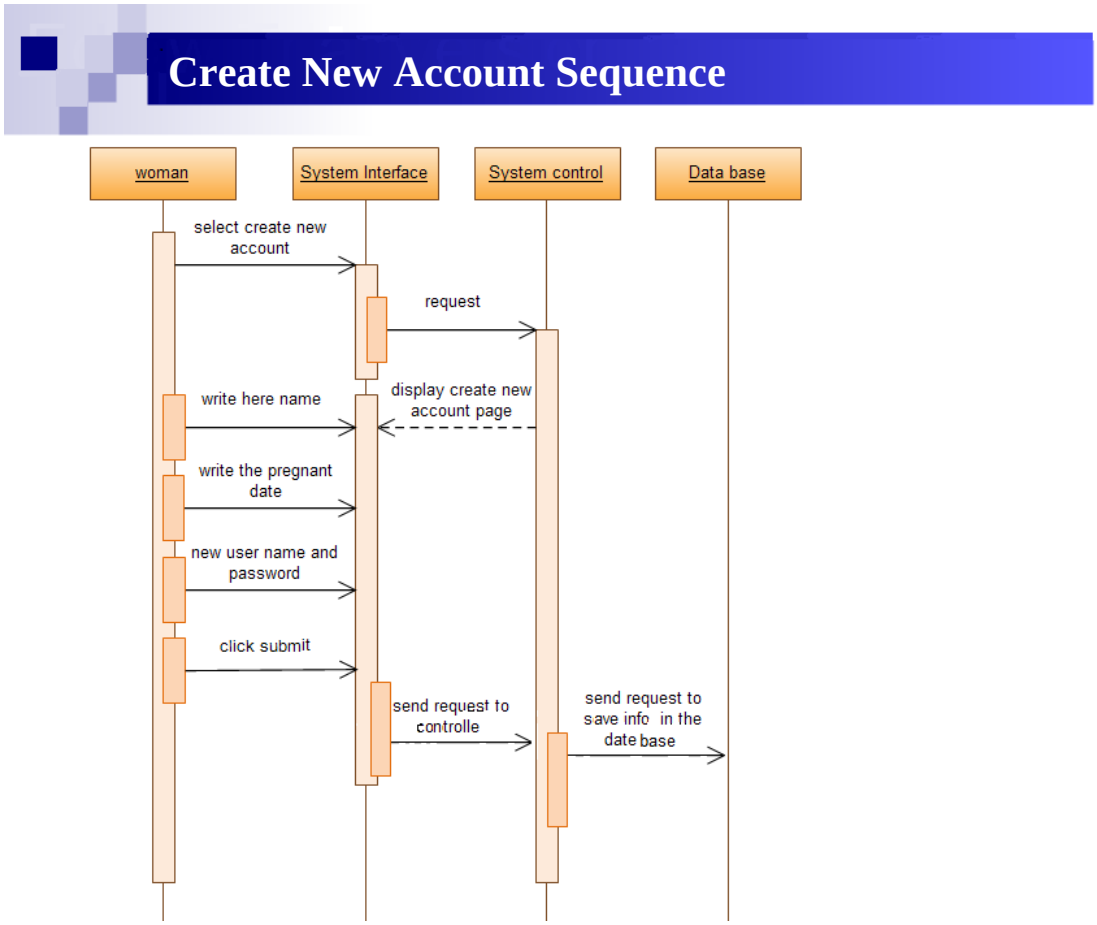


Figure 4. 4: Create New Account Sequence Diagram.

