



***mHealth Platform Design for Maternal and Child Health
Promotion***

By

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**In Partial Fulfilment of the Requirements for the Degree of Master of Science
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Declaration

I, the undersigned, declare that this thesis is my original work. It has never been presented for a degree in any other institution and that all sources of the materials used in it have been duly acknowledged.

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This MSc. thesis has been submitted for examination with my approval as an advisor.

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Abstract

mHealth Platform Design for Maternal and Child Health Promotion

By Selam Belachew Tegegn

Maternal and child health depends on the health decisions the mother takes before, during and after pregnancy. These health decisions can be effective when they are based on information and knowledge. In Ethiopia, health information is available mostly in health facilities and sometimes promoted via radio and TV. Such health promotion can be further supplemented by the use of mHealth solution.

The intent of this thesis was to design and develop an Android App and website platforms using Android studio and WordPress respectively to educate women about maternal and child healthcare using the official language (Amharic) so that they can make informed and effective health decision. The content of both platforms is based on the World Health Organization recommendation and Ethiopian Ministry of Health training manual on prenatal, birth and postnatal care intervention. During the development of both platforms, emphasis has been given to the danger signs of the mother and newborn; pregnancy, birth and postpartum complications; and the importance of delivering at a health facility in order to empower women and seek on-time medical care throughout the continuum of care.

The mobile App calculates the due date using the Ethiopian calendar and sends notifications about prenatal visits, fetus development, postnatal visits, and immunizations. Reminders were integrated to have a profound influence on the timelines of prenatal, birth and postnatal care. The website provides a platform for pregnant women, mothers and health professionals to interact, ask and get advice on topics related to pregnancy, childbirth, child development, and postpartum life. A pilot study assessing the user satisfaction survey on the mobile app resulted a Net Promoter Score of 100% and Customer Effort Score ranging between 86.1% and 100%. The app works in any Android device with Android version 4 and above while any device with an internet browser can access the website.

Keywords: *Android Studio, Consumer Health Informatics, Maternal and Child Health, mHealth, WordPress.*

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Table of Contents

| | |
|---|-----------|
| Abstract | iii |
| Acknowledgement..... | iv |
| List of Tables..... | viii |
| List of Figures | viii |
| List of Abbreviation | ix |
| Glossary | x |
| Chapter 1: Introduction | 1 |
| 1.1 Background | 1 |
| 1.2 Statement of the Problem | 4 |
| 1.3 Objectives..... | 5 |
| General Objective..... | 5 |
| Specific Objectives..... | 5 |
| 1.4 Rational and relevance of the study | 5 |
| 1.5 Scope | 6 |
| 1.6 Document Structure | 6 |
| Chapter 2: Literature Review | 7 |
| 2.1 Challenges in Existing mHealth Solutions..... | 7 |
| 2.2 Outcome of mHealth Solutions..... | 8 |
| 2.3 mHealth Infrastructure in Ethiopia..... | 9 |
| 2.4 Important MCH Information..... | 10 |
| Chapter 3: Materials and Methods | 12 |
| 3.1 Content Development Method | 12 |
| 3.2 System Development Tools | 14 |
| 3.2.1 Android Studio | 14 |

| | |
|---|-----------|
| 3.2.2 WordPress | 14 |
| 3.3 System Development Method | 15 |
| 3.3.1 Requirement Analysis | 15 |
| 3.3.1.1 Mobile application functional requirement..... | 16 |
| 3.3.1.2 Mobile application non-functional requirement | 17 |
| 3.3.1.3 Website functional requirement..... | 18 |
| 3.3.1.4 Website non-functional Requirement | 18 |
| 3.3.2 Use Case Diagrams | 19 |
| 3.3.2.1 Mobile application use case diagram..... | 19 |
| 3.3.2.2 Website use case diagram | 20 |
| 3.3.3 System Design | 21 |
| 3.3.3.1 Mobile application design..... | 22 |
| 3.3.3.2 Website design..... | 22 |
| 3.3.4 System Implementation | 23 |
| 3.3.4.1 Android app implementation | 23 |
| 3.3.4.2 Website implementation | 24 |
| 3.4 User Satisfaction Survey Method | 24 |
| 3.4.1 Survey Population | 25 |
| 3.4.2 Procedure | 25 |
| 3.4.3 Interview Questionnaire | 25 |
| Chapter 4: Result and Discussion..... | 27 |
| 4.1 Platform Content and User Interface..... | 27 |
| 4.1.1 Pregnancy | 27 |
| 4.1.2 Fetus development..... | 29 |
| 4.1.3 Prenatal care | 30 |

| | |
|--|-----------|
| 4.1.4 Child Birth..... | 31 |
| 4.1.5 Newborn Care..... | 32 |
| 4.1.6 Postnatal Care..... | 33 |
| 4.1.7 Child Development..... | 34 |
| 4.2 Android Tools | 35 |
| 4.2.1 Due date calculator and prenatal and fetus development notification..... | 35 |
| 4.2.2 Baby age calculator and postnatal and immunization notification..... | 38 |
| 4.3 Website Tools..... | 40 |
| 4.4 User Satisfaction Survey | 40 |
| Chapter 5: Conclusion and Recommendation..... | 45 |
| 5.1 Conclusion | 45 |
| 5.2 Recommendation..... | 45 |
| Bibliography | 47 |
| Appendix A | 50 |

List of Tables

| | |
|---|----|
| Table 1: Mobile Application development Environment Setup | 14 |
| Table 2: Website Development Environment Setup | 15 |
| Table 3: Mobile Application Functional Requirements | 16 |
| Table 4: Mobile Application Nonfunctional Requirements | 17 |
| Table 5: Website Functional Requirements | 18 |
| Table 6: Website Nonfunctional Requirement | 19 |
| Table 7: Number of Survey Candidates and Participants | 25 |
| Table 8: Notification Schedule | 40 |

List of Figures

| | |
|---|----|
| Figure 1: Content Categories | 13 |
| Figure 2: Mobile Application Use Case Diagram | 20 |
| Figure 3: Website Use Case Diagram | 21 |
| Figure 4: Pregnancy Symptom, Pregnancy Discomfort, Pregnancy Nutrition and Complication | 29 |
| Figure 5: Fetus Development | 30 |
| Figure 6: Prenatal Care | 31 |
| Figure 7: Birth | 32 |
| Figure 8: Newborn Care | 33 |
| Figure 9: Postnatal/Postpartum Care | 34 |
| Figure 10: Under 5 Children Care | 35 |
| Figure 11: Due Date Calculator | 37 |
| Figure 12: Prenatal and Postnatal Period Notification | 39 |
| Figure 13: Response of First Questionnaire | 41 |
| Figure 14: Response of Net Promoter Score Question | 42 |
| Figure 15: Response of Customer Effort Score Questions | 42 |
| Figure 16: Customer Effort Score | 43 |

List of Abbreviation

| | |
|--------|--|
| AIDS | Acquired Immuno Deficiency Syndrome |
| App | Mobile Application |
| CES | Customer Effort Score |
| CHI | Consumer Health Informatics |
| CMS | Content Management Systems |
| GPS | Global Positioning System |
| HEW | Health Extension Worker |
| HIV | Human Immunodeficiency Virus |
| JDK | Java Development Kit |
| JRE | Java Runtime Environment |
| ICT | Information and Communication Technology |
| IVR | Integrated Voice Response |
| IDE | Integrated Development Environment |
| LMIC | Low and Middle Income Countries |
| MCH | Maternal and Child Health |
| MMR | Maternal Mortality Rate |
| MoH | Ministry of Health |
| NPS | Net Promoter Score |
| PDA | Personal Digital Assistants |
| PHP | Personal Home Page |
| SDK | System Development Kit |
| SMS | Short Message Service |
| SQL | Structured Query Language |
| UI | User Interface |
| UML | Unified Modeling Language |
| UNICEF | United Nations International Children's Emergency Fund |
| USS | User Satisfaction Survey |
| USSD | Unstructured Supplementary Service Data |
| WHO | World Health Organization |

Glossary

| | |
|------------|--|
| Child | A child between birth and 5 year |
| Infant | A child between the age of 28 days and 1 year |
| Newborn | A child between birth and 28 days |
| Prenatal | The time of pregnancy before birth |
| Postnatal | The time immediately after birth and the first 6 weeks |
| Postpartum | The time immediately after birth and the first 6 weeks |

Chapter 1: Introduction

1.1 Background

Women's and children's health was the pillar agenda of the timely bound Millennium Development Goals (MDGs) 4 and 5, which was set out to reduce maternal and child deaths by 2015 [1]. Women and children collectively constitute about 70% of the Ethiopian population [2]. By the end of the MDG, there were 3,176,000 births and 14,602,000 under-five population [3]. Under-five mortality rate reached 59 per 1000 live births. Neonatal and infant mortality rates per 1000 live births were 28 and 41, respectively. The maternal mortality rate (MMR) was 412 per 100,000 live births [4].

The interrelated causes and determinants of maternal and newborn mortality in low-income countries are mainly preventable communicable diseases and nutritional disorders. Access to maternal and child healthcare services is also limited causing a delay in getting proper medical care. According to the 2018 UNICEF data sheet, the main cause of child mortality under the age of 5 is pneumonia (16.8%), intrapartum (16.7%), preterm birth (15%), sepsis (8.7%), congenital (7.8%), diarrhea (7.6%), and injury (6.9%) while other problems account for 20.5% of the deaths in Ethiopia. On the other hand preterm (30.4%), intrapartum (26.3%) and sepsis (14.5) are the major cause of newborn deaths [5].

According to a study conducted by Wubegzier Mekonnen and Alem Gebremariam, obstetric complications such as hemorrhage (29.9%), obstructed labor/ruptured uterus (22.34%), pregnancy-induced hypertension (16.9%), puerperal sepsis (14.68%), and unsafe abortion (8.6 %) are the main direct causes of maternal deaths in Ethiopia between the year 1990 and 2016. In addition anemia and malaria are the most indirect causes of maternal death [6].

Most of these maternal and child deaths are either preventable or treatable through prenatal, birth and postnatal care. Furthermore, avoiding delay in getting medical care allows early management of unforeseen obstetric and newborn complications. But, at the end of the MDG, only 16% of delivery was assisted by skilled birth attendant, 32% of the pregnant women had more than 4 prenatal visits and 12% of mothers have a postnatal visit [3]. Another challenge the country faces in delivering crucial healthcare service is a delay in getting proper medical care. A World Health Organization (WHO) publication indicates that one of the major causes of maternal and child

deaths is “*delay: in the decision to access care, in the identification of – and transport to – a medical facility, and in the receipt of adequate and appropriate treatment*” [7]. The people of Ethiopia are bound to their mores and they do not consider the need for medical attention unless the mother or the child is ill beyond survival which creates the first and major delay in receiving life-saving medical care.

To improve maternal and child health (MCH), the Ministry of Health launched the Health Extension Program (HEP) as a health strategy in 2003 which focuses on community-level health service. The program aims at increasing coverage of first level healthcare to meet the healthcare demand. Among four areas of care addressed by the HEP, the two cover family health and health education and communication. Family health package includes maternal and child health, family planning, immunization, adolescent reproductive health, and nutrition; whereas health education and communication aimed at incorporating health extension workers and volunteers in educating the community about self-health [8]–[10].

This health strategy plays a great role in increasing the uptake of prenatal and postnatal care. In 2018, the prenatal and postnatal care reached 72% and 77%, respectively. At the same year 66% of pregnant women also delivered their babies at a health facility assisted by skilled birth attendant. The report shows that despite the improvement, the figures are below the annual target of 85% (prenatal), 90% (postnatal) and 78% (health facility delivery) [11]. In 2019 the MoH aims at increasing these figures to 93% for prenatal and postnatal uptake and 89% for delivery with the help of skilled birth attendants [12]. This trend will determine the country’s ability to meet the 2030 Sustainable Development Goals (SDG).

By 2030, every country should reduce its maternal mortality ratio (MMR) by at least two-thirds from its 2010 baseline which was 523 per 100,000 live births. That means at the end of the SDG, MMR should decline to 175 per 100,000 live births. Whereas neonatal mortality should be reduced to at least as low as 12 per 1000 live births and under-5 mortality to at least as low as 25 per 1000 live births [13]. But at the outset of this new goal, preventable maternal, newborn and child morbidity and mortality remain unacceptably high.

In order to meet SDG, countries need to consolidate and expand their agendas to go beyond survival, with a view to maximizing the health and potential of their populations. As already

mentioned, the rate of prenatal, birth and postnatal care is still low and delay to seek medical care costing lives. Such poor clinical decisions can be improved by increasing public awareness on the dangers of pregnancy-related complications, improving education for females and empowering women to make a decision on their own health [14]. The HEP health education and communication package proves that improving public knowledge plays a great role in increasing the required clinical uptake throughout the continuum of care. That's why health promotion should not be limited in a health facility. Other means of information delivery and knowledge sharing mechanisms should be considered for better result.

In technology advanced century, using information and communication technology (ICT) to improve access and quality of healthcare service is becoming inevitable. Developments in the internet and mobile technologies are opening innovative opportunities for accessing important health knowledge and advice for both citizens and health-care professionals. Countries are already using mobile phones to improve health service provisions. Governments are using virtual channels, including websites and social media, to provide information to their populations, and to promote women's and children's health programs [15] , [16].

Governmental and non-governmental, profitable and non-profitable organizations all over the world are working substantially on empowering individuals about self-care and minimize any delay caused by lack of information. They use new multidisciplinary technological trends like eHealth, mHealth, medical informatics and telemedicine which incorporate health service with ICT to reach their population, to empower individuals and deliver service by overcoming delivery challenges, achieving universal health coverage and better individual health-related decisions.

The global observatory for eHealth defined mHealth (mobile health) as the use of mobile devices – like mobile phones, patient monitoring devices, personal digital assistants (PDAs) and wireless devices and their core utilities like voice, SMS, data, GPS and Bluetooth– for medical and public health practice. Advanced and cheap smartphone technologies are opening up new opportunities for mHealth promotion [15] , [17].

