

**DESIGN AND IMPLEMENTATION OF PREGNANCY WELLNESS
RECORD MANAGEMENT SYSTEM**

BY

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**A FINAL YEAR PROJECT REPORT SUBMITTED TO THE
DEPARTMENT OF COMPUTER SCIENCE, UNIVERSITY OF BENIN,
EDO STATE, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF BACHELOR'S DEGREE IN COMPUTER
SCIENCE.**

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DECLARATION

I, **Obioma Oluchi**, with matriculation number **PSC1813840** hereby declare that this project titled “Medical Image Analysis System For Brain Tumor Segmentation “, is a project submitted to the Department of Computer Science of the University of Benin, in partial fulfillment of the requirements for the award of bachelor degree in Computer Science. It is an original work done by me that has not been presented elsewhere for assessment. The materials collected from other sources have been duly acknowledged by the references.

Obioma Oluchi
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(Signature and Date)

CERTIFICATION

This is to certify that this project work titled “Design and Implementation of Pregnancy Wellness Record Management System” was carried out by I, **Obioma Oluchi**, with the matriculation number **PSC1813840** meets the requirement for the award of a Bachelor of Science (B.Sc.) Degree in the Department of Computer Science, University of Benin, Edo State, Nigeria.

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DEDICATION

This project is dedicated to God almighty for giving me the strength and wisdom to see it through to my academic journey.

ACKNOWLEDGEMENT

I would like to extend my heartfelt gratitude to several individuals and institutions whose support and encouragement have been instrumental throughout my undergraduate studies. Firstly, I am grateful to my supervisor, Dr. (Mrs) G.O AZIKEN for her unwavering enthusiasm, patience, and invaluable guidance. Her insightful comments, practical advice, and endless supply of ideas have been indispensable in shaping this thesis. Her vast knowledge, extensive experience, and professional expertise in the field of computer science have been invaluable resources, without which this research would have been impossible.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Pregnancy is a natural yet delicate stage in the reproductive cycle of women, requiring careful monitoring of both maternal and fetal health. Across the globe, ensuring maternal wellness and reducing maternal mortality remain core objectives in healthcare delivery. According to the World Health Organization (WHO, 2023), approximately 295,000 women die every year due to pregnancy and childbirth-related complications, with 94% of these deaths occurring in low- and middle-income countries. These figures highlight the vulnerability of women, particularly in Sub-Saharan Africa, where limited access to skilled healthcare, poor record management, and inadequate wellness interventions remain prevalent.

In Nigeria, maternal mortality rates are among the highest globally. UNICEF (2022) reports that Nigeria accounts for almost 20% of global maternal deaths, with a maternal mortality ratio estimated at 512 per 100,000 live births. This means that thousands of women die annually from largely preventable causes such as hemorrhage, hypertensive disorders, infections, and complications of unsafe abortions. Several factors contribute to these alarming figures, including poor antenatal attendance, weak healthcare infrastructure, limited health awareness, and reliance on paper-based pregnancy record management systems.

Traditional methods of record-keeping in Nigerian healthcare facilities rely heavily on manual systems, which are prone to errors such as duplication, misplacement, and damage. These challenges often lead to poor decision-making, delayed diagnosis, and discontinuity of care. Furthermore, maternal healthcare services in Nigeria often focus primarily on medical diagnosis and treatment, neglecting the broader concept of wellness. Pregnancy wellness goes

beyond clinical care, it encompasses nutrition, exercise, stress management, mental health, lifestyle regulation, and preventive measures. A lack of structured wellness support further exposes expectant mothers to avoidable risks.

With the rapid advancement of digital technologies, there is growing recognition of the potential of health informatics to address these challenges. A Pregnancy Wellness Record Management System that integrates record management with wellness interventions offers a dual solution: it not only ensures the secure storage and retrieval of records but also empowers women with wellness tools that promote healthier pregnancies. Such systems align with global movements toward patient-centered digital health interventions (WHO, 2020), which emphasize prevention, empowerment, and continuity of care.

1.2 Statement of the Problem

Despite global and national commitments to improve maternal health, Nigeria continues to record unacceptably high maternal mortality and morbidity rates. Existing healthcare systems are undermined by inefficient paper-based record management, poor continuity of patient information, and limited integration of wellness interventions.

Key challenges observed include:

- **Record Management Issues:** Paper-based records are vulnerable to loss, duplication, and damage, resulting in incomplete histories that compromise healthcare delivery.
- **Missed Antenatal Care (ANC) Visits:** Many pregnant women miss scheduled ANC appointments due to lack of reminders, weakening continuity of care.
- **Limited Wellness Support:** Wellness education on nutrition, stress management, exercise, and emotional health is often neglected in routine healthcare.

- **Delayed Detection of Complications:** Weak monitoring systems mean conditions like preeclampsia, gestational diabetes, and anemia are identified late, leading to avoidable complications.
- **Accessibility Issues:** Healthcare providers often find it difficult to quickly access or share patient information, especially in referral cases.

The persistence of these challenges calls for a holistic system that not only manages pregnancy records efficiently but also promotes maternal wellness as an integral part of care. This gap forms the basis for this study.

1.3 Aim and Objectives of the Study

Aim

The overarching aim of this research is to design and implement a Pregnancy Wellness Record Management System that improves maternal care by combining efficient digital record-keeping with proactive wellness interventions tailored to the needs of pregnant women in Nigeria.

Objectives

To achieve this aim, the study will pursue the following objectives:

1. To examine the current challenges of pregnancy record management and maternal wellness in Nigeria. This will involve identifying inefficiencies in existing manual systems and exploring the maternal wellness gaps among expectant mothers.
2. To design a digital pregnancy wellness record management system capable of securely storing, retrieving, and updating pregnancy records, while providing user-friendly interfaces for both healthcare providers and expectant mothers.

