ANTENATAL CARE MANAGEMENT INFORMATION SYSTEM.

BY

GROUP 5

DEPARTMENT OF INDOEMATION SYSTEMS TECHNOLOGY

SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY.

A PROJECT REPORT SUBMITTED TO THE SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY

FOR THE STUDY LEADING TO A PROJECT IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE IN INFORMATION SYSTEMS TECHNOLOGY OF

MAKERERE UNVERSITY

SUPERVISOR

MR. MUCHAKE BRIAN

DEPARTMENT OF INFORMATION TECHNOLOGY
SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY,
MAKERERE UNIVERSITY
0701178573, +256-41-540628, FAX +256-41-540620

OCTOBER, 2021

DECLARATION

We hereby do declare that this report, written in partial fulfillment of the requirements of the award of a bachelor of information systems technology degree at Makerere University, is an original and our very own authentic work and the contents this document contains has never been submitted to any institution before.

Note however that citations, quotations and References to other peoples work or sources of information many culminate to a common agreement and understanding.

NAME	REGISTRATION NUMBER	SISGNATURE
ATIONO SARAH	18/U/41725	
TUGUME BARRY	09/U/10464/EVE	
BULYA JACKIE KAKONGE	18/U/22788/PS	
NAKANWAGI DRUSCILLA	18/U/22871/PS	Druscilla

i

APPROVAL

This dissertation has been submitted for examination with the approval of our Academic supervisor.

Signature .... Date...5/07/2022

Mr. Muchake Brian

Department of Information Technology,

School of Computing & Informatics Technology,

College of Computing and Information Sciences,

Makerere University

DEDICATION

We would like to dedicate this report to our parent for their unconditional support in all ways emotionally, spiritually & financially. And to all individuals who have contributed in one way or the other toward our success.

To our academic supervisor for his endless guidance& perseverance during the entire period of this research and system development project, words alone cannot express our gratitude but all we have saying is God bless you in your entire endeavor.

ACKNOWLEDGEMENT

First &foremost, we that the Almighty God who has blessed us with the gift of knowledge, strength, guidance and above all the gift of life. Thank u Lord.

We would like to extend our sincere thanks all the staff of mengo hospital and antenatal care mothers who we interacted with for their time at their contribution towards the success of this project court them, our project would not have been a success.

We acknowledge our supervision Mr. Muchake Brian for his tireless efforts and dedication in guiding us throughout this project.

We also extend our sincere thanks to our parents for their support both financially & in any other way that enabled us carried out this project in trying times of the global pandemic COVID19 that shut down all economic activities around the globe.

We would also like to appreciate each member of group 4 for their maximum cooperation shown from the start of this project until the end.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATION

ANC	-	Antenatal care
ANCMIS	-	Antenatal care management information system
PHP	-	Hypertext Pre-processor
SDLC	-	Software Development Lifecycle
MYSQL	-	My Structured Query Language
HTML	-	Hypertext Markup Language
DFD	-	Data Flow Diagram
ERD	-	Entity Relationship Diagram
RAD	-	Rapid Application Development
ANC	-	Antenatal care
ANCMIS	-	Antenatal care management information system
PHP	-	Hypertext Pre-processor
SDLC	-	Software Development Lifecycle
MYSQL	-	My Structured Query Language
HTML	-	Hypertext Markup Language
DFD	-	Data Flow Diagram
ERD	-	Entity Relationship Diagram
RAD	-	Rapid Application Development

ABSTRACT

In a typical antenatal care management information system, records are usually kept for future reference, retrieval, reproduction and easy management. The daily activities, schedules and events are also recorded. If there is need to know the population of pregnant women, one may need to count the records obtained from different files that contain papers with information. The main objective of this project was to design and develop a new system of managing information in antenatal care. The system helps the hospital in reducing paper work and enhances tidiness in record keeping since the existing antenatal care uses manual keeping that is use of files, books and papers. It also reduces costs incurred in purchasing files, books and papers for individual entities. The system manages records of doctors and pregnant women and their children. The system allows the user to book appointment, print appointment letter and keep records. The study examined various aspects of objectives, and analyzed them and related to the literature and data which was corrected using interviews, questionnaire and observation. It focused on both qualitative and quantitative approach as the methodology. This is because the research is aimed to obtain non biased data from various respondents using both numerical and non-numerical figures such as feelings and emotions. The methodology that was used for software development shall be the rapid application development (RAD) model. It is based on prototyping and iterative development with no specific planning involved. It also focuses on gathering user requirements, early testing of the prototype by the customer using the iterative concept, re use of the existing component and continuous integration. RAD was preferred because requirement may change during project. It is suitable for short term projects that require quick delivery. By using RAD, it was easier to measure progress of the project. The chapter four deals with how the system was designed, developed and its implementation. The antenatal care management information system input and output specifications, designs and why PHP and Java Script language were chosen for development. It also describes why PHP web framework was selected for faster development of the system due to time. The last chapter of this report focuses on summary, concluding and further studies that can be carried out after the system was implemented like addition of new modules.

CHAPTER ONE: INTRODUCTION

1.1 Introduction

According to WHO (2015) the adoption of health informatics can greatly improve operational performance of health facilities. Health informatics is used to describe the acquiring, storing, retrieving and using healthcare information to bring about better collaboration among patient's various healthcare providers (US National library of Medicine, 2014). However, in Uganda, a number of health facilities offering antenatal services are yet to adopt health informatics. This has led to a number of challenges which include: unskilled, untimely and poor quality antenatal and delivery care, patient congestion because of many patients admitted per day, inadequate medical professional doctors, nurses, midwives, medical assistants/clinical officers and nursing aids, male midwives; expecting mothers don't like the idea of male health workers helping them to deliver, episiotomy; fear of being cut during episiotomy to allow baby to come out easily and faster to avoid losing either mother, unborn child or both, abusive midwives; expecting mothers have been either abused or rejected to be worked on by midwives who especially in many cases need money so they can attend to mother's so they can handle them well during labor and childbirth Rujumba (2013). This project study is therefore an effort to help fix this gap by developing antenatal care management information system.

1.2 Background to the Problem

Antenatal care is the routine health control of presumed healthy pregnant women without symptoms (screening), in order to diagnose diseases or complicating obstetric conditions without symptoms and to provide information about lifestyle, pregnancy and delivery Tidsskr (2002).

Antenatal care management refers to a system of support a woman is subjected to during pregnancy including supervision, examination and advice. The aim/objective of antenatal care management is to ensure a healthy pregnancy and a healthy baby from a healthy mother. In Asia, A Study undertaken in 11 communities in the Public Health Center area of Tinggiede and Marawola, Sigi Regency, Central Sulawesi Province.

According to Guidelines for pregnant women, postpartum mothers and newborn babies during social distancing, Healthy movement of life: (2020).). The use of an Android-based electronic technology antenatal care (e-ANC) app, built exclusively for midwives and pregnant women, is predicted to boost online ANC coverage for health counseling, high-risk early identification, Hb monitoring, and Fe tablet distribution. This relatively recent concept enhances the ability of midwives to track the progress of a pregnancy; it also improves their ability to give services at any time and in any location without requiring physical interaction. To get the most of the e- ANC capabilities, both sides will need to communicate and educate themselves. This is especially true when it comes to acquiring information, counseling, and dealing with medical personnel. Pregnant women are more at ease during their pregnancy, childbirth, and postpartum period.

The e-ANC model has numerous benefits which include, it delivers intense maternal and child health counseling to pregnant mothers and midwives in relation to the COVID-19 pandemic, midwives can efficiently monitor pregnant women, diagnose high-risk pregnancies early on, and assess Hb and Fe tablets as well as the development of pregnancy problems without having to make physical contact, at any time and in any location, during a pandemic, the model is straightforward, easy to grasp, and cost-effective.

The 30 respondents were chosen using a purposive sample strategy based on the inclusion criteria of pregnant women (in their second trimester [>4 months], ready to participate, able to speak Indonesian, and able to utilize an Android device). Meanwhile, 20 midwives (on duty at the Tinggiede and Marawola Public Health Centers, and capable of using an Android mobile) were chosen as respondents, Midwife services, such as counseling, high-risk early detection, and Hb and Fe tablet monitoring, were also proposed during the pandemic. During the lockdown, data on reproductive issues encountered by pregnant women was also collected.

Treatment was also offered after the release of the e-ANC application. There was also a tutorial for both midwives and pregnant ladies on how to use the application's treatment. Any

hurdles or concerns that are identified are, however, asked about and remedied online. With the support of midwife coordinators and Public Health Center leaders, the e-ANC is being developed on a daily basis based on firsthand observations. On this platform, all of the respondents' data was evaluated.

The characteristics of the respondents were based on their age, occupation, education, and the number of children they had, the majority of pregnant women (56.7 percent) were between the ages of 20 and 35, showing that the average respondent was of childbearing age. Furthermore, 76.7 percent of the participants were Nur et al. COVID-19, e-ANC housewives, implying a lack of a consistent source of income.

On the other hand, 56.3 percent of the participants had completed senior high school, indicating a moderate ability to use Android handsets with the e- ANC feature. Furthermore, the largest number of children was >3 (60 percent), indicating a lack of adherence to the National Family Planning Coordinating Agency's advice of no more than two children. In contrast, 60.0 percent of midwives were 35-55 years old, demonstrating that both Public Health Centers had a comparably young and productive workforce. Furthermore, 49.1% of the midwives have worked for more than five years, indicating that they have a lot of expertise with ANC.

In USA a study done at the Junior League Fetal Center at Vanderbilt (FCV) and the Expect with Me (EWM) group prenatal care program. Vanderbilt University Medical Center (VUMC).

According to Alexander. GR, Kotelchuck. M, (2001). During pregnancy, the quality and quantity of a family's support system can have an impact on mother and fetal outcomes. Family members, friends, coworkers, and community groups can all be part of an expectant family's support system. Emerging health information technologies (such as social media, websites, and mobile apps) provide new tools for pregnant families to supplement their support networks and cover information gaps. The goal of this study was to assess the quantity and nature of the components of pregnant women's support systems, as well as the function of health information technologies in these support systems. We looked at the

3

disparities in support systems between pregnant women and their caregivers, as well as the links between support system composition and stress levels.

Pregnant women and caregivers from advanced maternal-fetal and group prenatal care clinics were included in the study. Participants were asked to fill out surveys about their socio demographic, health literacy, numeracy, and stress levels, as well as design a picture of their support system. Individual people, groups, technology, and other support system aspects were isolated from drawings, categorized, and summarized for pregnant women and cares. The Pearson chi-square test for categorical variables and the Wilcoxon ranked sum test for continuous variables were used to compare participant characteristics and support system features. The Spearman correlation coefficient was used to assess the relationship between support system parameters and stress levels.

A total of 100 people took part in the study, including 71 pregnant women and 29 caregivers. Pregnant women's support systems were substantially larger than careers', with 7.4 components on average for pregnant women and 5.4 components for caregivers. Individual people (60.0 percent) were the most commonly reported support system elements by all participants, followed by people groups (19.4 percent), technologies (16.5 percent), and other resources (16.5 percent) (4.1 percent).

Pregnant women and caregivers had different technology preferences within their support systems—pregnant women reported more informational websites, apps, and social media as part of their support systems, whereas caregivers reported more generic websites, apps, and social media. The size and components of these support systems had little bearing on stress levels.

This is one of the first studies to show that technology plays a significant role in the support networks of pregnant women and their careers. Pregnant women mentioned specific medical information websites more frequently as part of their support system, whereas caregivers mentioned broad internet search engines more frequently. Although social support is vital for maternal and fetal health, this study revealed no links between stress, support system size, or

support system components. As health information technologies advance and become more widely adopted, their position in patient and caregiver support systems, as well as their effects, should be expanded

ANC used in urban areas in two European countries. Predisposing, enabling and pregnancy related determinants in Belgium and the Netherlands.