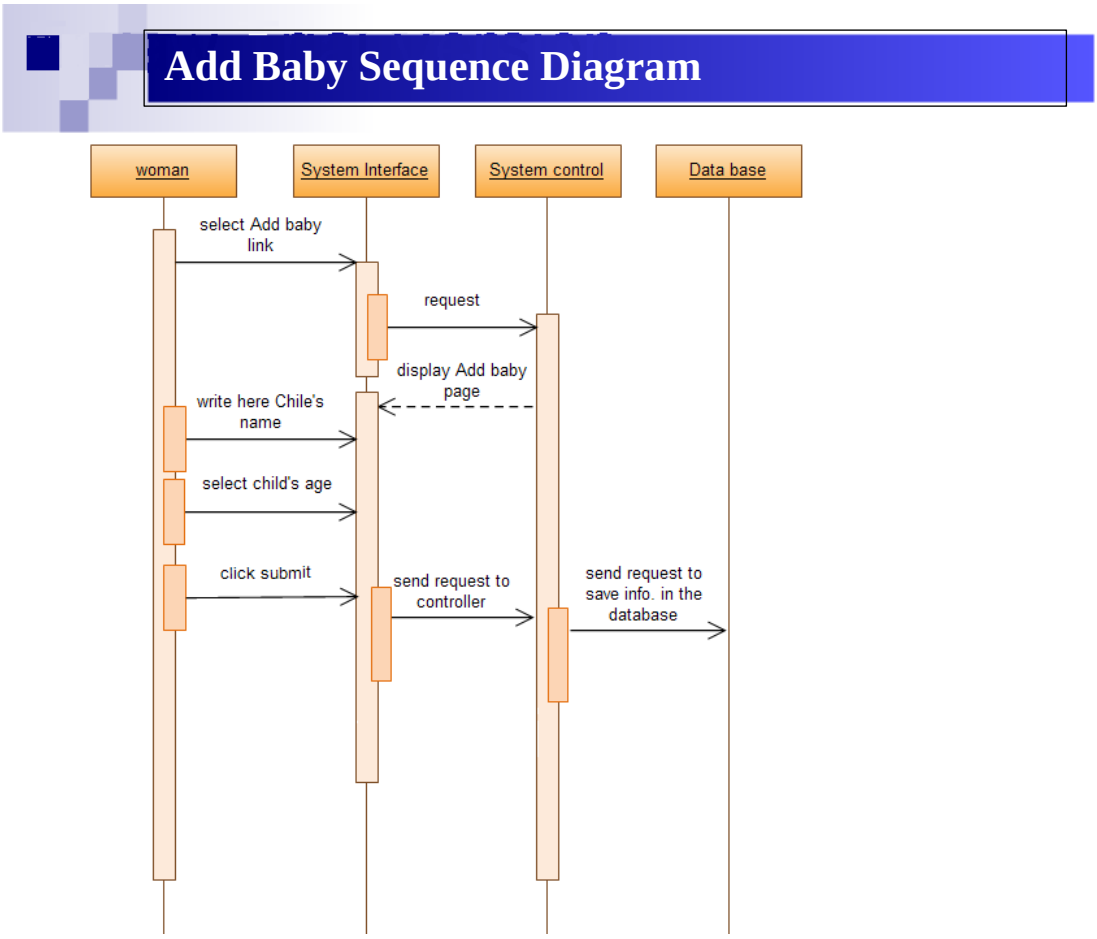


Figure 4. 5: Add Baby Sequence Diagram

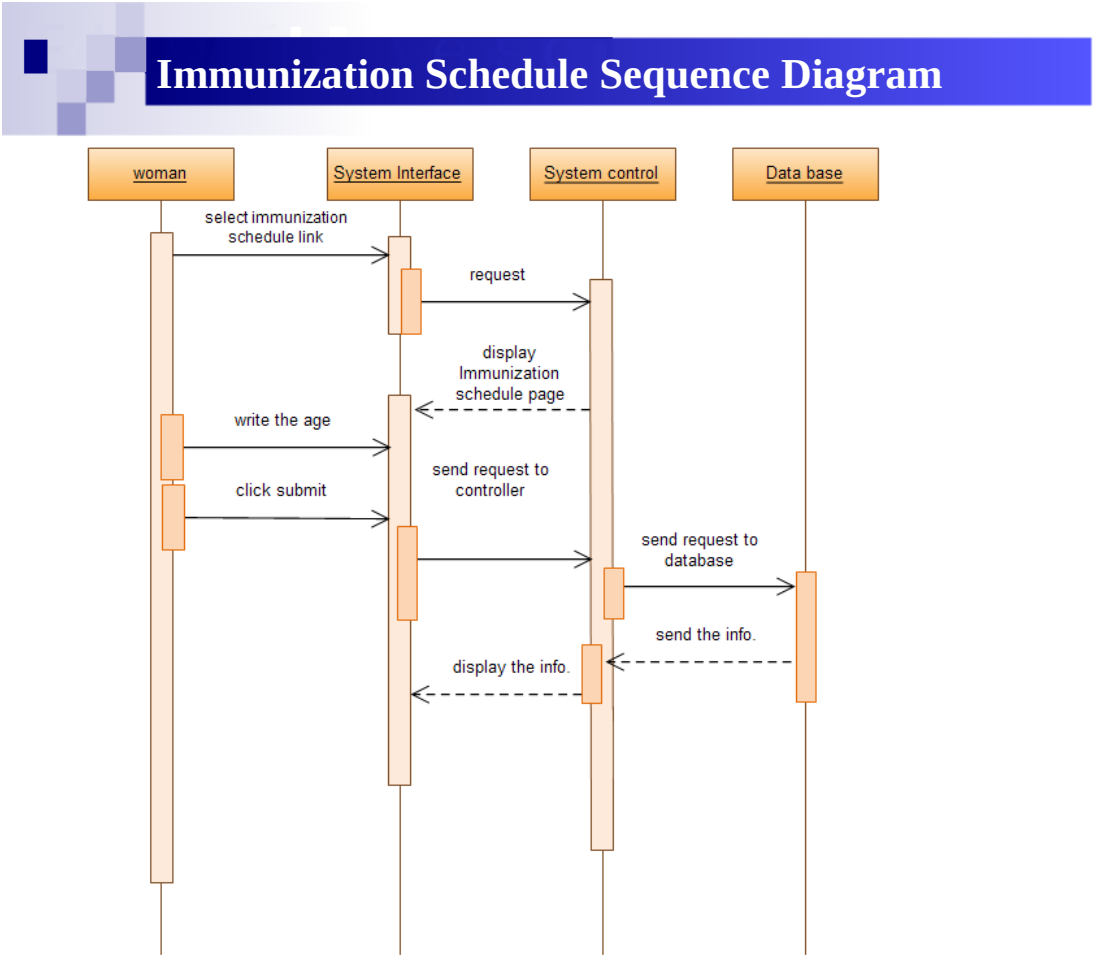


Figure 4. 6: Immunization Sequence Diagram

4.5.4 MCG Class Diagram

According to Barclay et al. (2004), class diagrams are commonly utilized to provide the descriptions of varying types of objects within a system and the relationship among them. Class diagrams with model call structure and contents make use of design elements like classes, packages and objects. These diagrams depict three varying perspectives in system design; conceptual, specification and implementation.

These perspectives are clarified with the development of the diagram and the design is solidified.