The new health informatics branch, consumer health informatics (CHI), uses multidisciplinary fields like mHealth to deliver health information to consumers. CHI focuses on empowering individuals on self-care and is trending as a new approach in health informatics. Although factors

like the quality of information available, infrastructure, skill of using technology and cost affect the outcome; a review on the impact of CHI applications shows that it has a positive impact on receiving treatment, self-management, health knowledge, health behaviors, clinician-patient communication and quality of life among users with no harmful findings [18].

In countries like Ethiopia, whose disease burden is mostly preventive and treatable, using ICT like mHealth for health promotion can increase health education coverage and improve the health outcome. Mobile and internet penetration is dramatically expanding, hence using mobile to empower individuals about self-care will be an effective solution.

1.2 Statement of the Problem

The maternal and child mortality rates, as seen from figures of the WHO are extremely alarming and need multi-sector involvements. MCH depends on the health decision a mother take before, during and after pregnancy which requires knowledge. Currently, health education and promotion is provided only in healthcare facilities, and sometimes via TVs and radios. The use of technology and innovation, like mHealth, for community empowerment needs to be considered.

Worldwide mHealth applications are assisting women to take control of their own health; providing pregnant women, mothers and the community with better healthcare information and advice. Health websites and mobile Apps are growing throughout the global market. But among many other challenges, lack of awareness and language barriers are restraining Ethiopian women from using those existing mHealth applications.

The purpose of this project is to develop an Amharic mHealth information platform for MCH promotion. The platform is intended to create a virtual network of information, professionals, educators, researchers, practitioners, pregnant women and mothers to learn, advice, get advice, teach, meet, ask and share experience on.

1.3 Objectives

General Objective

The general objective of this thesis is designing and developing an *Amharic Information Platform for MCH promotion*: An easy to use and community focused mHealth solution with a vision to promote self-health.

Specific Objectives

The specific objectives of this thesis are:

- Acquire, organize and prepare MCH information to be included in the platform
- Translate the content to Amharic language
- Design and develop user-friendly Amharic web-portal and Android app
- Plan and implement distribution strategies for all output formats of the platform

1.4 Rational and relevance of the study

Women have a basic right of knowing prenatal, postnatal, and delivery care given in the health facilities so that they can seek medical care when needed. Furthermore, they are entitled to know about the danger signs of the mother and the baby for proper management of related complications. In addition, tracking their pregnancy and child development will improve the health outcome for both the mother and the baby. Generally, they should be empowered to take control of their life and educated about self-care because that can save lives. In the era of ICT, they are not supposed to visit a health facility for the sole purpose of health education. But unfortunately, Ethiopia doesn't have a system implemented to facilitate health education and promotion at a distance.

That's why this study suggests the use of mHealth for health education and promotion delivered through an Android app and a website that can reach individuals irrespective of the user location and time of the day. The educational platform will benefit the mother and the child by transferring knowledge and skill that enables the mother to make an informed decision. This benefit will extend to a family level, to a community and generally, the country will benefit from reduced mortality

ratios. This project will be the start of a well-organized consumer-based information platform that can be scaled to achieve the health agendas related to the new SDG.

1.5 Scope

The outcomes of this thesis is a website and an Android application. The Android application focuses on delivering information and sending an individual tailored notification based on the due date and birth date whereas the website focuses on creating a community engagement tool where professionals, educators, researchers, practitioners, pregnant women, and mothers interact. This website will integrate Facebook to improve social media interaction on the website. Both products will end at the deployment stage of the software development lifecycle, that means it does not include maintenance and retirement phase.

1.6 Document Structure

The document presents an introduction in chapter one providing general background information, formulates the problem and sets the objectives, rational, and scope of the study. Chapter two summarizes the literature reviewed including previous similar works and their gaps, existing mHealth platforms in low and middle-income countries (LMIC) and their clinical outcomes, contents of existing platforms and available mHealth infrastructures in Ethiopia. Chapter three presents materials and methods used to develop the platforms. The chapter explains in detail the content, App and website analysis, design, and implementation. Chapter four focuses on the results of the study, the App and website, and discuss them independently in detail. Finally conclusion and recommendations are presented in chapter five.

Chapter 2: Literature Review

This section documents a summarized presentation of reviewed literature. The current work focuses on a somewhat multi-disciplinary subject matter; therefore, the need for a literature review was influenced to that extent. The literature will go through previous similar works and their gaps, review existing mHealth platforms in low and middle-income countries (LMIC) and assess what the contents of those existing platforms are to better customize the proposed system.

2.1 Challenges in Existing mHealth Solutions

Unacceptably high global rates of preventable maternal and child mortality and morbidity remain a health, development and human rights challenge. Women and children in the poorest countries bear the greatest burden of poor health and death. They are more exposed to health risks and often have lower resistance to illness. The interrelated causes and determinants of maternal and newborn mortality in low-income countries are mainly preventable communicable diseases and nutritional disorders. Access to maternal and child healthcare is also limited causing a delay in getting proper medical care.

As already mentioned in the introduction, increasing public awareness on the dangers of pregnancy-related complications, improving education for females and empowering women to make a decision on their own health has been proposed as a solution to minimize preventable, communicable, and treatable deaths [14]. Fortunately, the internet is full of multiple websites and mobile applications providing information and tools to better manage MCH by directly aiming the consumer, in this case, mothers and pregnant women. mHealth platforms are used to advise, support and track pregnancy and child development helping women in every step of motherhood across the continuum of care.

"MCH" is currently accepted terminology for describing the continuum of care for maternal and child health. The continuum of care main facet is time and place. This continuum of care includes integrated service delivery for mothers and children through the household, community, and health facility for women (from adolescence to motherhood) and children (from newborn to childhood).

Baby center, The Bump and What To Expect are just the tip of an iceberg in the pile of applications and websites that are free to use worldwide. These websites and mobile applications are mainly funded and managed by governments, NGOs and private companies with the contents developed by healthcare expertise. However, people in Ethiopia are not aware of the existence of such information and even if they were there are barriers in using them. This includes the language barriers caused by illiteracy. Most people can read and write only Amharic, the official language. Also, tools like due date calculator and reminders of the existing applications work based on the Gregorian calendar that most Ethiopians are not familiar with. The only mobile application written in Amharic language, "እርግዝናና ወሊድ Pregnancy ሙሉ መረጃ" also lacks basic tools and content on danger signs of the mother and the baby. John Hopkins is also developing a mobile App that educates women about MCH. At this stage, the app provides basic maternal, newborn and child health-related information in Amharic and Oromiffa language. The App integrates text with voice for content delivery. It is still under development and is not fully launched yet.

2.2 Outcome of mHealth Solutions

Once the existing mHealth solutions are assessed and the gaps are identified the next move was to assess the effectiveness of mHealth platform in a low and middle-income countries. Developing the right system doesn't mean it will deliver a positive outcome. So, there is a need for assessing the outcome of previous mHealth platform. Scientific papers showing the impact of mHealth in changing behavior and/or improving decision making were reviewed since they directly relate with the goals of the current thesis.

Cluster-randomized controlled trial in Zanzibar, Tanzania, shows mobile communication with midwives improves prenatal and birth care uptake. 60% of women communicating their midwives, using mobile, deliver their babies with skilled birth attendants compared to those with no communication with their midwife which is 47%. Percent of women receiving 4 prenatal visits was also better for women communicating their midwives which was 44% compared to 37% for those who were not communicating their midwives [19] , [20]. Furthermore, health education about danger signs and the importance of delivering at a health facility, and a reminder sent to mothers in Zanzibar shows a reduction of perinatal mortality [21]. An SMS reminder and cash transfer through mobile showed improvement in child vaccination uptake in a rural area of Kenya [22].

Other studies on SMS-based system in Rwanda shows an increased facility-based delivery by 27% while in Thai-Myanmar border area an SMS reminder resulted on time antenatal care and immunization and improve its coverage [23] , [24].

Zero mothers die, gifted moms, mobile midwife, and MomConnect are among many mobile-based platforms which show a positive outcome and currently providing service to thousands of LMIC pregnant women and mothers even though there is small scientific evidence proving it. They are mainly used for health education, appointment reminder, and health data storage. For example, zero mother dies provides small mobile phones to women in Africa, currently in Ghana and Nigeria, at no cost and uses SMS text to provide women living in isolated areas with essential information for having a healthy pregnancy. Whereas gifted moms registers pregnant women and new mothers to free text message to educate them about prenatal care, vaccines, and reproductive health. Thousands of mothers use this app in Cameroon and Nigeria. In Cameroon gifted mom led to a 20% increase in antenatal care attendance [25].

Mobile midwife and MomConnect are also mobile apps designed to endorse MCH care education. Women, in Ghana, using mobile midwife showed improvement in seeking medical care during pregnancy and childbirth. Furthermore, they were able to avoid traditional myths about pregnancy diet [26]. MomConnect based in South Africa is currently being used to register, manage and educate pregnant women and mothers [27]. These applications are available to be downloaded free in different app stores including Google Play and iTunes. Even though there is a need for more scientific research showing the positive outcome of using mHealth, these existing evidence shows a bright future for mHealth programs.

2.3 mHealth Infrastructure in Ethiopia

As already been mentioned mHealth solutions can take any form and can use different utilities of a mobile device like SMS, Integrated Voice Response (IVR), and Unstructured Supplementary Service Data (USSD), mobile application, web access and so on. So the choice of which utility to use depends on the target population and the available resource. The current thesis adopted mobile application and web access capability of any computer device to deliver the content because of their flexibility to incorporate many functionalities, their small investment needed for implementation and their small running cost. That means, besides having a positive outcome,

mHealth platform, the one proposed in this thesis, requires a smartphone and/or internet connection (browsing).

According to Ethio telecom statistics, there are 40.4 million active mobile devices and 17.87 million internet users in the network as of November 15, 2018. Among those 30.6% (12,379,927) are smartphones and 0.4% (162,286) device are tablets while feature phones account for 18.8% (7,597,815). The most widely used smartphones have Android as their operating system and account for 92.41% of all the smartphones in the network [28]. With the reduction of smartphone price and internet usage tariff in the country, mHealth is a way to go for reaching individuals wherever they are with tailored information about their current health and status.

2.4 Important MCH Information

Developing an information system requires analysis to decide on the contents and functionality of the system. For that WHO produced a publication as guidelines and policy-making references on MCH. The antenatal interventions identified by WHO are nutritional interventions, maternal and fetal assessment, preventive measure, interventions for common physiological symptoms, and health systems interventions [29]. There are also 12 areas of postnatal interventions concerning both the baby and the mother, namely: the timing of discharge from a health facility, number and timing of postnatal contacts, home visit for postnatal care, assessment of the baby, exclusive breastfeeding, cord care, other postnatal care for the baby, assessment of the mother, counseling, iron and folic acid supplementation, Prophylactic antibiotics, and psychosocial support [30]. These interventions can directly influence the outcome of the health status of both the mother and the baby especially when the cause of death is either preventable or treatable as in the current circumstances in Ethiopia.

Taking the above interventions and cause of death in mind, Ethiopian Ministry of Health (MoH) with WHO, UNICEF and other NGO's prepared a training manual for health extension workers (HEWs) providing detail procedures and contents for educating communities about prenatal, birth, and postnatal care. The content focuses on educating women about the importance of prenatal and post-natal visit; the danger signs of pregnancy, birth and newborn baby; the benefit of delivering their baby with a skilled birth attendant; the required nutrition to follow and the unwanted tradition they need to avoid that led to delay in seeking medical care. The WHO prenatal and postnatal

intervention and the MoH training manual was used as a guideline to prepare the content of the platform proposed in the current thesis.

In general, the literature review identified what has been recommended to prevent and manage the major causes of MNC deaths in Ethiopia; existing mHealth applications in LMIC focused on MCH; the positive impact of using mHealth to better health and reach individuals in LMIC; and the gaps to be filled by the proposed system.

In conclusion, to prevent and treat the deadliest MNC mortality factors, women in the first place must be aware of the danger signs and they need to be empowered to seek medical care along the continuum of care especially in time of complication. Considering the root causes of maternal and child health, preventable and communicable diseases, the solution should be the promotion of self-care. The health system must incorporate technology that can ease the delivery of health information and broaden access to reach its population.

Chapter 3: Materials and Methods

This chapter explains the materials and methods applied for the development of the website and Android application. It explains materials and methods used to develop the content, the application and website independently. The main platform will be the Android app since it can work offline once the application is installed. The application is also flexible for creating tools like due date calculator and sends a customized notification. The website will be used to create a community with dynamic content.

3.1 Content Development Method

Although the training manual obtained from MOH has detailed content, there was a need for data search to fill content gaps if there are any, and to find related multimedia contents that are not found in the existing manual. The search for relevant data focuses on discovering digital formats. BabyCenter and What to Expect are the selected websites and mobile applications for content development and requirement analysis.

The data sources are selected based on their congruence with WHO's recommended interventions. Majority of the contents on MCH are available for free and as an open source license. Therefore, productions of translated materials are backed up with a vast pool of resources. In addition, WHO's detailed documentation on MCH guidelines, policies, interventions, approaches, and programs are considered during content development. Since the aim is education, people are more attracted by pictures and videos than texts, so text, picture and multimedia data types are considered during data search.

The nature of the project created a challenge and/or opportunity of working with a large amount of data. Proper organization of the data was perceived as an important task in the successful accomplishment of project objectives. Based on HEW training manual, WHO recommendation and cause of MNC death in Ethiopia, a list of topics to be focused on is identified. These topics are categorized under general and subtopics to give the user the flow of information and improve the content readability. The content category also considered the functionality of the App and website so that notifications in the App and comments on the website can relate with specific

contents and ideas. As seen from figure 1 the information was organized under four generic categories:

Maternal health: information related to the health of a women during pregnancy and childbirth and the health of a baby inside a womb.