According to Vanden Broeck et al. (2016), the goal of this study is to compare ANC use in Belgium and the Netherlands as measured by the CTP instrument, as well as to investigate predisposing, enabling, and pregnancy-related factors.

Understanding the specific determinants (patient-related characteristics) of antenatal care (ANC) use may aid in achieving the appropriate levels of care for each pregnancy. Early and ongoing risk assessment, health promotion, and medical and psychosocial follow-up are all possible with

ANC. ANC is underutilized by some women, despite its importance. Individual determinants of health-care utilization can be split into predisposing, enabling, and need components, according to Andersen and Newman's health-behavioral model.

Individual factors that exist previous to the pregnancy and affect the inclination to use care are referred to as predisposing determinants in the context of ANC. Low maternal age, being single, low educational level, absence of a paid employment, foreign ethnic background or origin, poor language proficiency, (little) social support, and lack of awareness of the health care system have all been linked to inadequate ANC utilization in previous research. Conditions that make ANC available to pregnant women are referred to as enabling determinants.

Inadequate ANC has been linked to lack of health insurance, a planned pattern of ANC, hospital type at booking, individualized communication, and understanding of the care provider's cultural traditions.

The determinants' pregnancy-need component includes pregnancy-related elements that explain the level of care required/used. Inadequate ANC use appears to be linked to high parity, unplanned pregnancy, no previous preterm birth, discontinuity of treatment, late pregnancy recognition, and behavioral variables including smoking during pregnancy.

A secondary data analysis is carried out utilizing data from two studies that have been pooled.

Data for Belgium came from the CTP research, a prospective observational study undertaken in the Brussels Metropolitan Region. Between April and July 2008, nine out of twelve hospital centers for ultrasonography, to which every woman is directed, were recruited. All low-risk women who were at the start of their care (during a first or second visit or with a gestational age of less than 16 weeks) were eligible to participate.

At the time of recruitment, women completed a questionnaire about their personal characteristics and pregnancy history, a diary recording all antenatal visits in a structured manner (for each visit, 6 questions needed to be filled out, for each question closed answers were provided, and women needed to copy the code related to their answer), and bimonthly (once every two months) telephone follow-up interviews to record ANC.

The DELIVER (Dutch abbreviation for 'data primary care delivery') research provided statistics for the Netherlands. In 2009-2010, data was collected during a 12-month period. The Deliver study was a descriptive study that sought to learn more about the organization of midwifery care in the Netherlands, as well as the accessibility of midwifery care and the quality of primary midwifery care. Purposive sampling was used to find midwifery practices. To guarantee that diverse types of practices in different regions were covered, three stratification factors were used: geography (north, east, south, west), level of urbanization (urban or rural area), and practice type (dual or group practice). Following that, if a client could comprehend Dutch, English, Turkish, or Arabic and was receiving treatment in one of the participating main midwifery practices at any point during the 12-month study period in 2009-2010, they were eligible to participate.

The use of ANC varies widely among areas. According to the CTP tool, 9.7% of women in the Belgian subsample had an inadequate care trajectory, but only 5.6 percent of women in

6

the Dutch sub sample did. Furthermore, only 45.5 percent of Belgian women were assigned to the right ANC category, compared to 58.3 percent of Dutch women.

Appropriate ANC usage was higher among women with a college degree (61.7%), who were employed (60.4%), and who were native (54.9%), compared to women with a secondary education (44.9%), who were jobless (35.9%), and who had a foreign nationality (43.1%), respectively. In terms of enabling features, the results showed that the higher the equivalent income, the higher the proportion of women who used ANC appropriately. More than half of the women with a moderate (55.0%) or high (63.3%) equivalent income obtained adequate ANC. Women with low equivalent income made up 31.3 percent of the total, those with health insurance and supplementary health insurance coverage got appropriate pregnancy care content and timing more frequently than women without this coverage (52.8 percent versus 21.1 percent and 57.5 percent versus 40.3 percent respectively).

While it is reasonable to predict that the country in which women live, as well as the health-care system in which they live, would influence the appropriateness of antenatal care utilization, personal factors appeared to have a greater impact. Our findings show that in both locations, educational level and employment position are critical determinants in acquiring suitable ANC content and time, introduce measures encouraging women to attend prenatal classes, such as providing sessions free of charge to socially marginalized women, to promote proper ANC and influence practice, another recommendation for practice is to organize public education regarding the (value of) prenatal care. Furthermore, it is critical to systematically develop maternal health care models that assure provider continuity. All of them are controllable characteristics that can be taken into account by prenatal health care providers to help them provide better appropriate care.

Manual approach being used today at Mengo hospital Uganda and how it works.

The approach has different names such as mother child health passport from Ministry of Health, Patient/Expecting mother book, or Antenatal care Book.

This approach works in the following ways;

   i. Expecting mother visits Mengo hospital and is directed to the Antenatal care ward where she is tested to confirm whether she is pregnant.

  ii. If she is truly expecting she is told to buy a book from nearby by shop around Mengo hospital and medical personnel will record her details which may include the following;

 iii. Date of registration when Expecting mother visited Hospital to confirm whether she is expecting, name, address and age of expecting mother, name of father, date when mother might have conceived and date when mother is expected to give birth, body weight, HIV/AIDS status, body pressure and palpable mass.

  iv. Expecting mother is given some medication according to how the medical personnel has seen her condition, is told how she is expected to be eating and feeding herself and expected new born, she receives her first tetanus vaccine injection on her arm and is told that she will visit the hospital for five times so she can complete her tetanus vaccine injection which will also be protecting her unborn baby. Expecting mother will also receive counseling from medical personnel so she can be ready to receive her unborn baby, and will also receive HIV/AIDS status counseling and protection from HIV/AIDS.

   v. Expecting mother is told and made aware that she will receive antenatal care five times normally in nine months and is told that if she gets any complications she should visit the nearest health facilities with her book or go back to the hospital, told to comply with medical personnel advice for better safe delivery, and after giving birth; new born baby is given polio vaccine at birth, at 6weeks new born is given another polio vaccine, DPT- HebB +Hibl and Pneumococcal 1 injections, at 10 weeks baby is given 3 injections for Polio2, DPT-HebB+Hib2 and Pneumococcal2,at 14weeks baby is given Polio3, DPT-

HebB+Hib3 and Pneumococcal3 injections and at 9months baby is given last injection on arm for measles.

The challenges of this manual approach include;

i. High levels of illiteracy of majority of expecting mothers who can't afford to read and write and might not understand too much that have been told at first visit and also may fail to read what medical personnel might have written on her book.

ii. Poor handwriting of medical personnel making it hard to share information across hospital departments.

iii. Expecting mothers forget their books on their way back to hospital to receive antenatal care which is time consuming to re-record in new book.

iv. Failure to follow medical personnel prescriptions, long distances covered and travelled by expecting mothers to reach hospital.

v. Expecting mother forgetting when next to visit hospital because no one is reminding them.

vi. Self-medication is very common amongst Ugandan patients, in case of emergencies some expecting mothers run to medicate themselves which might cause pregnancy issues or even

vii. Losing either both expecting mother and unborn child.

The solutions to the above manual approach used in Mengo hospital include;

i. A suggestion for the new antenatal care management information system, a mobile application with detailed information for expecting mother and medical personnel about antenatal care for safe delivery, a healthy safe mother and child during pregnancy and after birth.

ii. Provide monthly notifications and alerts to both expecting mother and medical personnel about when expecting mother is expected to visit Hospital.

iii. Has questions and answers section, keep records and can be accessed by both expecting mother and medical personnel.

iv. Keeps track of pregnancy stages. Provides tips of pregnancy health.

v. Provide interaction with other pregnant mothers and medical personnel.

vi. Provide contacts of various medical personnel at antenatal care hospitals ward to be contacted in case of emergencies.

vii. Self-medication common amongst expecting mothers which might cause death of both expecting mother and unborn child, will be solved by providing contacts of medical personnel to be contacted at all times in case of emergencies so they can save situations.

1.3 Problem statement

Currently in Uganda, there is lack of an effective system to handle pregnant women information. The manual system used is faced with a number of challenges which include; long distances travelled by pregnant women to reach the health center is time consuming and costly, child mortality rates, poor health of mothers and their children due to lack of teachings, discussions and interactions during antenatal care, unintended pregnancy and difficulties in giving birth. Most of the times people fail to meet all these requirements and these results into high death rates. This project study therefore proposes a Mobile Based Antenatal Care Management Information System that will regularly alert and notify doctors, nurses and midwives in case of emergencies and also give reminders to visit the hospital.

1.4 Objectives of the study

1.4.1 Main objective

The main purpose of this study was to develop an Antenatal care management information system so as to improve on the process of antenatal care management in Uganda.

1.4.2 Specific objectives

1. To review existing systems so as to identify the requirements for the proposed Antenatal care management information system.
2. To design the Antenatal care management information system.
3. To implement the Antenatal care management information system based on the design.
4. To test and validate the Antenatal care management information system.

1.5 Scope of the Study

1.5.1 Geographical scope

The geographical scope of this study covered Kampala city in central Uganda. Kampala city is surrounded by Wakiso district. Mengo hospital/Namirembe hospital is located in central region of Uganda,00 degrees 18'46" N and 32 degrees 33'30" E, coordinates from Google map.

1.5.2 Functional scope

The functional scope involved function and non-function requirements. The functional requirements described what the system was expected to do or perform. They defined intended behavior of the system such as;

1. Providing and giving alerts in case of emergencies to doctors and nurse and midwives and reminders to visit hospital.
2. Automate record management.
3. Project will reduce number of workers like nurses and midwives.
4. Antenatal care management information system will decrease death rates of women and babies.
5. The antenatal care management information system should be reliable.

The non-functional requirements were constraints that should be compulsory to the services by the Antenatal care management information system such as;

1. The system should have a friend interface and be able provide multiple access and high performance in all situations.
2. The project will act as knowledge source to scholars studying related fields to develop their own applications.

1.5.3 Time Scope

The study involved the use of data related to the topic under investigation for the period of l year. This time range was suitable for arriving at correct conclusions.

1.6 Significance of the Study

The Antenatal care management information system contributed existing stock of knowledge in the field of health mobile application development. The complete operational system acts as a source of knowledge to scholars undertaking studies in other related fields.

The system provides and give alerts to the patients when take medicine, next visit to the hospital and give contacts for the different doctors whom patients can contact in case emergencies.

The system deployment contributes to the development of a pathway to adaptive and integrated (smart) guidelines in digital systems in order to improve the quality, coverage and accountability of health systems.

The system helps to make better use of data to monitor and improve antenatal care coverage and quality.

The system helps to reduce barriers to accessing care and reach out to women not accessing care.

Also, this study contributes to information resource in line with antenatal care management in developing countries like Uganda. This offers insight to researcher about existing systems in the sub health domain antenatal care.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This section explains the analysis of research work from books, Internet sources and Individual studies that exist in relation to mobile Applications. It also consists of the contribution of the existing systems in relation to the proposed system and a summary of comparative evaluation.

2.2 Antenatal Care Management

According to Omella. L, Seipati. M, A, Patricia. G, Steven. M, (2006), antenatal care management refers to a system of support a woman is subjected to during pregnancy including supervision, examination and advice.

The benefits of antenatal care management include the following;

a. Decreases women's' risk of serious maternal morbidities and mortality.

b. Reduces poor outcomes for newborns.

c. Contribute to USAIDs global agenda for ending preventable child and maternal deaths.

d. Can detect and prevent early complications such as hypertension and pregnancy diabetes both of which can affect the fetus.

e. Antenatal care management also provides best nutrition for both the mother and the fetus.

f. Prenatal vitamins play a big role in the health of the fetus.

g. Antenatal care provides education on the finer points of dealing with pregnancy, how the child is.

h. Developing, what to expect after giving birth and how to about giving a child the best after birth.

i. Antenatal care educates expectant fathers on what they can do to help.