In addition, class diagrams also depict relations including containment, inheritance, associations among others. The association is the most widely known relationship found in a class diagram. From its name, the association relationship presents the relations between class instances.

Class diagrams are also characterized by their common relationship of generalization. A generalization is utilized in two similar classes although they may have some differences.

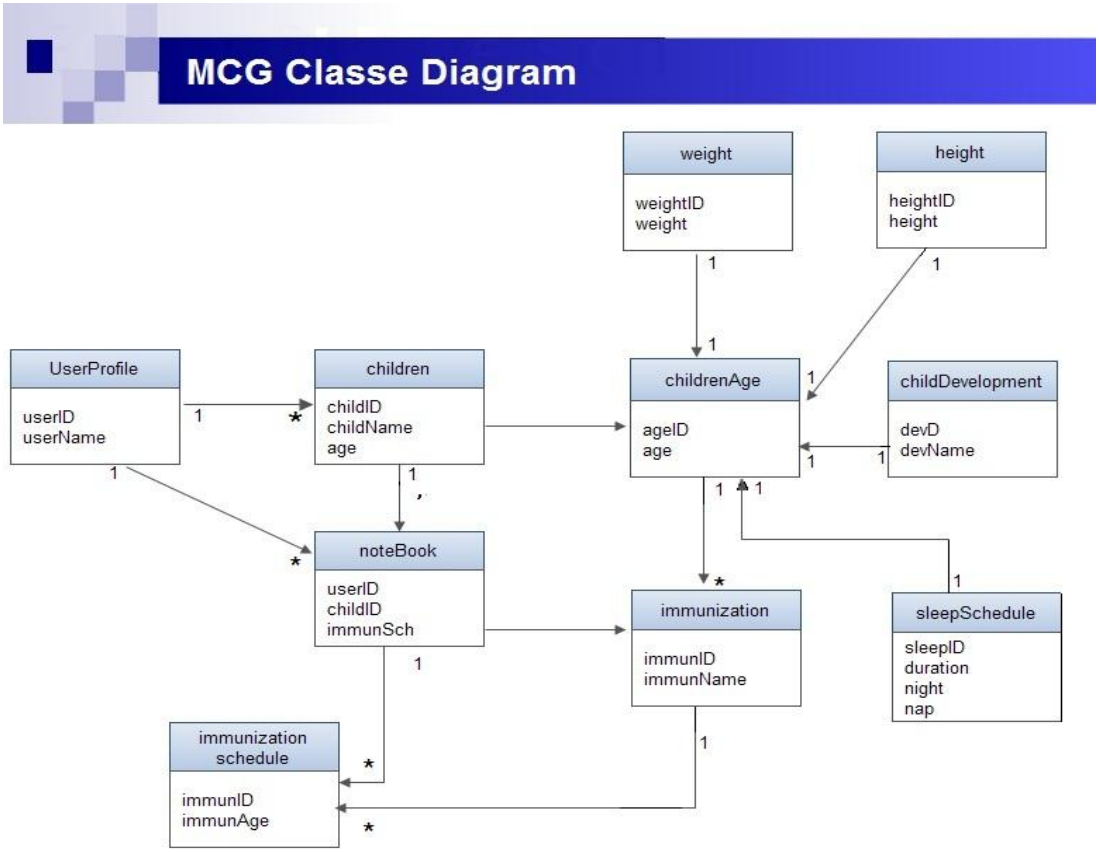


Figure 4. 7: MCG Class Diagram

4.6 Prototype Implementation

Maternity and Children Guide System (MCG)'s implementation is successful. The entire functional requirements previously discussed are reached and the prototype developed for testing is completely transformed to a working system. The programming language selected is JAVA with JSP and the back end database is created with the help of MySQL.