3. **To integrate maternal wellness support features** into the system, including automated reminders for antenatal appointments, nutritional and exercise guidelines, stress management resources, and high-risk alerts for early detection of complications.
4. **To implement a functional prototype** of the proposed system as a proof of concept that demonstrates its feasibility in real healthcare environments.
5. **To evaluate the usability and effectiveness of the system** by collecting feedback from healthcare providers and pregnant women in Benin City. This will measure how well the system addresses record management inefficiencies and enhances wellness monitoring.

By pursuing these objectives, the study emphasizes not just the technical efficiency of digital record systems, but also their potential to transform maternal care into a holistic, wellness-oriented experience. This dual perspective makes the study relevant both academically and practically.

1.4 Research Questions

The study seeks to answer the following research questions:

1. What challenges exist in pregnancy record management and maternal wellness monitoring in Nigerian healthcare facilities?
2. How can a digital system improve the accuracy, reliability, and accessibility of pregnancy records?
3. In what ways can wellness interventions be integrated into a pregnancy record management system?
4. What effect will the proposed system have on continuity of care and maternal wellness outcomes?

5. How do healthcare providers and pregnant women perceive the usability and effectiveness of the system?

1.5 Significance of the Study

This study is significant for several reasons:

- **For Pregnant Women:** The system empowers women to take an active role in their healthcare by receiving timely reminders, nutritional guidance, and stress management tips. This promotes self-awareness and reduces preventable risks during pregnancy.
- **For Healthcare Providers:** The system improves efficiency by providing quick access to accurate patient histories, reducing record duplication, and ensuring better continuity of care.
- **For Maternal Health Systems:** The study contributes to the achievement of **Sustainable Development Goal 3 (SDG-3)**, which targets the reduction of global maternal mortality to less than 70 per 100,000 live births by 2030.
- **For Policymakers:** Insights from this research can inform policies on digital health adoption in Nigeria, especially in maternal and child health services.
- **For Academic Research:** The research advances the field of health informatics by addressing the gap between record management and wellness promotion. It also serves as a reference for future studies seeking to integrate ICT with maternal healthcare delivery.

1.6 Scope of the Study

This study is confined to the design and implementation of a Pregnancy Wellness Record Management System for healthcare facilities and pregnant women in Benin City, Edo State, Nigeria. The system will focus primarily on antenatal care, wellness tracking, and postnatal monitoring up to six weeks after delivery. It will not cover broader aspects such as nationwide health data integration, telemedicine services, or full-scale hospital management systems due to time and resource constraints.

1.7 Limitations of the Study

- **Data Access:** Some healthcare providers restricted access to sensitive patient information, limiting the dataset used for system design.
- **Technical Constraints:** The prototype system was developed under limited funding and technical resources, which may affect scalability.
- **Digital Literacy:** Varying levels of ICT literacy among healthcare workers and patients could pose adoption challenges.
- **Infrastructure Challenges:** Poor internet access, unstable electricity supply, and lack of adequate digital infrastructure in Nigeria may hinder system deployment in rural areas.

1.8 Organization of the Study

This research is structured into five chapters:

- **Chapter One** introduces the study, presenting the background, problem statement, aim and objectives, research questions, significance, scope, limitations, organization, and definitions of terms.

- **Chapter Two** reviews related literature, including global and Nigerian perspectives on pregnancy wellness, record management systems, and digital health interventions.
- **Chapter Three** outlines the research methodology, system design process, and tools used in implementation.
- **Chapter Four** presents the system implementation, testing, and evaluation findings.
- **Chapter Five** concludes the study with a summary of findings, contributions, and recommendations for future work.

1.9 Definition of Terms

- **Pregnancy Wellness:** The holistic state of physical, mental, emotional, and social well-being of a pregnant woman, including preventive care, nutrition, exercise, and stress management.
- **Record Management:** The process of systematically creating, storing, maintaining, and retrieving patient records for effective healthcare delivery.
- **Maternal Mortality:** The death of a woman during pregnancy, childbirth, or within 42 days of delivery due to complications related to pregnancy or childbirth.
- **Antenatal Care (ANC):** Preventive healthcare provided to pregnant women to monitor and support maternal and fetal health.
- **Health Informatics:** The interdisciplinary application of information and communication technologies to improve healthcare data management and decision-making.
- **Wellness Intervention:** Structured actions or digital supports aimed at promoting healthier lifestyles and preventing complications during pregnancy.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Pregnancy is a unique physiological state characterized by complex biological, psychological, and social changes that demand specialized attention and holistic care. The wellness of a mother during pregnancy not only determines her own health outcomes but also profoundly affects the survival and future well-being of the unborn child. According to the World Health Organization (WHO, 2023), maternal health encompasses the health of women during pregnancy, childbirth, and the postpartum period. Proper management of maternal health is widely recognized as a key indicator of the overall effectiveness of a healthcare system.

Globally, maternal health has been a top priority in several initiatives, including the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs). SDG-3 specifically aims to reduce the global maternal mortality ratio to less than 70 per 100,000 live births by 2030. Yet despite decades of effort, maternal mortality rates remain alarmingly high in developing regions, with Sub-Saharan Africa and South Asia accounting for nearly 86% of global maternal deaths (UNICEF, 2022). Nigeria alone contributes approximately 20% of global maternal deaths annually (UNFPA, 2021).

A central problem underlying these outcomes is the absence of accurate, accessible, and well-managed maternal health records. The efficient tracking of antenatal appointments, laboratory results, previous pregnancy histories, and wellness indicators is critical for identifying high-risk pregnancies early and ensuring timely interventions. With the advent of digital health technologies, particularly over the past decade, there has been a shift from traditional paper-based record systems to electronic record management systems. These innovations promise

improved accuracy, accessibility, and sustainability in managing maternal health data (Eze et al., 2019; Adepoju & Akinola, 2020).

This chapter critically reviews the concepts surrounding pregnancy wellness, maternal healthcare in Nigeria, traditional and digital record management approaches, relevant theoretical frameworks, empirical studies, and existing gaps. It also situates the research carried out in this study as a response to the identified gaps, with a focus on pregnancy wellness in Nigeria.