Whereas the challenges of antenatal care management include the following;

    a. Shortage of staff

    b. Lack of cooperation from referral hospitals

    c. Lack of in-service training

    d. Problem with transportation of specimens to laboratories

    e. Lack of material resources

    f. Unavailability of basic Antenatal Care program guidelines and lack of management support.

2.3 Management Information System (MIS)

Management Information Systems (MIS) refer to a set of systems that gather information from various sources, compile it and present it in a readable format (Ingram, 2012). MIS provides advantages like effective and productive decision making to the managers by gathering information from different sources into a single database thus presenting the information in a more understandable manner (Ingram, 2012).

The benefits of management information systems (MIS) include the following as discussed in existing studies (Gerald, 2008);

    a. Better decisions. The improved communication MIS provides to all levels of the business improves the decision-making skills of those in charge. For example, a business owner checks his management information system and sees that his supply of components is not sufficient to meet his production goals. Therefore, the owner can then decide either to order more components or lower his production targets.

    b. Integrated system. An integrated system allows for improved communication among executives, managers, department heads and employees. A fully integrated management information system gives the same data framework to sales department as it provides to the manufacturing plan.

2.4 System development life cycle (SDLC)

According to Elliot and Strachan and Radford (2004), system development life cycle refers to the stages involved in bringing a project from inception to completion.

14

In systems engineering, information systems and software engineering software development life cycle are referred to as application development life cycle; is a process for planning, creating, testing, and deploying an information system.

SDLC concept applies to a range of hardware and software configurations, as a system can be composed of hardware only, software only or a combination of both.

There are usually six stages or phases in this cycle: requirements analysis, design, development and testing, implementation, documentation and evaluation.

There are six major effective models or types or methodologies of this cycle which include; Waterfall, V shaped interactive, spiral, big bang and agile models.

We are choosing an agile model as our best methodology to help us engineer our antenatal care management information system.

Agile model; This model breaks down projects into manageable cycles, delivers a working product and is a very realistic development approach that allows products to be tested at each stage of development and if there are errors they are corrected there and then.

Advantages of agile model include;

i. Breaks down projects into manageable cycles.

ii. Quickly delivers a working product.

iii. Is a very realistic development approach.

iv. Allows for testing of product at each stage of development.

v. Emphasizes interaction with clients and developers.

Disadvantages of agile modeling include;

i. With much interaction, projects may head the wrong way if customers are not clear on the direction they want to go.

2.5 Mobile Application Development

According to Sean. P, (2020), mobile application development is the act or process by which a mobile application is developed for mobile devices such as personal digital assistants,

enterprise digital assistants or mobile phones. They are designed to run on mobile devices like smart phones or personal computers.

They can be pre-installed on phones during manufacturing platforms or delivered as web application using server-side or client-side processing e.g., JavaScript to provide an application like experience

According to Harnil, (2019), the benefits of mobile application development include;

a. Strengthen customer engagement. It helps in creating a direct marketing channel between customer and their customers hence allowing direct and effective communication.

b. Increase accessibility. It allows businesses to send notification about what's new or what has changed in their services or product delivery which builds are strong relationship between the clients and service providers within a web browser.

c. Stand out from competition. Since mobile application is rare this is where you can make a difference and take a big leap by offering mobile application to perform services in the enterprise.

d. Unique service and payment. Mobile application can help you to target customers to book appointment, push notification can be used to remind or update them on their appointments. Mobile payment has now become are popular means of payment they are user friendly fast and secure.

According to Joanna. M, (2019), mobile health is the practice of medicine and public health supported by mobile devices such as mobile phones, computers other wearable devices such as smart watches for health services information and data collection.

Mobile health field has emerged as sub-segment of e-Health the use of information communication technology (ICT) such as computers, mobile phones, communication satellite, patient monitors among others for health services and information. It includes the use of mobile devices in collecting community and clinical health data, delivery and sharing of healthcare information among both parties

According to Michael. S, R, (2019), the benefits of mobile health includes;

i. Gives patients faster access to providers and care. Unlike traditional and inefficient telephone access to physicians and health care organizations, mobile health enables patients

to quickly send secure messages, schedule appointments and connect to providers 24/7 for telemedicine visits.

ii. Improves medication adherence. Once patients are discharged from the hospital or clinic it's not easy to control whether or how they take their medication or whether they pick medication at all this improves the image of the hospital or clinic.

iii. Makes remote patient monitoring possible and easy. It allows tracking of the patients using mobile devices, collecting of the data among others.

iv. Increase in medication reconciliation accuracy, which improves patient safety.

v. Improves provider communication and coordination.

2.6 Review of related existing Systems

According to Kollmann et al. (2002) mobile health care applications are developed with the intent to facilitate communication between medical workers and their patients, as well as to store and convey information about the condition of user accordingly.

Currently, there are thousands of medical mobile applications that exist to help users monitor various aspects of their health.

2.6.1 Sprout Pregnancy App

Week by week tracking, it is a must have for busy expecting mothers that helps them to stay organized and educated about different development of changes happening in their bodies. Supports both android and iOS and comes with the ability to capture belly photos and pair them with mothers' ultra sound to create custom pintables. It helps to log appointment reminders, questions for medical personnel and milestones reached along the pregnancy period.

It's easy to use, gives accurate pregnancy information, gives educative information for both mother and medical personnel and it is also compatible for both android and iOS systems.

However, it has many irritating advertisements and the application requires a strong network to download.

2.6.2 Baby Center Pregnancy App

This is a strong guide for pregnant women. It is an Android and iOS app with excellent reputation for its medical accuracy and up to date facts about antenatal care. After giving birth, the application transfers over to a parenting guide to help with the mothers' next adventure. It is easy to use and requires little storage space, supports different platforms like android and iOS and shows pretty amazing images of the baby's development.

However, users find difficulty in logging in or registering and have many irritating advertisements.

2.6.3 Bump Pregnancy App

It is an Android and iOS pregnancy count down app that helps mothers and medical personnel to read about the development of the unborn child.

It is easy to navigate for mother baby information, easy to use and add clients, has accurate helpful information for mothers and medical personnel, allows you watch baby's' development (not real baby) growth week by week through 3D visualization. However, it requires more storage space, has irritating adverts pop ups, difficulty in downloading the heavy app and it has difficulty in keeping mother and baby records, next doctors visit. Lindberg (2021).

2.6.4 Comparative Evaluation

Feature	Sprout pregnancy app	Baby center pregnancy app	Bump pregnancy app	Proposed system
Notification	Absent	Absent	Absent	Present
Location	Absent	Absent	Absent	Present
Schedule/cancel appointment	Absent	Absent	Absent	Present
Records	Absent	Absent	Absent	Present
Question/answer session	Absent	Absent	Absent	Present
Pregnancy stages	Present	Present	Present	Present
Medical personnel contacts	Absent	Absent	Absent	Present

Table 1: Comparative evaluation for ANCMIS and some existing antenatal care systems

KEY:

Present: This means that the mobile app has the mentioned feature

Absent: This means that the mobile app does not have the mentioned feature

2.7 Conclusion

With the above differences in the related systems, therefore there is need for development of the proposed system to provide and give alerts to the patients when take medicine, next visit to the hospital and give contacts for the different doctors whom patients can contact in case emergencies.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This section explains the tools and techniques used to achieve the stated objective. It includes the research design, population and sampling, requirements collection system analysis, system design, implementation testing and validation reliability of the tools, ethical considerations.

3.2 Research Design

Research design can be described as a general plan about what you will do to solve a research problem or answer the research question (Saunders et al. 2012).

In this study both qualitative and quantitative research designs were adopted. The case study method will also be used in the study where respondents will be selected for requirements collection.

3.2.1 Qualitative Research

It is research concerned with variables or factors whose values can't be expressed in numbers but can be expressed in text and/or graphical form (Kothari 2005). The aim of qualitative research is to cover the underlying motives and desires using techniques like interviews and questionnaires. We are to use qualitative research because we want to find out why women and babies are dying.

3.2.2 Quantitative Research

It is the systematic empirical investigation of observable phenomena via statistical, mathematical or computation techniques (Lisa, 2008)

We are to use quantitative research because it will help us to find out the average number of pregnant women who visit the hospital (Mengo), average number of babies.

3.2.3 Case study

According to Kothari (2005), case study research is a methodology which can take either a qualitative or quantitative approach. It is versatile as it uses many methods to gather information ranging from observation to interview to testing. The purpose of the case study

research is to describe particular cases in detail and take learning from them and develop theory from that approach

3.3Population and sampling

According to Kumar (2005), population is a group of potential participants to whom you want to generalize the result of the study out of thousands of stakeholders in Mengo hospital in our study we would like concentrate on a sample of 60 stakeholders. Sampling is a data collection methodology where one picks a small group to represent the larger population (Kumar, 2005) We are to randomly select the different people who will have to provide us with the information about pregnancy issues, our women, doctors, midwives, nurses and staff members as respondents so as to get a clear understanding of the problem.

3.4 Data collection Techniques

The following are the data collection techniques which we are going to use in order to get a clear understanding about the issues concerning pregnant women in their day today lives and be able to identify the necessary requirements for the Antenatal care management information system.

3.4.1 Interview

An interview is a conversation in which the interviewer questions the interviewee in order to gain information, interviews can be formal or informal structured or unstructured and can be conducted one to one or in groups face to face or by telephone, email.

According to Kothari (2005), an interview is a planned meeting during which you obtain information from another person through random open question based on a particular subject. Our group we are going to interview different kinds of people in connection with pregnant women (stakeholders in Mengo hospital).

3.4.2 Questionnaire

A questionnaire is a set of printed or written questions which can be open or close ended with a multiple choice of answers designed for purposes of survey, or statistical study and other prompts for the purpose of gathering information according to Kothari (2005). We are to use questionnaires in order to get information from the stakeholders of Mengo Hospital.

3.5 System and Data Analysis

The data collected during the requirements gathering is to be processed so as to eliminate inconsistencies. Microsoft Excel a data analysis tool will be used for statistical data analysis and graphical representation. Data analysis will be done based on the qualitative and quantitative data analysis techniques. Quantitative data analysis will be used because it supports percentage and statistical data analysis based on graphs and charts as (Kothari, 2009) portrays. The study also adopted the qualitative data analysis method due to its associated benefits, such as provision of depth and detail, encourages openness, simulates people's individual experiences and can help reduce attempts of prejudgment (Kothari, 2009).

3.6 System design

According to Rosenblatt (2014), systems design is creation of a physical model that satisfies all documented requirements. It involves designing user interface and identifying inputs, outputs, and processes of the system. Under this phase and user involvement is crucial. At the end of this phase we have to come up with the system design and specification. We are to use the following tools in the system design;

3.6.1 Use Case diagram

Shelly and Rosenblatt (2014), define a use diagram as a visual summary of several related use cases within a system or subsystem. A use case diagram is a Unified Modeling Language (UML) tool that visually represents the interaction, functionality between the external users and the information system. It contains actors, activities (use cases), and relations. It is a visually related use cases within a system or subsystem. Use case diagram describe what a system does from the standpoint of an external observer. The emphasis is on what a system does rather than how. In a use case diagram, the user becomes an actor, with a specific role that describes how he or she interacts with the system. They are closely connected to scenarios. A scenario is an example of what happens when someone interacts with the system. UML uses a set of symbols to represent graphically the various components and relationships with a system.

