

ANTENATAL AND POSTNATAL CARE INFORMATION SYSTEM

CASE STUDY: NAGONGERA HEALTH CENTRE IV

BY

NYABURU ROSE MARY

BU/UP/2023/1508

+256 761097562

rosemarynyaburu2@gmail.com

**A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF COMPUTER
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SUPERVISOR

DR. LUKYAMUZI ANDREW

**DEPARTMENT OF COMPUTER STUDIES
FACULTY OF SCIENCE AND EDUCATION**

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DECLARATION

I, NYABURU ROSE MARY, with registration number BU/UP/2023/1508 hereby declare that this project report is original and has not been published or submitted for any other degree award to any other university before.

Sign: 

Date: 24th . 08 . 2026

NYABURU ROSE MARY

APPROVAL

This is to acknowledge that this project report is for Nyaburu Rose Mary, Registration number BU/UP/2023/1508. It was done under my supervision and was completed successfully.

Sign: 

Date: 

DR. LUKYAMUZI ANDREW

Department of Computer Studies, Faculty of Science and Education

Sign: 

Date: 

MR. MULIKA GERALD

Department of Computer Studies, Faculty of Science and Education

DEDICATION

I thank the Almighty God who successfully enabled me to complete with a sound mind and good health. I then dedicate this report to my parents for being supportive both financially and spiritually throughout this project work.

I also appreciate my mother Mrs. Mukhwana Celestine and my sister Miss. Nangila Margaret who have been putting me in their prayers. Thank you so much for the support and may the Almighty God reward you abundantly.

Special thanks to my dear supervisor Dr. Lukyamuzi Andrew who guided me on the dos and don'ts that made this report a success. For if it was not him, maybe I would not reach this level.

Let me also thank everyone that has put his/her effort in support for my education up to this level including my dear colleagues in the computer class as well. I would like to dedicate this report to them too. Since I would not have completed this research without their help. Thank you, my dear friends. May the Almighty God bless you.

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LIST OF ACRONYMS

ANC – Antenatal Care

PNC – Postnatal Care

WHO – World Health Organization

MOH – Ministry of Health

HMIS – Health Management Information System

EMR – Electronic Medical Record

EHR – Electronic Health Record

HIS – Health Information System

HC IV – Health Centre IV

OPD – Outpatient Department

HIV – Human Immunodeficiency Virus

AIDS – acquired immunodeficiency syndrome

LMP – Last Menstrual Period

EDD – Expected Date of Delivery

HTML – Hypertext Markup Language

CSS – Cascading Style Sheets

PHP – Hypertext Preprocessor

MySQL – My Structured Query Language

XAMPP – Cross-Platform, Apache, MySQL, PHP and Perl

RAD – Rapid Application Development

SDLC – System Development Life Cycle

UML – Unified Modeling Language

ERD – Entity Relationship Diagram

DFD – Data Flow Diagram

UAT – User Acceptance Testing

CRUD – Create, Read, Update and Delete

API – Application Programming Interface

SMS – Short Message Service

ABSTRACT

The maternal health services at Nagongera Health Centre IV, including antenatal care (ANC), delivery, and postnatal care (PNC), have traditionally been documented using a manual, paper-based approach. This has proven to be inefficient, time-consuming, and prone to errors such as data loss, duplication, inefficiencies in patient tracking, and delays in reporting. As a result, healthcare workers experience difficulties in record management while mothers face delays in service delivery.

This study focused on the design and implementation of a Web-Based Antenatal and Postnatal Care Information System aimed at improving the efficiency, transparency, data security, and reliability of maternal health record management. Drawing on best practices from existing electronic medical record and maternal health tracking systems, the proposed system enables healthcare workers to register patients digitally, record prenatal visits, schedule appointments, manage deliveries, register children, track immunizations, and generate reports. Administrators can monitor the entire process, manage user accounts, and generate system-wide statistics.

A qualitative research design was used, combining interviews, observation, questionnaires, and document review to gather system requirements from health administrators, midwives, nurses, and records officers. The system was developed using the Software Development Life Cycle (SDLC) methodology. Implementation was carried out using XAMPP, PHP, MySQL, HTML, CSS, and JavaScript.

The system was tested through unit, integration, functional, and user acceptance testing. The results from validation indicated improved efficiency, reduced record retrieval time, and increased user satisfaction. The findings confirm that the proposed system effectively addresses the limitations of the manual antenatal care process and supports digital transformation in healthcare administration. Future work should focus on hosting the system on a commercial cloud platform, integrating SMS notifications, and extending it to a mobile application for enhanced accessibility.

CHAPTER ONE: INTRODUCTION

1.1 Background of study

Maternal and neonatal health remains a top priority for global public health, particularly in Sub-Saharan Africa, where the burden of maternal mortality is so high. In Uganda, the Ministry of Health has implemented various frameworks to improve Antenatal Care (ANC) and Postnatal Care (PNC), yet many rural facilities continue to struggle with the management of patient data (Musiimenta et al., 2022). Traditionally, these health centers rely on the National Health Management Information System (HMIS), which is predominantly paper-based.

According to (Fatajo & Sa, 2026), the reliance on manual records in Uganda's health sector leads to significant delays in data retrieval and limits the ability of clinicians to make evidence-based decisions during critical obstetric emergencies. The World Health Organization (WHO) emphasizes that high-quality maternal care requires a minimum of eight antenatal contacts to reduce stillbirths and improve the pregnancy experience (Von Dadelszen & Magee, 2017). However, achieving this continuity is difficult without a centralized tracking mechanism. Recent studies by (Musiimenta et al., 2022) suggest that digital health interventions, such as web-based or mobile applications, can significantly bridge this gap by improving maternal knowledge and ensuring that both midwives and mothers adhere to clinical care schedules.

1.2 Problem statement

The manual antenatal care management system at Nagongera Health Centre IV is paper-based, which is inefficient, time-consuming, and limits transparency and accountability. Healthcare workers face challenges such as loss or damage of patient records, slow retrieval of patient information, data duplication and inconsistency, poor security of sensitive patient information, difficulty in generating reports, increased workload, and delays in service delivery.

Administrators face challenges with limited oversight of maternal health records across service points, inability to identify bottlenecks in patient flow, difficulty in generating reports on antenatal attendance and outcomes, and no centralized data for decision-making and process improvement.

1.3 Main objective

To develop a web-based Antenatal and Postnatal Care Information System for Nagongera Health Centre IV that enables healthcare workers to register patients digitally, manage prenatal records, schedule appointments, record deliveries, manage child records, track immunizations, and offers administrators tools for monitoring, reporting, and decision-making.

1.4 Specific objectives

- 1) To review literature and determine requirements for a university-level antenatal and postnatal care information system.
- 2) To design a web-based antenatal and postnatal care information system based on identified requirements and user needs.
- 3) To implement the proposed system using suitable modern technologies (XAMPP, PHP, MySQL, HTML, CSS, JavaScript).
- 4) To test and validate the web-based antenatal and postnatal care information system to ensure usability, reliability, security, and accuracy.

1.5 Significance of the study

The need for a web-based antenatal and postnatal care information system at Nagongera Health Centre IV is clear due to the limitations of the current manual system for helping healthcare workers manage maternal health records. The present reliance on paper records results in poor patient record keeping, limited ability to monitor, track and report maternal health services. Administrators also face limited oversight of the workflow, inability to identify bottlenecks, and lack of data for strategic decision-making. These inefficiencies result in delayed service delivery, overworked staff, and compromised quality of maternal healthcare.

The successful completion of this study provides several important benefits: digital patient registration and prenatal record management; appointment scheduling with tracking; delivery and child record management; immunization tracking; automated report generation; role-based access control for administrators and healthcare workers; improved data security; and support for district-level reporting, contributing to Uganda's health goals and promoting equity in rural maternal health care services.

1.7 Scope of the study

1.7.1 Geographical Scope

The study was conducted at the Antenatal Care department of Nagongera Health Centre IV, located in Nagongera Town Council, Tororo District, Uganda.

1.7.2 Content Scope

A web-based antenatal and postnatal care information system provides a complete digital platform designed specifically for maternal health record management at Nagongera Health Centre IV. The system features multiple user roles, including administrators and healthcare workers. Core functionalities of the system include user management, patient registration, prenatal visit management, appointment scheduling, delivery management, child record management, immunization management, and report generation.

Administrators are responsible for system management tasks such as user registration, overall system monitoring, and report generation. Healthcare workers are responsible for logging into the system, registering patients, recording prenatal visits, scheduling appointments, recording deliveries, registering children, tracking immunizations, and generating reports.

1.7.3 Time Scope

The study was conducted over a period of three (3) months, beginning from 1st January 2026 to 30th March 2026.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This literature review examines existing research and implemented systems related to antenatal care information systems, electronic medical records, and maternal healthcare management. The review synthesizes findings from multiple studies conducted across various healthcare institutions and identifies gaps that the proposed system seeks to address.

2.2 Design and Development of an Antenatal Care Management Platform

(Aliyi et al., 2023) conducted a study on the design and development of a web-based antenatal care management platform. The authors noted that maternal health remains a critical public health concern, particularly in low-resource settings where manual record-keeping leads to incomplete data, delayed interventions, and poor continuity of care.

The study identified that traditional antenatal care documentation relies on paper registers and cards, which are prone to loss, damage, and difficulty in retrieval. Healthcare workers spend considerable time searching for records, and managers lack timely data for planning and reporting. The main idea of the project was to design and develop a new system for managing maternal health in antenatal care.

The system was developed as a web-based application supporting patient registration, prenatal visit recording, appointment management, and basic reporting. The authors emphasized improved data accuracy, faster retrieval of patient information, and support for clinical decision-making. The study concluded that a computerized antenatal care platform can significantly improve service delivery and data quality when designed around the workflow of midwives and nurses.

2.3 Electronic Medical Records and Antenatal Care Services in Rural Health Centers

(Chawani, 2014) presented a qualitative cross-case analysis of the effects of Electronic Medical Record (EMR) deployment on antenatal care services in two rural health centers. The paper examined how EMRs change work practices, data quality, and service delivery in antenatal clinics.

The study found that before EMR implementation, antenatal care information was recorded in multiple paper registers, leading to duplication, incomplete entries, and challenges in generating monthly reports for the district health management information system. After deployment, clinicians could access previous visit history more quickly, and reporting became more consistent. However, the authors also noted challenges including limited computer skills among staff, intermittent power supply, and the need for ongoing technical support.

The study concluded that EMRs can improve antenatal care documentation and reporting in rural settings, but success depends on training, infrastructure, and alignment of the system with existing clinical workflows. These findings are highly relevant to Nagongera Health Centre IV, which faces similar infrastructural and skill constraints.

2.4 Implementing Electronic Health Records in Primary Care: Lessons from Kenya

(Muinga et al., 2018) studied the implementation of an open-source electronic health record system in Kenyan primary care facilities. The research highlighted that many facilities in sub-Saharan Africa still rely on paper-based systems despite national digital health strategies.

The study identified key enablers of successful EHR implementation including strong leadership support, user training, phased rollout, and adaptation of the system to local workflows. Barriers included inadequate ICT infrastructure, resistance to change, and lack of interoperability with national reporting systems such as DHIS2. The authors recommended that systems designed for maternal health should integrate antenatal, delivery, and postnatal modules and support both facility-level care and district-level reporting.

Implementation technologies commonly used in such projects included web-based front ends, MySQL or similar relational databases, and PHP or other server-side languages similar to the technology stack proposed for the Nagongera system (XAMPP, PHP, MySQL, HTML, CSS, and JavaScript).

2.5 Patient-Held Maternal and Child Health Records

(Turner & Fuller, 2011) reviewed patient-held maternal and/or child health records used in many countries to track health risks, vaccinations, and care contacts. The review noted that patient-held records improve continuity of care when mothers move between facilities, but they do not

replace facility-based information systems needed for aggregate reporting, audit, and decision support.

The authors argued that electronic facility systems and patient-held records can complement each other: digital systems improve data quality and reporting at the facility, while portable records (or digital equivalents such as SMS reminders) support the mother. This dual perspective informs the proposed system, which focuses on facility-level digital records while leaving room for future SMS notifications and patient portals.