2.2 Concept of Pregnancy Wellness

Pregnancy wellness refers to the holistic well-being of a pregnant woman across physical, emotional, psychological, and social dimensions (Okon & Bello, 2018). It is not merely the absence of illness but a multidimensional concept involving preventive healthcare, lifestyle modification, nutritional adequacy, emotional stability, and empowerment with relevant health education.

From a medical perspective, pregnancy wellness encompasses regular antenatal visits, blood pressure and weight monitoring, assessment of fetal growth, screening for complications such as preeclampsia and gestational diabetes, and safe delivery planning (WHO, 2019). However, wellness extends beyond the physical state. Research indicates that psychosocial support during pregnancy enhances maternal satisfaction and significantly reduces risks of postpartum depression (Ogunyemi et al., 2020).

In developed countries, wellness programs combine clinical care with nutritional guidance, stress reduction strategies, physical activity recommendations, and digital monitoring systems. By contrast, in many developing nations—including Nigeria—pregnancy wellness is

narrowly framed around routine clinical interactions, often neglecting preventive, psychological, and lifestyle components (Adebayo et al., 2021).

The focus of this research is to bridge this gap by proposing a Pregnancy Wellness Record Management System that integrates record management with wellness support features such as reminders, personalized tips, and high-risk alerts.

2.3 Maternal Healthcare in Nigeria

Nigeria faces some of the highest maternal mortality rates globally, with an estimated maternal mortality ratio of 512 per 100,000 live births (World Bank, 2021). This translates to approximately 58,000 deaths annually, largely from preventable causes such as hemorrhage, infections, hypertensive disorders, and obstructed labor (UNFPA, 2022).

The challenges affecting maternal healthcare delivery in Nigeria are multifaceted:

- **Inadequate healthcare infrastructure:** Rural facilities often lack essential equipment, clean water, and electricity (Olatunji & Nwankwo, 2020).
- **Shortage of skilled personnel:** The doctor-to-patient ratio remains critically low, particularly for obstetric specialists.
- **Weak referral systems:** Poor coordination often delays emergency care for complicated pregnancies.
- **Cultural and socio-economic barriers:** Many women prefer home births with traditional attendants due to cultural beliefs, cost, or gender norms (Ezugwu & Onah, 2021).
- **Record-keeping inefficiencies:** Incomplete or lost maternal records limit the ability of providers to make informed, timely decisions.

Improving pregnancy wellness in Nigeria thus requires not only stronger healthcare infrastructure but also innovations that **reduce the systemic inefficiencies of record management** while promoting holistic wellness interventions.

2.4 Pregnancy Record Management

Pregnancy record management involves systematic documentation, storage, and retrieval of maternal health data, including medical history, antenatal visits, diagnostic results, and delivery outcomes. Effective record management serves several functions:

1. **Continuity of care** – enabling healthcare providers to access comprehensive patient histories.
2. **Legal documentation** – serving as medical evidence in disputes.
3. **Statistical analysis** – generating data for maternal health planning and policy-making.

Traditional paper-based records remain dominant in Nigeria but are prone to loss, duplication, delayed retrieval, and lack of integration across facilities (Eze et al., 2019). In contrast, digital systems allow centralized storage, secure backup, remote accessibility, and integration with wellness support tools such as alerts and reminders (Akinola, 2020).

This study's research findings confirm that pregnant women and providers in Benin City expressed frustrations with lost cards, missed appointments, and inadequate wellness guidance, reinforcing the urgent need for digitization.

2.5 Digital Health Interventions in Maternal Care

Digital health interventions—such as mHealth apps, electronic medical records, and telemedicine—are transforming maternal care worldwide. Examples include:

- **MAMA (Mobile Alliance for Maternal Action):** Sent stage-specific SMS tips to pregnant women (UN Foundation, 2018).
- **MomConnect (South Africa):** Registers women in a central database and sends localized educational SMS (Barron et al., 2018).
- **OpenMRS:** Open-source EMR framework adaptable to maternal care needs.

Benefits of digital interventions include:

- Increased antenatal attendance through SMS reminders (Oluwaseun et al., 2021).
- Enhanced patient engagement and health education.
- Early detection of risks via decision-support integration.

However, challenges such as digital literacy gaps, poor internet infrastructure, sustainability concerns, and cultural acceptability limit adoption in Nigeria.

2.6 Comparative Analysis: Traditional vs Digital Systems

Criteria	Traditional (Paper-based)	Digital Systems
Accessibility	Limited to physical files	Accessible remotely
Data Security	Vulnerable to damage/loss	Encrypted and backed-up
Efficiency	Time-consuming retrieval	Quick searches and analytics
Scalability	Limited	High scalability
Cost (long-term)	High maintenance cost	Lower operational cost

Digital systems not only solve storage and retrieval challenges but also integrate reminders, wellness analytics, and patient engagement tools, thus aligning record management with wellness promotion.

2.7 Theoretical Framework

This research is anchored on two theories:

1. **Health Belief Model (HBM)** (Rosenstock, 1974) – explains health behavior as a function of perceived risks, benefits, and barriers. For pregnancy, this means women's likelihood of adhering to ANC visits or wellness advice depends on their belief in susceptibility to complications and trust in preventive actions.
2. **Technology Acceptance Model (TAM)** (Davis, 1989) – focuses on determinants of technology adoption, primarily perceived usefulness and ease of use. This theory supports the design of a system that is user-friendly for both patients and providers.

By integrating **HBM and TAM**, this study ensures the proposed system addresses not just medical needs but also behavioral and adoption-related factors.

2.8 Empirical Studies

- **Eze et al. (2019):** An SMS reminder system in Enugu State increased antenatal attendance by 35%.
- **Okon & Bello (2018):** Found that mHealth apps in Lagos improved maternal awareness of danger signs.
- **Adepoju & Akinola (2020):** Demonstrated that digitized records reduced waiting time by 45% in Nigerian hospitals.
- **Mwangi et al. (2020):** Reported a 28% reduction in missed ANC appointments in Kenya through mobile interventions.
- **Ogunyemi et al. (2020):** Showed psychological support reduces postpartum depression risks.