Use case for ANCMIS has two users that is Doctor/ADMIN and Maternity mother who interact with system in the following ways;

The Doctor/ADMIN.

    a) Logs in.

    b) Creates/updates records

    c) Assign midwives/nurses

    d) Retrieves records

The Midwives/nurses.
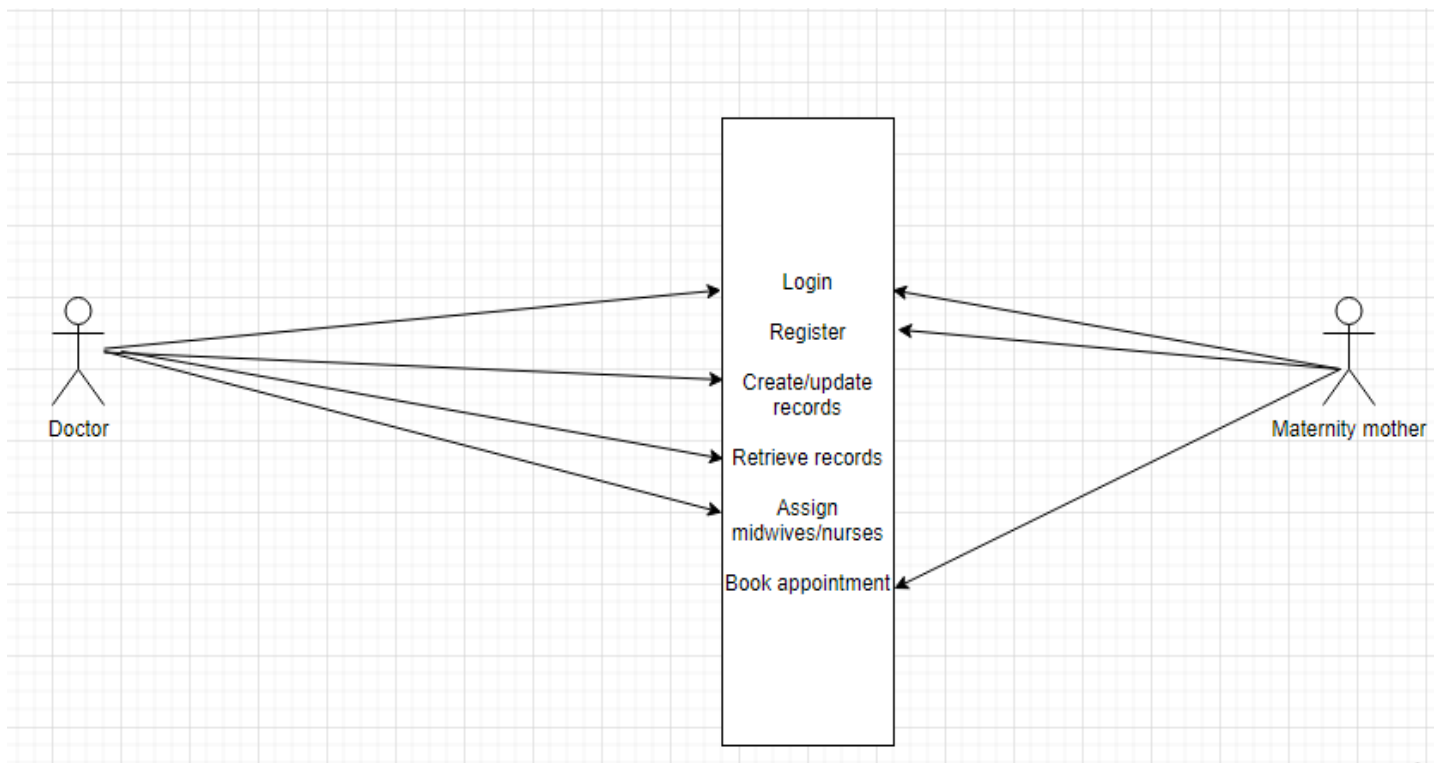
    a) Logs in

    b) Registers

    c) Book appointment.

Figure 1: ANCMIS use case diagram.

3.6.2 Sequence Diagram

A sequence diagram is dynamic model of a use case showing the interaction among classes during a specified time period. It represents the sequence of messages between instances of classes, components, subsystem or actors. A sequence diagram graphically documents the use case by showing the classes, the message, and the timing of the messages. Sequence diagrams include symbols that represent classes, lifeline, messages, and focuses according to Rosenblatt (2014).

The activities that take place in the ANCMIS include;

   a) The maternity mother books appointment from the ANCMIS
   b) The ANCMIS notifies the Doctor about the booked appointment
   c) The Doctor assigns midwives/nurses to maternity mothers
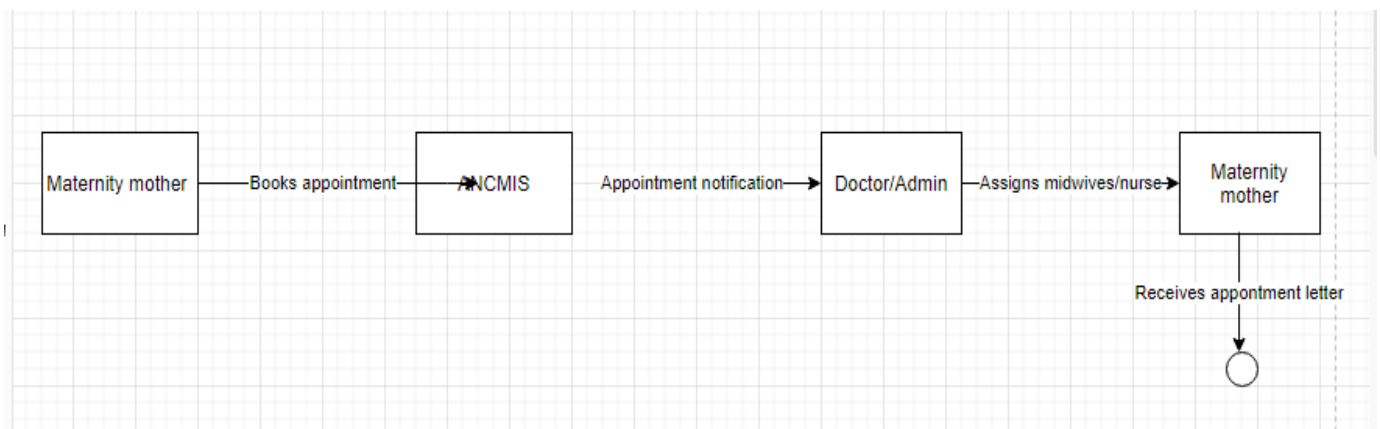   d) The maternity mother receives the appointment.

Figure 2: ANCMIS Sequence diagram.

3.6.3 Class Diagram

A class diagram shows the object classes and relationships involved in a use case. It is a logical model, which evolves into a physical model and finally becomes a functioning information system. It represents a detailed view of a single use case, showing the classes that participate in the underlying business transaction, and the relationship among class instances, which is called cardinality. It consists of the class, attributes, methods and activities which describe the relationships between classes, Rosenblatt (2014). To create a

class diagram, one has to review the sue case and identify the classes that participate in the underlying business process.
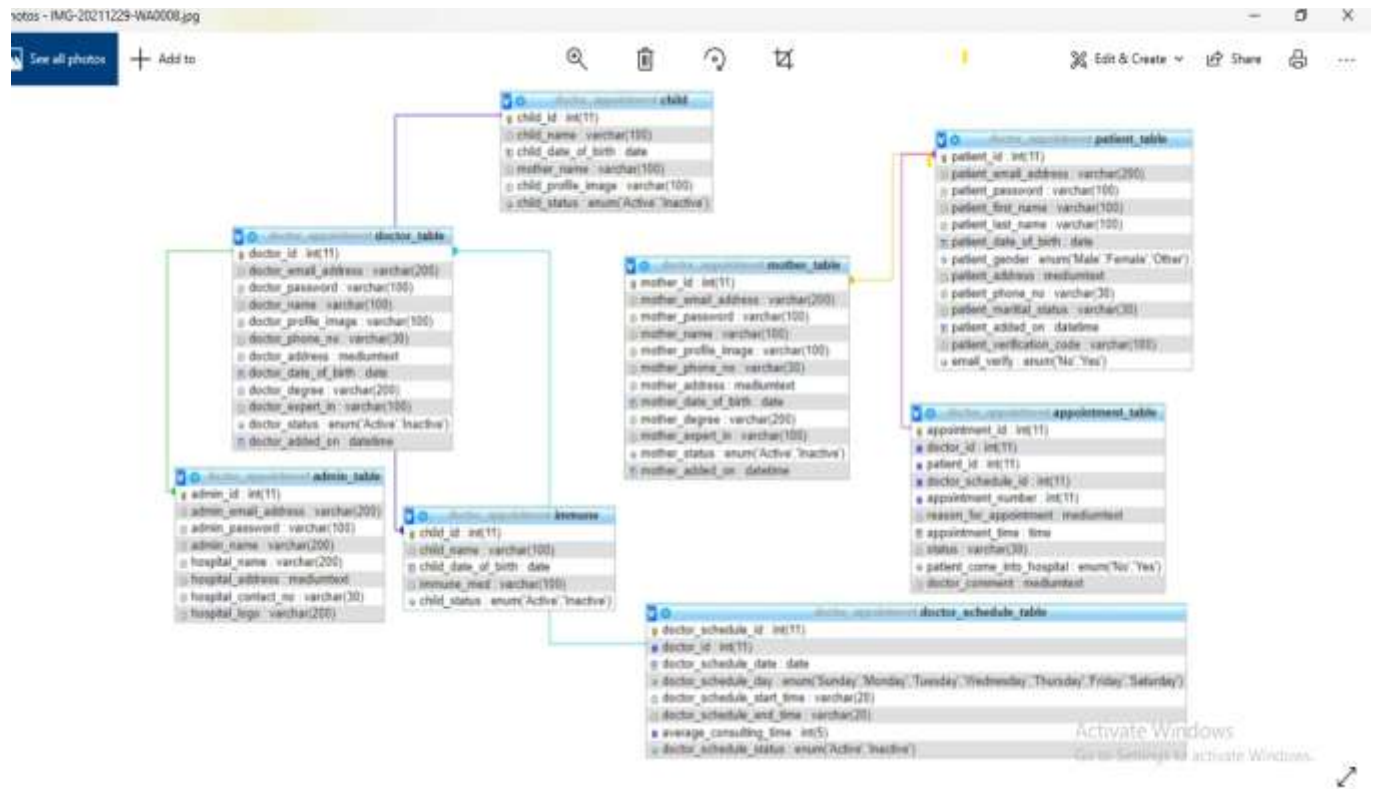

Figure 3: ANCMIS Class diagram.