2.6 Maternal and Newborn Clinical Management Systems

Large-scale maternal and newborn electronic health record projects, such as the Maternal & Newborn Clinical Management System (MN-CMS) in Ireland, demonstrate the value of integrated digital records covering pregnancy, delivery, and newborn care (Electronic Medical Records in Obstetric and Perinatal Care literature). These systems aim to support clinical documentation, care pathways, and national reporting within a single platform.

Although such national systems operate at a scale beyond a single health centre, their design principles centralized data storage, role-based access, structured prenatal and delivery forms, and reporting are applicable to a health centre level system. The proposed Antenatal and Postnatal Care Information System adopts these principles at a scale appropriate for Nagongera Health Centre IV.

2.7 Features of Electronic Antenatal Care Systems

Based on the reviewed studies, common features of effective electronic antenatal and maternal health systems include:

1. Centralized Repository: A single database that stores patient registration, prenatal visits, appointments, deliveries, child records, and immunization data, eliminating scattered paper files (Aliyi et al., 2023)
2. Role-Based User Modules: Different interfaces and permissions for administrators and healthcare workers (midwives, nurses, records officers) (Aliyi et al., 2023)

3. Prenatal Visit and Appointment Management: Structured recording of antenatal visits (including clinical observations such as blood pressure and weight) and scheduling of follow-up appointments (Aliyi et al., 2023)
4. Delivery and Child Record Linkage: Ability to record delivery outcomes and link newborn records to the mother's file for continuity of care (Turner & Fuller, 2011).
5. Immunization Tracking: Recording of vaccines administered and schedules for subsequent doses.
6. Reporting and Analytics: Generation of reports on antenatal attendance, deliveries, immunizations, and other indicators required for facility and district reporting (Adedeji et al., 2022)
7. Security Features: Role-based access control, secure login credentials, and protection of sensitive patient data (Adedeji et al., 2022)

2.8 Research Gap

The review of literature indicates that many healthcare systems focus on general hospital management or national-scale EHR projects and do not provide a comprehensive, lightweight solution tailored for antenatal and postnatal care at a Health Centre IV level in Uganda. Some systems provide patient registration and appointment management but lack complete prenatal monitoring, delivery management, child record management, immunization tracking, and integrated reporting in a single platform suited to the resource constraints of facilities such as Nagongera Health Centre IV.

Therefore, there is a need for a Complete Antenatal and Postnatal Care Information System that integrates all these functions into a single web-based platform using accessible technologies (PHP, MySQL, HTML, CSS, JavaScript) and aligned with the workflows of midwives, nurses, and records officers at the facility.

2.9 Proposed System

The proposed Antenatal and Postnatal Care Information System is designed to address the limitations of existing systems and of the manual process at Nagongera Health Centre IV by providing a comprehensive solution for maternal healthcare management.

The system includes the following modules: User Management Module; Patient Management Module; Prenatal Records Module; Appointment Management Module; Delivery Management Module; Child Records Module; Immunization Management Module; and Reporting Module. Implementation uses XAMPP, PHP, MySQL, HTML, CSS, and JavaScript, consistent with successful web-based health information systems reviewed in this chapter.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter outlines the methods and procedures used to conduct the research. It encompasses system development that involves research design, area of study, population and sampling methods, data collection methods and analysis, design, implementation, testing and validation, and ethical considerations.

3.2 Research design

Given the nature of the data that was to be collected, which included both numerical figures and descriptive responses, the study adopted both quantitative and qualitative approaches to ensure complete data collection and system validation. The qualitative method involved in-depth interviews to gather detailed insights into user needs and system requirements from healthcare workers and administrators at Nagongera Health Centre IV. This approach was chosen to capture complicated perspectives on natural preferences and challenges in manual antenatal and postnatal record management. The quantitative method was used to validate the system through structured testing, measuring user satisfaction, system performance, and adherence to requirements.

3.3 Area of study

The research was conducted at Nagongera Health Centre IV, located in Nagongera Town Council in Tororo District, about 17 kilometres from Tororo town along Tororo-Busolwe road. The facility provides antenatal care, delivery services, postnatal care, and immunization services to the surrounding community.

3.4 Population and sampling method

Population total

The target population for this study comprised healthcare workers (midwives, nurses, and records officers) and administrators at Nagongera Health Centre IV. Based on facility records, the total population (N) included approximately 12 healthcare workers and 2 administrators who were directly involved in antenatal and postnatal care services.

1. Participants

Participants included: Administrators (Male: 1, Female: 1); Healthcare Workers / Midwives (Male: 1, Female: 6); Records Officers (Male: 1, Female: 0). Total: 11 participants (Male: 4, Female: 7).

<i>Participants</i>	<i>Male</i>	<i>Female</i>
<i>Administrator</i>	1	1
<i>Midwives and health workers</i>	2	6
<i>Records Officers</i>	1	-
	0	1
<i>Total</i>	4	8

*Table 1*Participants

3.5 Data collection methods and analysis

Data collection involved in-depth interviews to identify requirements and gaps in the existing antenatal care system. A semi-structured interview was conducted with healthcare workers and administrators to explore challenges faced with the manual system. Twelve semi-structured interview questions were developed to guide data collection. This number was chosen to ensure complete requirement gathering while maintaining data quality. Observation of the antenatal clinic workflow and review of existing registers and patient cards were also used.

For data analysis, qualitative data from interviews was examined and organized to identify challenges faced by healthcare workers and administrators when managing antenatal and postnatal records. Quantitative data from system testing was analyzed using descriptive statistics

to evaluate user satisfaction. Based on these analyses, the final system requirements were validated.

3.6 System development

The system was developed using Structured Systems Analysis and Design Methodology (SSADM) because it provides a clear, step-by-step approach to system development. Specifically, Rapid Application Development (RAD) was used because of the limited time. The RAD approach followed four key phases: requirements determination, design, implementation, and testing. Eventually, a working prototype was developed which was tested and validated.

3.7 System Design

The system design phase involved creation of a blueprint of the web-based Antenatal and Postnatal Care Information System. The design process steps were as follows.

The development follows the Rapid Application Development (RAD) approach within the Structured System Analysis Design Method (SSADM) framework. RAD is an agile methodology that prioritizes iterative prototyping and user feedback over rigid planning, aimed at shortening the transition from planning to implementation.

The main aim of using RAD in this research is to shorten the time in a traditional system development life cycle between planning and implementing an online transaction processing system.

There are four stages under RAD;

1. Requirement determination. Analysts engage with healthcare workers and administrators to identify pain points, such as physical document loss and lack of real-time tracking of antenatal attendance.

2. Design. At this stage this iterative phase involves creating system mock-ups. Users provide input on the interface for registering patients, recording prenatal visits, and viewing dashboards.

3. Implementation. This is where a discussion between the user and the system analyst and the design of the information system to be built takes place.

4. Testing. The final stage where the system is checked for user satisfaction, ensuring it effectively supports patient registration, prenatal records, appointments, deliveries, and immunization tracking.

Rapid Application Development (RAD)

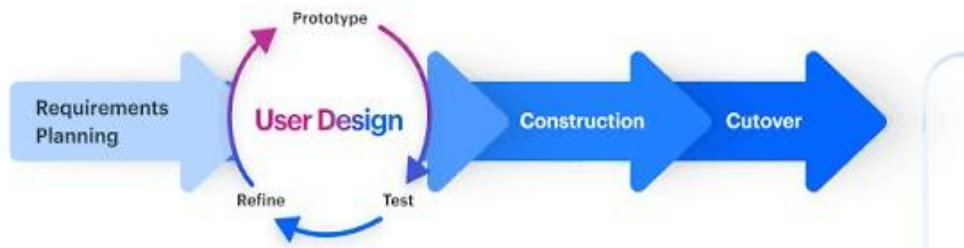


Figure 1: Rapid Application Process

3.7.1 System Architecture

This defined the overall structure of the system and outlined how components interact. The architecture adopted a client-server model, where the frontend provided user interfaces for healthcare workers and administrators, and the backend handled data processing and storage, which ensured efficient data flow.

3.7.2 Context Diagram

The context diagram illustrated the system's interactions with external entities, such as healthcare workers, administrators, and patients. These provided a high-level view of the system's scope and boundaries.

3.7.3 Dataflow Diagram (DFD)

The DFD illustrated how information moves through the system. It broke down the system's main functions into smaller processes, showing how data is transformed from input into useful output for both healthcare workers and administrators.

3.7.4 UML Diagram (Use-Case Diagram)

A Use-Case Diagram visually summarized the interactions between the system's users (called "actors") and the key functions (called "use cases") the system provides. It helped ensure that the system is designed to meet the core needs of both healthcare workers and administrators. The diagram featured three primary actors namely healthcare workers who use the system to register

patients and record clinical data, administrators who manage and monitor the system, and patients whose care records are managed.

3.8 Implementation

The system was developed using modern web technologies to ensure reliability, security, and ease of use. Visual Studio Code was the primary code editor for writing and managing project files, while web browser (Microsoft Edge) developer tools were employed for real-time debugging and testing of the frontend interface during development. The implementation followed a structured approach with clear separation between the backend and frontend components. For the backend development; the server-side of the system was built using PHP: The server-side scripting language used to handle business logic, process patient and clinical records, and communicate with the MySQL database. The frontend included HTML & CSS: For structuring the forms and styling the user interface, JavaScript: To handle client-side validation and asynchronous updates (AJAX) for a smoother user experience. XAMPP was used as the local development environment.

3.9 Testing and validation

The system went through rigorous testing to ensure it is functional, user-friendly, and reliable. The testing process included the following stages:

- 1. Unit Testing:** Individual components were tested in isolation to verify they worked correctly on their own.
- 2. Functional Testing:** The system was evaluated against the initial requirements to ensure all key features worked as intended such as patient registration, prenatal visit recording, appointment scheduling, delivery and immunization tracking.
- 3. Integration Testing:** All system components were tested together to ensure they interact seamlessly. For example, the user interface was tested on how it communicates with the server and database to confirm that data flows smoothly.
- 4. User Acceptance Testing (UAT):** Healthcare workers and administrators from the study sample used the system in a real-world setting at Nagongera Health Centre IV. Their feedback on the system's ease of use, interface design, and relevance was collected to identify any final improvements needed.

5. System Validation: The final system was evaluated to confirm it meets the objectives of the study. The system was validated to ensure that it successfully allows registration of patients, recording of prenatal visits, scheduling of appointments, recording of deliveries and children, tracking of immunizations, and provides useful tools for administrators. Success was measured through user satisfaction surveys and feedback from system participants.

3.10 Ethical consideration

The study adhered to the following ethical principles to ensure integrity and protect participants;

1. Informed consent. All participants were informed about the study's purpose, procedures, and written consent was obtained before interviews.

2. Confidentiality. Participants' data was stored securely in compliance with data protection regulations. Patient health information was treated with strict confidentiality.

3. Participation was voluntary. Participants were free to withdraw at any time without consequences.

4. Transparency. Findings and system outcomes were shared with participants, promoting trust and accountability.

5. Risk minimization. The study prioritized doing no harm by ensuring the system was rigorously tested to prevent errors in patient record management.

6. Respect for autonomy. Participants' rights to make informed decisions about their participation and system usage was respected.

CHAPTER FOUR: FIELD STUDY AND SYSTEM DESIGN

4.1 Introduction

This chapter presents the results from the field study conducted at Nagongera Health Centre IV located in Nagongera Town Council, Tororo District. This chapter describes background information of the current system and new system requirements gathered during the study, including user requirements, functional requirements, and non-functional requirements. It also details the design of the proposed system, covering the system architecture, context diagram, data flow diagrams, entity relationship diagram, and use case diagram.

4.2 Background information of the current system

The current system at Nagongera Health Centre IV for antenatal and postnatal care is completely manual. Healthcare workers are required to record patient information in books, files and registers. The following problems were identified during the field study:

- 1. Time consuming and costly.** Retrieving patient records and generating reports was found to be time consuming due to manual searching through paper files. Healthcare workers reported taking a long time to locate a single patient's history.
- 2. Poor Record Management.** Since the system relied on paper-based forms, antenatal documents were highly vulnerable to loss, misplacement, and physical damage. In cases where records were lost, mothers were required to restart registration or provide information again, leading to increased stress and duplication of work.
- 3. No real-time monitoring.** Administrators did not have a centralized system to monitor antenatal attendance, deliveries, and immunization activities. This made it difficult to track service coverage, identify delays, and monitor performance.
- 4. Limited security and Data integrity.** The current manual system does not have security mechanisms to protect sensitive patient information. Unauthorized access to documents was possible since files were stored physically.