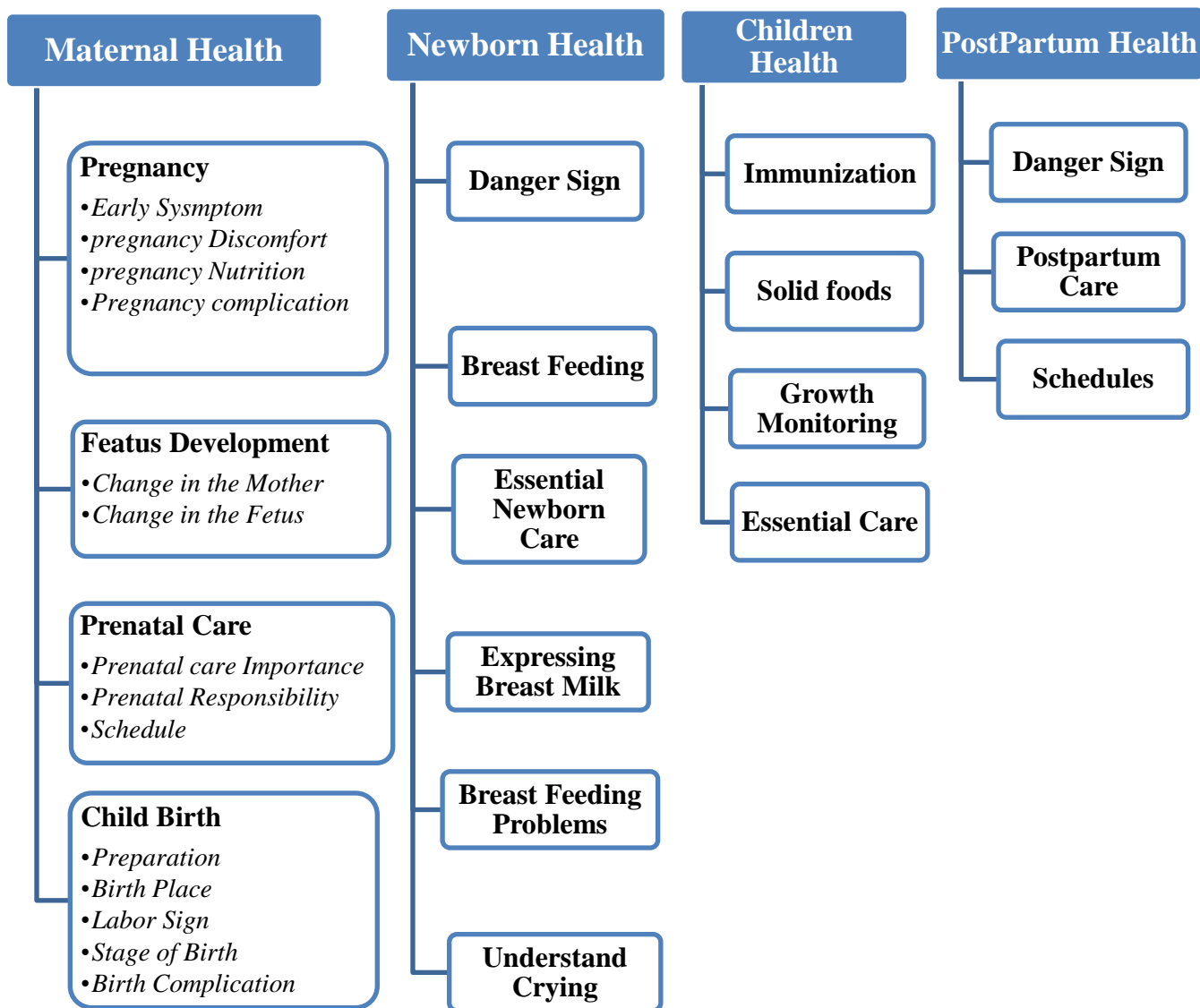


Figure 1: Content Categories

Newborn health: information related to the period immediately following the birth and ongoing through the first year of extra-uterine life of a baby.

Child health: information related to children under the age of 5.

Postpartum health: the health of a mother after childbirth and for the first 6 weeks

3.2 System Development Tools

3.2.1 Android Studio

Android Studio, developed by Google, is the official IDE (Integrated Development Environment) for Android-based mobile applications development. Among various way of approaching Android development, using Android Studio is the most powerful one. It uses the native application development method which is used to build an app for a specific operating system and can be accessed only from a dedicated app store like Google Play [31]. Android studio provides the fastest tools for building apps for every type of Android device with Google’s Material Design and access to all the advanced features of the platform. It has a world-class code editing, debugging, performance tool, a flexible build system, and an instant build/deploy system which enables anyone to build unique and high-quality apps. The current project scope was to develop an Android app due to the fact that Android is a widely used smartphone in Ethiopia. Due to that, the development method is chosen to be a native method and Android Studio is selected as a design material because of its rich libraries, support documents, and communities [32].

Android Studio integrates Android system development kit (SDK), Java development kit (JDK) and Java runtime environment (JRE) for the development of an app. The development tool and version or revision used in this thesis are summarized on table 1.

Table 1: Mobile Application development Environment Setup

| Development Tool | Version |
|--------------------------------------|----------------|
| Android Studio IDE | 3.2.1 |
| Android system development kit (SDK) | 26.1.1 |
| Java | 8 |
| Java development Kit (JDK) | jdk1.8.0_66 |

3.2.2 WordPress

Content management systems (CMS) are web-based applications that are designed for the creation of websites. Instead of the traditional way of developing a website from a scratch, CMS provide

pre-built-in templates that can be customized to an individual need, saving time spent on constructing common layouts and functionalities [33]. WordPress was selected as a tool for the development of the web platform because it's easy to add new content and there are abundant free plug-in and layouts to choose from [34], [35]. It also has rich security updates and features. WordPress needs a web server, a database, and PHP to correctly function. The development tool and version used in this thesis are summarized on table 2.

Table 2: Website Development Environment Setup

| Development Tool | Version |
|-------------------------|----------------|
| WordPress | 4.1 |
| PHP | 7 |
| MySQL | 5.6 |
| Web Server | Techno Bros |

3.3 System Development Method

The whole development lifecycle is governed by agile methodology. The advantage of using agile methodology is its flexibility to change. Instead of concrete planning at the beginning of the project, agile methodologies allow the requirement to change over time. Although the life cycle of agile is like other methodologies, for example, the famous waterfall i.e. Requirement Analysis, Design, Implementation, Verification, and Maintenance; agile methodology iterates through these development stages. This can help in incorporating user ideas and requirement change in the future. Both Android studio and WordPress allow agile methodology of developing an App and website respectively. This section explains the method used to develop both platforms.

3.3.1 Requirement Analysis

Requirement analysis is done to outline the problem to be solved. It defines the goals and objectives that the system must achieve. The requirement is based on the MOH training manual, WHO recommended intervention, and the underline cause of death stated in the introduction section. Considering the scope and intention of the two platforms, the requirement is developed for the app and website individually.

3.3.1.1 Mobile application functional requirement

The functional requirement is used to describe particular results of the system. It outlines what the app should do at each interaction with the user. 12 functional requirements are identified and listed below on table 3.

Table 3: Mobile Application Functional Requirements

| REQ ID | Requirement | Description |
|---------|--|---|
| REQ-AF1 | View information | Must be able to display all the information provided |
| REQ-AF2 | Calculate due date in Ethiopian calendar | Must calculate the due date based on the user input (First day of Last menstruation) - all the input and output date in Ethiopian Calendar |
| REQ-AF3 | Calculate baby age in Ethiopian calendar | Must calculate baby age based on the user input (the baby birthday) - all the input and output date in Ethiopian Calendar |
| REQ-AF4 | Save user input and request | Must save user input and requests even if the app is closed or the phone is switched off |
| REQ-AF5 | Send prenatal Notification | Must send a prenatal notification about a prenatal visit, fetus development, and labor information based on the calculated due date if the user checks the notification box |
| REQ-AF6 | Send postnatal Notification | Must send a postnatal notification about a postnatal visit and vaccination based on the calculated baby age if the user checks the notification box |
| REQ-AF7 | Cancel prenatal notification | Must cancel all pregnancy-related notifications when the user unchecks the notification checkbox |
| REQ-AF8 | Cancel postnatal notification | Must cancel all after birth related notifications when the user unchecks the notification checkbox |
| REQ-AF9 | Open notification | When user clicks on the notification the app must be launched and a specific information must be opened |

| | | |
|----------|------------------------------|---|
| REQ-AF10 | Redirect to a face book page | When user clicks follow us on Facebook menu the app should send a request for any browser to open the app Facebook page |
| REQ-AF11 | Redirect to eenat.com | When the user clicks website menu the app should send a request for any browser to open the website |
| REQ-AF12 | Send email to developer | When the user clicks contact us menu the app should send a request for any browser or email client to open compose mail with send address beselamdev@gmail.com and default subject: Concerning your app |

3.3.1.2 Mobile application non-functional requirement

Nonfunctional requirements are set to meet the app expected behavior when installed and perform the functional requirement. Nonfunctional requirements for the mobile application were five and they are presented on table 4.

Table 4: Mobile Application Nonfunctional Requirements

| REQ-ID | Requirement | Description |
|----------|----------------|--|
| REQ-ANF1 | Device Support | The app should work on all Android phones which run API level equal or/and greater than 14(Android version 4.0 – Ice Cream Sandwich). It should also work on any range of screen size. |
| REQ-ANF2 | Responsiveness | The app should be responsive to a user input (Action Events) without crashing |
| REQ-ANF3 | Usability | The app should work without a user manual |
| REQ-ANF4 | Performance | The app should have fast execution time, low battery usage and small memory usage. |
| REQ-ANF5 | Reliability | The app should be able to deliver all the requirement under any circumstance |

3.3.1.3 Website functional requirement

The website functional requirement focuses on describing what the website should do based on the different user role. Since the purpose of the website is to create a community with professionals submitting health content and users commenting and asking a question, their role differs. How the website should function depend on the user role. Based on that table 5 details the 10 functional requirements of the website.

Table 5: Website Functional Requirements

| REQ ID | Requirement | Description |
|----------|--------------------|---|
| REQ-WF1 | Create Account | Must allow user subscription using their email account |
| REQ-WF2 | Deactivate Account | Must allow user to deactivate their account |
| REQ-WF3 | View Information | Must present MCH information in Amharic language using a responsive technology that is comfortable to view in a range of devices irrespective of subscription |
| REQ-WF4 | Change user role | Must allow user role change based on user profession |
| REQ-WF5 | Create content | Must allow users to create new content or delete existing one according to their approval level. |
| REQ-WF6 | Delete Content | Must allow users to Delete content according to their approval level |
| REQ-WF7 | User Comment | Must allow all registered users to post comments on any contents |
| REQ-WF8 | Download App | Must provide link at the home page to redirect the user to the Android application Google play link |
| REQ-WF9 | Facebook connect | Must display the website Facebook page activities and allow users to react on the page from within the website irrespective of registration. |
| REQ-WF10 | Social sharing | Allow content share on major social media (Facebook, Twitter, Google Plus) irrespective of subscription |

3.3.1.4 Website non-functional Requirement

The nonfunctional requirement of the website focuses on security and availability since it works online and contents will be saved in the server. The 4 nonfunctional requirements listed on table 6 are necessary for the proper implementation of the website.

Table 6: Website Nonfunctional Requirement

| REQ-ID | Requirement | Description |
|----------|-------------|--|
| REQ-WNF1 | Security | Sensitive information such as user passwords will be kept secured and hidden. |
| REQ-WNF2 | Back Up | The website will be backed up regularly |
| REQ-WNF3 | Site Size | The website size will not be more than 1 GB. Any content more than that will be placed in an external storage like Google. |
| REQ-WNF4 | Reliability | The system should be able to deliver all the requirement under any circumstance |

3.3.2 Use Case Diagrams

A use case diagram is one of the unified modeling language (UML) used to describe the behavior of a system. The below use case diagrams are used to define a set of action the app and the website should or can perform when the user interacts with it. It represents the different capability that the system provides to its client and designed based on the list of the requirement.

3.3.2.1 Mobile application use case diagram

Figure 2 shows the mobile application use cases. The user is the only actor for this use case. The use cases are designed based on the functional requirement and focus on providing the user with flexible user experience.

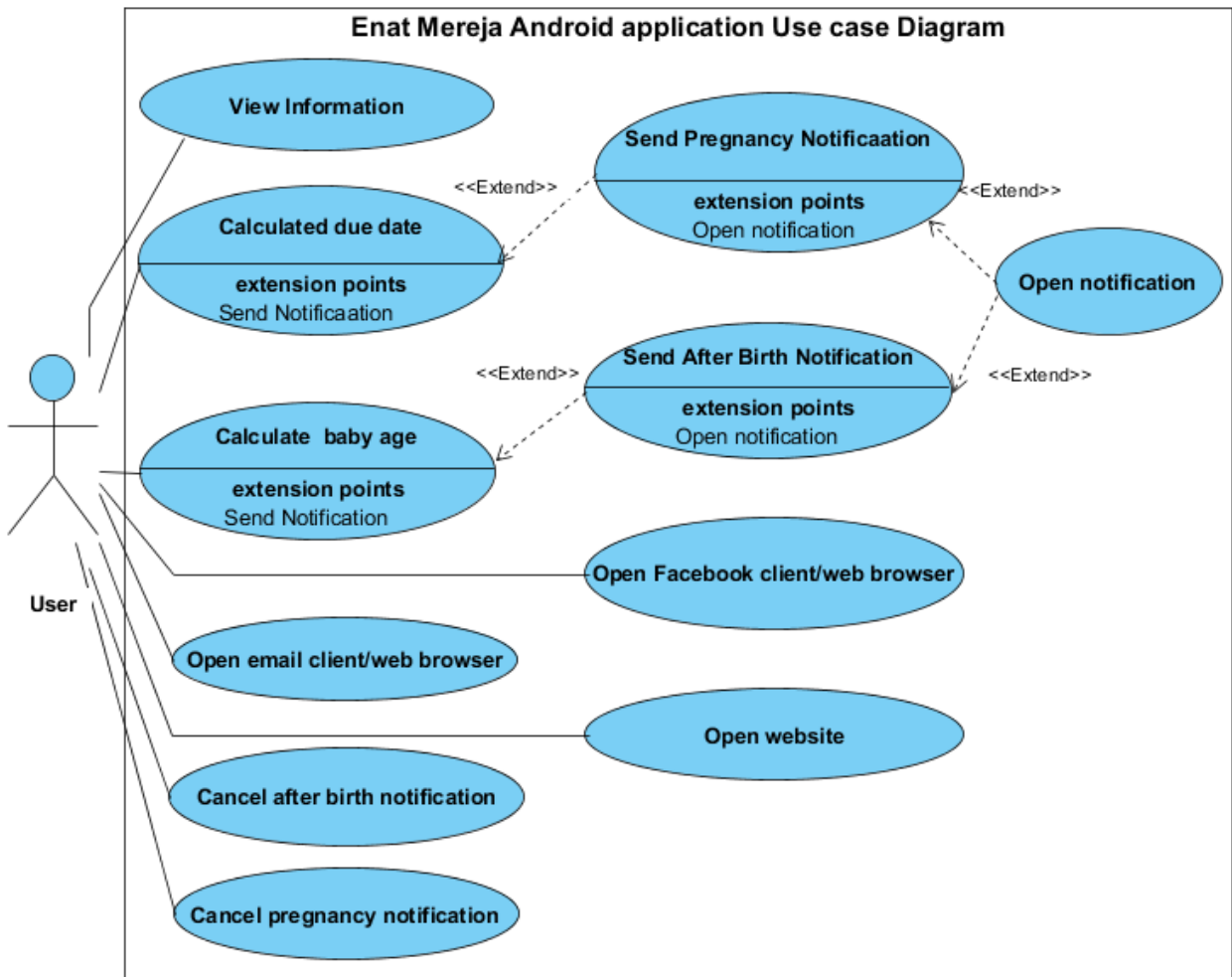


Figure 2: Mobile Application Use Case Diagram

3.3.2.2 Website use case diagram

Unlike the Android app which has one user, the website has multiple users with a different role. WordPress provides 6 predefined roles as Subscriber, Contributor, Author, Editor, Administrator, and Super Admin. For this specific website, anyone can register as a subscriber which has the least capability which is managing their own account and commenting on contents. For volunteer professionals who wanted to submit a content Author role will be given. An author can add and delete their own content while having every privilege a subscriber has. The Administrator will have full control of the website including all the privilege both the author and subscriber have but add unlimited functionality including user role change, adding and deleting the user, and change the structure and design of the website. Besides the predefined roles Visitors, those who visit the website but does not register, are also considered during use case modeling. Figure 3 shows the