3.7 Interfaces design

Shows the detailed view of the user interface for ANCMIS. The following page is a sample of the design that was generalized for ANCMIS development. The general layout of the system was as follows the chosen background color of the system was grey. Text color for the links was to be blue. The navigation bar was to be common to every webpage.
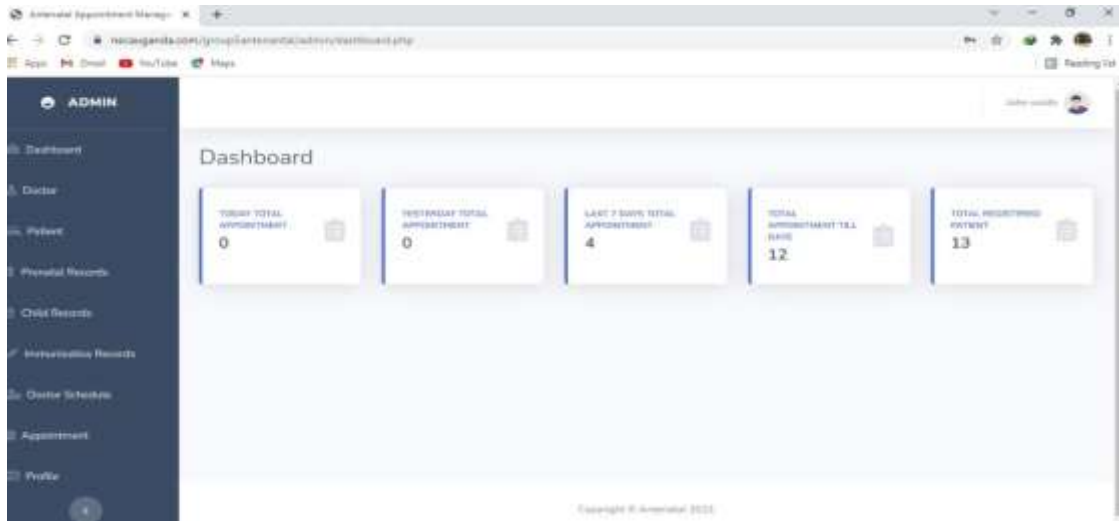

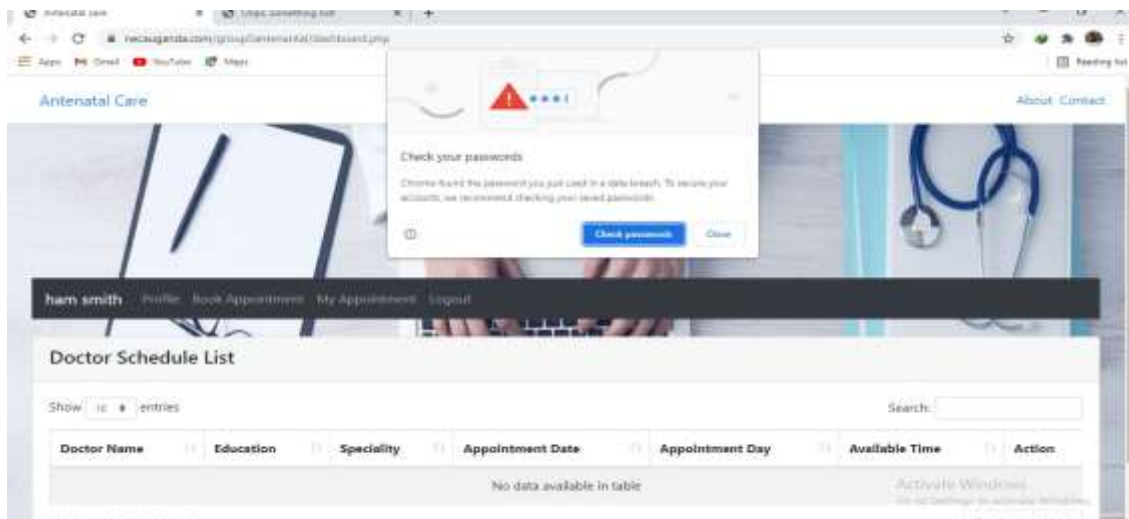*Figure 4: ANCMIS Admin/Doctor interface.*

Figure 5: ANCMIS maternity mothers' interface when logged in.

3.8 Input specifications

The input specification is used for data collection of the system. The Admin/Doctor and Patient are required to register and login into the system by inputting in their credentials which is the emails, usernames and passwords.

The data is captured and stored in database. The other input forms that are available include forms for schedule dates, immunization records, Doctor and maternal mother information. There is a contact form which requires maternity mother to contact medical personnel for help in case of emergency.

3.9 Output specifications

The ANCMIS can export information saved in tables as either html, pdf or excel worksheets thus generating reports when needed. The reports on the children's records, maternity mothers, doctors are generated by exporting to the formats aforementioned.

CHAPTER FOUR: JUSTIFICATION OF THE PROGRAM LANGUAGE

PHP was the main language used to develop ANCMIS; PHP is an open-source programming language, server site scripting language that encourages dynamic and creative programming. Different frame works are available in PHP which basically provide the foundation to promote rapid application development process; the methodology used.

Frames works incorporate a proper methodology and encourages developers to create more efficient and effective code suitable for enterprise applications.

During development Yii frame work, PHP web frame work was used to develop ANCMIS.

Yii is an open-source object oriented, component-based MVC (MODEL-VIEW-CONTROLLER) PHP web application framework (Yii 2008) PHP is efficient, free and open-source programming language. PHP is compatible with operating systems such as windows, databases like MySQL and major web servers such as Apache and Nginx. The need to make things mobile due to technology makes it better to make responsive, interactive and app compatible with all devices. Here is where Bootstrap, JavaScript, HTML and CSS came in besides using PHP.

4.1 System implementation

According to Rosenblatt (2014), implementation is the physical realization of an application, or execution of a plan, idea, model, design, standard, specification, algorithm, or policy.

It involves defining how the information system is to be built (physical design), ensuring that the information system meets the quality standards (quality assurance)

We shall use different tools to achieve the physical realization of Antenatal care management system positive living information management system and some of them are discussed below;

i. **Android Editors and IDEs -** IDE stands for "integrated development environment" which is an effective piece of software that allows you to create other software in our case mobile application.

ii. **Android studio** - the official IDE on the community created intelli JIDEA and object-oriented programming specifically meant for Android application development.

iii. **Hypertext Markup Language (HTML)** is a predominant markup language used for designing web pages.

iv. **Cascading Style sheet (CSS)** is a style sheet language used for describing the presentation of a document within a markup language

v. **PHP** is a server-side scripting language designed for web development but also used as general-purpose programming language.

vi. **Bootstrap** is front-end frameworks used for designing an interface for the user, unlike the PHP sever side code which resides on the "back end" sever. Bootstrap gives the ability to create responsive designs for both mobile and desktop screen sizes.

vii. Bootstrap includes HTML and CSS based design templates for typography, forms, buttons, tables, nav-models etc.

viii. **JavaScript** is a text-based scripting language that's interpreted by a client system to perform tasks in various settings. JavaScript was originally conceived as a means for making web pages' dynamic.

ix. **jQuery**is a cross-platform JavaScript library designed to simplify the client-side scripting of HTML.

x. **MySQL** is an open-source relational database management system (RDBMS) that use structured Query Language (SQL), the popular language for adding, processing, and accessing data in a database.

xi. **SQLite** is an in-process library that implements a self-contained, server less, zero configuration, and transactional SQL database engine.

After successful completion of design and development the ACNMIS was then put on production environment to check whether the intended objectives were met. To ascertain whether the objectives were met different users had to interact with the system using different computers and smartphones and it was positive. The following diagrams represent screenshots of web pages taken a web browser during implementation.

29

4.1.1 Login pages.

The figure below represents the login pages that enable registered users access the system. Only authenticated users with correct credentials are logged in. if credentials are correct the user is successfully logged in. if users fail to input login details the system produces an error of either wrong username or wrong password.
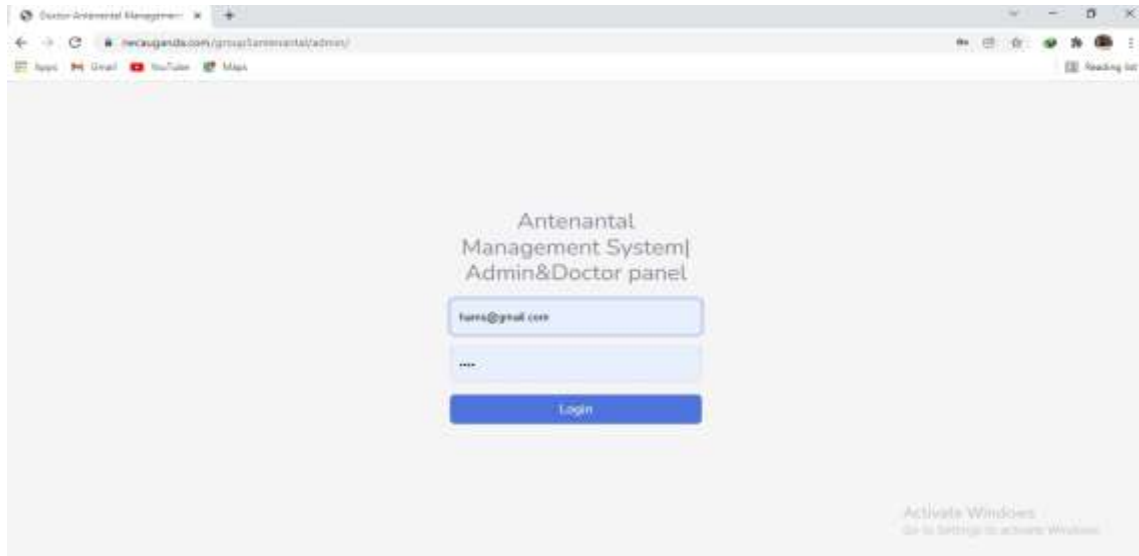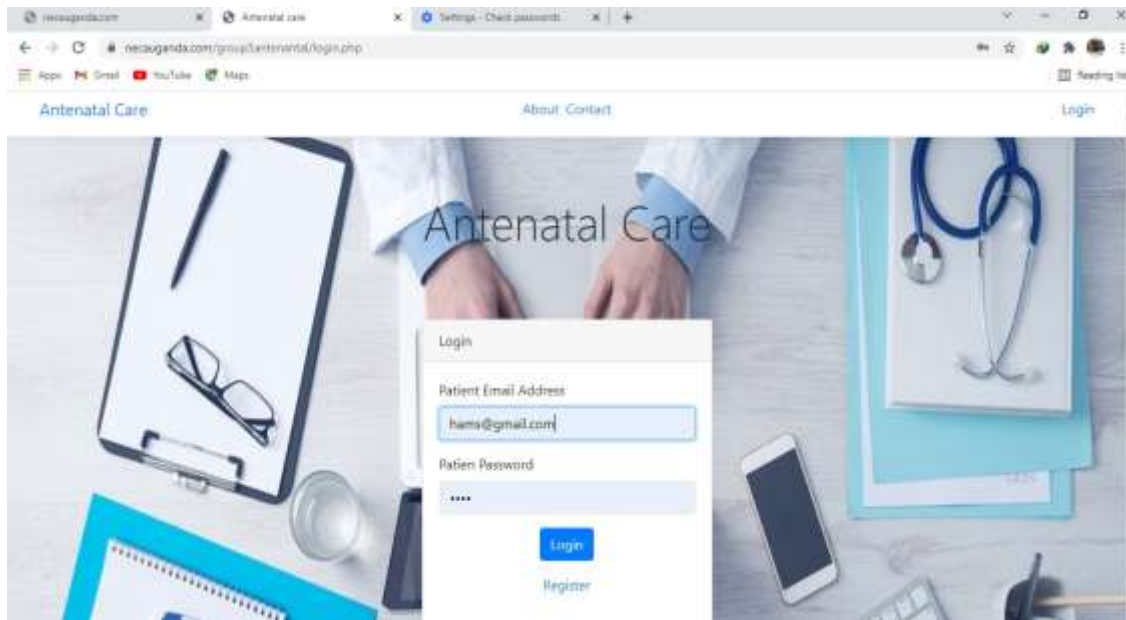

Figure 6: ANCMIS Admin/Doctor Log in page.

Figure 7: ANCMIS maternity mother log in page.