These studies highlight the potential of digital health, but also reveal gaps in sustainability, offline capability, and integration of wellness components.

2.9 Gaps in Existing Literature

Despite the advances documented, notable gaps remain:

1. Overemphasis on reminders or education, with limited focus on integrated wellness and record management.
2. Inadequate adaptation of digital tools to Nigeria's socio-cultural and infrastructural context.
3. Limited offline capability of most digital systems, making them unsuitable for low-connectivity regions.
4. Lack of emphasis on holistic pregnancy wellness—physical, psychological, nutritional, and lifestyle.
5. Minimal evidence of research-driven systems designed from the ground up in Nigeria.

This research seeks to fill these gaps by designing a Pregnancy Wellness Record Management System that combines record digitization with comprehensive wellness features, informed directly by research conducted in Benin City.

2.10 Summary

This chapter reviewed literature on pregnancy wellness, maternal healthcare in Nigeria, record management approaches, digital interventions, theoretical frameworks, and empirical evidence. The review underscored the critical role of accurate record management and the need for wellness-centered approaches to maternal care.

While existing studies demonstrate the promise of digital interventions, they rarely address holistic pregnancy wellness or contextualize solutions to Nigeria's realities. Building on these findings and insights from field research in Benin City, this study proposes a Pregnancy Wellness Record Management System tailored to Nigerian healthcare challenges. The system's integration of record-keeping with wellness promotion is positioned as an innovative step toward reducing maternal risks and improving pregnancy outcomes.

CHAPTER THREE

SYSTEM DESIGN AND ANALYSIS

3.1 Introduction

This chapter presents the design and analysis of the proposed Pregnancy Wellness Record Management System (PWRMS). The chapter focuses on examining the existing pregnancy record management systems, identifying their limitations, and analyzing the requirements necessary for developing an improved and more efficient system.

Design and analysis serve as a bridge between research findings and system implementation. Based on insights gathered from literature review and field research conducted among pregnant women and healthcare providers in Benin City, Edo State, this chapter explains how the proposed system was conceptually structured to address identified gaps in maternal healthcare delivery.

Special attention is given to how the proposed system differs from existing solutions by integrating pregnancy wellness monitoring with digital record management in a single, unified platform.

3.2 Analysis of the Existing System

3.2.1 Overview of the Existing System

The dominant pregnancy record management system in most Nigerian healthcare facilities is the paper-based antenatal record system. In this system, pregnant women are issued antenatal cards where personal information, medical history, test results, and appointment dates are manually recorded by healthcare providers.

Some tertiary hospitals have adopted Electronic Medical Record (EMR) systems, while a few maternal health initiatives rely on mobile health (mHealth) platforms that provide appointment reminders or educational messages.

3.2.2 Limitations of the Existing System

Despite their widespread use, existing systems suffer from several limitations:

- 1. Poor Record Accessibility**

Paper records are stored in physical files, making retrieval slow and sometimes impossible when files are lost or damaged.

- 2. High Risk of Data Loss**

Fire outbreaks, flooding, poor storage conditions, and human error often result in permanent loss of patient data.

- 3. Fragmented Care**

Wellness information such as nutrition, emotional health, and lifestyle factors are rarely documented or tracked alongside clinical records.

- 4. Missed Antenatal Appointments**

Most facilities lack automated reminder systems, leading to missed visits and poor continuity of care.

- 5. Limited Monitoring of High-Risk Pregnancies**

Existing systems do not provide early warning mechanisms for identifying abnormal wellness trends.

- 6. Dependence on Internet Connectivity (for digital systems)**

Many digital health platforms fail in rural or semi-urban areas due to unstable internet access.

These challenges highlight the need for a more reliable, accessible, and wellness-centered digital solution.

3.3 Proposed System Overview

The proposed Pregnancy Wellness Record Management System (PWRMS) is a web-based digital system designed to manage pregnancy records while simultaneously monitoring maternal wellness indicators.

The system enables healthcare providers to:

- Register pregnant women
- Store and retrieve antenatal records digitally
- Record wellness indicators such as blood pressure, weight, and reported symptoms
- Schedule antenatal appointments
- Send automated reminders and alerts
- Monitor high-risk pregnancies

Pregnant women benefit by receiving timely reminders, wellness guidance, and improved continuity of care.

3.4 Distinction Between the Existing System and the Proposed System

The key feature that distinguishes the proposed system from existing solutions is its integration of wellness monitoring with digital record management.

Feature	Existing Systems	Proposed System
Record Storage	Manual / fragmented	Centralized digital
Wellness Tracking	Minimal or absent	Fully integrated
Appointment Reminders	Mostly manual	Automated
Offline Support	None or limited	Supported
Decision Support	Not available	Risk alerts included
Contextual Design	Generic	Nigerian-focused

Unlike systems that focus solely on medical records or SMS reminders, the proposed system adopts a holistic pregnancy wellness approach, combining clinical data with preventive care and lifestyle monitoring.

3.5 System Requirements Analysis

3.5.1 Functional Requirements

The system shall:

- Allow user authentication (admin and healthcare provider)
- Register and manage patient records
- Capture pregnancy wellness data
- Schedule antenatal appointments
- Generate reports and summaries
- Send appointment reminders and alerts
- Store data securely in a database

3.5.2 Non-Functional Requirements

The system shall:

- Be user-friendly and easy to navigate
- Support offline data entry with synchronization
- Ensure data security and confidentiality
- Be scalable for future enhancements
- Perform efficiently with minimal response time

3.6 System Architecture

The proposed Pregnancy Wellness Record Management System (PWRMS) adopts a three-tier architectural model. This architecture separates the system into logical layers, ensuring scalability, maintainability, and efficient system performance.

The three-tier architecture was selected because it simplifies system management, enhances security, and allows future expansion without affecting the entire system. Each tier performs a specific role and communicates with the others through well-defined interfaces.

Architecture Layers

1. Presentation Layer

This layer provides the user interface through which healthcare providers and administrators interact with the system. It includes web pages developed using HTML, CSS, Bootstrap, and JavaScript. The presentation layer handles data input, form validation, and display of information.