4.3 System Study and Analysis

The study was carried out at Nagongera Health Centre IV. The main purpose of the study was to find out the challenges faced during antenatal care record management by healthcare workers, as well as the difficulties encountered by administrators in monitoring maternal health services and data storage. The study involved examining the existing manual system to identify its strengths and weaknesses. The information acquired from the study was gathered by employing a number of data collection methods, including semi-structured interviews, observation, questionnaires, and document review. The data collected were analyzed to provide the basis for designing a new, web-based antenatal and postnatal care information system.

4.3.1 Findings from interviews and questionnaires

Findings from Healthcare Workers

Healthcare workers (midwives, nurses, and records officers) reported that all maternal health information was recorded manually. The process was not clearly structured for retrieval, and staff often spent significant time searching for patient cards and registers. Delays were attributed to volume of paper records, incomplete entries, and difficulty generating monthly reports for the district. Workers expressed a strong need for digital registration, prenatal visit recording, appointment scheduling, delivery and child records, immunization tracking, and automated reports.

Findings from Administrators

Administrators reported challenges in manual record management, increased workload during busy clinic days, lack of centralized monitoring and control, and communication gaps. They recommended a centralized digital system, dashboards for monitoring, and reporting tools. Conclusion of findings: the existing manual system was inefficient, time-consuming, lacked transparency, and suffered from poor record management. Users were ready for a digital solution.

4.4 User Requirements

User requirements describe what the system must do from the perspective of the end-users. The user requirements were categorized into functional and non-functional requirements as described below.

4.4.1 Functional Requirements

1. User login and authentication. Healthcare workers and administrators must log in with username and password and role-based access.
2. Patient registration. The system must allow registration of pregnant mothers with personal and clinical details.
3. Prenatal records management. Healthcare workers must record prenatal visits including blood pressure, weight, and clinical notes.
4. Appointment scheduling. The system must support scheduling and tracking of antenatal appointments.
5. Delivery and child records. The system must record delivery outcomes and register newborn children linked to the mother.
6. Immunization tracking. The system must record vaccines administered and support follow-up schedules.
7. Report generation. Administrators and authorized workers must generate reports on patients, appointments, deliveries, and immunizations.
8. User and account management. Administrators must manage user accounts and roles.

4.4.2 Non-Functional Requirements

1. Usability. The system must be simple and easy to use with clear menus and buttons.
2. Performance. Pages and reports should open quickly within a few seconds.
3. Security. User and patient information must be protected with passwords and role-based access.
4. Reliability. The system should work without crashing and validate data before saving.
5. Scalability. The system must handle growth in patients and users without redesign.

4.5 Hardware / software requirements

4.5.1 Hardware Requirements

1. A server or hosting machine with a minimum of 80GB hard disk space.
2. A server or hosting machine with a minimum of 4GB RAM.
3. End users only require a smartphone, tablet, or computer with internet access.

4.5.2 Software Requirements

Server-Side Software: Windows, Linux, or macOS; PHP; HTML; MySQL database management system; CSS; JavaScript. End User Software: A modern web browser such as Microsoft Edge or Google Chrome. Development environment: XAMPP.

4.6 System Design

Based on the gathered requirements, the system was designed following the development approach described earlier in chapter 3.

4.6.1 The system architecture

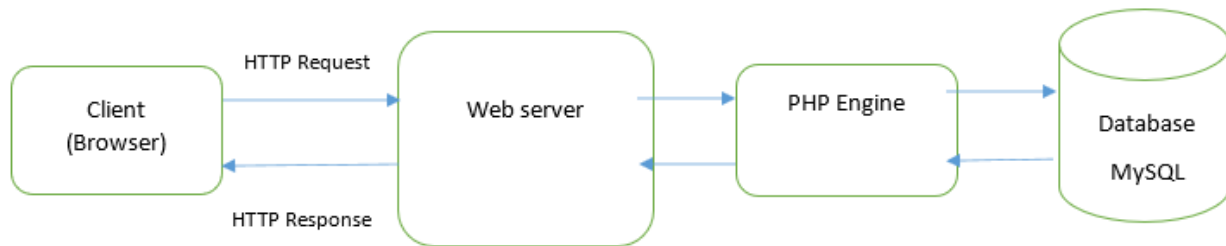


Figure 2: System Architecture

Client Side (Frontend): The client side represents the presentation layer of the system, comprising the devices and web browsers through which end-users interact with the application.

1. Healthcare Worker Client: Accessed via smartphones or computers, this interface allows workers to login, register patients, record prenatal visits, schedule appointments, record deliveries, manage child records, track immunizations, and generate reports.
2. Administrator Client: Accessed via smartphones, computers or tablets, this dashboard enables administrators to manage users, view system-wide statistics, and generate reports.

The client communicates with the server by sending HTTP requests (e.g., POST, GET) and receiving responses.

Server Side (Backend): The server side hosts the core application logic, data storage, and integrations. It is responsible for processing client requests, enforcing business rules, securing data, and returning appropriate responses.

1. Web Server: Entry point for all client requests; handles HTTP/HTTPS traffic and routes requests.
2. Application Server (PHP Engine): Handles business logic organized into modules (user management, patient, prenatal, appointment, delivery, child, immunization, reporting).
3. Database Server: MySQL RDBMS stores user profiles, patients, prenatal records, appointments, deliveries, children, and immunizations.

4.6.2 Context Diagram (Level 0 DFD)

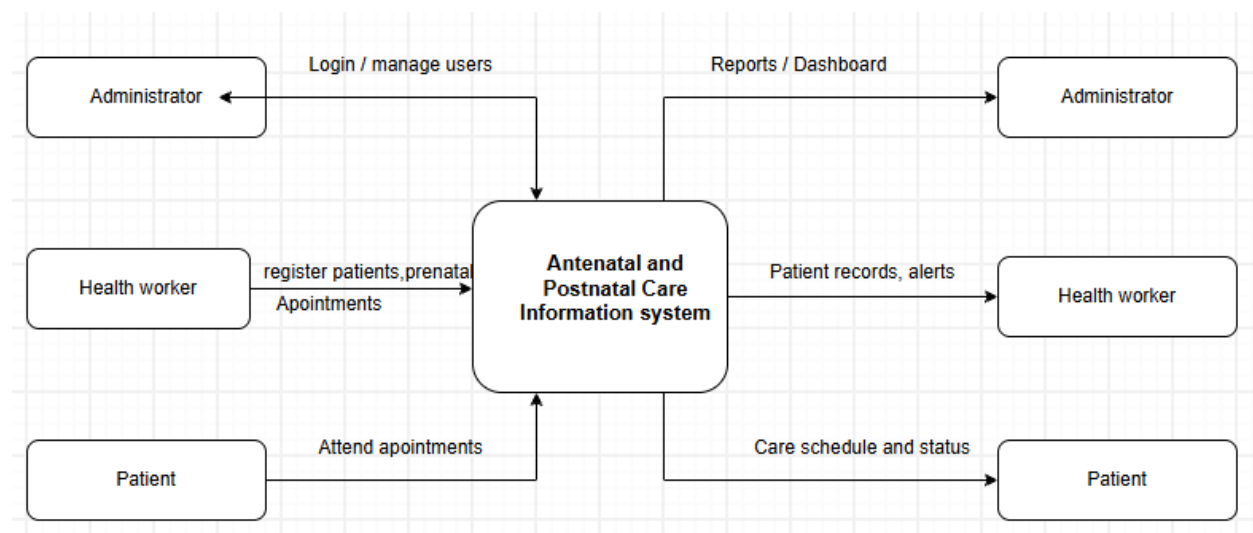


Figure 3: Context Diagram (Level 0 DFD)

Inputs and Outputs for Context Diagram

From Healthcare Worker to System (Inputs): Login credentials; patient registration details; prenatal visit data; appointment schedules; delivery and child records; immunization records.

From System to Healthcare Worker (Outputs): Patient records; appointment lists; reports; confirmation messages.

From Administrator to System (Inputs): Login credentials; user management actions; system configuration.

From System to Administrator (Outputs): Dashboards; statistics; reports; user activity logs.

From Patient to System (Inputs): Attendance at appointments; receipt of care (captured by workers).

From System to Patient (Outputs): Care schedule information; immunization status (via workers).

4.6.3 Data Flow Diagram (DFD)

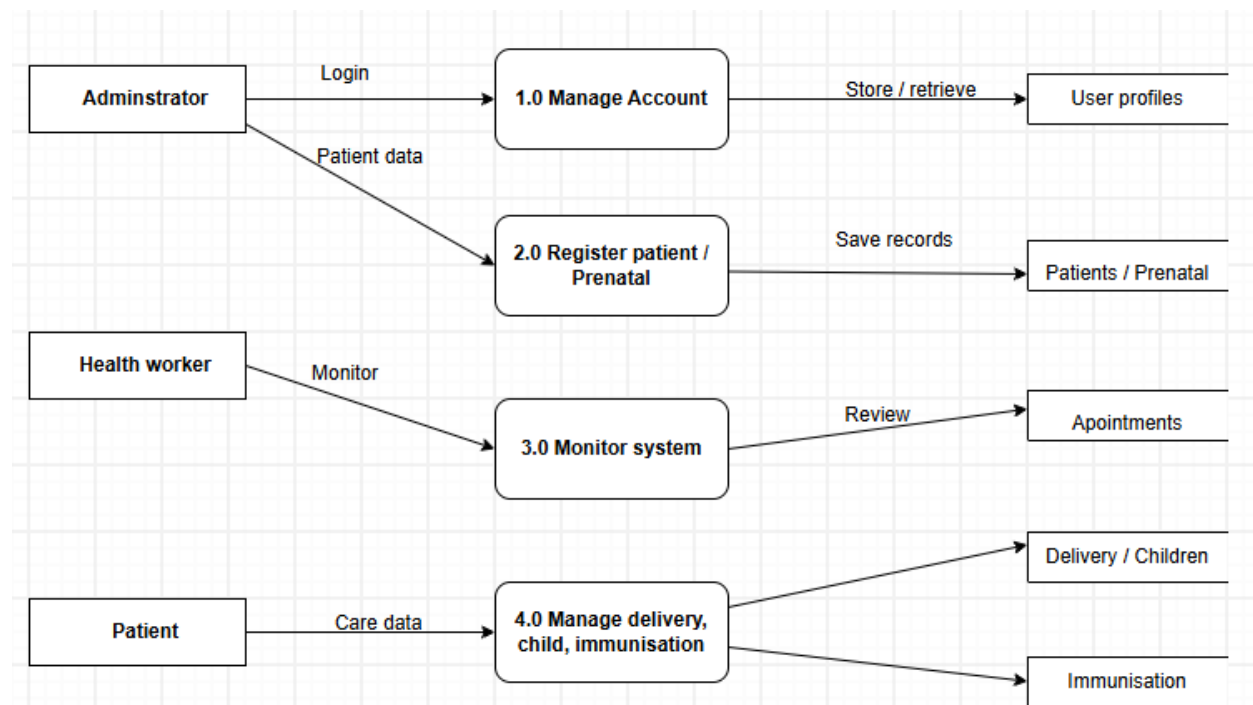


Figure 4: Data Flow Diagram

The components of the DFD Level 1

1. Processes: 1.0 Manage Account (registration, login, profile updates); 2.0 Register Patient / Prenatal (patient registration and prenatal visit recording); 3.0 Monitor System (administrator dashboards and user lists); 4.0 Manage Delivery / Child / Immunization (delivery outcomes, child registration, immunization tracking).

2. Data Stores: User Profiles; Patients / Prenatal Records; Appointments; Deliveries / Children; Immunizations.

3. External Entities: Healthcare Worker; Administrator; Patient.

4. Data Flows: Register/Login; Store/Retrieve patient and clinical data; Display records and reports; Confirmation messages.