MCG's front end is created through the use of JavaScript and html. The user interface appearance aesthetics are focused upon to provide a pleasant user experience. The figures below depict a sample of user interfaces.

4.6.1 Log in Page

The first page of the system is the log in page. The user (Pregnant woman or mother) must log in to the system first then she can navigate into other pages. Figure 4.8 shows the Log in page of MCG System .The system member is required to enter the correct user name and password to allow her to log in the main page of the MCG System. This page supports the privacy of the personal information

Figure 4. 8: MCG Log in Page

4.6.2 Create New Account page

This page helps the user to create a new account. The user can log in to this page from the log in page by clicking on create new account link and by filling the requirement information that she needs when she uses the system. This information includes; user name and password to log in, and the pregnancy date to calculate her child's birth date. Figure 4.9 shows the whole information needed to create a new account

Figure 4. 9: MCG Create New Account Page

4.6.3 Update Profile Page and View Profile Page

To allow the woman to view her information or give her permission to change her information, view profile and update profile pages were created. Figure 4.10 and Figure 4.11 show the view page and update page respectively.

Figure 4. 7: MCG View Profile Page

Figure 4. 8: MCG Update Profile Page

4.6.4 Main Page

The page contains all the links of other pages in MCG System. Via this page, the user is able to navigate into other system pages. Pregnant women can log in to the page through during pregnancy link and also mothers can enter to the children care part through after pregnancy link.

Figure 4.12 shows the contents of Main Page.

Figure 4. 9: MCG Main Page

4.6.5 Add Baby Page

From this page mother can add her child's information, child's name, child's age. Figure 4.13.Figure 4.14 show the successful mission

Figure 4. 10: MCG Add Baby Page

Figure 4. 11: System Response Message

4.6.6 During Pregnancy Page and After Pregnancy Page

MCG system comprises two parts. First part is for pregnant women and presents During Pregnancy part as depicted in Figure 4.15. After Pregnancy link presents the second part of this system; the part that helps mothers by providing them information about children heath care. Figure 4.16 shows After Pregnancy Page.

Figure 4. 12: During Pregnancy Page

Figure 4. 13: After Pregnancy Page

The following Figures present the content of During Pregnancy part.

4.6.7 Fetal Development Week By Week

Content 39 image of fetal development from 3 to 39 weeks of age. Figure 4.16 shows fetal development in week 6.

Figure 4. 14: Fetal Development Week By Week Page

4.6.8 How babies acquire skills before birth

Figure 4.18 show the steps how mother can learn her child inside her and also content multimedia of some surah from Holy Quran

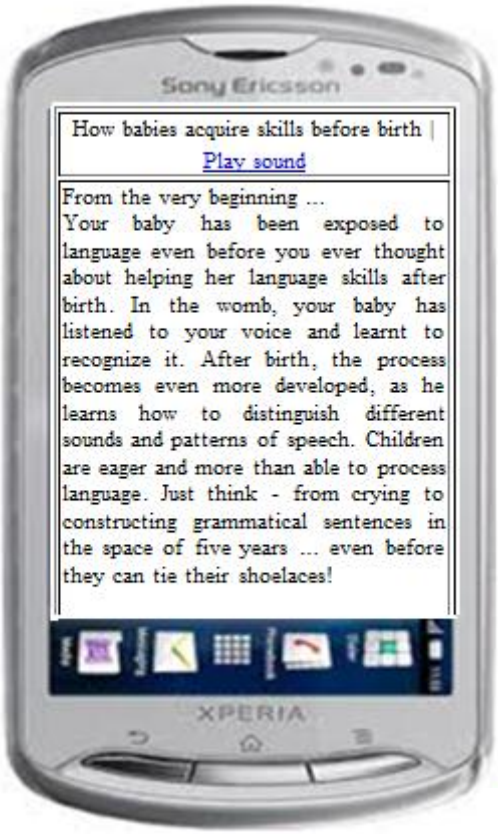


Figure 4. 15: How Fetal Acquire Skills before Birth page

1.1.12 Depression Test

This page contains Depress test which includes ten questions. This test is called the Edinburgh Depression Scale. After answering all the questions, the result will appear with suitable advice. Figure 4.19 shows one of those questions.