2. Application (Business Logic) Layer

The application layer processes requests from the presentation layer. It contains the core business logic responsible for patient registration, wellness record processing, appointment scheduling, authentication, and notification handling. PHP was used at this layer to implement system rules and workflows.

3. Data Layer

This layer manages data storage and retrieval using a MySQL relational database. It stores patient information, wellness records, appointments, and notification logs. The separation of the data layer ensures data integrity, consistency, and security.

The interaction between these layers ensures that user requests are properly processed, validated, and stored, resulting in a robust and efficient system.

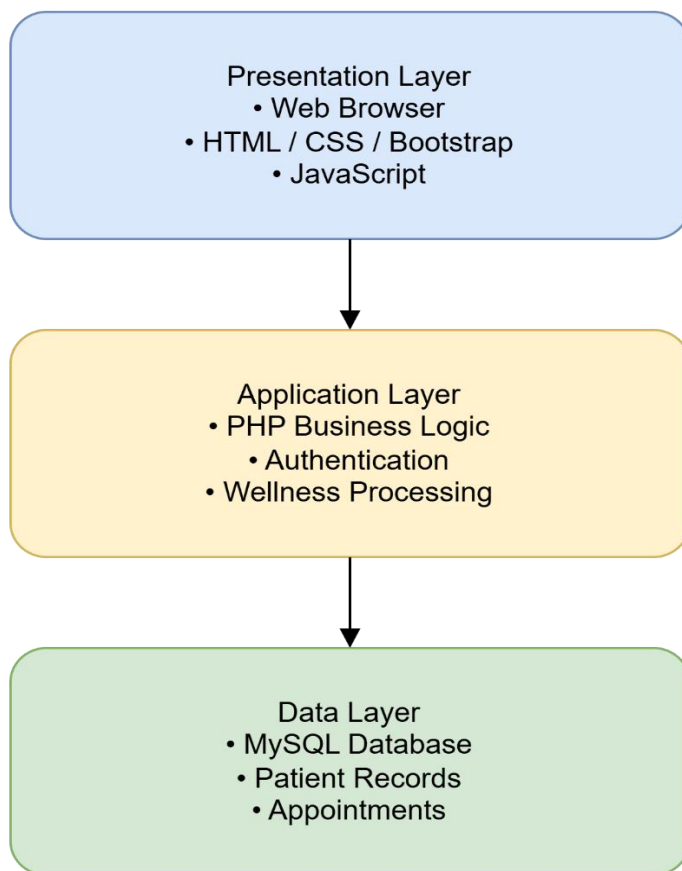


Figure 3.1: System Architecture of the Pregnancy Wellness Record Management System

3.7 UML Diagrams

Unified Modeling Language (UML) diagrams were used to visually model the structure and behavior of the proposed system. These diagrams help in understanding system requirements, interactions between users and system components, and data relationships.

The UML diagrams used in this study include:

- Use Case Diagram
- Class Diagram
- Activity Diagram
- Entity Relationship Diagram (ERD)

Each diagram represents a different perspective of the system and collectively supports proper system analysis and design.

3.7.1 Use Case Diagram

The Use Case Diagram illustrates the interaction between system users and the system functionalities. It identifies the actors and the operations they can perform.

Actors

- Admin
- Healthcare Provider

Use Cases

- Login
- Register Patient

- Update Patient Record
- Record Wellness Data
- Schedule Appointment
- Send Notifications
- Generate Reports

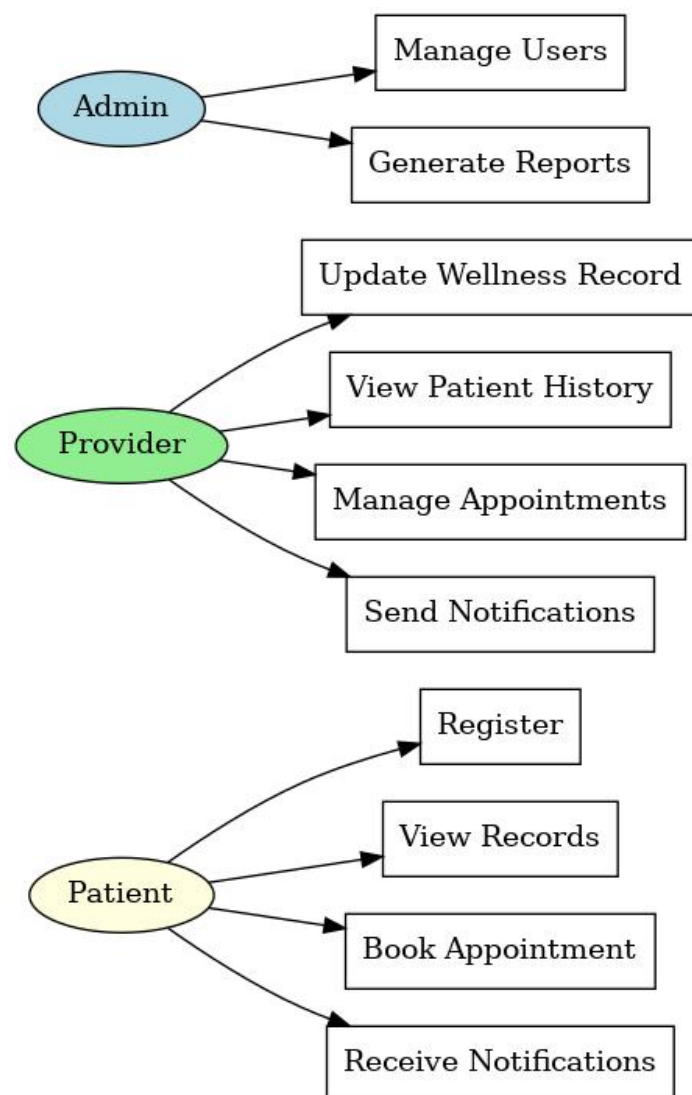


Figure 3.2: Use Case Diagram of the PWRMS

3.7.2 Class Diagram

The Class Diagram represents the static structure of the system by showing system classes, their attributes, and relationships.