use case diagram of the website which includes a user role named as Administrator, Author, Subscriber, and unregistered users or Visitors.

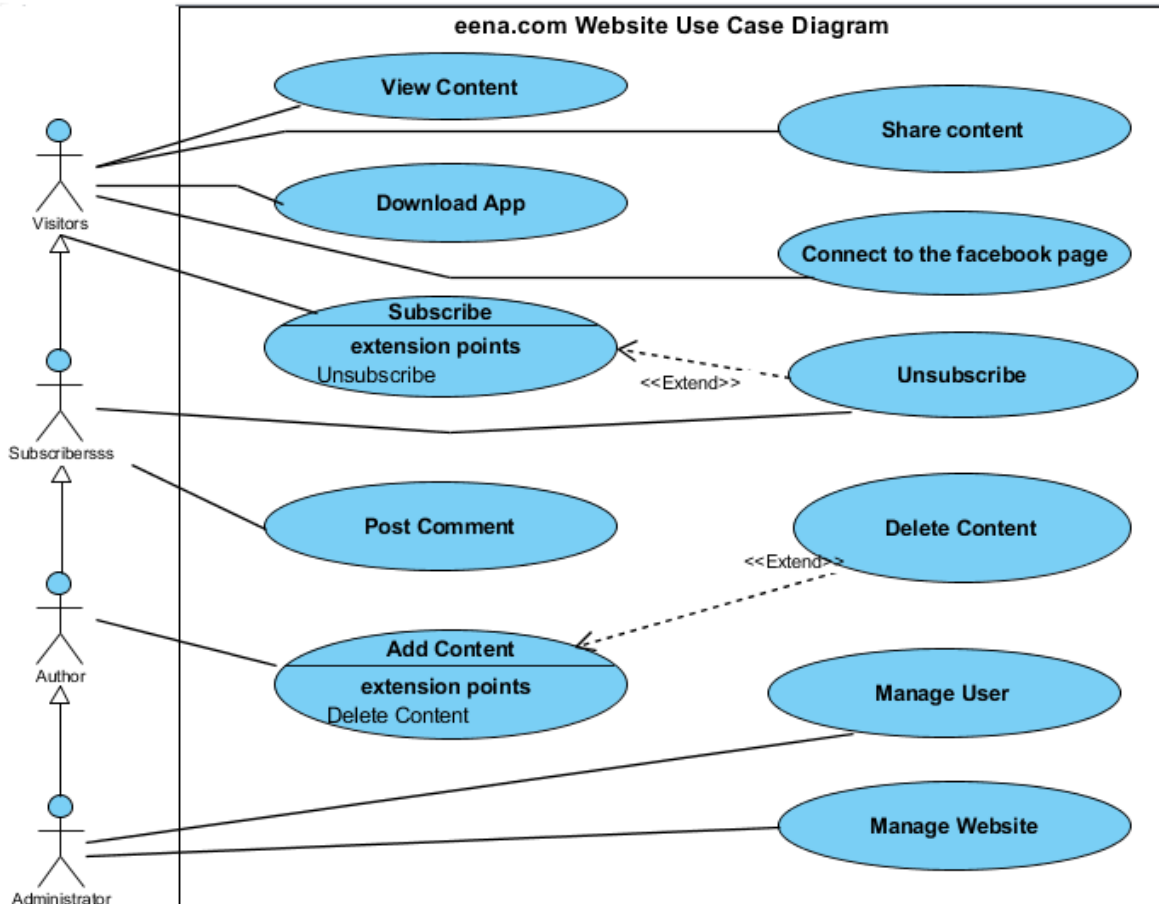


Figure 3: Website Use Case Diagram

3.3.3 System Design

This part explains the last detail design consideration before implementation starts. The design is based on the requirement and the use case diagrams. It details components to be used to achieve the functionality and the interaction of the platform with the user. Development of design components such as layout, navigation, action buttons, headers, and icons was performed with a vision of creating a visually attractive and content-appropriate presentation. The UI is designed separately using Microsoft Visio so that the mapping to Android Studio can be done efficiently.

3.3.3.1 Mobile application design

Android powers more than a billion phones, tablets, and other devices in a wide variety of screen sizes. Designing the structure and presentation of the app considered taking advantage of Android flexible layout system. The app is planned to gracefully scale from large tablets to smaller phones. For that Google's material design concepts were massively employed. The below list of Android Studio components is selected to fulfill the UI design and the user interaction with the app.

Activity and fragment: define the user interface layout

Recycler view: manage the main and sub menu

Toolbar: Display title and navigation button

Navigation Drawer and navigation button: navigate back and forth between contents.

Tab: construct a sliding page for lower level related contents

Text view and Image view: display text and image

Floating action button: redirect to the website

Edit Text: accept day, month and year of last menstrual start date and birth date.

Button: send a command to calculate due date and baby age.

Radio Button: activate and deactivate the notification

Notification Manager: Send notification based on WHO recommended schedule

Broadcast receiver: Handle notification when the app is no longer alive.

Exception handling: throw an exception if the user enters an incorrect date or forget to enter date

3.3.3.2 Website design

WordPress provides pre-built in themes for developing a website. So, the design phase focus on identifying plugins to best create a website that meets the specification and use case diagram. The

website is planned to gracefully scale from small phone and tablet to any range of computer size. For that, a page builder called Elementor was used. The following WordPress components are selected to design the look and feel of the website.

Pages: publish static contents

Single Posts: publish new contents

Multiple posts: list posts in chronological order

Comments: allow comment and discussion on each page and post

User registration and login form: to register and sign in users

Header and Footer: display main menu and logo

Navigation menu: navigate back and forth between contents.

Edit Text, Image, and Video: display text, image, and video

Image Carousel: Slide related images

Edit Button: Redirecting to the mobile application Google play store download page

Social Media Icon: allow sharing content, page, and post, on Facebook, Twitter and Google plus

Facebook Page and Group Plugin: used to incorporate the website Facebook page and Group

3.3.4 System Implementation

3.3.4.1 Android app implementation

For the implementation of the requirement set in the requirement analysis and design into the actual application, Android Studio provides different built-in components and allow third-party libraries to be added for more functionality. The built-in libraries and components are used to design the UI and achieve their functionality. In addition, a third Party library called Joda time is used to manipulate dates for the due date and baby age calculations in the Ethiopian calendar. The app is

designed to work for Android version 4 (Ice Cream Sandwich) and above with the target version of Android 8 (Oreo). With this android version, the app will run on 100% of the device that is active on the Google Play Store.

3.3.4.2 Website implementation

A 12 months web hosting subscription was purchased from Techno Bros to host the website. The web hosting service supports the latest versions of WordPress and other dependencies. OceanWP theme is selected as a template to build the website. Elementor, a page builder and a design tool, is also used to design the look and feel of the overall website. It allows the design of a UI that can scale between different screen size; laptop, tablet, and mobile.

WordPress utilizes plugins for site functionality and presentation. UpdraftPlus Backup/Restore plugin is used to back up the entire website to avoid file and database loss due to server crashes, hacking, security flaws, bad plugin or theme updates and insecure web hosts. In addition, under construction plugin is used to notify the front-end user that the site is under construction before the first launch and during future maintenance. For changing built-in texts in the template to the Amharic language a plugin called code snippets is installed. WordPress Ultimate member is also used to customize the authentication form of the website.

3.4 User Satisfaction Survey Method

The scope of this thesis was to design, develop and deploy a mobile application and website for MCH promotion. The main purpose was to provide women with essential health information that can help them make an informed clinical decision. Studying the clinical outcome of both the mobile app and the website was beyond the scope of this thesis both in terms of time and resource. But a small pilot study was conducted to collect feedback about the developed system. The purpose of this pilot study was to conduct a user satisfaction survey (USS) on the mobile App. The App was chosen for the study because it can be shared offline without any internet cost for the participant. Two questionnaires; the first one conducted before the survey participants used the mobile app and the second conducted after they install and use the app; were used for the overall assessment.

3.4.1 Survey Population

The developed system deliver information throughout the continuum of care for women (from pregnancy to motherhood) and children (from newborn to the age of five). Therefore pregnant women and/or mothers with a child under the age of 5 were selected to participate in the USS. The interview was held at Betsega MCH center, Addis Ababa. Among 47 willing candidates approached for interview 5 (10.6%) of them don't own a smartphone and were excluded from the survey. The rest of the candidates, 42 people, participated in the first interview. Of those 42 candidates, only 36 (85.7%) were able to participate in the second interview. 6 of the participant were unable to respond for the second interview within the given period. Table 7 summarizes the participant distribution.

Table 7: Number of Survey Candidates and Participants

| Consumer population | Number of People |
|-----------------------------------|-------------------------|
| Willing candidates | 47 |
| Smart phone owners | 42 |
| First questionnaire participants | 42 |
| Second questionnaire participants | 36 |

3.4.2 Procedure

Users were approached individually and asked to voluntarily participate in the survey. The interviewer read the questions and record the participant answer. The first questionnaire was conducted mainly to explain the purpose of the survey and assess their awareness of mHealth solution. The second questionnaire evaluates the user satisfaction using Net promoter Score (NPS) and Customer Effort Score (CES) metrics. The participant was given 10 days to use the mobile app before they respond to the second questionnaire.

3.4.3 Interview Questionnaire

The two questionnaires comprising the USS are listed in the Appendix. The first questionnaire comprises of 7 general questions conceptually divided into two sections. The first section comprises of 2 questions placed at the beginning of the questionnaire and was used to collect basic information of the participant including name, contact information and current health status. The second section comprises of 5 questions, focused on evaluating the participant awareness and

engagement of using the internet and existing mHealth solutions as a means of acquiring health-related information.

The second questionnaire comprises of two general questions measuring the NPS and CES. NPS, composed of 1 question, state the likelihood of recommending the mobile app to other pregnant women and/or mothers on a scale of 0 to 10. Whereas CES was comprised of 8 questions which evaluate the application usability, the content appropriateness, and the overall effect of the application on the participant health management and decision. A 5 point Likert scale was used to evaluate each CES question. At the end of the questionnaire, one open-ended question was used to collect any feedback from the participant.

Chapter 4: Result and Discussion

In this thesis, an Android App and website platforms are designed and developed using Android studio and WordPress respectively to educate individuals and communities about MCH care using the official language (Amharic). For this work, the contents from WHO recommendations and Ethiopian MoH training manual on prenatal, birth and postnatal care intervention were used. During content selection, emphasis has been given to danger signs of the mother and newborn; pregnancy, birth and postpartum complications; and importance of delivering at a health facility to empower women and seek medical care throughout the continuum of care.

Both platforms provide important pieces of information on pregnancy, fetus development, childbirth, newborn, postpartum, and under 5 children care. The content is written in Amharic language and narrated using “second-person point of view” to create better interaction with the reader. The content is categorized into different topics to ease navigation.

4.1 Platform Content and User Interface

4.1.1 Pregnancy

The pregnancy topic as seen in figure 4 focuses on pregnancy symptoms, pregnancy discomfort, pregnancy nutrition, and pregnancy complications. Identifying early pregnancy symptoms open up an opportunity for beginning the prenatal visit on time while recommendations that ease pregnancy discomforts provide remedies that can affluence the pregnancy period. Poor nutrition during pregnancy affect the healthy growth of the fetus causing prematurity and increase the risk of pregnancy complications. Hence information on what to eat, what not to eat and available nutrition supplement is presented. Also, symptom, probable causes and available treatment of common pregnancy complications and danger sign of pregnancy have been presented to increase awareness and persuade women to seek medical care.