4.1.2 Doctor management information.

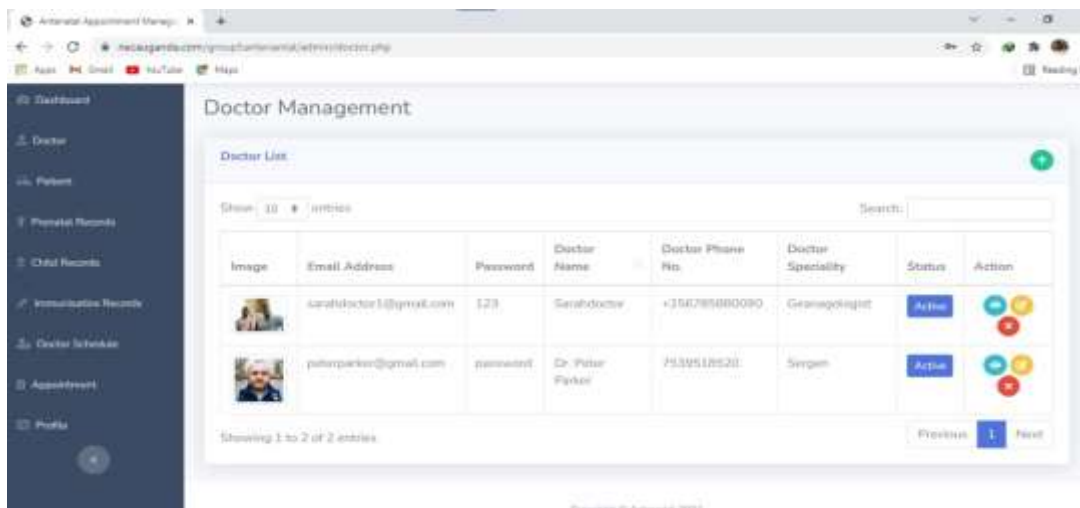This shows doctors and their areas of specialty, email address, contacts, password and images.
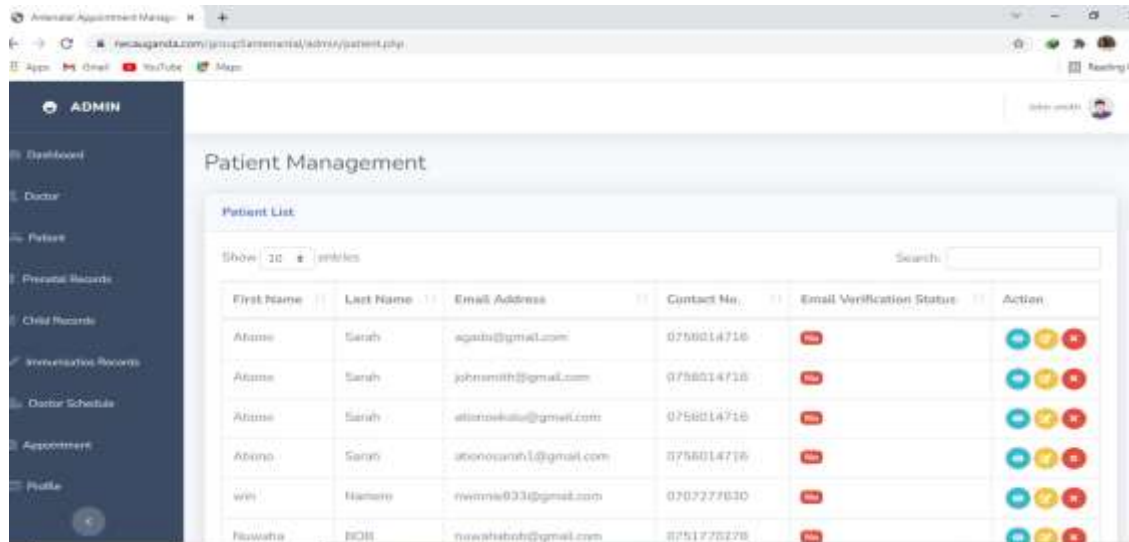

Figure 8: ANCMIS Doctor management information.

4.1.3 Patient management information

Has details for patients such as name, emails, address, contacts an email verification status and actions.

Figure 9: ANCMIS Patient management information

4.1.4: Maternity mothers' information.

It has expectant mother details like size of the tummy, when she is supposed to be attended to by medical personnel, and other details like email address, name, contact, status and images.

Figure 10: ANCMIS Maternity mothers' management records.

4.1.5 Doctor schedule management information.

It has doctor name, schedule date and day, start and end time, consulting time, status and action.

Figure 11: ANCMIS Doctor schedule management information.

4.1.6 Appointment management information.

Has appointment number, patient name, doctor name, appointment time, appointment day and appointment status and view.

Figure 12: ANCMIS Appointment management information.

4.1.7 Antenatal care/patient interface/maternal mother interface.

It has doctor name, doctor education, specialty, appointment date and day, available time, action which appears after user who has already registered logs in but if patient has not yet registered, she has to register first and logs in then afterwards the patient will be browsed into a new interface which has patient name, profile, book appointment, patient appointment and log out.
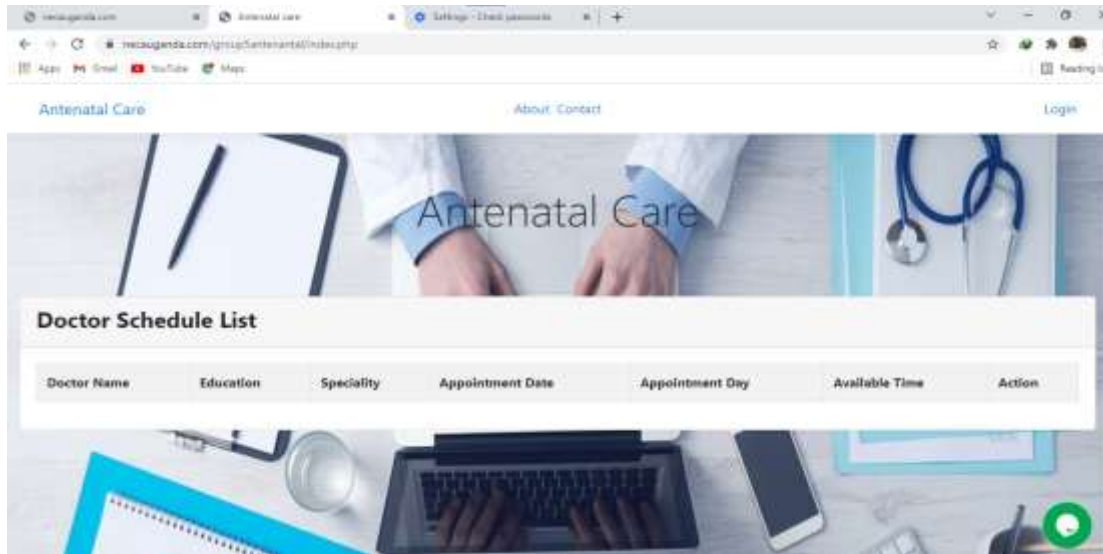
Figure 13: ANCMIS Maternal mother interface when not logged in.

4.1.8 Password recovery

The figure below is a password reset form. Helps users recover forgotten passwords in a way that if you put in wrong password a pop up appears telling user to check their passwords and after checking it, user is able to see the password and change it you need to.
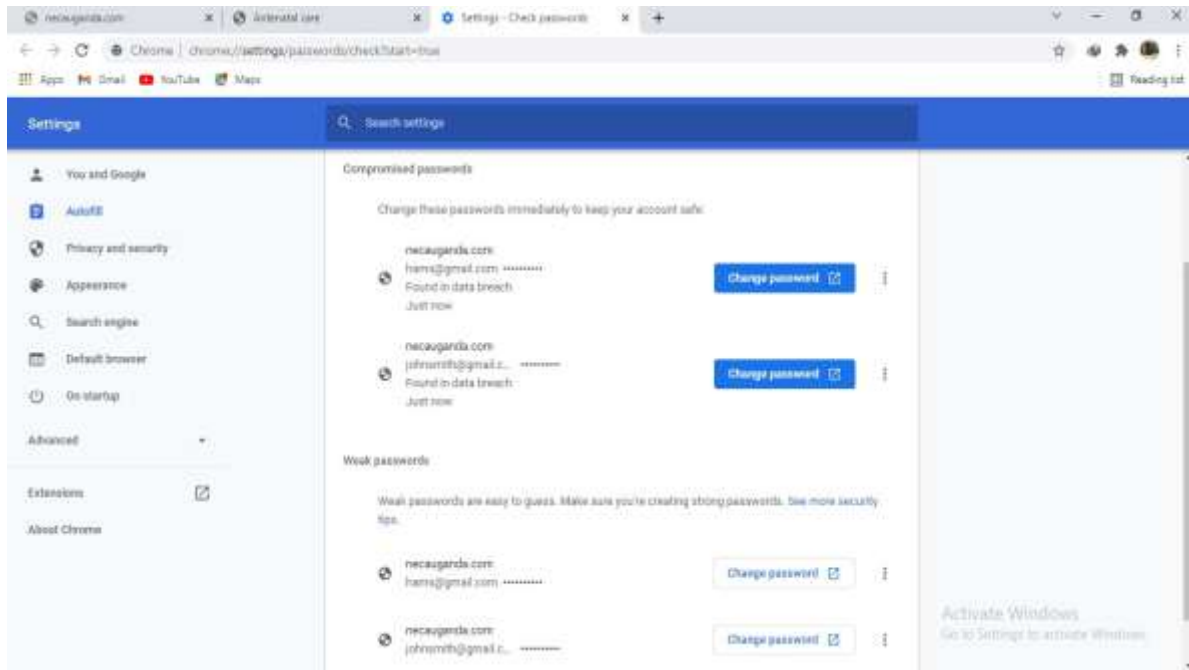
Figure 14: ANCMIS Password recovery.

4.1.9 Admin sidebar

The figure below shows admin sidebar that contains dashboard, doctor, patient, prenatal records, child records, immunization records, doctor schedule, appointment and profile.
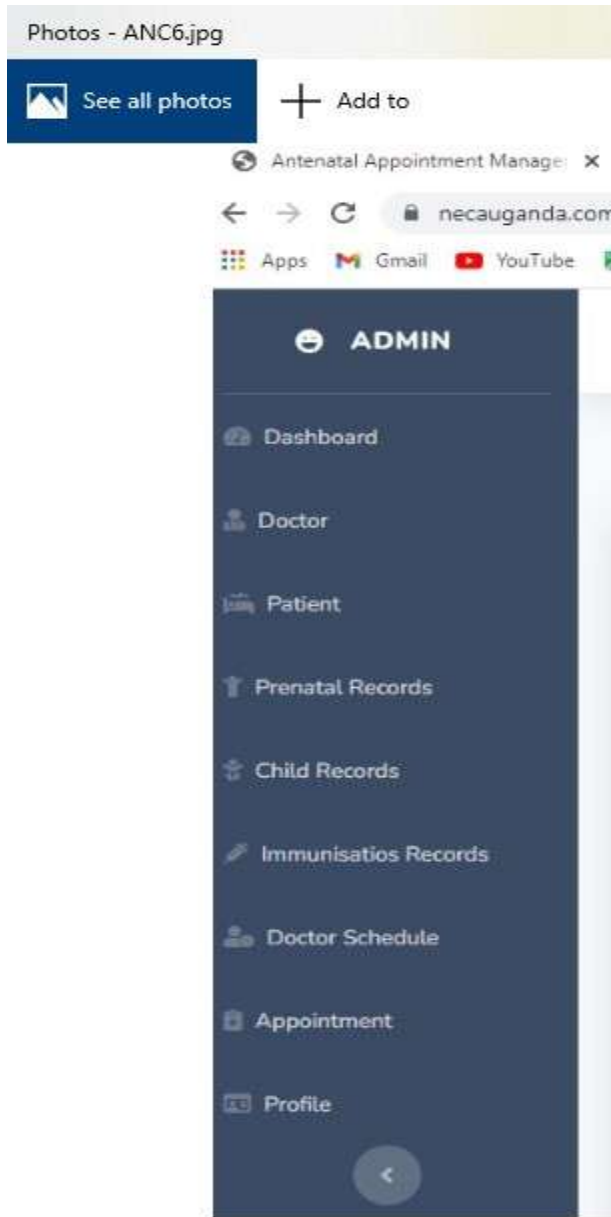
Figure 15: ANCMIS Dashboard/side bar

4.2.1 Tawk.to App

This application enables maternity mothers interact with doctors, contains questions and answers session.