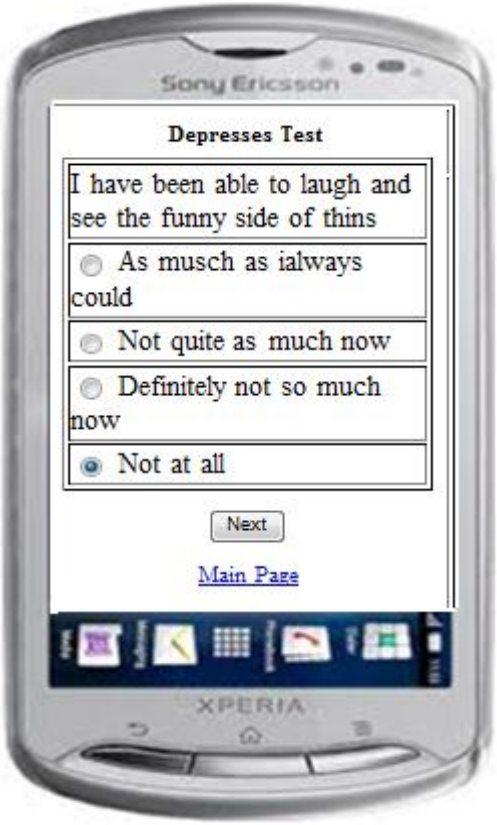


Figure 4. 16: Depresses Test page

4.6.9 Exercises for Pregnant Woman

The Exercises Page as show in Figure 4.20, several exercises suitable for pregnant women that help them to relax.

Figure 4. 17: Exercises for Pregnant Woman page

The (Figure 4.21 to Figure 4.29) represent children health care part of MCG System

4.6.10 Immunization

MCG System contains information about immunization schedule. This schedule is according to the National schedule and the table contains each vaccine type and its abbreviated name. Figure 4.21 shows the immunization in newborn child and Figure 4.22 shows the table of abbreviation of the immunization to help a mother recognize the type of immunizations.

Figure 4. 18: Immunization Page

Figure 4. 19: Table of Immunization Page

4.6.11 Baby development

This page presents three levels of development, which is; .what all child can do, half childe can do and a few child can do those skills depends on child's age. Figure 4.23 show development of child his age is one month.

Figure 4. 23: Baby development Page

4.6.12 Notebook

In this page a mother can save her child's information. Figure 4.24, Figure 4.25 and Figure 4.26 show the pages Add, View and Update respectively.

Figure 4.24: Add in Notebook

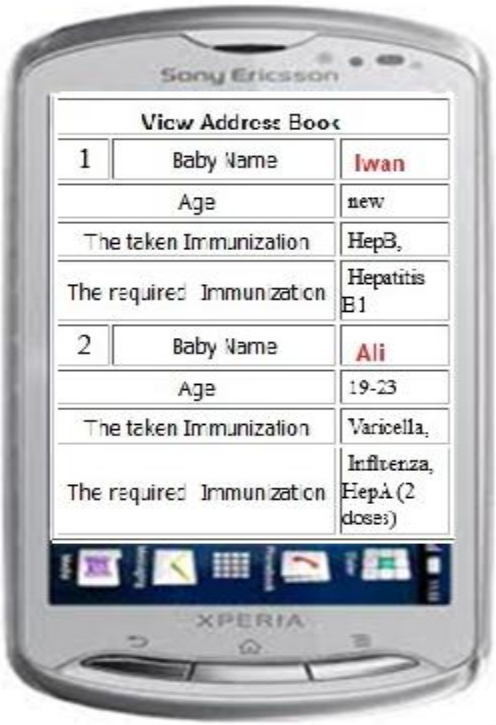


Figure 4.25: View in Notebook

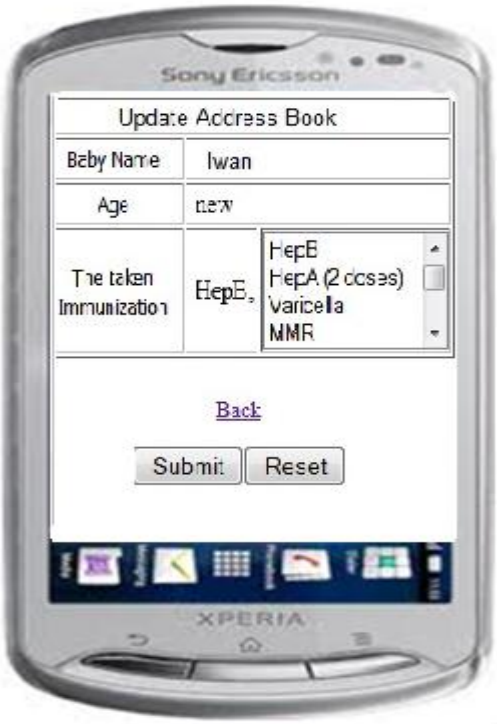


Figure 4. 26: Update Notebook Page

4.6.13 Child Growth Chart

In child growth chart field MCG System contains two pages, for weight and height. The mother may select her child age and write his weight/height. MCG System views the real weight/height between the expected weight/height after the age of two months and before. Figure 4.27 and Figure 4.28 shows the process of height calculation and the same process can be followed by the mother for weight.