የወር አበባ መቅረት

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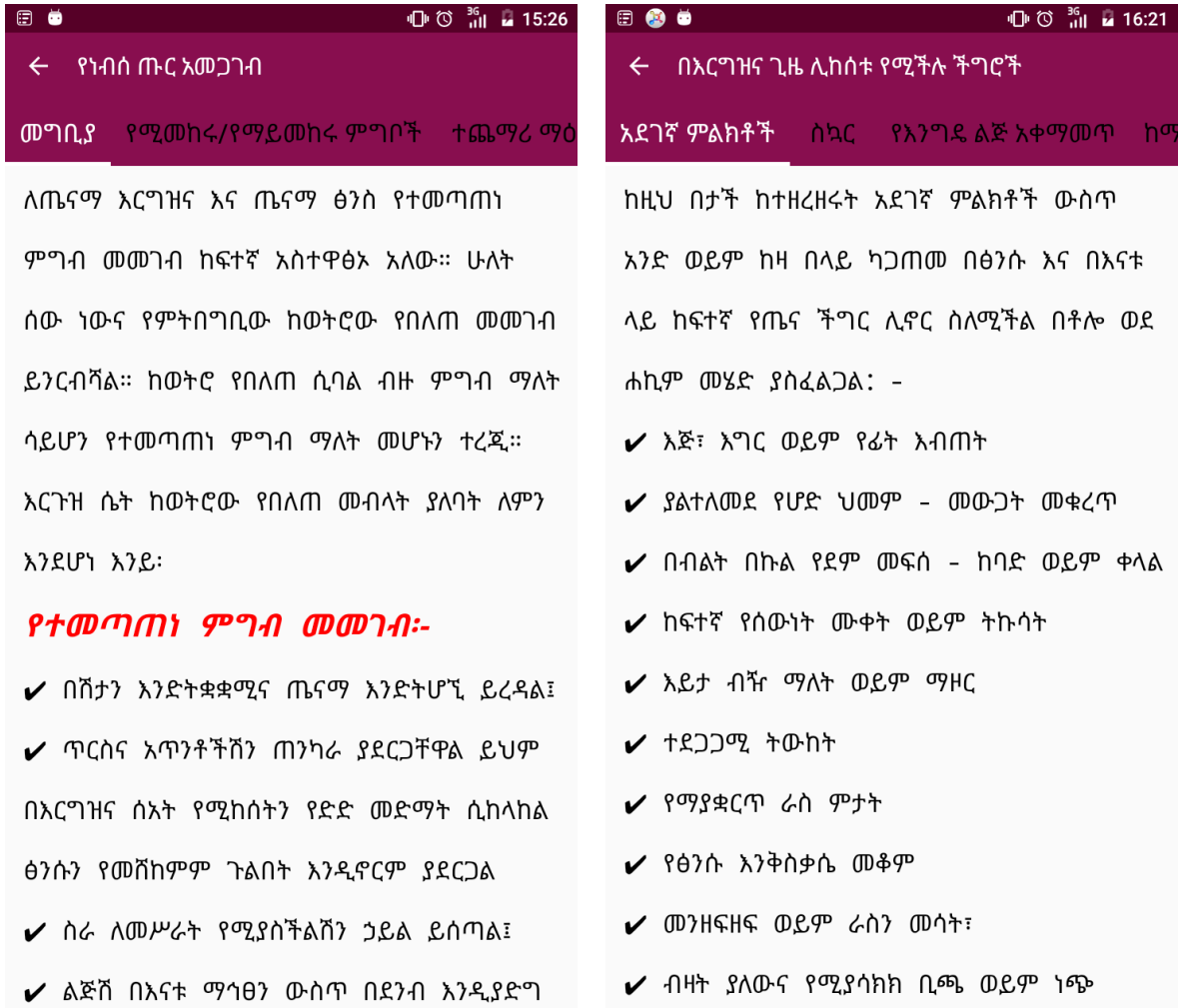


Figure 4: Pregnancy Symptom, Pregnancy Discomfort, Pregnancy Nutrition and Complication

4.1.2 Fetus development

Figure 5 shows the fetus development section. This section aims at engaging women with the platform by providing monthly based fetus development information and picture, expected physical and psychological changes, and how to cope with pregnancy challenges. Throughout the content danger signs, the importance of the prenatal visit, pregnancy nutrition and the advantage of delivering at a health facility have been emphasized.

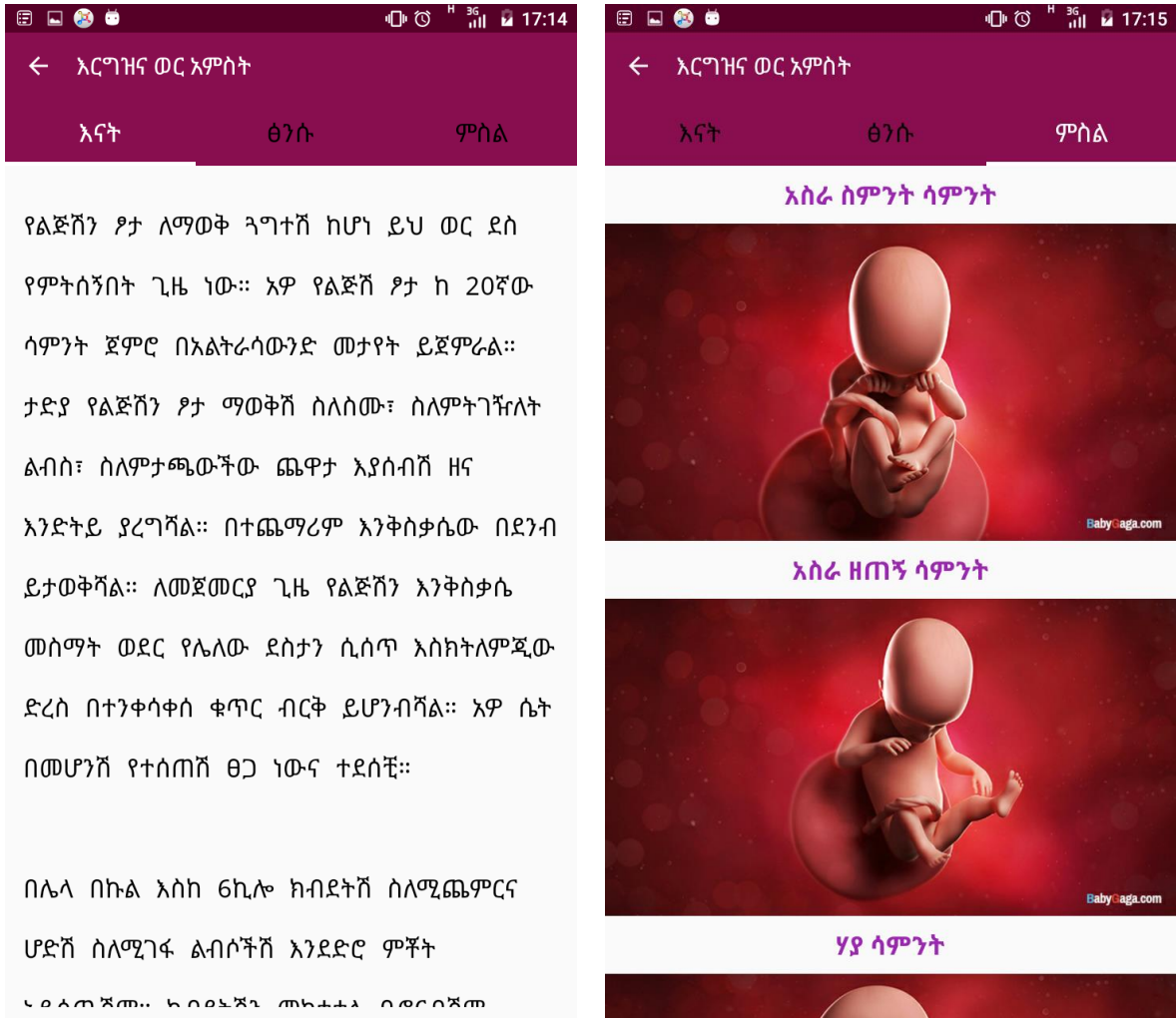


Figure 5: Fetus Development

4.1.3 Prenatal care

Common causes of maternal deaths like anemia, pre-eclampsia, antepartum hemorrhage, and malaria; and common causes of neonatal deaths like prematurity can be prevented or managed through prenatal care. So benefits of prenatal care, number of prenatal visits and what to expect at each visit, and pregnant women responsibilities throughout the pregnancy period are covered as seen in figure 6.

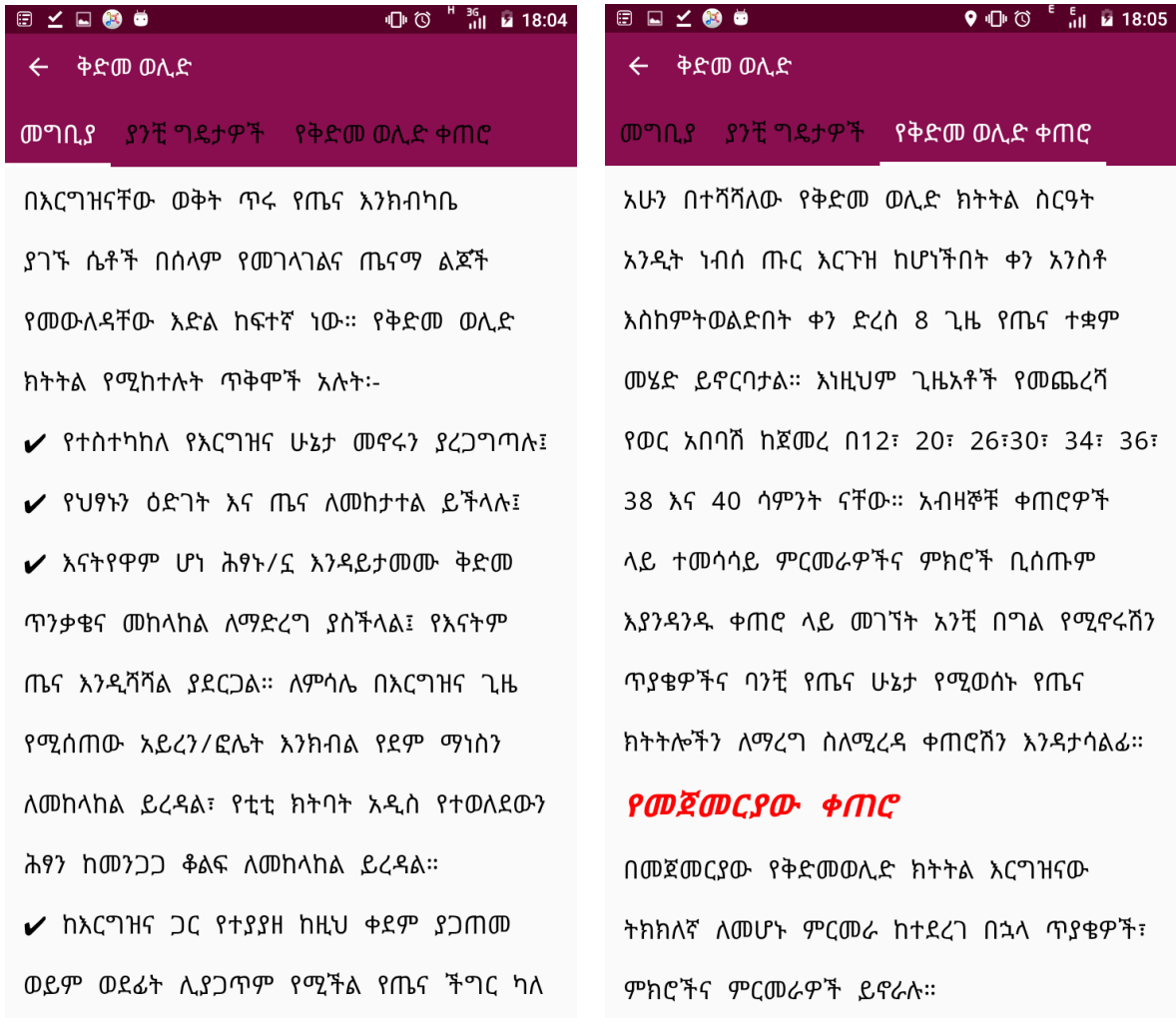


Figure 6: Prenatal Care

4.1.4 Child Birth

Neonatal mortality factors like intrapartum (birth asphyxia), sepsis, and unskilled home delivery and maternal mortality factors like obstructed labor, ruptured uterus, and postpartum hemorrhage /retained placenta can be minimized by delivering a baby at a health facility. To inhibit the traditional way of delivering a baby at home and encourage on-time medical care uptake, the birth section shown in figure 7 provides information on sign and stage of labor, different child delivery methods available in a health facility, the unexpected birth complications and related advantage of delivering at a health facility.