4.6.4 The Use Case Diagram

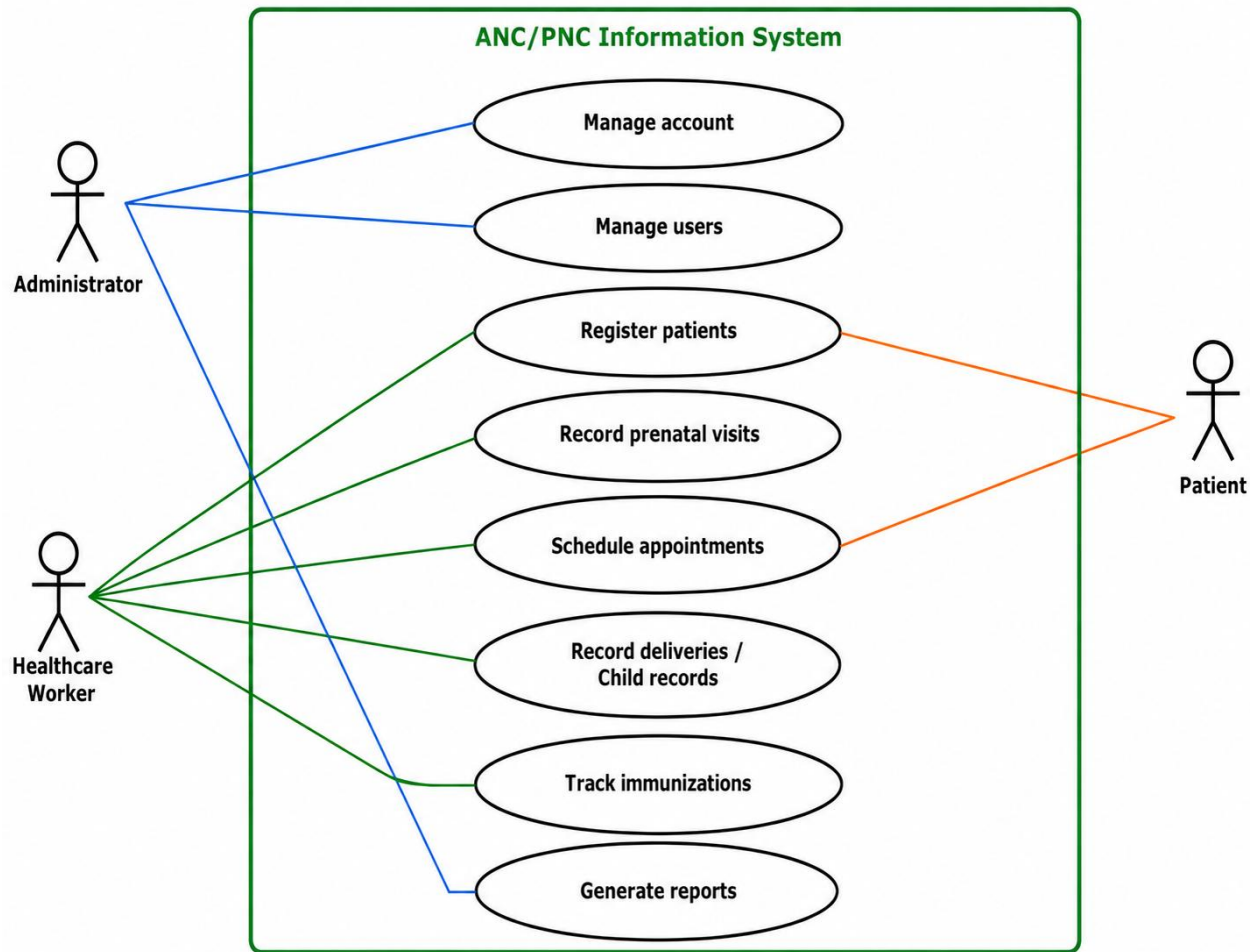


Figure 5: Use Case Diagram

Actors

1. Administrator: Responsible for overall system management, user accounts, and reporting.

2. Healthcare Worker: Midwives, nurses, and records officers who register patients, record prenatal visits, schedule appointments, record deliveries, manage child records, and track immunizations.

3. Patient: Pregnant mother or caregiver who receives services; data is captured by healthcare workers.

Use Cases

For the Administrator: Manage account; Manage users; Monitor system; Generate reports.

For the Healthcare Worker: Register patients; Record prenatal visits; Schedule appointments; Record deliveries; Manage child records; Track immunizations; Generate reports.

For the Patient: Attend appointments; Receive antenatal and immunization services (records updated by workers).

4.6.5 The Entity Relationship Diagram (ERD)

The Entity Relationship Diagram shows the relationship between the entities within the system. The major entities include Users, Patients, Prenatal Records, Appointments, Deliveries, Children, and Immunizations. Relationships are primarily one-to-many (1:M) from patients to clinical records, and from Children to Immunizations.

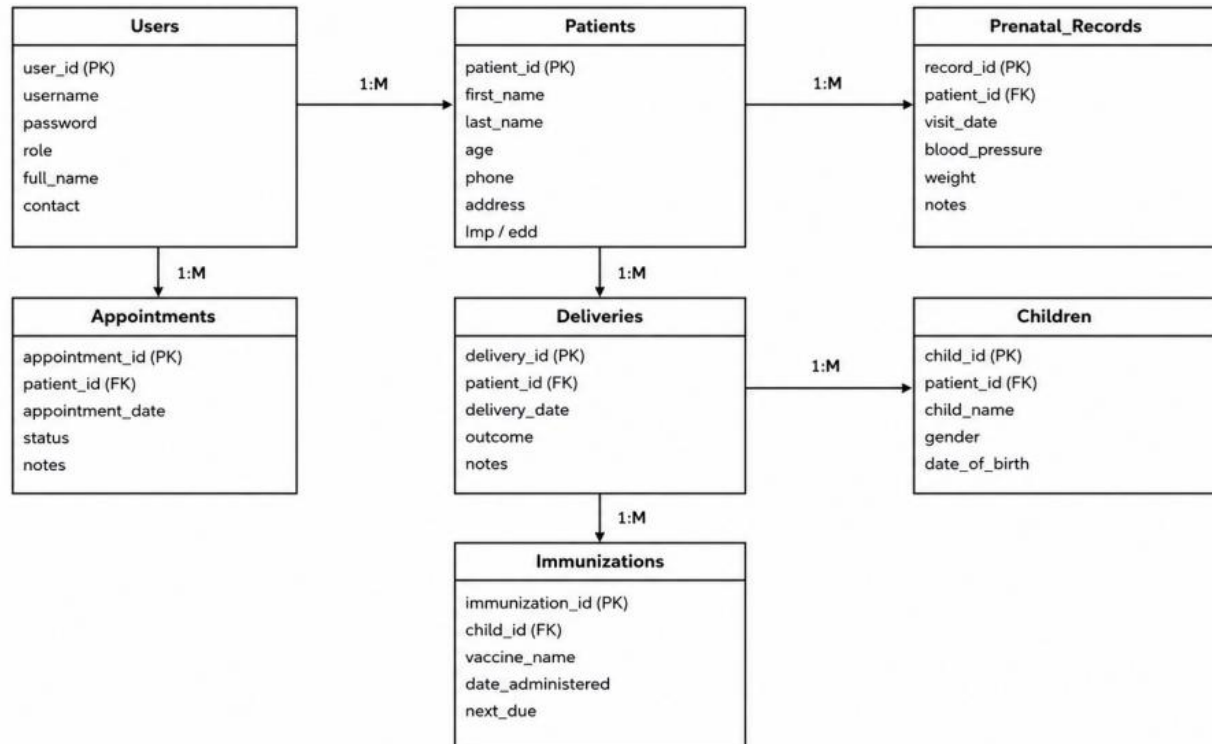


Figure 6: Entity Relationship Diagram

1. Users table

This table stores information about people who are authorized to access the antenatal care information system. It manages login credentials and user roles.

Field Name	Data Type	Description
user_id	INT (PK)	Primary key
Username	VARCHAR(100)	Login username
Password	VARCHAR (255)	Hashed password
Role	VARCHAR (50)	admin / healthcare_worker
full_name	VARCHAR (150)	Full name
Contact	VARCHAR (20)	Phone number

Table 2:Users

2. Patients table

The **Patients table** stores the personal and pregnancy-related information of mothers receiving antenatal care at the health facility.

Field Name	Data Type	Description
patient_id	INT (PK)	Primary key
first_name	VARCHAR (100)	First name
last_name	VARCHAR (100)	Last name
Age	INT	Age in years
Phone	VARCHAR (20)	Contact number
Address	TEXT	Home address
Lmp	DATE	Last menstrual period
Edd	DATE	Expected date of delivery

Table 3:Patients

3. Prenatal records table

This table stores information collected during a patient's antenatal visits.

Field Name	Data Type	Description
record_id	INT (PK)	Primary key
patient_id	INT (FK)	Foreign key to Patients
visit_date	DATE	Date of visit
blood_pressure	VARCHAR (20)	BP reading
Weight	DECIMAL (5,2)	Weight in kg
Notes	TEXT	Clinical notes

Table 4: Prenatal records

4. Appointments table

This table stores information about scheduled antenatal or follow-up appointments for patients.

Field Name	Data Type	Description
appointment_id	INT (PK)	Primary key
patient_id	INT (FK)	Foreign key to Patients
appointment_date	DATE	Scheduled date
Status	VARCHAR (50)	pending / completed / missed
Notes	TEXT	Appointment notes

Table 5: Appointments

5. Deliveries table

The Deliveries table stores information about a patient's delivery after pregnancy.

Field Name	Data Type	Description
delivery_id	INT (PK)	Primary key
patient_id	INT (FK)	Foreign key to patients
delivery_date	DATE	Date of delivery
Outcome	VARCHAR (100)	Birth outcome
Notes	TEXT	Delivery notes

Table 6: Deliveries

6. Children table

The Children table stores information about children born to patients registered in the system.

Field Name	Data Type	Description
child_id	INT (PK)	Primary key
patient_id	INT (FK)	Foreign key to mother (Patients)
child_name	VARCHAR (100)	Child name
Gender	VARCHAR (20)	Male / Female
date_of_birth	DATE	Date of birth

Table 7: Child records

7.Immunizations table

This table stores vaccination information for children registered in the system.

Field Name	Data Type	Description
immunization_id	INT (PK)	Primary key
child_id	INT (FK)	Foreign key to Children
vaccine_name	VARCHAR (100)	Vaccine name
date_administered	DATE	Date given
next_due	DATE	Next dose due date

Table 8: Immunizations

The Entity Relationship Diagram relationships

1.Patients to Prenatal Records

There is a one-to-many (1:M) relationship between Patients and Prenatal Records.

One patient can have many prenatal records because a mother normally attends several antenatal visits.

3. Patients to Appointments

There is a one-to-many (1:M) relationship between Patients and Appointments.

- One patient can have several appointments during pregnancy.

4. Patients to Deliveries

There is a one-to-many (1:M) relationship in the database structure between Patients and Deliveries.

- A patient can have delivery records.

5. Patients to Children

There is a one-to-many (1:M) relationship between Patients and Children.

- One mother can have one or more children recorded in the system.
- Each child is associated with one mother.

6. Children to Immunizations

There is a **one-to-many (1:M)** relationship between **Children** and **Immunizations**.

- One child can receive several vaccines.
- Each immunization record belongs to one child

CHAPTER FIVE: IMPLEMENTATION AND TESTING

5.0 Introduction

This chapter introduces the developed application and places emphasis on the outputs produced by the system. It explains the interfaces designed for entering user information, querying the database and generating reports.

5.1 Interface Design

5.1.1 Login Page

This is the page displayed when the system starts. Users enter their username and password to access the system. The system validates the credentials before granting access. Upon successful login, administrators can access all modules while healthcare workers can access authorized functions.