Figure 4. 27: Insert Height Page

Figure 4. 28: View Height Page

4.6.14 Child Sleep Schedule

This page provides information about the perfect number of sleeping hours that every child needs in different ages. Figure 4.29 shows the perfect number of sleeping hours for a child of two years.

Figure 4. 29: Sleep Page

4.7 Summary

The chapter conducted the achievement of the requirement of MCG System along with content design, implementation and development of the system and the prototype level. Both functional and non-functional system requirements were first defined and the system modeling was conducted through the Unified Modeling

Language (UML). In addition, the chapter also presented the class diagrams and sequence diagrams in the design stage. The implementation of the MCG System was carried out through the use of JSP and MySQL. Snapshots of user interfaces and their varying functionalities and operations were also discussed.

CHAPTER FIVE

RESULT AND DATA ANALYSIS

5.1 Introduction

The present chapter deals with the result of the statistical analysis conducted to design and implement system prototype usability. SPSS version 19 was utilized for statistical analysis and the data analysis is carried out to meet the objectives of the research. The system is evaluated through a survey questionnaire and the analysis methods tested the usability of the system.

5.2 Functionality Testing Evaluation

According to Holzinger (2005), the usability test with end users if among the basic methods to evaluate the usability of the system. The reason behind usability testing is to highlight the usefulness level, operability and system ease of use (Neilson, 2006). The MCG system usability testing was carried out through a survey distributed to the 40 female participants in the hopes of evaluating the system. Each of the respondents was instructed on the prototype's workings, functionality, objective and description. The main objective of which is to obtain the level of user satisfaction and agreement in light of usefulness and ease of use with the MCG prototype's operability.

5.3 Instruments of the survey

The MCG prototype's functionality is evaluated through a testing session and through the questionnaire survey. The questionnaire is adopted from Davis (1989)

and Crawford (1997). It comprises of three parts; Section A which included the respondent's general information; Section B which included the existing practice on maternity and child care and; Section C which included the usefulness and ease of use variables with several items under each variable.

5.4 Respondents' Information

5.4.1 General Information

The respondents' profile is listed in Table 5.1 and from the table it is evident that majority of the respondents are in the age range of 31-40 years (55%) followed by 20-30 year olds (42.5%) and over 40 years (2.5%).This percentage was shown in figure 5.1 The respondents have varying degrees of education; most of them had master degrees (37.5%) followed by degree qualification degrees (32.5%) and PhDs (25%).

Majority of the respondents have had two children (45%), followed by respondents whose pregnancy was their first (25%), those who have had one child (17.5%) and those with more than two children (12.5%).

Most of them work (75%) while the remaining ones are housewives (25%) (Figure 5.2). None of the participants have had experience with systems of the same caliber. All the respondents' general information is depicted in Table 5.1

Table 5. 1: General Information

	Percentage	**Frequency (N=40)**
Age		
20-30 years	**42.5%**	**17**
31-40 years	**55%**	**22**
above 40 years	**2.5%**	**1**
Level of Education		
Degree qualification	**32.5%**	**13**
Master qualification	**37.5%**	**15**
PhD qualification	**5%**	**2**
Other	**25%**	**10**
How many children do you have?		
this is my first pregnancy	**25%**	**10**
one	**17.5%**	**7**
two	**45%**	**18**
more than two	**12.5%**	**5**
Do you work?		
Yes	**75%**	**30**
No	**25%**	**10**

Have you got any experience on similar systems?		
Yes	**00%**	**00**
No	**100%**	**40**