+
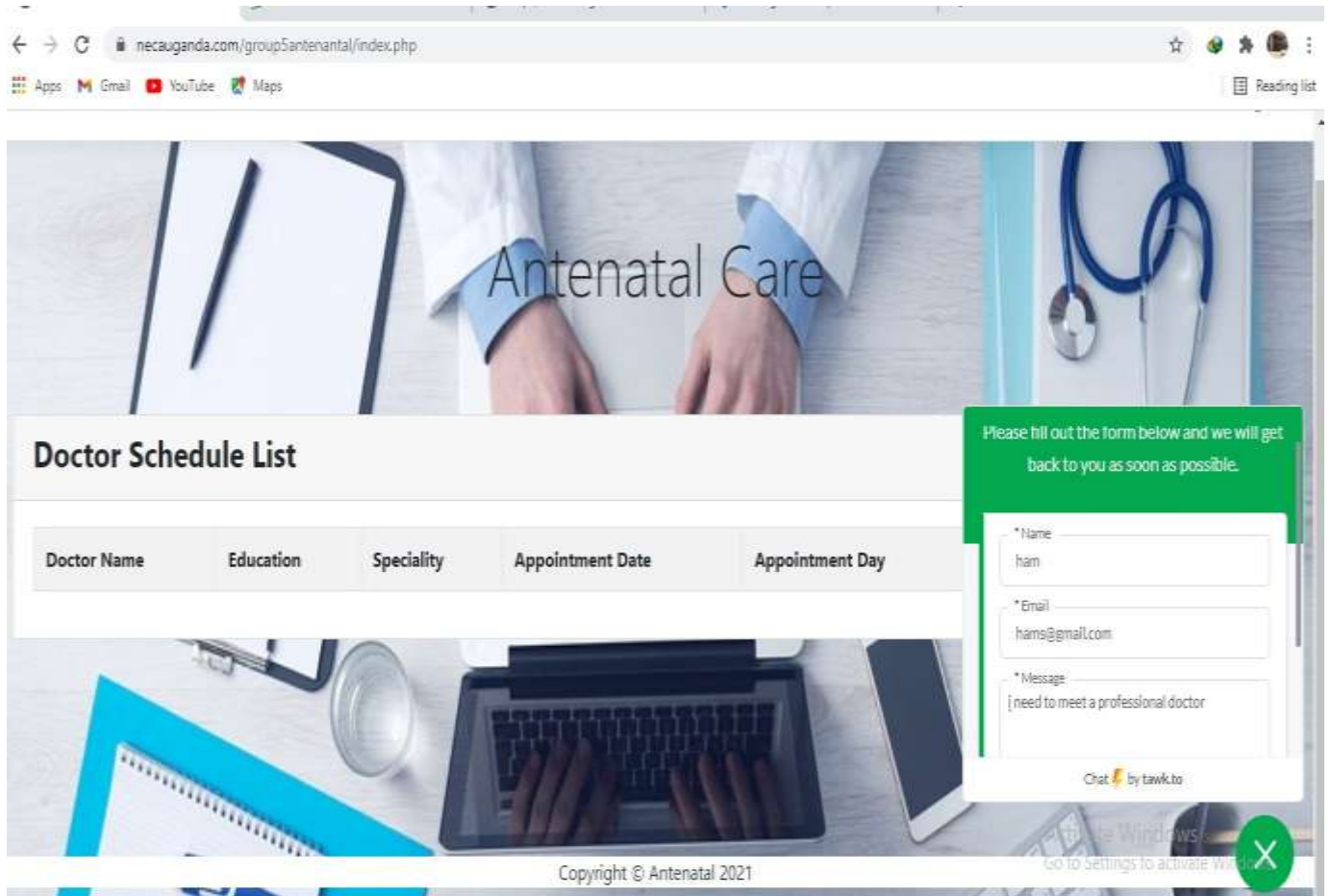
Figure 16: Messaging tawk.to application/questions and answers session

4.2.2 A Summary of methods, techniques and tools used to achieve the objectives.

TOOLS	TECHNIQUES	METHOD(S)	OBJECTIVES
Questionnaires	Conducting interviews using questionnaires, reading secondary data, such as data about existing antenatal	Data collection and analysis	To determine requirements for the proposed antenatal care management information system such as inputs, processes
Using software like MS Visio	Using data flow diagrams, sequence diagrams, use case diagrams and class diagrams	Modeling and drawing	To design the antennal care management information system specifications
Using software like Android studio, Android editors and IDEs, Android emulator Firefox	Prototyping using MYSQL, php5, java, C/C++, ASP.NET, Delphi.	Using prototypes	To implement, test and validate the antenatal care management information system

CHAPTER FIVE: TESTING AND VALIDATION

Testing is the activity to assess the system quality and improve it after identifying the defects or errors it is divided into Unit testing and integration testing. Integration testing is the software development process in which program units are combined and tested as groups in multiple ways (Margret, 2017). Unit testing is a component of test-driven development (TDD), a pragmatic methodology that takes a meticulous approach to building a product by means of continual testing and revision. (Margret, 2017)

It involves two main activities i.e., Validation (Did you build the right system? Are you responding to the real needs of the user?) and verification (Did you build the system right?)

Validation ensures that system actually meets the user needs and project objectives. It answers the question of, are we building the right system? This is to be done by first developing the version of the system and allowing users to interact with it as they provide feedback on how they find the system.

We shall use different tools to test our application performance including;

1. Android emulator

2. Firefox Mobile emulator

3. Sam sung Java emulator

4. We shall also develop prototypes that we shall serve out to people and get their feedback about our proposed system.

ANCMIS was tested to check whether the system satisfied user needs and expectations. Four testing criteria namely unit testing, integration testing, system testing and user acceptance testing were used for checking the efficiency and effectiveness of the ANCMIS.

5.1 Unit testing

Several units of ANCMIS were tested against the inputs into the system to validate and verify their functionality.

a) Login page.

Item name	Test description	Expected results	Actual results
User name/Email	-leave it blank	-An error message that informs user that username/email can't be blank	-Error message; user name/email cannot be blank
	-type wrong user name	-Error message tells user that user name/email is incorrect	-Error message; incorrect user name/email
	-type correct user name	-No error is expected	-No error.
Password	-leave it blank	-an error message that tells a user that password cannot be blank	-Error message; password cannot be blank
	-type wrong password	-an error message tells user that password is incorrect.	-Error message; incorrect password
	-type correct password	- No error	-No error
Login button	-click on button	-if password and email are correct, user successfully logs in ANCMIS	-User logs in successfully

Table 2: Unit testing results

5.2 Integration testing

Entailed testing of all modules to check on quality assurance, verification and validation or reliability. The units that were tested as in unit testing above were tested as a whole to point on their performance.

5.3 System testing

The whole system functionality was tested. The researchers acknowledge that all the modules were tried on various devices using various inputs and the system showed consistency in giving the outputs as it had been required to do.

5.4 User acceptance testing

Involved a series of specific tests that helped to indicate whether or not the ANCMIS met the user needs and expectation. The testing was to continue even after software release. The testing included two tests that are the alpha and beta testing.

a) **Alpha testing**

it was implemented in the early testing phases of the system development which included checking of bugs and usability issues in the web application.

b) **Beta testing**

Testing of computer applications not yet officially released. Beta testing was implemented in Terry's health center Nakulabye Kampala. The pre released version was unstable and the users' suggestions and feedbacks were to be considered in the next development cycle.

CHAPTER SIX: RELIABILITY OF THE TOOLS

Reliability of research tools is the degree to which an assessment tool produces stable and consistent results (Mosksl and Leydens, 2000). They define the following types of reliability;

Test-retest reliability. It's a measure of reliability obtained by administering the same test twice over a period of time to a group of individuals. The results from the two tests can then be correlated in order to evaluate the test for stability over time.

Internal consistency reliability. It's a measure of reliability used to evaluate the degree to which different test items that probe the same construct produce similar results.

Parallel forms reliability. It's a measure of reliability obtained by administering different versions of an assessment tool to the same group of individuals.

6.1 Ethical Considerations

Ethical considerations

According to Miller (2008), ethical considerations are accepted or not accepted in research and they include the following;

Privacy: what information about one's self or one's association must a person reveal to other, under what conditions and with what safeguards? What thing can people keep to themselves and not be forced to reveal to other? What information is required to divulge about one's self to other? Under what conditions? What information should one be able to keep strictly to one self? These are among the questions that a concern for privacy raises. Today more than ever cautious citizens must be asking these questions.

Accuracy: who is responsible for the authenticity and accuracy of information? Similarly, who is to be held accountable for errors in the information and how is the injured party to be

compensated? Misinformation has a way of destroying people's lives, especially when the part with the inaccurate information has advantage in power and authority

Respect for intellectual Property: who owns information? What are the just and fair prices for its exchange? Who owns the channels, especially the airways, through which information is transmitted? How should access to this scare resource be allocated? One of the most complex issues we face as a society is the question of intellectual property rights. These are substantial economic and ethical concern surrounding these rights; concerns revolving around the special attributes of information itself and the means by which it is transmitted. Any individual item of information can be extremely costly to produce in the first instance.

Accessibility: what information does p person or an organization have a right or a privilege to obtain, under what conditions and with safeguards? Our main avenue to information is through literacy.

CHAPTERSEVEN: SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1 Summary

To summarize, ANCMIS is a web mobile application designed and developed based on Yii framework used for management of information of a typical antenatal care. It is accessed by users who are based within the antenatal care of Mengo hospital. The ANCMIS enables the users to create, update, search, and delete antenatal related records. Apart from these, the user can book appointment with available doctors in the system. Exporting the records to other file types such as PDF and HTML. Retrieving records and doctors' contacts unlike the existing systems discussed in the literature review. For proper functioning of ANCMIS, the users need a reliable internet connection since it is a web mobile based application. Therefore, ANCMIS helps the mess that has been happening in antenatal care in managing records while protecting the principles of information security that is data confidentiality, integrity and availability.

7.2 Conclusions

ANCMIS provides information management solutions in antenatal care. It is secure, user friendly which makes it a proper solution to the manual systems used in managing records within antenatal care. Its user interface makes it easier to access all the information without necessarily moving from one page to another, therefore user does not have more hustle in accessing the content, creating, updating and retrieving records.

7.3 Recommendations

To maximize the utility, effectiveness and the efficiency of the ANCMIS web mobile application, it is recommended to use a desktop, laptop, smartphone or tablet. The system being of help to these antenatal cares, I would recommend the government to provide subsidized or free web hosting to each hospital for the ANCMIS web application.

References

David, P. (2009). A Place to put your apps. New York Times. (2013).

Gerald. (2008). Benefits of management information systems (MIS).

OrnellaLincetto, SeipatiMothebesoana-Amoh, Patricia Gomez, Steven Munjaja. Opportunities for Africa's newborns: Practical data, Policy and programmatic support for newborn care in Africa: (2006).

HarnilOza. (2019). Benefits of Mobile Application.

Harry, J. Rosenblatt. (2014). Systems Analysis and Design, 10th Edition, International Edition. Course Technology, Cengage Learning.

Svangerskapsomsorg I Nnorge, Mange UnodvendigeKontroller, Backs B, Tidsskr Nor Laegeforen. (2002).

Ingram. (2012). Management information systems

Michael S. Ross, MD MHA. (2019).

Joanna Milward. (2019). Kings College London. What is Mobile Health?

Kollmann et al. (2002).Mobile health care applications development.

Kothari, C. R. (2005). Research Methodology: Methods and Techniques (2nd Ed). New Delhi, New Age International (P) Ltd.

Kumar, R. (2005). Research Methodology: A Step-by-Step Guide for Beginners (6th Ed). Montreal, Queen's University Press.