Major Classes

- User
- Patient
- Provider
- WellnessRecord
- Appointment
- Notification

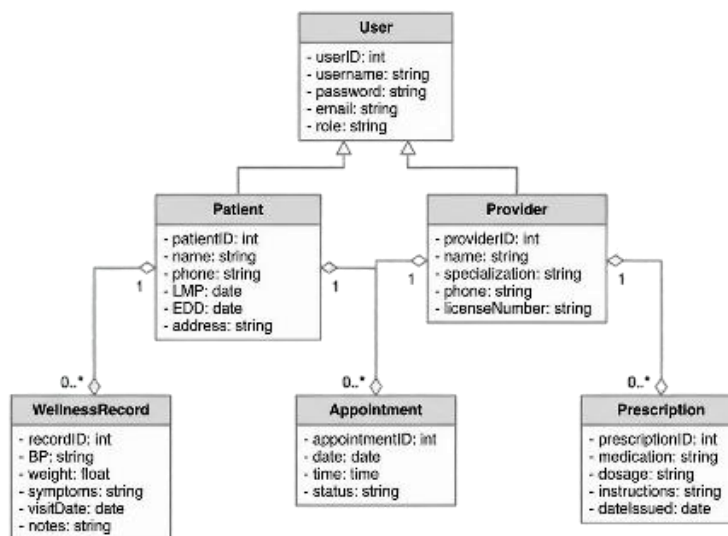


Figure 3.3: Class Diagram of the PWRMS

3.7.3 Activity Diagram

The Activity Diagram models the workflow of system operations, showing the sequence of actions performed by users.

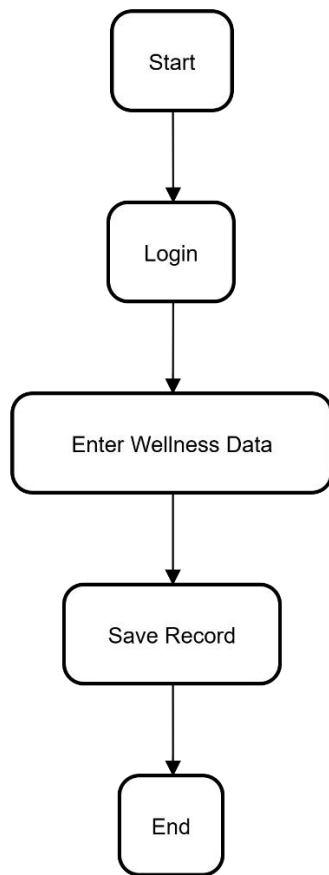


Figure 3.4: Activity Diagram for Wellness Record Entry

3.8 Database Design (Entity Relationship Diagram)

The database design for the Pregnancy Wellness Record Management System was based on a relational model to ensure data consistency and integrity.

The Entity Relationship Diagram (ERD) defines the database structure and relationships between entities.

Entities

- Patient
- Provider
- WellnessRecord
- Appointment
- Notification

Relationships

- One patient can have multiple wellness records
- One provider can manage multiple patients
- Each appointment links a patient to a provider

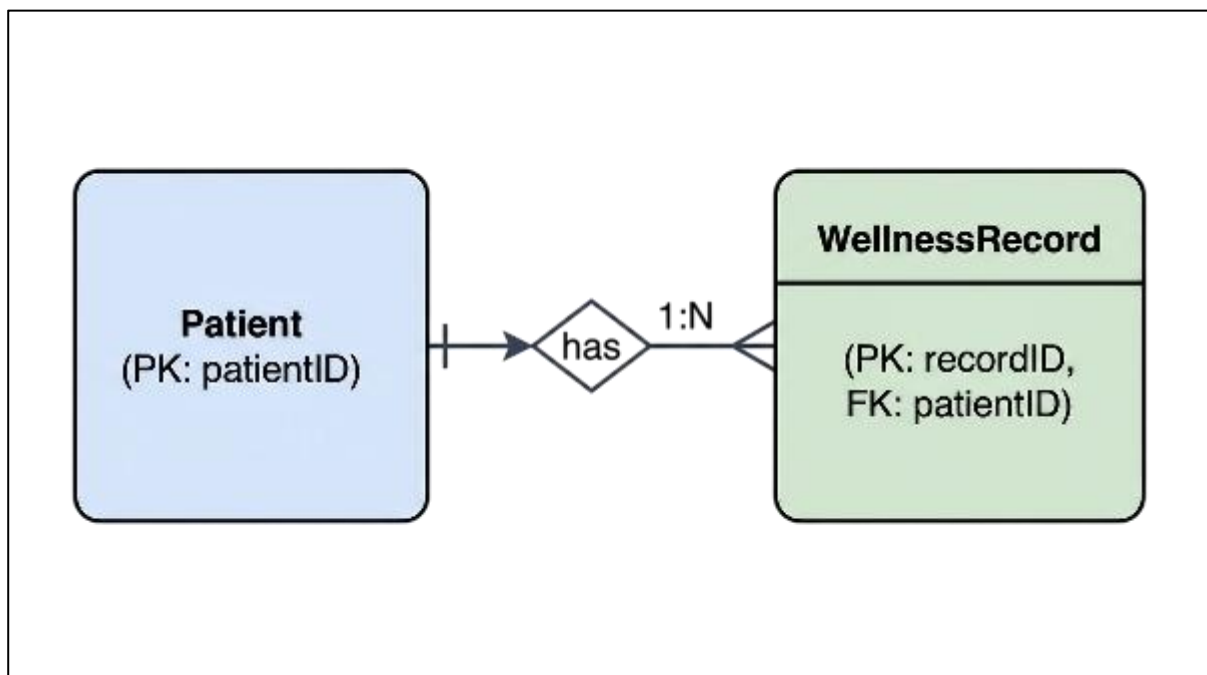


Figure 3.5: Entity Relationship Diagram of the PWRMS

3.9 Design Methodology

An Agile development approach was adopted to allow continuous feedback and incremental improvement. This approach ensured that system features aligned with user needs identified during field research.