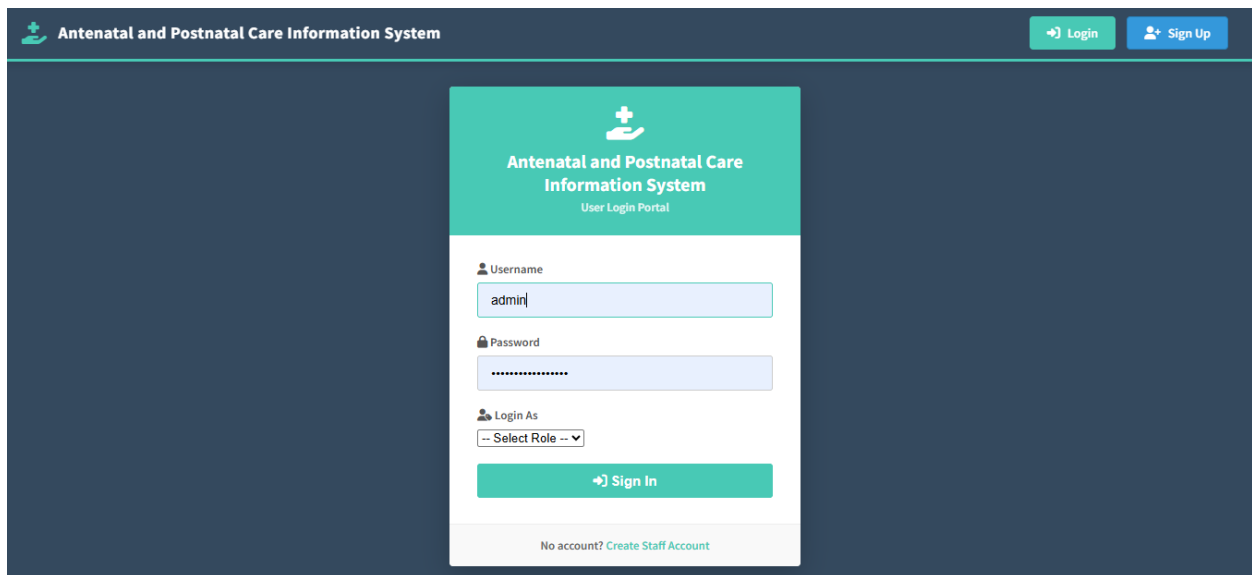
The screenshot shows the login interface of the 'Antenatal and Postnatal Care Information System'. At the top, a dark blue header contains the system name on the left and 'Login' and 'Sign Up' buttons on the right. The main content area features a central white login card. The card has a teal header with a medical icon and the text 'Antenatal and Postnatal Care Information System User Login Portal'. Below this, there are input fields for 'Username' (containing 'admin') and 'Password' (masked with dots). A 'Login As' dropdown menu is set to 'Select Role'. A teal 'Sign In' button is positioned below the fields. At the bottom of the card, a link reads 'No account? Create Staff Account'.

Figure 7: Login

5.1.2 Home Page / Dashboard

This is the first interface displayed after successful login. It provides navigation to all modules of the system. The home page displays summaries of patients, appointments, deliveries, immunizations and reports.

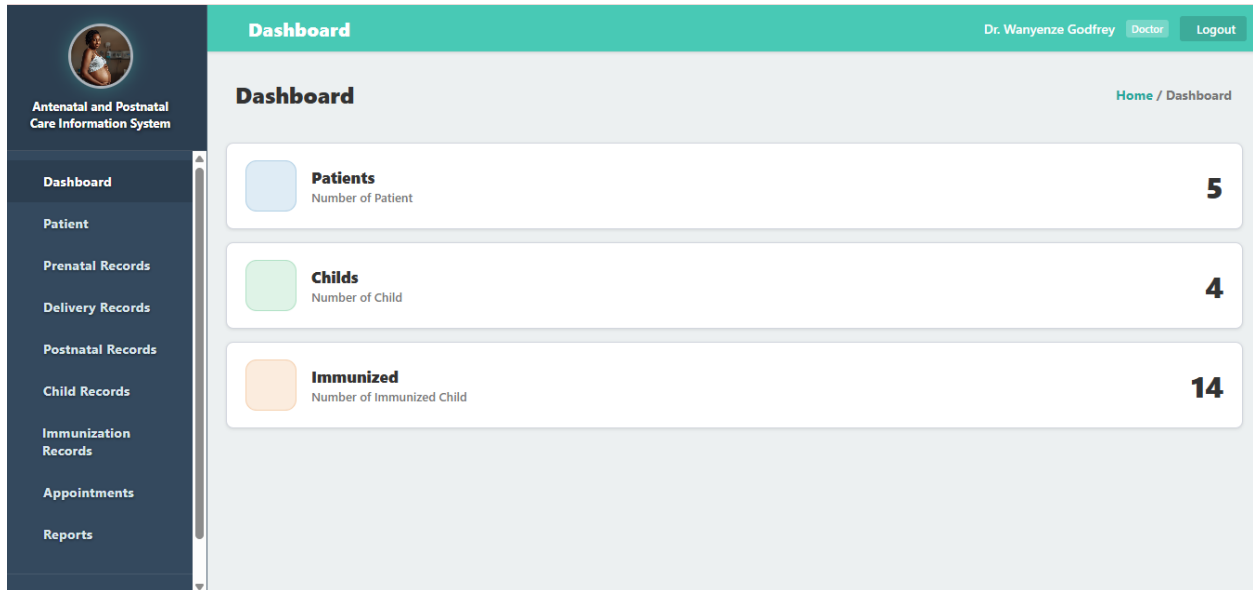


Figure 8: Dashboard

5.1.3 Patient Records

This interface allows healthcare workers to register pregnant mothers into the system. Information captured includes patient name, age, contact information and medical details.

Antenatal and Postnatal Care Information System

Patients List

Dr. Rose Mary **Midwife** [Logout](#)

Patients List [Home / Customers](#)

[Add New](#)

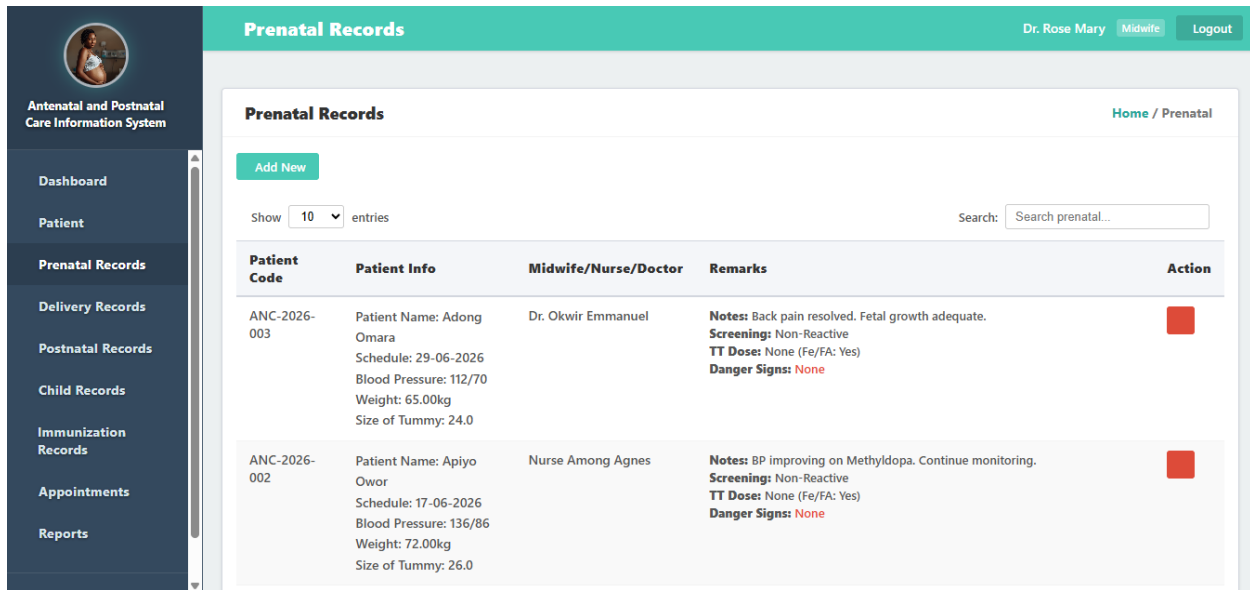
Show **10** entries Search:

Patient Code	Full Name	Contact	Email	Address	Birthdate	Age	Status	Action
ANC-2026-005	Atim Okello	+256 763 567805	atim.okello@gmail.com	Nagongera Sub-county, Tororo District	18 Feb 1991	35	Delivered	Green Red
ANC-2026-004	Awor Ojwang	+256 754 456704	awor.ojwang@gmail.com	Buteba Cell, Malaba Town Council, Tororo District	30 May 1998	28	Delivered	Green Red
ANC-2026-003	Adong Omara	+256 771 345603	adong.omara@gmail.com	Gogonyo Sub-county, Pallisa District	22 Nov 1993	32	Active	Green Red
ANC-2026-002	Apiyo Owor	+256 782 234502	apiyo.owor@gmail.com	Budama North, Namutumba Road, Tororo District	09 Jul 1996	29	Active	Green Red
ANC-2026-001	Akello Opiyo	+256 775 123401	akello.opiyo@gmail.com	Mella Zone, Tororo Municipality, Tororo District	14 Mar 2000	26	Active	Green Red

Figure 9: Patient Records

5.1.4 Prenatal Records

This interface is used to record prenatal visits and monitor pregnancy progress, including blood pressure, weight, and clinical notes.



The screenshot displays the 'Prenatal Records' interface. On the left is a dark sidebar with a user profile and navigation links: Dashboard, Patient, Prenatal Records (selected), Delivery Records, Postnatal Records, Child Records, Immunization Records, Appointments, and Reports. The main header is teal with the title 'Prenatal Records', the user 'Dr. Rose Mary' (Midwife), and a Logout button. The main content area has a breadcrumb 'Home / Prenatal' and an 'Add New' button. Below this is a search bar and a 'Show 10 entries' dropdown. A table lists two prenatal records with columns for Patient Code, Patient Info, Midwife/Nurse/Doctor, Remarks, and Action.

Patient Code	Patient Info	Midwife/Nurse/Doctor	Remarks	Action
ANC-2026-003	Patient Name: Adong Omara Schedule: 29-06-2026 Blood Pressure: 112/70 Weight: 65.00kg Size of Tummy: 24.0	Dr. Okwir Emmanuel	Notes: Back pain resolved. Fetal growth adequate. Screening: Non-Reactive TT Dose: None (Fe/FA: Yes) Danger Signs: None	
ANC-2026-002	Patient Name: Apiyo Owor Schedule: 17-06-2026 Blood Pressure: 136/86 Weight: 72.00kg Size of Tummy: 26.0	Nurse Among Agnes	Notes: BP improving on Methyldopa. Continue monitoring. Screening: Non-Reactive TT Dose: None (Fe/FA: Yes) Danger Signs: None	

Figure 10: Prenatal Records

5.1.5 Appointment Scheduling

This interface enables healthcare workers to schedule and manage appointments for antenatal visits.

Appointments Management

Dr. Rose Mary Midwife Logout

Appointments Schedule Home / Appointments

+ Add New Appointment

Filters: All Scheduled Completed Cancelled

Show 5 entries Search: Search appointments...

Date & Time	Patient Name	Patient Code	Purpose / Consultation	Assigned Doctor	Status	Notes	Action
17 Jun 2026 10:30 AM	Atim Okello	ANC-2026-005	Postnatal Check - 4 Weeks (Twins)	Dr. Okwir Emmanuel	Completed	Twins both progressing well. C-section wound fully healed.	[Delete]
03 Jul 2026 09:30 AM	Awor Ojwang	ANC-2026-004	Postnatal Check - 4 Weeks	Nurse Among Agnes	Completed	Mother and baby both well. Family planning given.	[Delete]
05 Aug 2026 10:00 AM	Apiyo Owor	ANC-2026-002	High Risk ANC Review - BP Monitoring	Dr. Okwir Emmanuel	Scheduled	Check BP and adjust Methyldopa dosage if needed.	[Check] [Cancel] [Delete]
10 Aug	Akello	ANC-2026-	Routine ANC Visit - 36	Dr. Okwir		Monitor fetal position and BP.	[Check] [Cancel] [Delete]

Figure 11: Appointment Scheduling

5.1.6 Delivery Records

This interface records information about childbirth and delivery outcomes.

Delivery Records

Dr. Rose Mary Midwife Logout

Delivery Records Home / Delivery Records

+ Add New Delivery

Show 10 entries Search: Search deliveries...