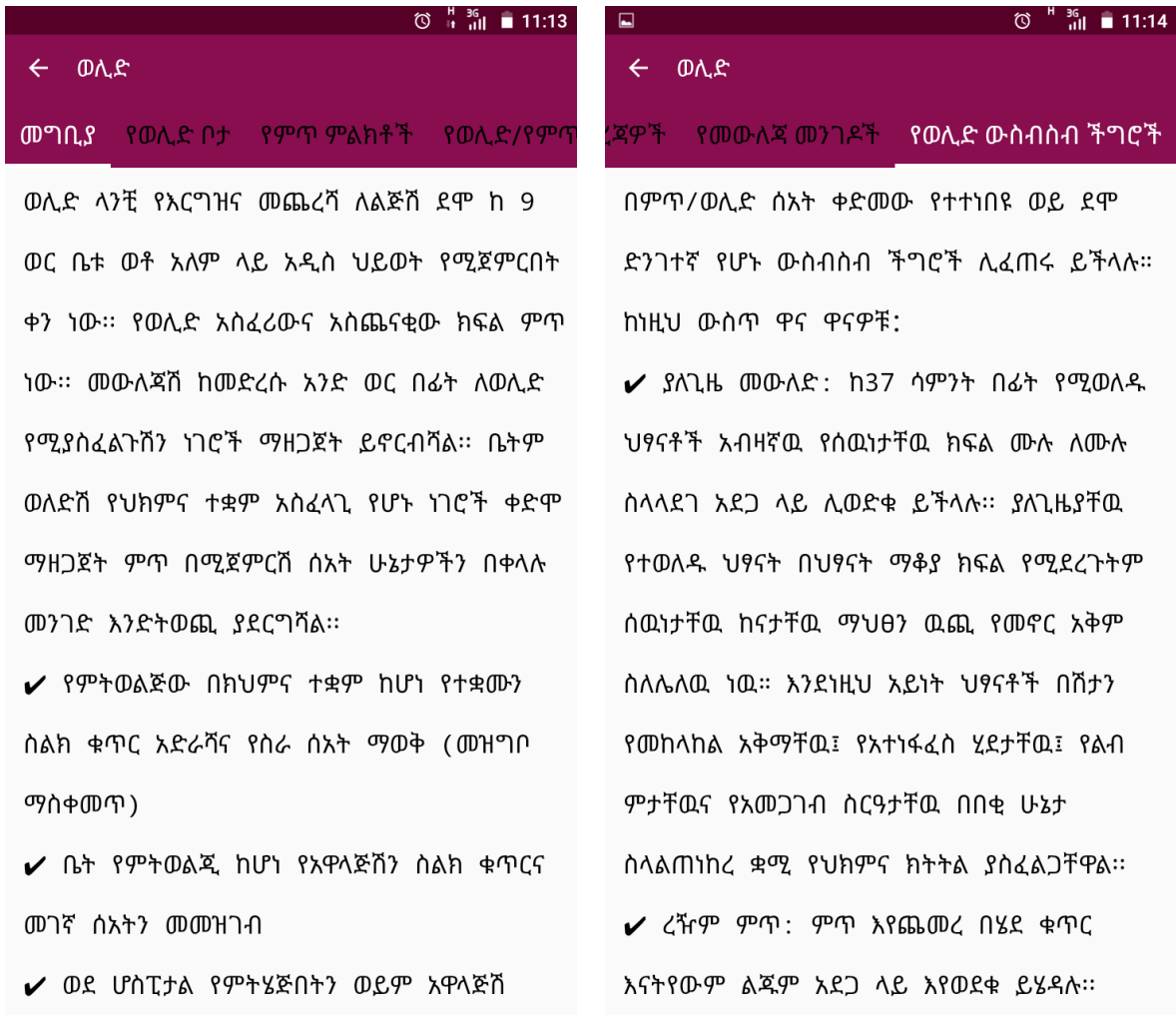


Figure 7: Birth

4.1.5 Newborn Care

The first 28 days of life is a high-risk period for a child and require special attention. So the newborn care section in figure 8 includes all topics related to newborn care including danger sign of a newborn baby, essential newborn care, breastfeeding, and cause of crying.

Since malnutrition is the underlying cause of most newborn deaths, the importance of exclusive breastfeeding for six months is explained in detail. Exclusive breastfeeding for six months does not only maintain proper growth but it decreases infant death by improving their immune system and minimize the risk of infection. Understanding newborn danger signs can lead to early diagnosis. Since newborns and infants communicate through crying, understanding their cause of crying can help in identifying and managing serious issues on time.

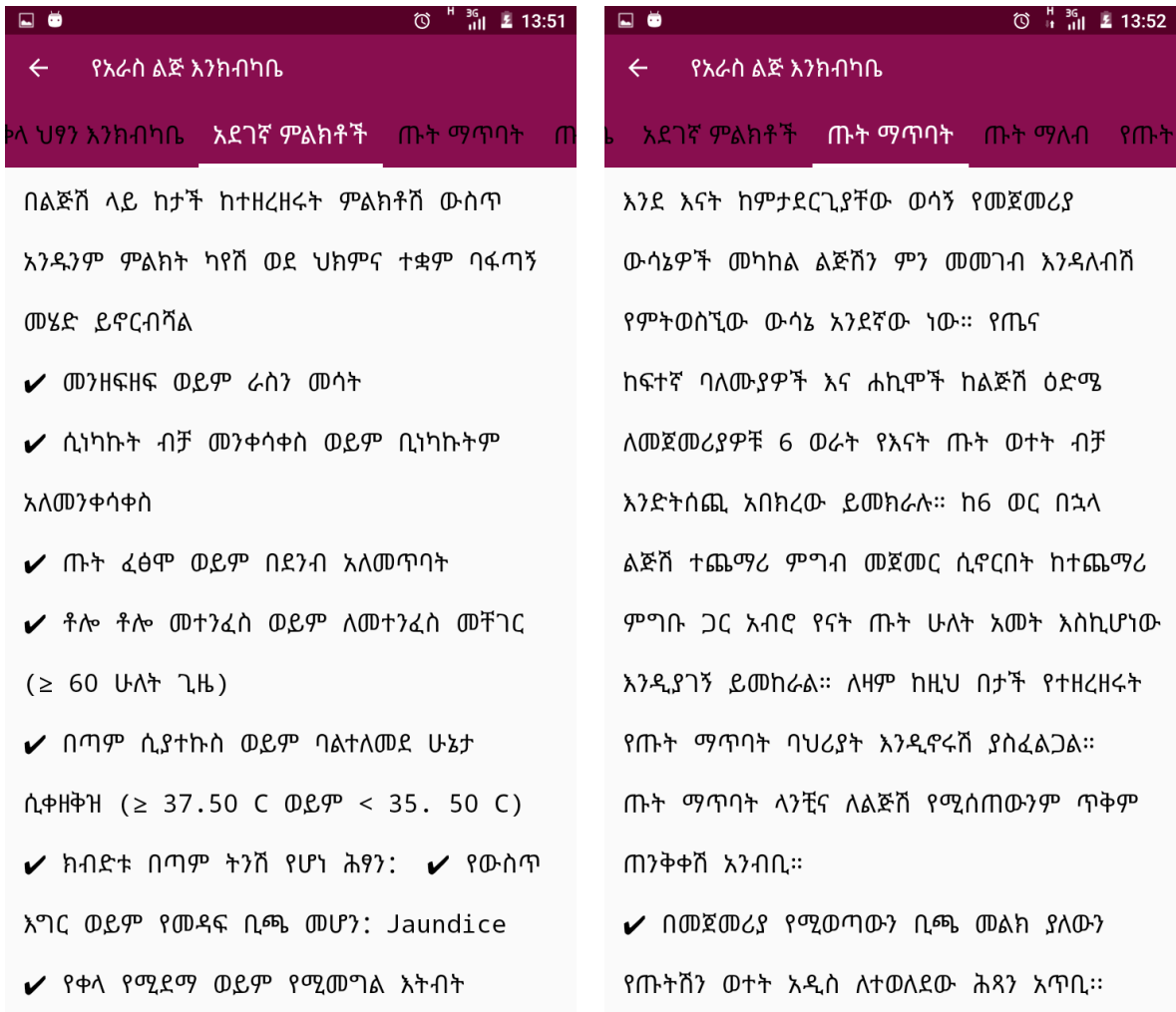


Figure 8: Newborn Care

Another important piece of information incorporated related to newborns is immunization. Immunization enables newborns to fight subsequent diseases by stimulating their immune system using vaccines. Vaccination given for babies under the age of one prevents deadly childhood diseases like polio, measles, tetanus, pneumonia and more. So information related to the number of vaccination, their schedule and the type of vaccines given in every appointment is briefly explained.

4.1.6 Postnatal Care

Postnatal care of the mother is equally important as newborn care as the survival of a newborn baby is directly related to the survival of the mother. As seen in figure 9, focus has been given to information on postnatal care of the mother after childbirth, danger sign of the mother, personal

care after birth and family planning to minimize maternal and newborn mortality rate caused by lack of postnatal care follow up, malnutrition and infection.

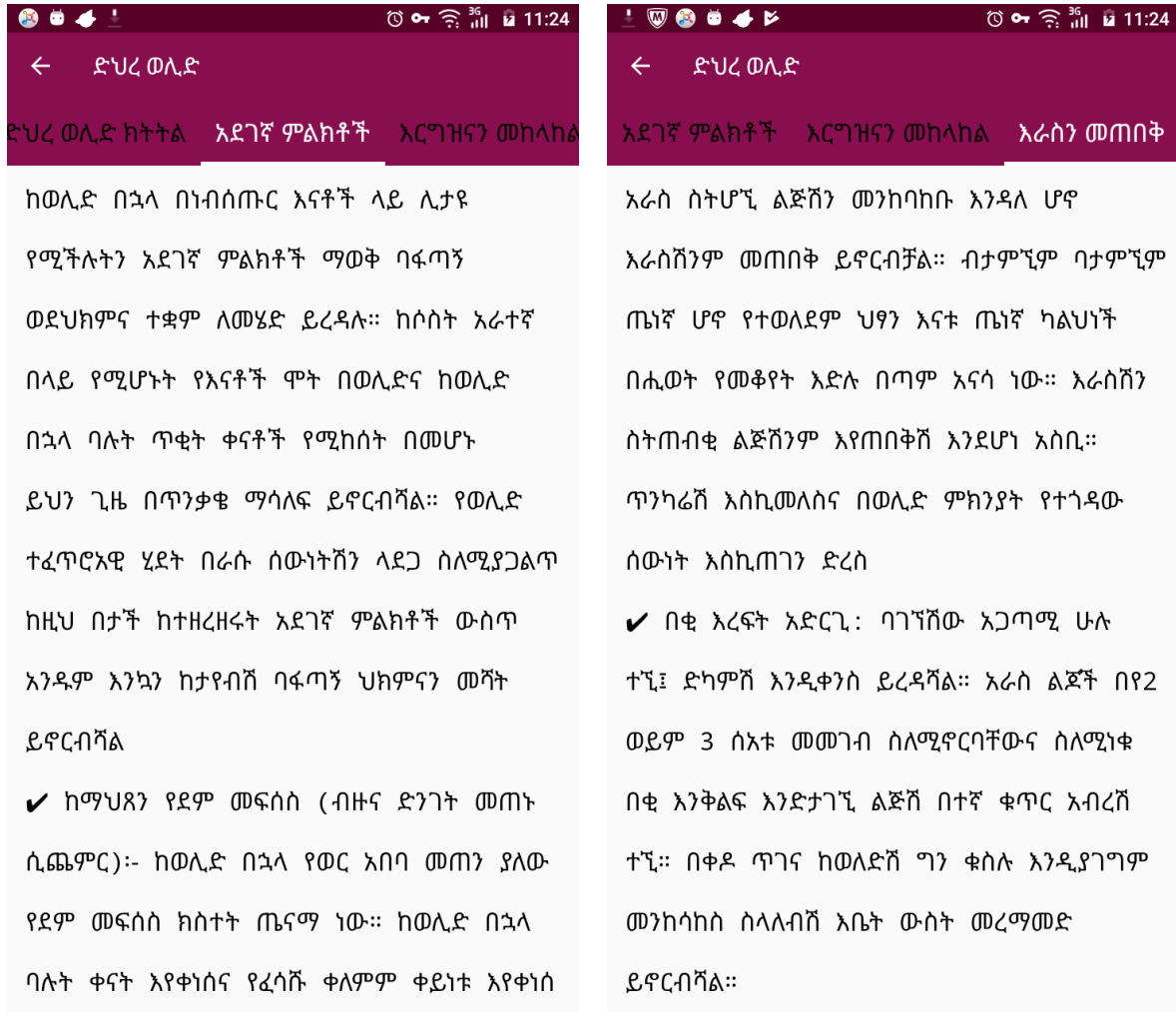


Figure 9: Postnatal/Postpartum Care

4.1.7 Child Development

Impairment of mental and physical health occurred before the age of 5 is difficult to treat so essential care for children under the age of 5 focuses on creating awareness about the need for balanced diet and solid food for children above 6 months; importance of following children growth as it helps identify stunted kids earlier; environment that children need to have a healthy life; parents responsibilities in keeping children safe; and avoid traditional practices that are bad for the kids. This UI section is shown in figure 10.

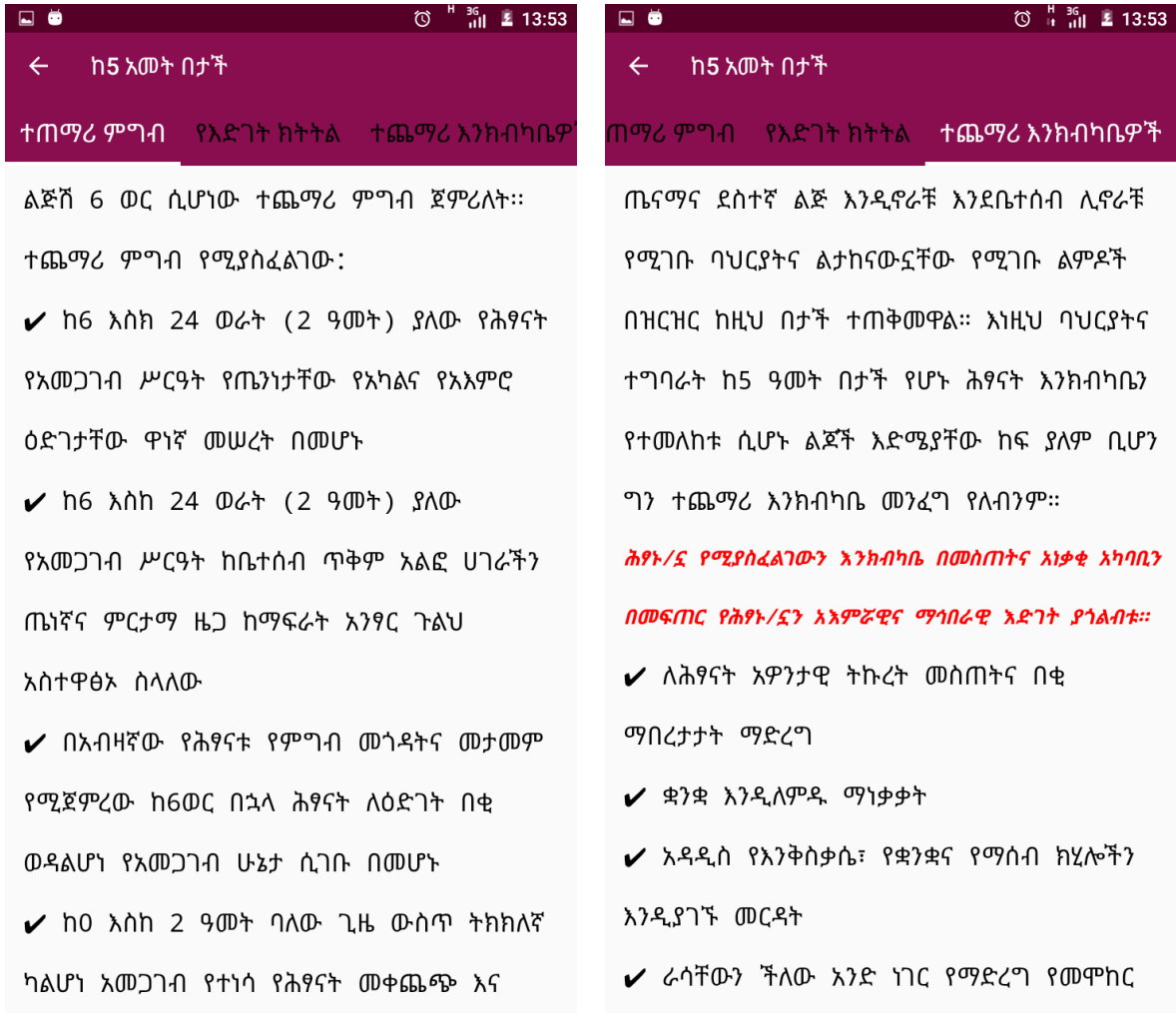


Figure 10: Under 5 Children Care

4.2 Android Tools

4.2.1 Due date calculator and prenatal and fetus development notification

All prenatal cares including prenatal visits, pregnancy screening, pregnancy nutrition and supplement, and pregnancy vaccination depend on how far the pregnancy goes. So besides providing information, the mobile App calculates a due date in the Ethiopian calendar. The App receives the last menstrual start date, calculates and display the pregnancy progress and the baby due date. This is calculated based on Naegele's rule.