Laudon, K. C. (2009). Essentials of Management Information Systems (9th Ed.). Connecticut, Pearson College Divisions

Laudon, K. C. (2010). Systems Analysis and Design (9th Ed). New York.

Lisa M. (2008). The sage encyclopedia of Qualitative research methods. Los Angeles, California. Sage Publications ISBN 1-4129-4163-6.

Margret Rouse (2008) What you need to know about software testing automation. Retrieved from http://searchsoftwarequalitv.techtarget.com/definition/unit-testing

Miller, C. (2008). Reasons to Use A Content Management System (8th Ed.).England, University of Nottingham.

Rujumba et al. (2013): http://www.biomedcentral/1472_6963/13/189

Samira M Haddad & Renato Souza T. (2019). Antenatal Care

Saunders, M. Lewis, P. &Thornhill, A. (2012) Research Methods for Business Students (6th Ed). Pearson Education Limited.

Sean Peek. Business news daily contributing writer. (2020).

U.S National Library of Medicine (2014).Health Informatics.Retrieved from. https://healthinformatics.uic.edu/resources/articles/4-wavs-health-informatics-improves- patient-care/

Alexander GR, Kot el chuck M. Assessing the role and effectiveness of prenatal care: history, challenges, and directions for future research. Public health Rep. (2001).

VandenBroeck et al. BMC Health Services Research (2016).

APPENDICIES
Appendix A: Work Break-Down Structure

1. Work plan for the proposed antenatal care management information system

Objectives	Activities	Person responsible	When(begin and end)
Understanding how the current system works	Observing different people, attending different workshops about antenatal care	Ationo Sarah, Tugume Barry	Nov to Dec
Identifying requirements for proposed system	Conducting interviews and focused group discussions	Bulya Jackie Kakonge and Nakanwagi Druscilla	Nov to Dec
Designing the system	Drawing DFDs, use case diagrams, EERDs, class diagrams and sequence diagrams.	All group members	Nov to Dec
Testing and validating the proposed system	Giving out prototypes to different people to get their views about the ANCMIS.	All group members	April to May

Table 3: Work plan for the proposed ANCMIS

Appendix B: Budget Estimates

2. Budget estimates for the proposed Antenatal Information Management System in Uganda shilling

ITEMS	AMOUNT(UGX)
Internet	150,000
Labor	0.00000
Transport	100,000
Printing	100,000
Binding	40,000
Total	390,000

Table 4: Budget estimates for the proposed ANCMIS in Uganda shillings

APPENDIX C: Sample Questionnaire for the Doctor

MAKERERE   **UNIVERSITY**

Dear Respondent

We are students of Makerere University pursuing a bachelor of information systems Technology. We are conducting research for the development of an antenatal care management information system. A case for improving on existing antenatal care system at Mengo Hospital. We kindly request you to spare sometime and fill this questionnaire.

The purpose of this study is purely academic and all the information given will be treated with confidentiality and anonymity will be strongly observed.

Name:

…………………………………………………………………………………..

Department.

…………………………………………………………………………………

For how long have you been were at Mengo Hospital?

…………………………………………………………………………………………

How do you find Antenatal Care Operations?

…………………………………………………………………………………………

Do you provide Antenatal Care on a daily basis?

…………………………………………………………………………………………

Do you have any plans of recommending information system technology to be used in
Antenatal?

……………………………………………………………………………………………

……………………………………………………………………………………………

Have you used any Information system technology in Antenatal Care here at hospital?

……………………………………………………………………………………………

What challenges do you as specialists face in administering Antenatal Care?

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

If you were to change which method would you recommend to hospital?

……………………………………………………………………………………………

How many mothers do you attend to on a daily basis?

……………………………………………………………………………………………

Appendix D: Sample Questionnaire for the antenatal mothers. / patient

MAKERERE   UNIVERSITY

Dear Respondent

We are students of Makerere University pursuing a bachelor of information systems Technology. We are conducting research for the development of an antenatal care management information system. A case for improving on existing antenatal care system at Mengo Hospital. We kindly request you to spare sometime and fill this questionnaire.

The purpose of this study is purely academic and all the information given will be treated with confidentiality and anonymity will be strongly observed.

QUESTIONNAIRE ON MATERNAL HEALTH SERVICES

I.   INVESTIGATOR INFORMATION

Name of investigator………………………Starting time……………………..

Date…………………………….Ending time……………………………………

II. DEMOGRAPHIC QUESTIONS

1).What is your name?..

2).What is your age?..

3).Location/address…………………………………………………

III. QUESTIONS ON MATERNAL HEALTH SERVICES

GENERAL

4).Which type of health facility did you visit for maternal health services during your most recent pregnancy?

1-government clinic/hospital(skip to question 6)

2-private clinic/hospital

3-NGO

4-traditional birth attendant

5) If you did not use government clinic/hospital, what was the primary reason?

1-service not satisfactory

2-long waiting periods

3-doctors are not available

4-medicines are not available

5-long distance

6-treatment is costly

(if the respondent has not used a government clinic, the interview ends here)

ACCESSIBILITY

6) How long does it take to travel to government primary health clinic?

1-less than 30 mins

2-30 mins to 1 hour

3-1 hour to 1- 30mins hours

4-more than 2 hours

7) Which mode of transport do you use to go to the government health clinic?

1-walking

2-bicycle

3-public transportation

4-car

8) What was the average amount of time that you waited to see medical staff when you visited the clinic?

1-less than 30mins

2-30 mins to 1 hour

3-1 hour to 1-30mins hours

4-1-30mins to 2 hours

5-more than 2 hours

HEALTH SERVICES RECEIVED DURING PREGNANCY

9) Did you receive medical care during pregnancy at the government primary clinic?

1-yes

2-no (skip to question 14)

10) How many times did you visit the clinic during your pregnancy?

1-1-3 visits

2-more than 3 visits

11) What health services did you receive when you visited the clinic during your pregnancy?
(multiple responses)

1-physical examination (including weight, blood pressure, heart rate)

2-gynaecological examination

3-ultra sound

4-HIV/STD testing

5-blood tests

6-nutritional supplements

7-tetanus vaccine

12) Were there any complications detected during your pregnancy?

1-yes

2-no

HEALTH SERVICES RECEIVED DURING DELIVERY

14) During delivery, were you attended by a skilled birth attendant(doctor, nurse or midwife?)

1-yes

2-no

15) Who were you attended by?

1-doctor

2-nurse

3-midwife

16) How satisfied were you with the care you received from the skilled birth attendant?

1-completely satisfied

2-partially satisfied

3-neither satisfied nor dissatisfied

4-dissatisfied

17) What were the reasons for your dissatisfaction?(open ended)

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

18) Did you experience any complications during delivery?

1-yes

2-no(skip to question 23)

19) Did the primary clinic provide emergency care for these complications?

Yes (skip to question 23)

2-no

20) Were you taken to secondary hospital for emergency care?

1-yes (skip to question 23)

2-no

21) What was the primary reason you did not receive emergency care?

1-no skilled birth attendant

2-necessary drugs unavailable

3-necessary medical supplies/equipment unavailable

4-no transport to secondary education

5-others (please specify ;……………………………………………………………….…)

22) What happened as a result of not receiving emergency care?(open ended)

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

HEALTH SERVICES RECEIVED AFTER DELIVERY

23) Did you receive medical care after delivery?

1-yes

2-no (skip to question 28)

24) How many times did you visit the clinic after delivery?

1-1-2 visits

2-more than 2 visits

25) What health services did you receive when you visited the health clinic after your delivery?

(multiple responses)

1-physical examination

2-counselling on breast feeding

3-contraceptives

4-blood test for anaemia

5-nutritional supplements

6-information on warning signs of problems

26) Did you experience any problems after your delivery?

1-yes

2-no (skip to question 28)

27) Did you receive a referral to a secondary hospital?

1-yes

2-no

COSTS

28) In total, how much did your household spend for maternal health services during your last pregnancy?

1-less than 100,000 ugx

2-200,000 to 400,000 ugx

3-more than 400,000 ugx

29) Did you pay any bribes for maternal health services?

1-yes

2-no (skip to question 32)

30) For what purpose was the bribe paid?(open ended)

……

……

……

31) Was it demanded or you paid it on your own?

1-demanded

2-paid on my own

SATISFACTION

32) Overall how satisfied were you with the maternal health services you received?

1-completely satisfied

2-partially satisfied

3-dissatisfied

SUGGESTIONS

33) What are your suggestions for improving maternal health services at government primary health clinics?(Open ended)

Appendix E: Sample Questionnaire for the midwife

MAKERERE   **UNIVERSITY**

Dear Respondent

We are students of Makerere University pursuing a bachelor of information systems Technology. We are conducting research for the development of an antenatal care management information system. A case for improving on existing antenatal care system at Mengo Hospital. We kindly request you to spare sometime and fill this questionnaire.

The purpose of this study is purely academic and all the information given will be treated with confidentiality and anonymity will be strongly observed.

Name:

…………………………………………..

For how long have you been working at Mengo Hospital?

………………………………………………………………………………………………….

How do you find antenatal care operations?

………………………………………………………………………………………………….

Do you provide / administer antenatal care on a daily?

………………………………………………………………………………………………….

Has the hospital used any information system technology in providing antenatal care before?

………………………………………………………………………………………………

What challenges do you face as a midwife at your work place?

……………………………………………………………………………………………………

Would you recommend to hospital management to start using information system technology

in administering Antenatal Care?

……………………………………………………………………………………………………

How many mothers do you help in delivering daily basis?

……………………………………………………………………………………………………

Appendix F: Sample questionnaire for nurse

MAKERERE   **UNIVERSITY**

Dear Respondent

We are students of Makerere University pursuing a bachelor of information systems Technology. We are conducting research for the development of an antenatal care management information system. A case for improving on existing antenatal care system at Mengo Hospital. We kindly request you to spare sometime and fill this questionnaire.

The purpose of this study is purely academic and all the information given will be treated with confidentiality and anonymity will be strongly observed.

Name:

…………………………………………………..

Address:

………………………………………………………

For how long have you been working at Mengo hospital?

………………………………………………………………………………………………

How many maternal mothers do you attend to in a day?

………………………………………………………………………………………………

Do you attend maternal mothers on a daily basis?

………………………………………………………………………………………………

What challenges/ problems do you nurses face when providing antenatal care?

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

Has the hospital management used any information system technology in antenatal care?

………………………………………………………………………………………………

Have nurses recommended to hospital management to use information system technology in administering antenatal care?

………………………………………………………………………………………………

Appendix H: Sample questionnaire for validation of new system

MAKERERE   UNIVERSITY

Dear Respondent

We are students of Makerere University pursuing a bachelor of information systems Technology. We are conducting research for the development of an antenatal care management information system. A case for improving on existing antenatal care system at Mengo Hospital. We kindly request you to spare sometime and fill this questionnaire.

The purpose of this study is purely academic and all the information given will be treated with confidentiality and anonymity will be strongly observed.

MESSAGE

i)   Background of respondents

   a) Gender   Male ☐   Female ☐

   b) Age ………..

2) Experience with system

i) Do you like to use this system more often.

  Yes ☐   No ☐

ii) Would you need a technical person to give you support

  Yes ☐   No ☐

iii) I felt very confident using new system

    Yes ☐   No ☐

iv) Do you need to learn a lot before using new system

Yes ☐   No ☐

Overall reaction to new system.

Difficult

Frustrating

Terrible

Rigid

Not communicating

Learning to operate system.

Very difficult ☐   Difficult ☐   Easy ☐   Very easy ☐

Error messages are

Very helpful ☐   Not helpful ☐

Help messages on screen are.

Not helpful ☐   Helpful ☐

System reliability.

Unreliable ☐   Reliable ☐   Very reliable ☐

Use of colors and sounds.

Very poor ☐   Poor ☐   Good ☐   Very good ☐