Delivery Date & Time	Mother Name	Patient Code	Delivery Mode	Gest. Age	Gender & Weight	Outcome	Attended By	Action
05 Jun 2026 06:40 AM	Awor Ojwang	ANC-2026-004	Spontaneous Vaginal Delivery	39 wks	Female (3.20 kg)	Live Birth	Nurse Among Agnes	[Delete]
20 May 2026 09:22 AM	Atim Okello	ANC-2026-005	Caesarean Section (Emergency)	37 wks	Female (2.40 kg)	Live Birth	Dr. Okwir Emmanuel	[Delete]
20 May 2026 09:15 AM	Atim Okello	ANC-2026-005	Caesarean Section (Emergency)	37 wks	Male (2.60 kg)	Live Birth	Dr. Okwir Emmanuel	[Delete]

Showing 1 to 3 of 3 entries

Previous 1 Next

Figure 12: Delivery Records

5.17 Postnatal Records

This interface records information about mother and baby's health status and delivery outcomes after birth.

Patient Code	Mother & Baby Info	Visit Details	Midwife/Nurse/Doctor	Action
ANC-2026-004	Mother Name: Awor Ojwang Baby Name: Acen Ojwang Family Planning Discussed: Yes	Timing: 2 Weeks Post-Delivery Mother Vitals: BP 116/74 / Temp 36.6°C Baby Vitals: Wt 3.45kg / Temp 36.8°C Assessment: Breast: Normal Lochia: Normal (Lochia Serosa) Cord: Healed	Nurse Among Agnes	
ANC-2026-004	Mother Name: Awor Ojwang Baby Name: Acen Ojwang Family Planning Discussed: Yes	Timing: 48 Hours Post-Delivery Mother Vitals: BP 114/72 / Temp 36.8°C Baby Vitals: Wt 3.20kg / Temp 36.7°C Assessment: Breast: Normal Lochia: Normal (Lochia Rubra) Cord: Clean and Dry	Nurse Among Agnes	
ANC-2026-005	Mother Name: Atim Okello Baby Name: Auma Okello	Timing: 2 Weeks Post-Delivery Mother Vitals: BP 120/78 / Temp 36.7°C	Nurse Among Agnes	

Figure 13: Postnatal Records

5.1.8 Child Records

This interface stores information about newborn babies linked to the mother's record.

Child Name	Date of Birth	Gender	Birth Weight (kg)	Birth Height (cm)	Mother	Patient Code	Status	Action
Odongo Omara	15 Sep 2024	Male	3.10	48.0	Adong Omara	ANC-2026-003	Registered	
Auma Okello	20 May 2026	Female	2.40	45.0	Atim Okello	ANC-2026-005	Registered	
Okello Okello	20 May 2026	Male	2.60	46.5	Atim Okello	ANC-2026-005	Registered	
Acen Ojwang	05 Jun 2026	Female	3.20	49.0	Awor Ojwang	ANC-2026-004	Registered	

Showing 1 to 4 of 4 entries

Previous 1 Next

Figure 14: Child Records

5.1.9 Immunization Records

This interface records vaccines administered to children and tracks future immunization schedules.

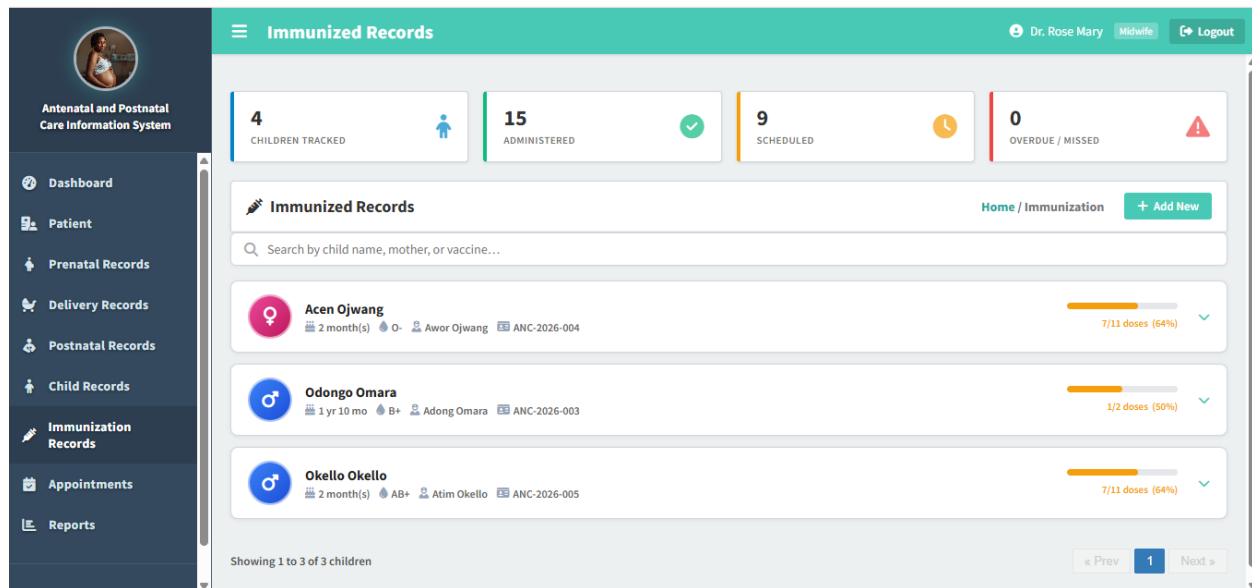


Figure 15: Immunisation Records

5.1.10 Reports Interface

This interface generates reports on patients, appointments, deliveries, children and immunizations.

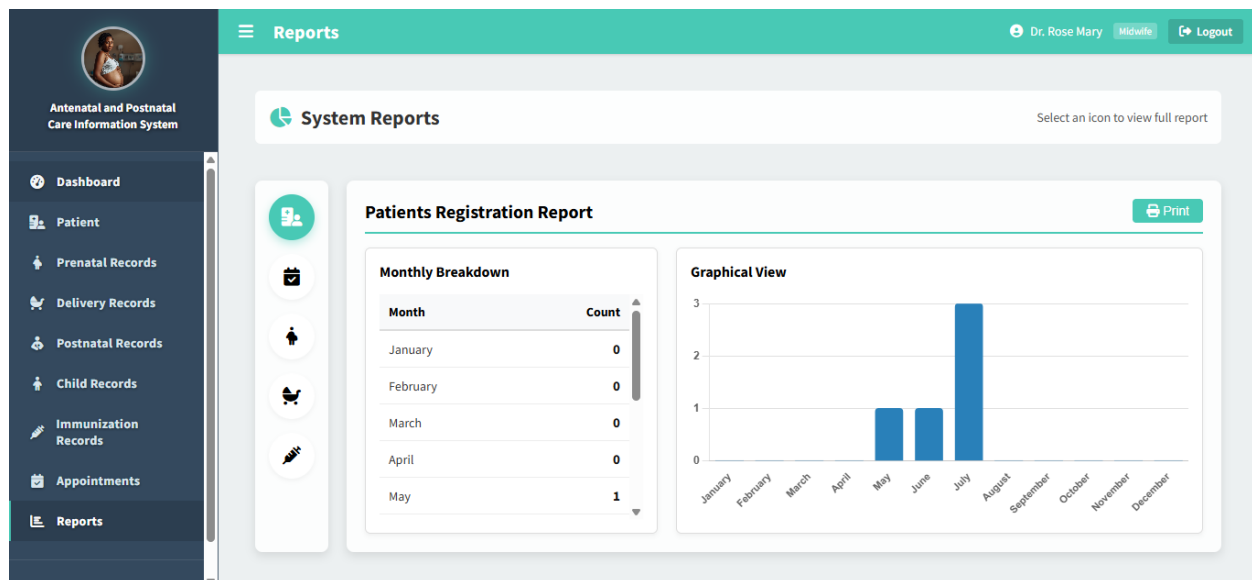


Figure 16: Reports

5.1.11 Admin Dashboard

This is the main overview screen for administrators after login. It displays system-wide summaries of patients, appointments, deliveries, immunizations, and key statistics for monitoring and decision-making.

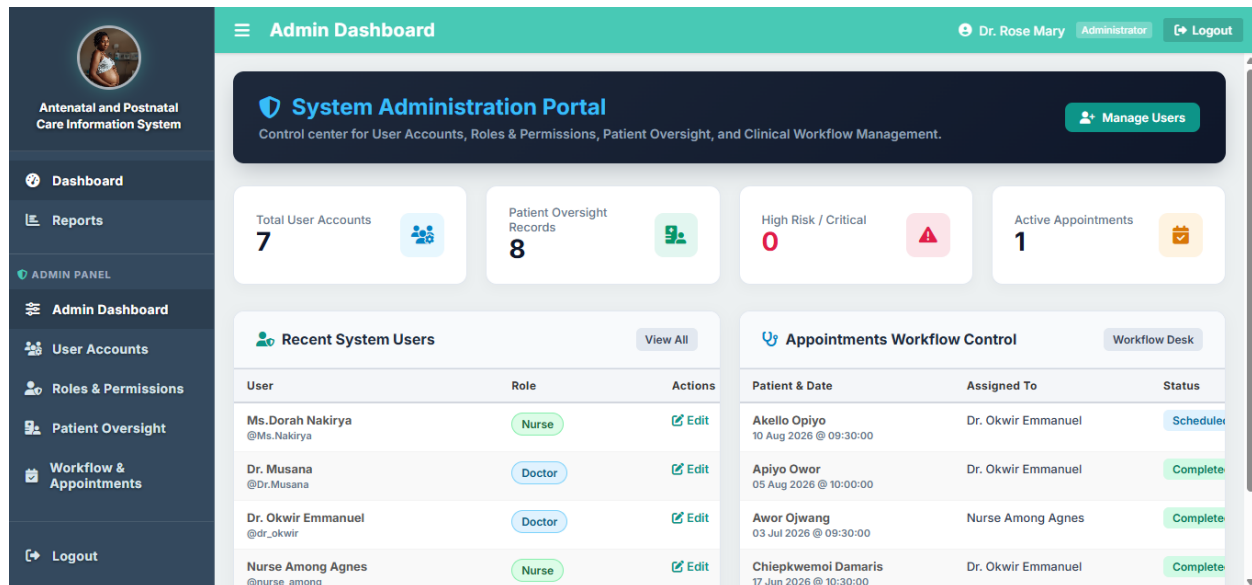


Figure 17:Admin Dashboard

5.1.12 User Account Management

This interface allows administrators to create, view, edit, and manage user accounts for healthcare workers and other administrators, including assigning roles and controlling access.

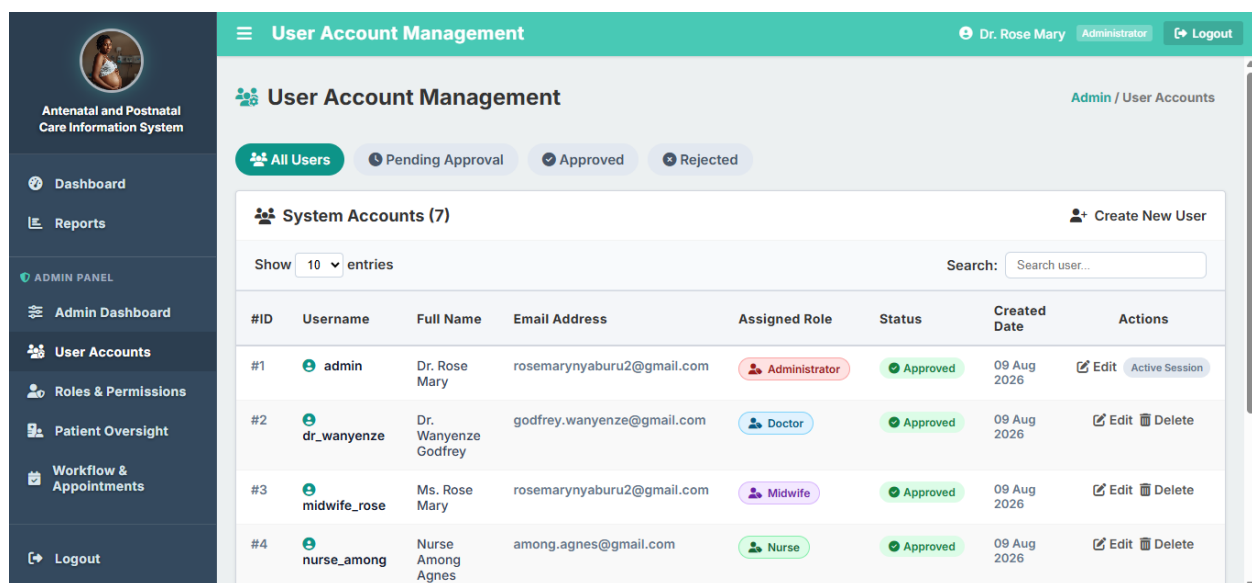


Figure 18:User Account Management

5.1.12 Roles and Permissions

This interface enables administrators to define and manage user roles and the specific permissions attached to each role within the system.