$$DD = LMP + 280 \quad DD = \text{Due date}, \quad LMP = \text{Last Menstrual Start Date}$$

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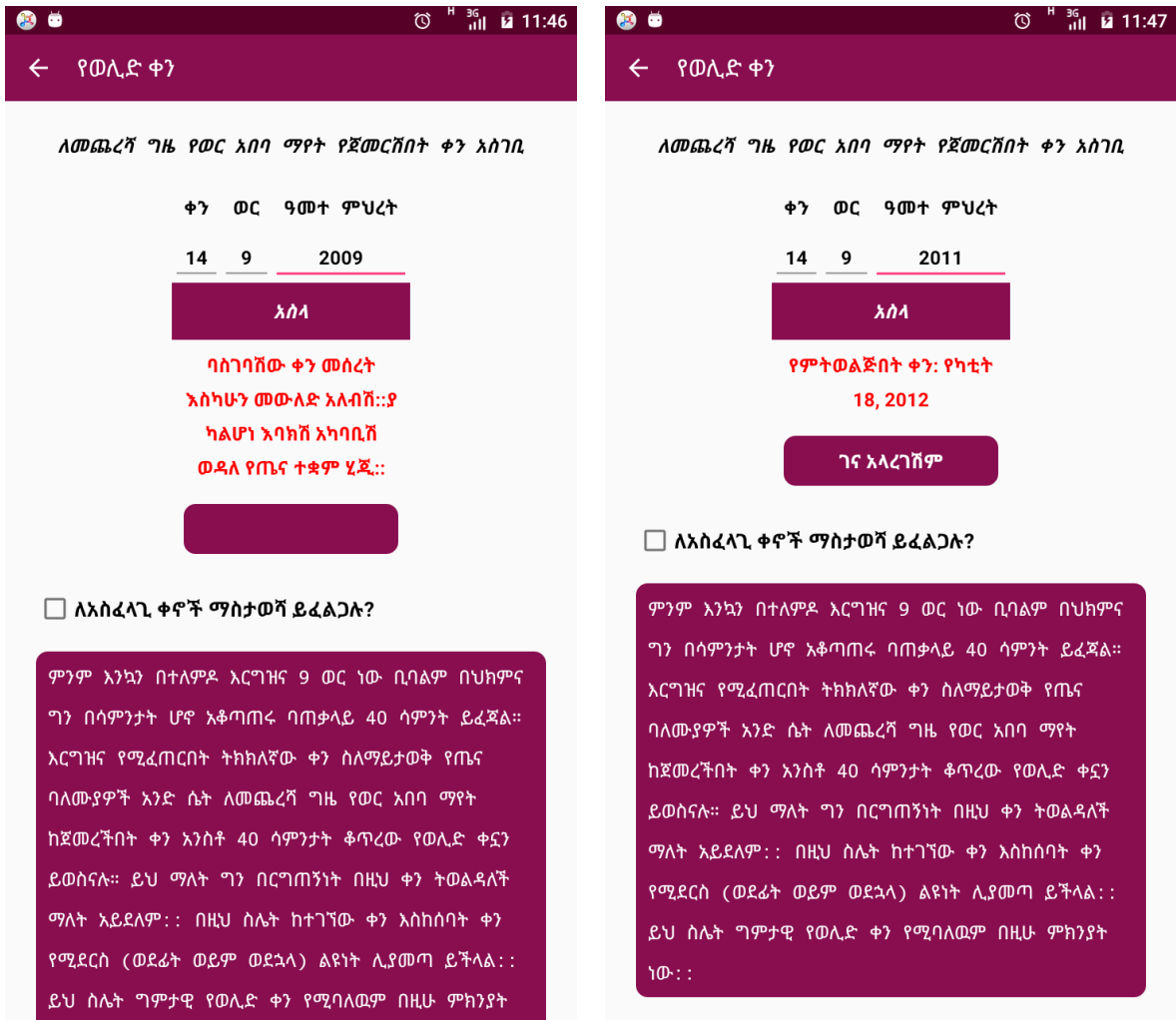


Figure 11: Due Date Calculator

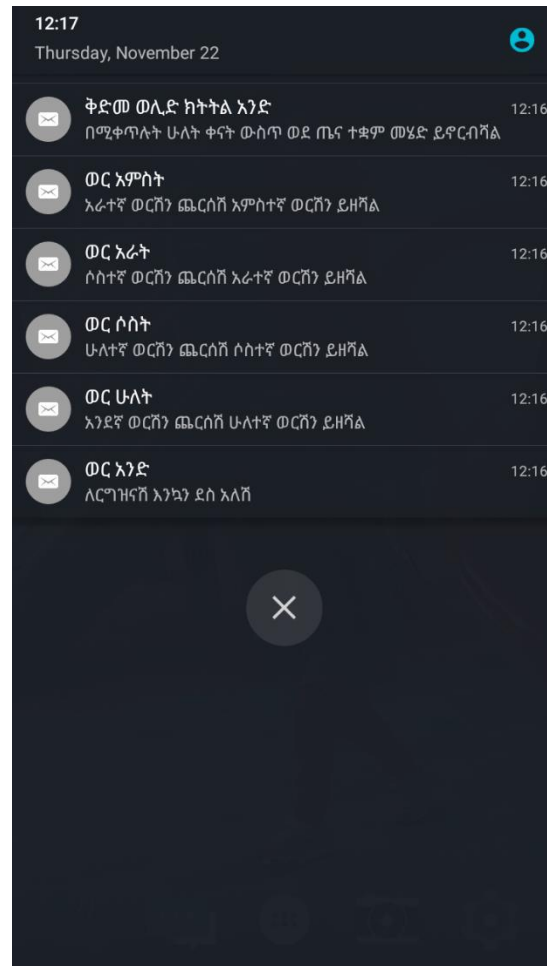
To validate the entered date exception handling mechanism has been integrated. As seen in figure 11 for the wrong input of date it throws an exception and displays a text to ask the user to enter the correct date. If the due date is passed or if the last menstrual start date is in the future it still calculates the due dates. But if the due date is passed it notifies the user to visit a hospital and if the last menstrual start date is in the future it will notify her that she is not pregnant yet.

To increase the prenatal care uptake and interaction of the user with the App, the due date calculator incorporates notification service. The notification is activated only if the user ticks the notification checkbox as seen in the first picture of figure 12. Once activated the user receives reminders about prenatal visits and fetus development as shown in the second picture of figure 14. Each notification opens to a specific page that has information about the coming prenatal visit

and/or the current fetus development information. If the user uses the App at the later time of pregnancy, the App will send a notification for past month's fetus development but not for past prenatal visits. By unticking the checkbox the user can cancel the notification at any time.

4.2.2 Baby age calculator and postnatal and immunization notification

Child immunization and postnatal follow up play a great role in minimizing newborn, neonatal and maternal deaths. So the same approach is used to calculate the baby's age and send immunization and postnatal care reminders. The age calculator accepts the baby birth date and calculates the date for the notifications. The notification is activated by ticking a notification checkbox and can be canceled any time. The age calculator with a notification checkbox and a sample immunization and postnatal care reminders is shown in figure 12 picture 3 and 4 respectively.



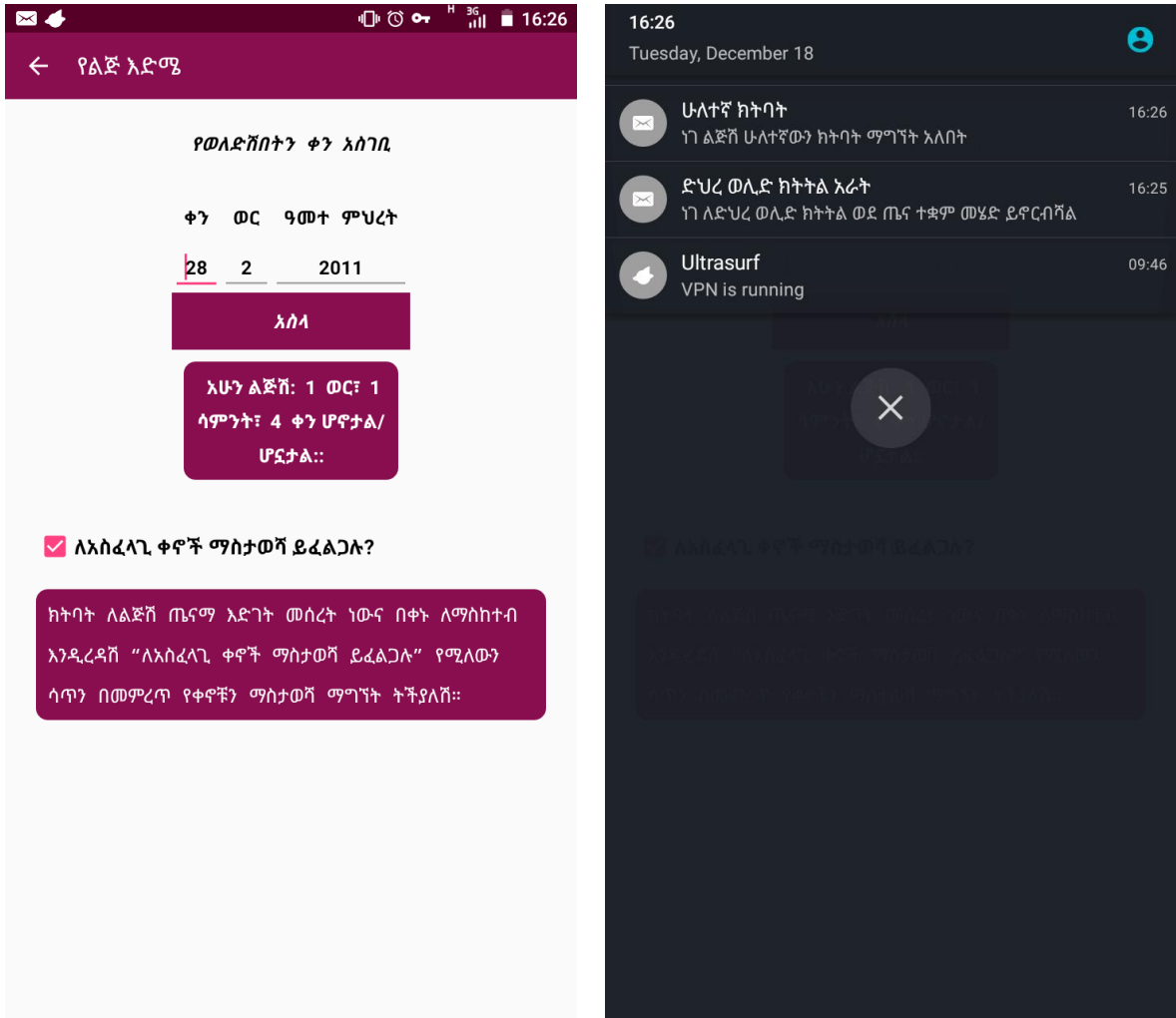


Figure 12: Prenatal and Postnatal Period Notification

The notification time table for prenatal, postnatal and child immunization visits is based on WHO guideline. WHO recommends 8 prenatal visits and 4 postnatal visits while child immunization is given in 6 different time table starting from the first day of birth up to the age of one. The fetus development information is sent every month to increase user engagement with the App. The overall notification schedule in the App is summarized in table 8.

Table 8: Notification Schedule

| Prenatal Visit Schedule | | Postnatal Visit Schedule | | Immunization Schedule | |
|-------------------------|-------------------|--------------------------|-------------------|-----------------------|-------------------|
| Recommended date | Notification Date | Recommended date | Notification Date | Recommended date | Notification Date |
| Between 8 and 12 weeks | Day 80 | Birth Date | Birth Date | Birth Date | Birth Date |
| Week 20 | Day 138 | Day 3 | Day 2 | Week 6 | Day 40 |
| Week 26 | Day 180 | Day 7 | Day 6 | Week 10 | Day 68 |
| Week 30 | Day 208 | Week 6 | Day 41 | Week 14 | Day 96 |
| Week 34 | Day 236 | - | - | Month 9 | Day 268 |
| Week 36 | Day 250 | - | - | - | - |
| Week 38 | Day 264 | - | - | - | - |
| Week 40 | Day 278 | - | - | - | - |

4.3 Website Tools

The website provides a platform for pregnant women, mothers, and health professional to interact, ask and get advice on topics related to pregnancy, childbirth, child development, and postpartum life. It aims at creating an online community platform that can encourage open discussion between people from different background and share experience. Anyone can access the information on the website but to comment and interact they have to register using a valid email address. This is done to minimize spam and secure the site. The default role during registration is “Subscriber” and other user roles, for instance, Author, is assigned by the administrator.