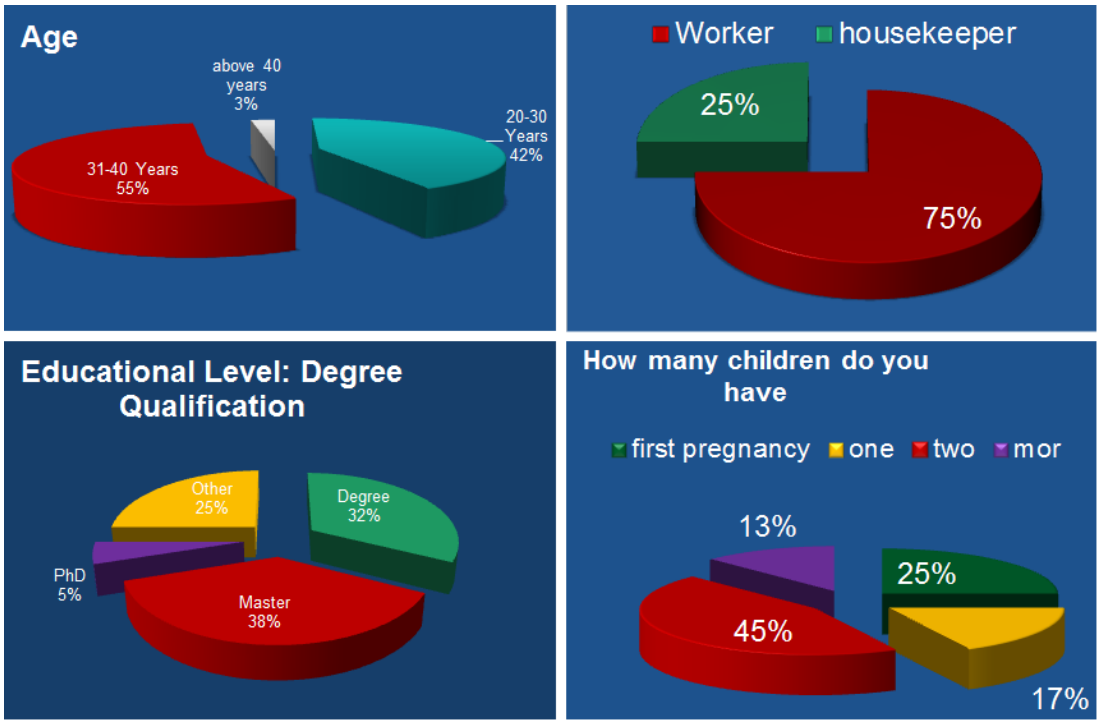


Figure 5. 1: General Information

5.4.2 Practice on Maternity and Child Care

Most of the respondents (62.5%) stated that they obtain their information regarding maternity and health care from healthcare centers. Table 5.1 lists the percentages of their choices.

Table 5.2 Question 1

Q1/what your information source about Maternal and child Health			
		Frequency	**Percentage**
Valid	Maternity and Children Care Centers	25	62.5
	Books	5	12.5
	Websites	7	17.5
	other means	3	7.5

Table 5.3 contains the answer to question two of the questionnaire, with the highest number of respondents (75%) stating that they sometimes forget their child's health information, 20% stated that they never forget while 5% stated that they always forget.

Table 5.3 Question 2

Q2/ Do you ever forget your child's health information?			
		Frequency	**Percentage**
Valid	Always	**2**	**5**
	Sometime	**30**	**75**
	Never	**8**	**20**

Responses to question three presented in table 5.4 shows that majority of the respondents (75%) believe that the best place to get their information from is from health care centers where?, followed by 20% who prefers to obtain the information from healthcare centers and 5% from doctors.

Table 5.4 Question 3

Q3/ What is the best way to get your information about Pregnancy and children health care?			
Valid		**Frequency**	**Percentage**
	Via my Mobile	**30**	75
	Maternity and Children Care Centers	**8**	20
	by the doctor	**2**	**5**
	other means	**0**	**0**

5.4.3 Usefulness and Ease of Use

The prototype system is tested under its usefulness and ease o use. The questions were designed to be specific and to the point to eradicate ambiguity in understanding and to achieve the objectives of the questionnaire. The percentages of each question depicting both ease of use and usefulness of MCG prototype are presented in Table 5.5.

Table 5.5 Usefulness and Ease of Use

PERCEIVED USEFULNESS	**1**	**2**	**3**	**4**	**5**	**Means**
The MCG is useful.	0.00%	0.00%	05%	32.5%	62.5%	**4.5750**
It saves my time when I us e the MCG System.	0.00%	0.00%	02.5%	47.5%	50%	**4.4750**
It saves my effort when I use the MCG.	0.00%	0.00%	02.5%	47.5%	50%	**4.4750**
The MCG help me to save my child health information	0.00%	0.00%	05%	32.5%	62.5%	4.5750
The MCG help me to face the pregnancy without any difficulties	0.00%	0.00%	07.5%	42.5%	50%	**4.4250**
It does everything I would expect it to do.	0.00%	0.00%	02.5%	37.5%	60%	**4.3500**
PERCEIVED EASE OF USE	**1**	**2**	**3**	**4**	**5**	**Means**
It is easy to use.	0.00%	0.00%	02.5%	47.5%	50%	**4.4750**
It is simple to use.	0.00%	0.00%	05%	32.5%	62.5%	4.5750
It is user friendly.	0.00%	0.00%	02.5%	47.5%	***50%***	**4.4750**
I can use MCG without	0.00%	12.5%	12.5%	42.5%	32.5%	**3.9500**
I can recover from mistakes quickly and easily	0.00%	0.00%	02.5%	50%	47.5%	**4.4500**
I can use it successfully every	0.00%	0.00%	07.5%	42.5%	50%	**4.4250**