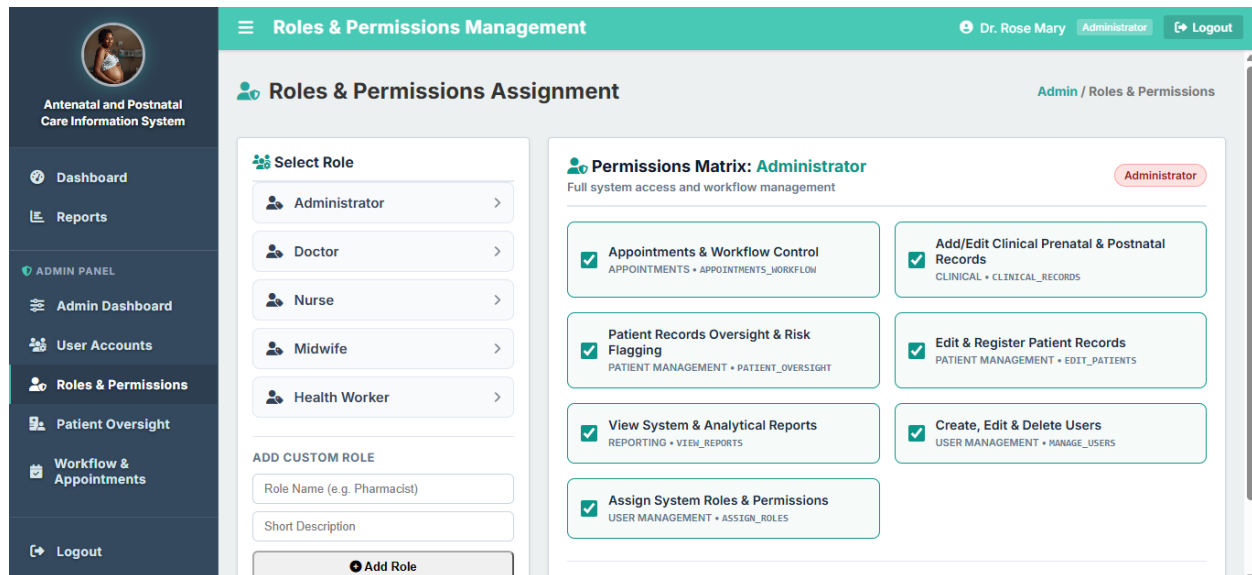


Figure 19: Roles and Permissions

5.1.13 Patient Oversight

This interface provides administrators with a centralized view of all registered patients, allowing them to monitor patient records, care progress, and overall maternal health data.

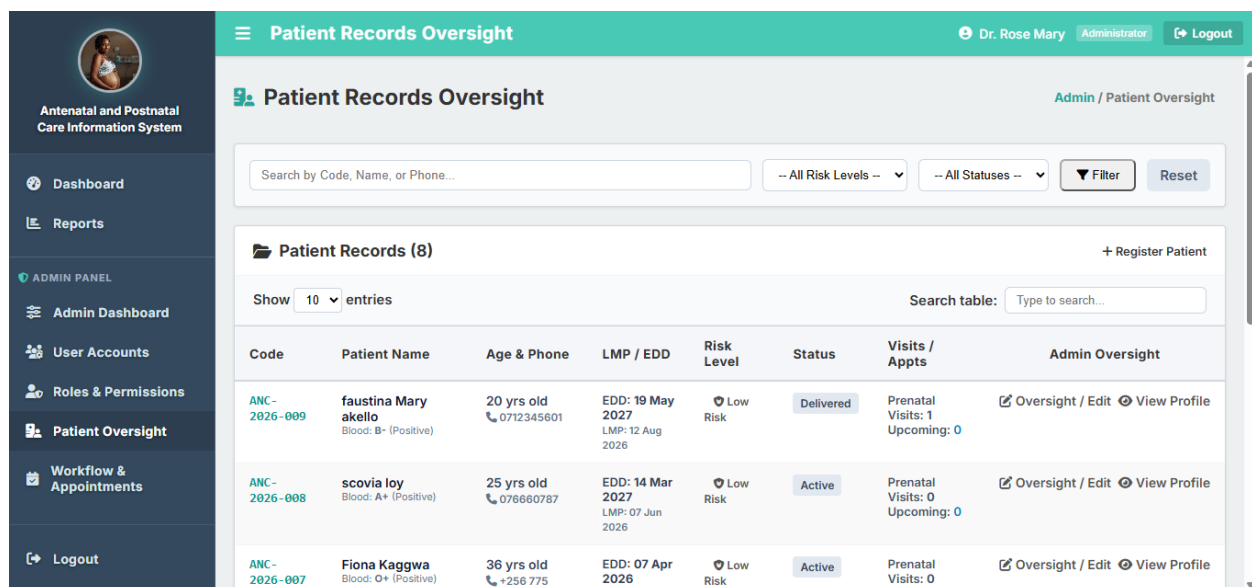


Figure 20: Patient Oversight

5.1.14 Workflow and Appointments

This interface allows administrators to oversee the flow of antenatal appointments, track status (pending, completed, or missed), and monitor clinic workload and service coverage

Antenatal and Postnatal Care Information System

Appointments & Workflow Control

Dr. Rose Mary | Administrator | Logout

Admin / Appointments Workflow

Search patient, provider, or purpose... -- All Workflow Statuses -- Filter Reset Schedule Appointment

Workflow Schedule Queue (4)

Show 10 entries Search: Type to search...

Date & Time	Patient	Purpose / Clinical Objective	Assigned Healthcare Staff	Workflow Status	Workflow Actions
17 Jun 2026 10:30 AM	Chiepkwemoi Damaris ANC - 2026-005 • +256 763 567805	Postnatal Check - 4 Weeks (Twins) Note: Twins both progressing well. C-section wound fully healed.	Dr. Okwir Emmanuel	Completed	Edit
03 Jul 2026 09:30 AM	Awor Ojwang ANC - 2026-004 • +256 754 456704	Postnatal Check - 4 Weeks Note: Mother and baby both well. Family planning given.	Nurse Among Agnes	Completed	Edit
05 Aug 2026 10:00 AM	Apiyo Owor ANC - 2026-002 • +256 782 234502	High Risk ANC Review - BP Monitoring Note: Check BP and adjust	Dr. Okwir Emmanuel	Completed	Edit

Figure 21: Workflow and Appointments

5.2 Data Storage

The system's database stores all persistent data required for system operation, including user profiles, patient information, antenatal records, appointments, delivery records, child records, and immunization information. The following tables were implemented using MySQL for development and provide centralized storage for managing antenatal and maternal healthcare information.

5.2.1 User Table

The User table stores personal and login information for each system user, including user ID as the primary key, username, password, role, full name, and contact details. This table is used to uniquely identify each user and control access to the system according to the user's assigned role.

5.2.3 Prenatal Records Table

The Prenatal Records table stores information about antenatal visits for each patient, including record ID as the primary key, patient ID as a foreign key, visit date, blood pressure, weight, and notes. This table is used to record and monitor the health progress of pregnant mothers during their antenatal visits.

The screenshot displays a web application interface for the Prenatal Records table. At the top, there are controls for 'Show all', 'Number of rows' (set to 25), 'Filter rows' (with a search box), and 'Sort by key' (set to None). Below these is an 'Extra options' button. The table itself has columns: id, patient_id, visit_number, visit_date, gestational_age_weeks, weight_kg, bp_systolic, bp_diastolic, fundal_height_cm, and fetal. Four rows of data are visible, each with edit, copy, and delete icons. At the bottom, there are 'Check all', 'With selected' (with edit, copy, delete, and export icons), and another set of table controls (Show all, Number of rows, Filter rows, Sort by key). A 'Console' tab is visible at the very bottom.

	id	patient_id	visit_number	visit_date	gestational_age_weeks	weight_kg	bp_systolic	bp_diastolic	fundal_height_cm	fetal
☐ Edit Copy Delete	1	3	1	2026-06-29	29	65.00	112	70	24.0	
☐ Edit Copy Delete	2	2	1	2026-06-17	31	72.00	136	86	26.0	
☐ Edit Copy Delete	3	3	2	2026-07-27	0	0.00	0	0	0.0	
☐ Edit Copy Delete	4	9	1	2026-08-12	2	60.00	100	80	0.0	

Figure 24:Prenatal table

5.2.4 Appointments Table

The Appointments table stores information about scheduled antenatal appointments, including appointment ID as the primary key, patient ID as a foreign key, appointment date, and appointment status. This table is used to schedule and monitor patients' antenatal appointments and follow-up visits.

5.2.6 Children Table

The Children table stores information about children born to registered patients, including child ID as the primary key, patient ID as a foreign key, child name, gender, and date of birth. This table is used to identify children and maintain their records in relation to their mothers.

	id	mother_id	delivery_id	child_name	gender	birthdate	birth_weight_kg	birth_height_cm	apgar_score	blood_type	created_at
☐ Edit Copy Delete	1	3	NULL	Odongo Omara	Male	2024-09-15	3.10	48.0	9/10	B+	2026
☐ Edit Copy Delete	2	5	2	Auma Okello	Female	2026-05-20	2.40	45.0	9/10	O+	2026
☐ Edit Copy Delete	3	5	3	Okello Okello	Male	2026-05-20	2.60	46.5	9/10	AB+	2026
☐ Edit Copy Delete	4	4	1	Acen Ojwang	Female	2026-06-05	3.20	49.0	9/10	O-	2026
☐ Edit Copy Delete	5	4	NULL	Nekesa Gift	Female	2026-07-01	3.16	5.6	9/10	O+	2026
☐ Edit Copy Delete	7	9	4	Nasser Twaifu	Male	2026-08-12	3.50	NULL	9/10	O+	2026

Figure 27:Children's Table

5.2.7 Immunizations Table

The immunizations table stores information about immunizations administered to children, including immunization ID as the primary key, child ID as a foreign key, vaccine name, and date administered. This table is used to maintain and track the immunization history of each child.

	id	child_id	vaccine	dose_number	scheduled_date	immunization_date	status	administered_by	notes	created_at
☐ Edit Copy Delete	1	4	BCG	At Birth	2026-06-05	2026-06-05	Administered	Nurse Among Agnes	Left upper arm.	2026-08-09
☐ Edit Copy Delete	2	4	OPV 0	At Birth	2026-06-05	2026-06-05	Administered	Nurse Among Agnes	Oral drops.	2026-08-09
☐ Edit Copy Delete	3	4	OPV 1	6 Weeks	2026-07-17	2026-07-17	Administered	Nurse Among Agnes	Given.	2026-08-09
☐ Edit Copy Delete	4	4	Pentavalent 1	6 Weeks	2026-07-17	2026-07-17	Administered	Nurse Among Agnes	Given.	2026-08-09
☐ Edit Copy Delete	5	4	PCV 1	6 Weeks	2026-07-17	2026-07-17	Administered	Nurse Among Agnes	Given.	2026-08-09
☐ Edit Copy Delete	6	4	Rotavirus 1	6 Weeks	2026-07-17	2026-07-17	Administered	Nurse Among Agnes	Given.	2026-08-09
☐ Edit Copy Delete	7	4	OPV 2	10 Weeks	2026-08-14	2026-08-14	Administered	Nurse Among Agnes	Given.	2026-08-09
☐ Edit Copy Delete	8	4	Pentavalent 2	10 Weeks	2026-08-14	NULL	Scheduled	NULL	Pending.	2026-08-09
☐ Edit Copy Delete	9	4	PCV 2	10 Weeks	2026-08-14	NULL	Scheduled	NULL	Pending.	2026-08-09
☐ Edit Copy Delete	10	4	Rotavirus 2	10 Weeks	2026-08-14	NULL	Scheduled	NULL	Pending.	2026-08-09

Figure 28:Immunizations Table

5.3 System Testing

5.3.1 Unit Testing

Individual modules were tested independently to ensure correct functionality of login, patient registration, prenatal recording, appointment scheduling, delivery recording, child registration, immunization tracking, and report generation.