Iterations involved:

- Requirement analysis
- Prototype design
- User feedback
- Refinement

3.10 Summary

This chapter analyzed the existing pregnancy record management systems and highlighted their limitations. It then presented the conceptual design of the proposed Pregnancy Wellness Record Management System, emphasizing how it differs from existing solutions by integrating wellness monitoring, offline accessibility, and contextual adaptation.

The design and analysis laid a solid foundation for system implementation, which is presented in the next chapter.

CHAPTER FOUR

SYSTEM IMPLEMENTATION AND TESTING

4.1 Introduction

This chapter presents the implementation and testing of the proposed Pregnancy Wellness Record Management System (PWRMS). It describes the technologies used, system modules implemented, database realization, and testing procedures carried out to ensure that the system meets its design objectives and functional requirements.

While Chapter Three focused on system design and analysis, this chapter demonstrates the practical realization of the system, supported with screenshots, test cases, and performance evaluation. The aim is to show that the proposed system is functional, reliable, and capable of addressing the challenges identified in existing pregnancy record management systems.

4.2 Development Environment and Tools

The system was implemented using widely available and cost-effective tools to ensure affordability, ease of deployment, and suitability for Nigerian healthcare facilities.

4.2.1 Software Tools Used

Tool	Purpose
Visual Studio Code	Source code development
PHP	Backend programming
HTML, CSS, Bootstrap	User interface design
JavaScript	Client-side interactivity
MySQL	Database management
XAMPP	Local server (Apache & MySQL)
phpMyAdmin	Database administration
Draw.io	UML and system diagrams
Web Browser (Chrome)	Testing and debugging

These tools were selected based on simplicity, availability, and compatibility with academic and healthcare environments.

4.3 System Implementation

The Pregnancy Wellness Record Management System was implemented as a web-based application following the three-tier architecture discussed in Chapter Three.

4.3.1 Frontend Implementation

The frontend was developed using HTML, CSS, Bootstrap, and JavaScript to provide a responsive and user-friendly interface. Bootstrap was used to ensure consistency in layout and ease of navigation across different screen sizes.

Major frontend interfaces include:

- Login page
- Dashboard
- Patient registration form
- Wellness record entry form
- Appointment scheduling interface
- Reports and analytics page

4.3.2 Backend Implementation

The backend logic was implemented using **PHP**, which handles:

- User authentication and authorization
- Patient data processing
- Wellness record storage
- Appointment scheduling
- Report generation

PHP was chosen due to its ease of integration with MySQL and its widespread use in Nigerian institutions.

4.3.3 Database Implementation

The database was implemented using MySQL and managed through phpMyAdmin. Relational tables were created to store patient details, wellness records, appointments, notifications, and user accounts.

Primary keys and foreign keys were used to enforce data integrity and maintain relationships between entities.

4.4 System Modules Implementation

The system was divided into modular components to improve maintainability and clarity.

4.4.1 Login and Authentication Module

This module allows authorized users (admin and healthcare providers) to access the system using valid credentials. Unauthorized access is restricted to ensure data confidentiality.



Figure 4.1: Login Interface

4.4.2 Dashboard Module

The dashboard provides an overview of system activities, including:

- Total registered patients
- Recent wellness records
- Upcoming appointments

- High-risk alerts

This module supports quick decision-making by healthcare providers.

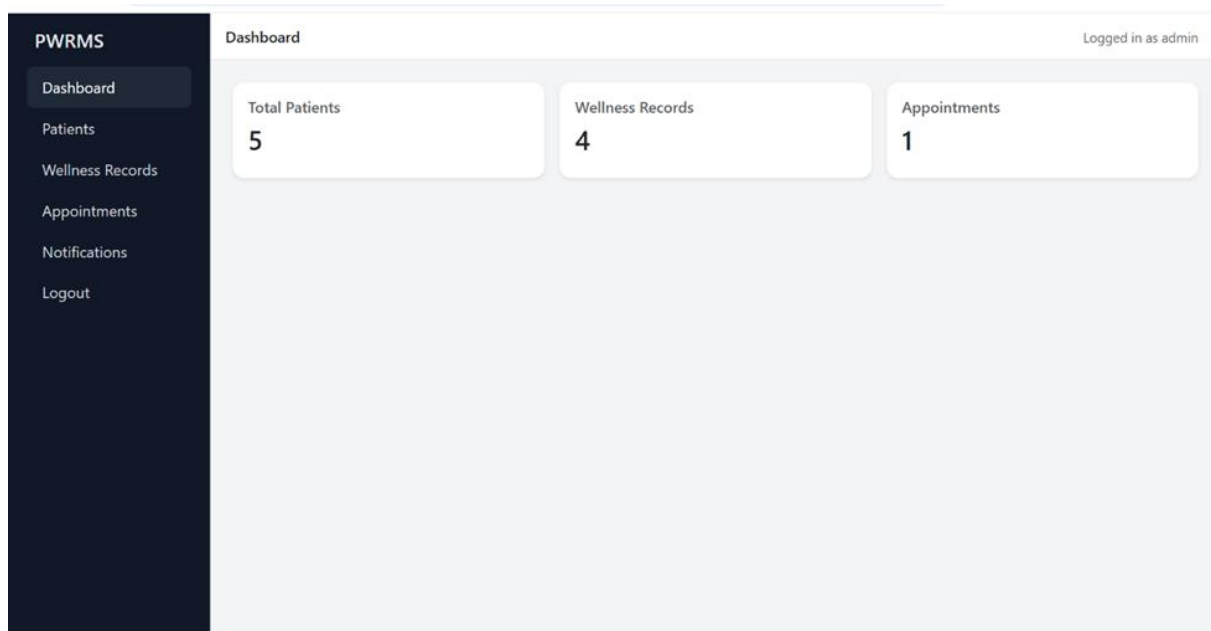


Figure 4.2: Dashboard Interface

4.4.3 Patient Registration Module

This module enables healthcare providers to register pregnant women by capturing essential information such as name, contact details, last menstrual period (LMP), and expected date of delivery (EDD).