5.5 Summery

The present chapter presented the evaluation of MCG system prototype and the results imply that most of the respondents (62.5%) strongly agree and (32.5%) agree with the system's usefulness (Table 5.5, Question 1). Most of them (80%) forget their child's health information, 75% who stated that they sometimes forget their child's vaccination date and 5% who stated that they always forget their child's

health information. The findings of the chapter evidence the importance of the study and it application entail the education of women regarding pregnancy and monitoring their children's health.

CHAPTER SIX

CONCLUSION

6.1 Introduction

The present chapter expounds on the overall development of the project providing a full view of the objectives of the research. The chapter also lists the project limitations and recommendations.

6.2 Objective Achievements

The objectives of the research mentioned in chapter one of the study, have been achieved through the successful implementation of MCG system. The first two objectives entailed the definition of system requirements, explanation of the rules and functions and the development of application prototype. These objectives were achieved and finalized by the completion of the implementation phase.

The findings from the survey method imply that the MCG system is easy to use, clear and useful. The surveys involving 40 respondents presented the satisfaction and agreement of almost all of the users of the application architecture and functionalities implying that the user's requirements have been determined correctly. Hence, the third objective which is to identify the prototype's functionality and testing has been achieved.

6.3 Recommendations

The MCG system is developed by using the JSP and WAP technology. The database tables are developed through MySQL and the limitation of this development and its hindrance are listed as follows:

6.4 Limitation

1 Due to the unaffordable cost of airtime payment and the time constraints, the proposed (MCG) System is still just a simulation on mobile emulator, and has not been registered to the real website.

2 The proposed developed system can only be accessed only by those that possess a WAP accessing features mobile phone, which can surf the internet.

3 The limited time to do more in depth research and study is another challenge to gather the complete information and understanding for this study area. Better result will be achieved if the project period is lengthened.

At list can said that by this research a Maternity and children Guide system was developed to educate women during pregnancy and after that, including information about children care. The prototypes usability was evaluated and the results prove that it is useful for users and it is capable to help them to reach to the information easy, direct and successful.

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Appendix A
QUESTIONNAIRE

Maternity and Children Guide (MCG)

Thank you for participating in the Maternity and Children Guide (MCG). The survey is part of our research work to investigate the usefulness of the Maternity and Children Guide (MCG) on pregnant women and mothers. We appreciate your kind cooperation in completing this questionnaire, and we ensure you that all your information will be held in strictest confidence and will be used for research purposes only.

The study's questionnaire involved three parts, namely "Section A " consists of the general information of the respondent and "Section B" contains the Existing Practice on Maternity and Child Care "Section C" Usefulness and Ease of Use variables and under each variable a several items.

If you have any questions about this survey, please contact us by phone at (0172996306) or by email at (russul18@yahoo. com).

Section A: Respondent General Information

This section focus on general information about the respondent in general

1. Age: 20-30[] 31-40[ ] Above 40[].
2. Educational Level: Degree Qualification [ ] Master Qualification [ ] other []
3. How many children do you have? this is my first pregnancy [] one [] two[] more than two[]

4. Do you work? Yes [] No [] If Yes pleas set your occupation_____.

5. Do you use a similar application before Yes[] No[]

Section B: Existing Practice on Maternity and Child Care

1. what your information source about Maternal and child Health

Maternity and Children Care Centers [] from books [] other means []

2. Do you ever forget your child's health information?

Always [] Sometime [] Never []

3. What is the best way to get your information about Pregnancy and children health care?

Via Specialist Mobile System [] Maternity and Children Care Centers []

By the doctor [] Other means []

Section C:

For the next segments, please tick or shade the answer to the following questions using the scale.

1	**2**	**3**	**4**	**5**
Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

PERCE IVED EASE OF USE		**1**	**2**	**3**	**4**	**5**
1.	It is easy to use.					
2.	It is user friendly.					
3.	I can use it without written instructions.					
4.	I can recover from mistakes quickly and					
5.	I can use it successfully every time.					
PERCEIVED USEFULNESS		**1**	**2**	**3**	**4**	**5**
6.	The MCG System is useful.					
7.	It saves my time when I use the MCG					
8.	It saves my effort when I use it the MOAD.					
9.	The MOAD gives me more control over the activities in my life.					

Thank you