5.3.2 Integration Testing

Modules were integrated and tested to ensure that patient information entered during registration is correctly linked to prenatal records, appointments, deliveries, child records and immunization records.

5.3.3 Functional Testing

Functional testing verified that all system features performed according to the specified requirements.

5.3.4 User Acceptance Testing

User acceptance testing was conducted with healthcare workers and administrators. The results confirmed that the system met user requirements and performed successfully.

5.3.5 System validation

Validation confirmed improved efficiency in record management, reduced retrieval time, and increased user satisfaction compared to the manual system.

CHAPTER SIX: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

This chapter discusses the findings from developing a Web-Based Antenatal and Postnatal Care Information System for Nagongera Health Centre IV in relation to the set objectives and methodology outlined in Chapter One. The study found that Nagongera Health Centre IV fully relied on a manual, paper-based approach for documenting antenatal care (ANC), delivery, and postnatal care (PNC) services. This system focuses on replacing the manual system with a digital platform that enables healthcare workers to register patients, record prenatal visits, schedule appointments, manage deliveries, register children, track immunizations, and generate reports, while providing administrators with monitoring and decision-making tools. The implementation of this system involved healthcare workers (midwives, nurses, and records officers) and administrators at Nagongera Health Centre IV, with validation results discussed as shown in Chapter Five.

6.1 Discussion

The discussion of this chapter is based on the theme of objectives stated in the first chapter.

Objective (1): To review literature and determine requirements for a university-level antenatal and postnatal care information system.

The requirements of the study were obtained from two main sources: library research and field research. Under library research, the study examined previous projects and published works on similar topics. According to Aliyi et al. (2023), maternal health remains a critical public health concern, particularly in low-resource settings where manual record-keeping leads to incomplete data, delayed interventions, and poor continuity of care. Traditional antenatal care documentation relies on paper registers and cards, which are prone to loss, damage, and difficulty in retrieval. Healthcare workers spend considerable time searching for records, and managers lack timely data for planning and reporting.

Chawani (2014) presented a qualitative cross-case analysis of the effects of Electronic Medical Record (EMR) deployment on antenatal care services in rural health centres and found that before EMR implementation, information was recorded in multiple paper registers, leading to duplication, incomplete entries, and challenges in generating monthly reports. Muinga et al.

(2018) highlighted key enablers of successful EHR implementation including strong leadership support, user training, phased rollout, and adaptation of the system to local workflows. Manual record-keeping systems, as observed in rural health facilities, were prone to data loss, inaccuracies, and inefficiency. Healthcare workers relied on physical records, which were difficult to maintain and retrieve. This led to poor decision-making due to lack of reliable data.

Objective (2): To design a web-based antenatal and postnatal care information system based on identified requirements and user needs.

The field research, conducted through interviews, observation, questionnaires, and document review with healthcare workers and administrators at Nagongera Health Centre IV, helped establish how the manual system operated and gathered respondents' views toward the proposed digital system. The field research generated key requirements. Key functional requirements included user login and authentication with role-based access, patient registration, prenatal records management, appointment scheduling, delivery and child records management, immunization tracking, report generation, and user account management. Non-functional requirements included usability, performance, security, reliability, and scalability.

The system was designed depending on the requirements gathered, followed by the Rapid Application Development (RAD) approach within the Structured Systems Analysis and Design Methodology (SSADM). The design stage included the System Architecture (client-server model), Context Diagram (Level 0 DFD), Data Flow Diagram (DFD), Use Case Diagram, Entity Relationship Diagram (ERD), and Database Schema, which enabled the smooth flow of data throughout the system.

The System Architecture adopted a client-server model. The client side (frontend) was built using HTML, CSS, and JavaScript, providing separate interfaces for healthcare workers and administrators. The server side (backend) was built using PHP to allow connection to the frontend and to handle business logic. The database server used MySQL for development. The Database Schema and Entity Relationship Diagram defined the structure with tables for Users, Patients, Prenatal Records, Appointments, Deliveries, Children, and Immunizations, establishing appropriate primary key and foreign key relationships to maintain data integrity. The design and evaluation of the system's effectiveness in providing efficient maternal health record management was guided by these structured design stages.

Objective (3): To implement the proposed system using suitable modern technologies (XAMPP, PHP, MySQL, HTML, CSS, JavaScript).

The implementation of the system design was carried out using the identified implementation tools which included: Visual Studio Code as the primary code editor, Microsoft Edge and Google Chrome browsers for testing, MySQL for database management, PHP for backend development, and HTML, CSS, and JavaScript for frontend development. XAMPP was used as the local development environment. The implementation produced the interfaces shown in Chapter Five, including the Login Page, Home Page/Dashboard, Patient Records, Prenatal Records, Appointment Scheduling, Delivery Records, Postnatal Records, Child Records, Immunization Records, and Reports Interface. The system was also optimized for accessibility via smartphones, tablets, and computers to ensure usability by healthcare workers in a busy clinical setting.

Objective (4): To test and validate the web-based antenatal and postnatal care information system to ensure usability, reliability, security, and accuracy.

The system was tested during and after implementation using multiple testing strategies. Unit testing was used to test individual parts and modules of the code, whereby every part of each interface was tested to check whether it worked properly (login, patient registration, prenatal recording, appointment scheduling, delivery recording, child registration, immunization tracking, and report generation). Integration testing was done after all the different modules had been put together to make a complete system. Integration aimed at ensuring that all modules of the system worked hand in hand and that patient information entered during registration was correctly linked to prenatal records, appointments, deliveries, child records, and immunization records. Functional testing evaluated the system against the initial requirements to ensure all key features worked as intended. User Acceptance Testing (UAT) was conducted with healthcare workers and administrators from Nagongera Health Centre IV. Their feedback confirmed that the system met user requirements and performed successfully. System validation confirmed improved efficiency in record management, reduced retrieval time, and increased user satisfaction compared to the manual system.

6.2 Conclusion

User feedback from Nagongera Health Centre IV indicates strong agreement that the Web-Based Antenatal and Postnatal Care Information System effectively meets their needs. The system directly tackles the key shortcomings of the previous manual approach, which were outlined in the problem statement found in Chapter One. Healthcare workers can now register patients digitally, manage prenatal records, schedule appointments, record deliveries, manage child records, track immunizations, and generate reports, while administrators have improved tools for monitoring, reporting, and decision-making. The system is well-suited for adoption at Nagongera Health Centre IV in Tororo District.

Overall, the study successfully achieved its objectives by analyzing the existing antenatal care system, identifying system requirements, and designing, implementing, and testing a web-based Antenatal and Postnatal Care Information System for managing maternal and child health records. The developed system addressed the limitations of manual record-keeping by providing a centralized, automated, and efficient platform. The system improved data accuracy, enhanced access to patient information, and supported healthcare workers in effective monitoring and decision-making. The system demonstrated that affordable and user-friendly digital solutions can significantly improve the efficiency, accuracy, and management of antenatal and postnatal care services.

6.3 Recommendations

Based on the findings of the study, the following recommendations are made:

1. I recommend that the Web-Based Antenatal and Postnatal Care Information System should be adopted by Nagongera Health Centre IV and other Health Centre IV facilities, especially those in rural areas that are still using manual ways of managing maternal health records.
2. I recommend that the system should be adopted by different academic institutions as a point of reference for the development of similar maternal health information systems, and for study purposes in courses related to health informatics and digital platforms.
3. I also recommend that the Ministry of Health and district health offices consider adopting or adapting the system so that it can be deployed in various health facilities across the country to support national maternal and child health goals.

4. Healthcare workers should be trained on how to use the system effectively to maximize its benefits.
5. Regular data backup procedures should be implemented to prevent data loss, and routine system maintenance should be carried out to ensure continuous operation and improved performance.
6. Healthcare facilities should improve internet and network infrastructure to support efficient system operation, and strong security mechanisms (strong passwords, role-based access control, database encryption, and regular security updates) should be maintained.

6.4 Limitations and Future Work

Although the system successfully meets its objectives, the following limitations and future work are identified:

The system has been optimized for access via computers, smartphones, and tablets, but more work should be done to enhance responsiveness across a wider range of screen sizes; therefore, Progressive Web Application (PWA) capabilities should be implemented to enable offline functionality and home screen installation.

System maintenance is necessary for continued optimal performance; therefore, regular maintenance should be performed to improve system performance and security.

The current technology stack (PHP, MySQL, HTML, CSS, JavaScript) may limit certain advanced features; therefore the researcher should explore complementary technologies and frameworks for mobile development and enhanced analytics.

The system is not currently hosted on a commercial platform, which limits its security, uptime, and accessibility; therefore, the system should be hosted on a commercial web-hosting or cloud platform such as Google Cloud or a similar service to enhance its security and ensure optimal uptime.

Suggested future enhancements include: SMS notifications for appointments and immunization schedules; development of a dedicated mobile application for smartphone and tablet access; an online patient portal for viewing appointments and health information; integration with national health systems (such as DHIS2); advanced reporting and analytics; and cloud-based deployment for improved accessibility and scalability.

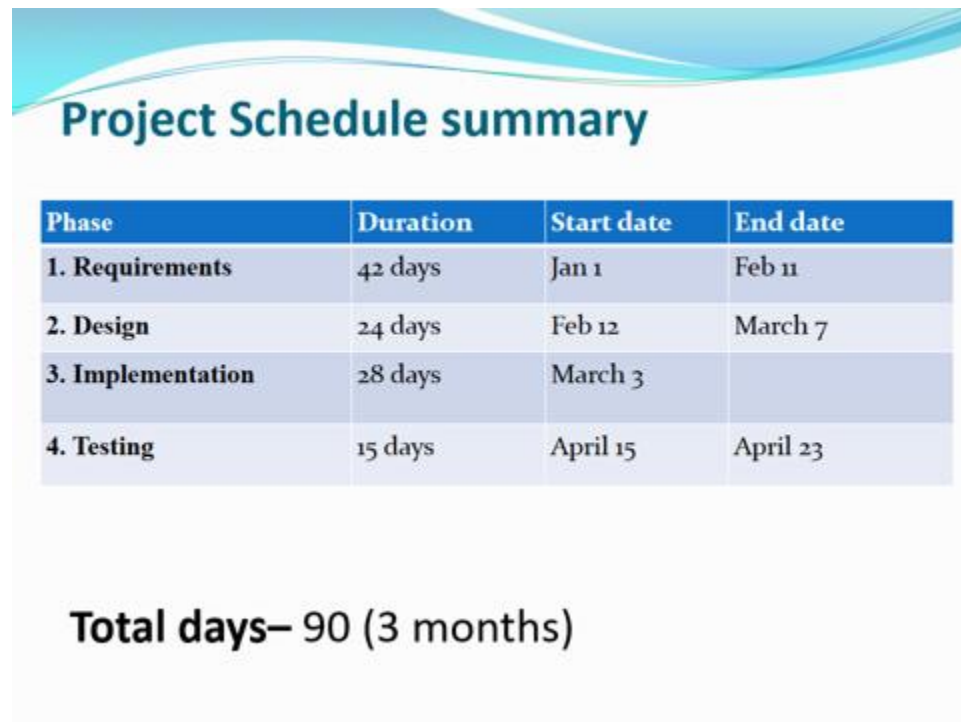
Future researchers may focus on mobile-based antenatal care systems, artificial intelligence in maternal healthcare, predictive analytics for pregnancy monitoring, telemedicine integration in antenatal care, and full electronic health records integration.

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APPENDIX

Appendix I: Time Schedule



Appendix II: Budget



Item	Description	Quantity	Cost (UG shs.)
Data bundles	Research and development	40 GB	80,000
Transport	Meet up with stakeholders		20,000
Airtime and communication	For follow-up calls with stakeholders		30,000
Printing, binding and photocopying	Reports(4) and questionnaires(30)	34 items	40,000
Stationery	Pens(4) and notebook(2)	6 items	30,000
Miscellaneous	For unforeseen costs		150,000
Total			320,000