The website embeds a Facebook page and group to take advantage of the popularity of Facebook and increase its reach. The Facebook page allows people to get information without directly going to the website and by joining the group they can share their point of view or ask any question. Group educational activity and peer support in a community can motivate behavioral change and improve pregnancy outcome among pregnant women and mothers.

Every content on the website can be shared on Facebook, Twitter and Google Plus so that people can share them and the content reach more people. The website is backed up on Google Drive every week using updraft plus backup and restore plugin. The website flexibly scales between mobile and computer screen.

4.4 User Satisfaction Survey

Since studying the clinical outcome was beyond the scope of this thesis a User Satisfaction Survey was conducted as a pilot study to collect user feedback about the system. In this pilot study, four

first time pregnant women and thirty-eight mothers were selected and participated in the first questionnaire. The response distributions of the first questionnaire close-ended questions can be found in figure 13. Among the total 42 participants 37 of them (88%) uses the internet for accessing health-related information and mostly use Google search as a searching mechanism. 20 participants (47.6%) were aware of existing mHealth solutions related to MCH while 22 participants (52.4%) were not. Of those 20 participants who are aware of the existing mHealth solutions, only 8 participants (40%) use them to get health-related information. The reasons given by the 12 participants for not using the existing mHealth solutions include the bulkiness of the platforms, cost of internet, language barrier and credibility of the information.

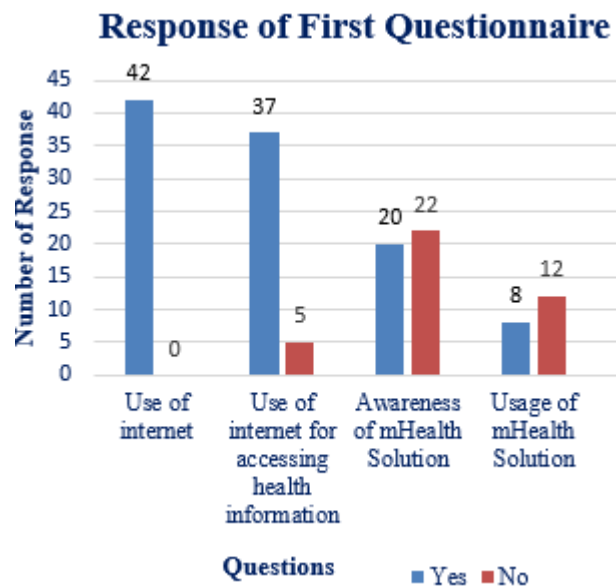


Figure 13: Response of First Questionnaire

The second questionnaire response, constituting the core of the USS and permit a scaled evaluation of the user satisfaction, is summarized in figure 14 and 15 respectively. Figure 14 shows the number of promoter, passive and detractor response. Based on the statistics the NPS which is calculated by subtracting detractors response from promoters response gives 100% score. On the other hand, figure 15 shows the response of the participant for 8 CES Likert scale questions.

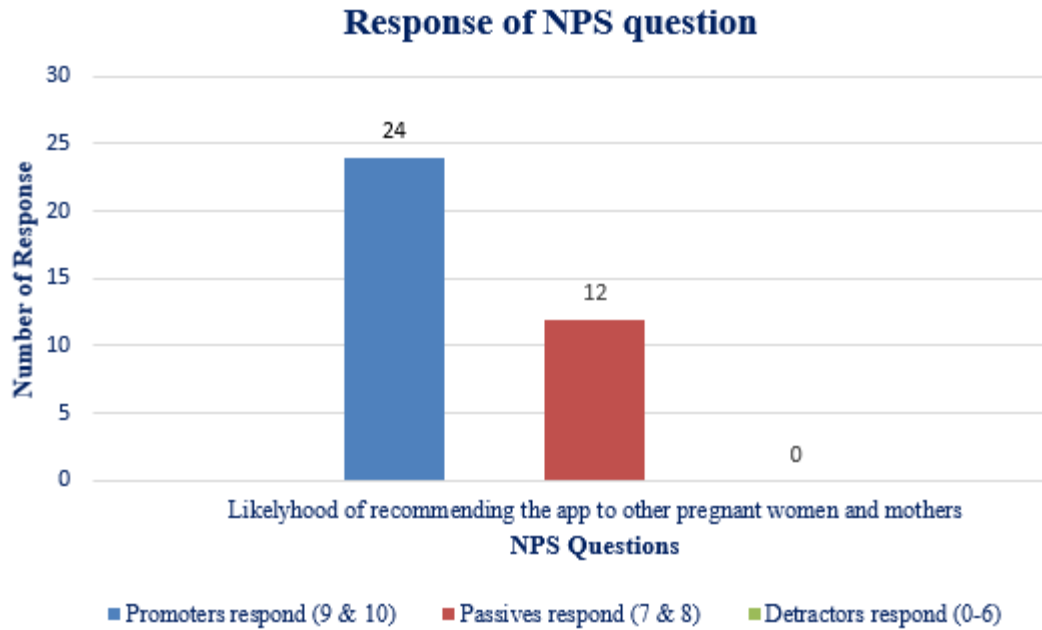


Figure 14: Response of Net Promoter Score Question

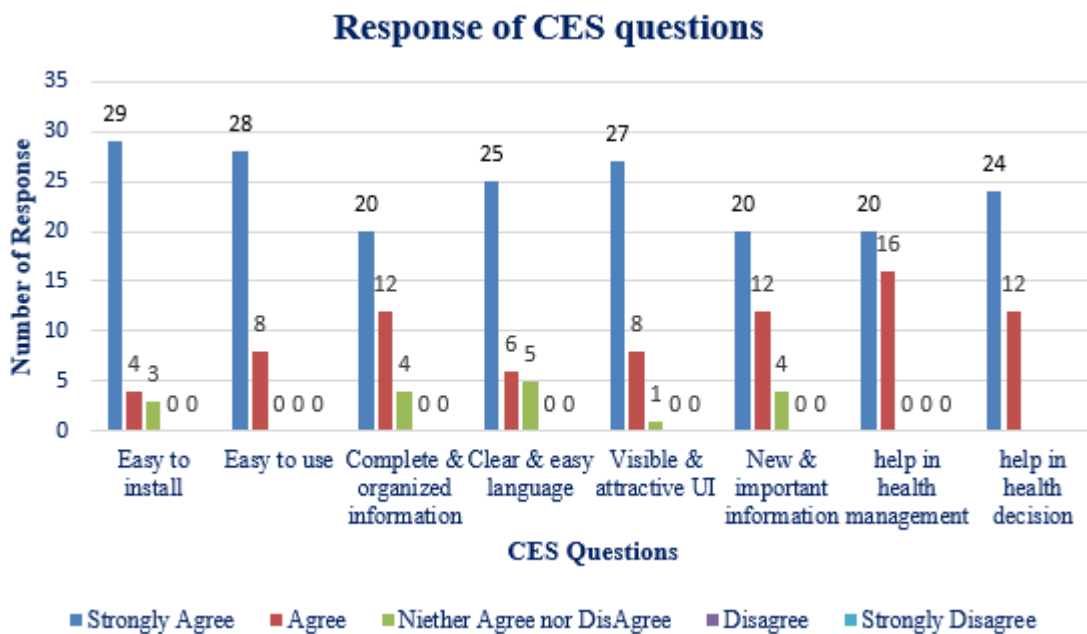


Figure 15: Response of Customer Effort Score Questions

The CES, calculated using “top-2-box” score method, ranges between 86.1% and 100% as shown in figure 16. The top-2-box score method adds the number of participants responded “Strongly Agree” and “Agree” and divide the result with the total number of respondents to calculate the CES. The CES is 100% for ease of the app usage and its help in health management and decision.

The visibility and attractiveness of the app and how easy it was to install scores 97.2% and 91.6% of CES respectively. The smallest CES was recorded for completeness and organization of the information and clarity and easiness of the language which is 86.1%. 32 participants agreed that they found new information on the platform leading to 88.8% of CES.



Figure 16: Customer Effort Score

The participants provide positive feedback and suggest making the application available in other local languages. Overall the CES, NPS and participant individual feedback shows that the application is useful and easy to use.

In general, the health and wellbeing of every individual depend on the health and wellbeing of the mother. The health status and the clinical decision of the mother before, during and after pregnancy affects the fate of a child and the population at large. That’s why the continuum of care has been internationally taken as a major intervention in minimizing maternal and child death. But the uptake of prenatal, postnatal and birth care needs improvement and delay to seek medical care is still a bottleneck. Hence this thesis aimed at using ICT for educating pregnant women and mothers about prenatal, birth and postnatal care to create awareness about the pregnancy-related complications that need immediate decision to seek medical attention, thereby reducing maternal and child mortality and morbidity rate.

Information and knowledge can play a great role in decision making and important health information should be readily available to the population. To break the traditional way of getting health information at a health facility and/or via TV and radio, the penetration of smartphone and internet was used as an opportunity to teach individuals and community. The choice of technology is influenced by the belief that people who use smartphones and the internet have a greater chance of using mHealth solutions. Besides, the implementation of other solutions such as SMS, IVR or USSD, which can work in any mobile device including the basic ones, requires an investment and running cost that the user may not afford.

The User Satisfaction Survey was conducted as a pilot study to collect user feedback about the system. And as seen from the result of the first questionnaire most of the participant use the internet to assess health information but only some of them use dedicated mHealth solution that provides MCH information. The second questionnaire adopted NPS and CES metrics to assess user satisfaction. These metrics are selected because the survey participants were given only 10 days to try out the application and asking detail information requires long term engagement with the system. Both the NPS (100%) and CES (86.1% - 100%) result was good, showing a positive acceptance by the participant. Nonetheless, a scientific study with more participant and statistical figures is required to evaluate the clinical outcome of the developed system.

The app works on any Android device with Android version 4 and above while the website can work in any device that can access the internet. The app was tested with different Android versions (4.2, 5.1 and 6) and screen sizes (4, 5.1 and 5.7 inches) using a real device. The user interface and the functionality is compatible in Samsung Note4, Lenovo Phab2, and Techno Camon CX. It was also virtually tested in low-end device with Android version 4 and low screen resolution. The webpages are flexibly scaled between mobile, tab and laptop. The website is implemented with a domain name of www.eenat.com. The mobile application named “እናት መረጃ” is uploaded on Google Play Store.

Chapter 5: Conclusion and Recommendation

5.1 Conclusion

The main purpose of this work was to design and develop an mHealth solution that can provide essential MCH information to support women to make informed and effective health decision. An Android mobile application and a website have been developed to deliver prenatal, birth and postnatal related health contents. The development of the content and the system perceived individually. The content development undergoes a process of content gathering, classification, and translation. WHO and Ethiopian MoH guideline has been used as a basis for the content preparation. On the other hand, system development undergoes requirement analysis, use case diagram design, system design, and implementation. The requirement analysis and use case diagram design allowed to depict what the system should be able to do. Following that at the system design and implementation stage tools and libraries have been selected.

To validate the acceptance and usefulness of the system, a user satisfaction survey was conducted using two questionnaires. Smartphone users were selected to participate in the survey and provide feedback about the mobile application. The first questionnaire was used to assess awareness and usage of internet and mHealth solution whereas the second questionnaire was used to calculate the participant satisfaction score with Net Promoter Score (NPS) and Customer Effort Score (CES) metrics. The results of the two scores (NPS of 100% and CES of 86.1% - 100%) show the potential of the developed system to be accepted and used among women.

5.2 Recommendation

Mobile phone usage in Ethiopia is increasing significantly. Their diverse core utility allows the design of mHealth solution that fits a specific need. This thesis took advantage of the smartphone capability of installing an application and any device with internet browsing capability. Even though the same content can be designed to reach individuals through other core utilities like SMS, Integrated Voice Response (IVR), and Unstructured Supplementary Service Data (USSD) that can work on a feature and basic phones, the cost of running these platforms is more expensive than an App and a website.

The content of the platform can be modified and widened to include more health topics related to maternal and child health. Other tools like pregnancy weight gain calculator, pregnant women registration system, and clinical decision support system can also be integrated into the app. The platform can be updated regularly in a multidimensional aspect to include more functionality. Studying the clinical outcome of the platform and showing its positive effect in healthcare can invite governmental and nongovernmental organizations to further invest in the area of mHealth.

The MoH can promote, create awareness and avail the platforms in their existing ICT infrastructure. Health education and promotion play a great role in minimizing the burden of diseases that are preventable and mHealth is a way of reaching a population using a tool that can reach a considerable amount of population at any time and place. Not only expanding the same project using different technology, but mHealth can also be used to manage any other health problem that can be solved by interacting with the population through a mobile phone.

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Appendix A

Questionnaire 1

1. Name _____ Contact Option: _____
2. What is your current Status
 - a. First Time pregnancy
 - b. Mother
3. Do you use internet?
 - a. Yes
 - b. No
4. If your answer is “Yes” for question 3, do you use internet for accessing health related information
 - a. Yes
 - b. No
5. Are you aware that there are free applications and website available for dedicatedly guiding through pregnancy, childbirth and child care?
 - a. Yes
 - b. No
 - c. If yes for question 10, do you use them?
6. If your answer is “Yes” for question 5, do you use them?
 - a. Yes
 - b. No
7. If your answer is “No” for question 6, why are you not using them?
_____ .

Questionnaire 2

1. Choose your level of agreement for the below questions.

| Questions | Strongly Agree | Agree | Neither agree nor disagree | Disagree | Strongly Disagree |
|---|----------------|-------|----------------------------|----------|-------------------|
| ✚ The application is easy to install | | | | | |
| ✚ The application is easy to use | | | | | |
| ✚ The information is complete and organized in a clear manner | | | | | |
| ✚ The language is clear and easy to understand | | | | | |
| ✚ The user interface is visible and attractive to read | | | | | |
| ✚ I found new and important information in the platform | | | | | |
| ✚ The information incorporated can help a mother manage her health and the health of her baby | | | | | |
| ✚ The information incorporated can help a mother make better health decision | | | | | |

2. “On a scale of zero to ten, how likely are you to recommend Enat Mereja mobile application to other pregnant women and mothers?” (0 being not likely and 10 being very likely)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|----|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | | | | | | | | | |

3. Any Additional feedback that can help improve the application?

_____.