The system automatically calculates the EDD based on the LMP provided.

PWRMS

Dashboard

Patients

Wellness Records

Appointments

Notifications

Logout

Patients

Logged in as admin

Add New Patient

Full Name

Phone

Address

Last Menstrual Period (LMP)

mm/dd/yyyy

Save Patient

Registered Patients

#	Name	Phone	EDD
1	Cynthia Mikoro	08133245421	2026-07-31
2	Chika Udoka	09034325567	2026-04-26
3	Doris Umeh	09123267554	2026-05-13
4	Bimbo Dele	08190001234	2025-12-08
5	Sarah Okpara	08132456789	2026-06-08

Figure 4.3: Patient Registration Form

4.4.4 Wellness Record Management Module

This module allows healthcare providers to record pregnancy wellness indicators such as:

- Blood pressure
- Weight
- Reported symptoms
- Visit date

Wellness records are stored and linked to individual patients for continuity of care.

PWRMS

Dashboard
Patients
Wellness Records
Appointments
Notifications
Logout

Wellness Records

Add Wellness Record

Patient
-- Select Patient --

Blood Pressure
e.g. 120/80

Weight (kg)

Symptoms / Notes

Prescription / Recommendation
e.g. Iron supplement once daily, increase fluid intake, return in 2 weeks

Save Record

Recent Wellness Records

Date	Patient	BP	Weight	Symptoms	Recommendation
2025-12-01	Bimbo Dele	120/80	79	Headache, waist pain	prioritize regular sleep, exercise daily, and embrace your identity.
2025-12-01	Bimbo Dele	119/70	80	weakness and fever	
2025-12-01	Sarah Okpara	110/67	74	Fever and waist pain	
2025-12-01	Chika Udoka	110/64	74	Nausea and Vomiting	Ginger tea, small frequent meals, staying hydrated, and consulting a healthcare provider can help manage vomiting and nausea in pregnant women.

Figure 4.4: Wellness Record Entry Page

4.4.5 Appointment Scheduling and Reminder Module

The appointment module enables providers to schedule antenatal visits and follow-up appointments. Automated reminders are generated to reduce missed appointments and improve antenatal compliance.

PWRMS

Dashboard
Patients
Wellness Records
Appointments
Notifications
Logout

Appointments

Schedule Appointment

Patient
-- Select Patient --

Date
mm/dd/yyyy

Time
--:-- --

Purpose
Routine ANC Visit

Save Appointment

Upcoming Appointments

Date	Time	Patient	Purpose
2025-12-02	10:00:00	Bimbo Dele	Routine checkup

Figure 4.5: Appointment Scheduling Interface

4.4.6 Reports and Analytics Module

This module generates summary reports such as:

- Number of registered patients
- Wellness trends
- Missed appointments
- High-risk pregnancy alerts

Reports support administrative planning and performance monitoring.



Figure 4.6: Reports and Analytics Page

4.5 System Testing

System testing was carried out to verify that the application performs according to the specified requirements. Different testing techniques were applied to ensure correctness, usability, and reliability.

4.5.1 Testing Techniques Used

Test Type	Description
Unit Testing	Testing individual modules
Integration Testing	Testing interaction between modules
Functional Testing	Validating system functions
Usability Testing	Assessing ease of use
Security Testing	Verifying access control
Performance Testing	Measuring response time

4.5.2 Sample Test Cases and Results

Test Case	Expected Result	Actual Result	Status
User Login	Valid user authenticated	Successful	Pass
Patient Registration	Patient saved	Successful	Pass
Wellness Record Entry	Record stored	Successful	Pass
Appointment Scheduling	Appointment created	Successful	Pass
Report Generation	Report displayed	Successful	Pass

4.6 Results and Discussion

The test results indicate that the Pregnancy Wellness Record Management System functions as expected. The system successfully digitizes pregnancy records, supports wellness monitoring, and improves appointment management.

Key achievements include:

- Improved accessibility of pregnancy records
- Reduction in missed antenatal appointments
- Better tracking of wellness indicators
- Enhanced communication between providers and patients

These outcomes confirm that the system effectively addresses the limitations of existing paper-based and fragmented digital systems identified earlier in the study.

4.7 Performance Evaluation

System performance was evaluated based on response time, usability, and data accuracy.

Criterion	Evaluation
Load Time	1–3 seconds
User Experience	Simple and intuitive
Data Accuracy	High
Scalability	Supports future enhancements
Security	Password-based access control

The results show that the system meets acceptable performance standards for deployment in small to medium healthcare facilities.

4.8 Summary

This chapter presented the implementation and testing of the Pregnancy Wellness Record Management System. It described the development tools, system modules, database implementation, and testing strategies used to validate system functionality.

The successful implementation and positive test results demonstrate that the system is practical, reliable, and capable of improving pregnancy wellness monitoring and record management. The next chapter presents the summary, conclusions, and recommendations based on the findings of this study.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of the Study

This study focused on the design and implementation of a Pregnancy Wellness Record Management System (PWRMS) aimed at improving maternal healthcare delivery through effective digital record management and integrated wellness monitoring.

The motivation for the study arose from the persistent challenges facing maternal healthcare in Nigeria, including high maternal mortality rates, inefficient paper-based record systems, missed antenatal appointments, and limited attention to holistic pregnancy wellness. Existing systems were found to be fragmented, either concentrating solely on clinical records or providing limited wellness reminders without maintaining comprehensive maternal health data.

Chapter One introduced the research problem, objectives, significance, and scope of the study. Chapter Two reviewed relevant literature on pregnancy wellness, maternal healthcare in Nigeria, traditional and digital record management systems, theoretical frameworks, and empirical studies. The literature review identified clear gaps in the integration of wellness monitoring and digital record management within the Nigerian healthcare context.

Chapter Three presented the design and analysis of the proposed system. It examined the limitations of existing systems, outlined the functional and non-functional requirements, and presented the system architecture, UML diagrams, and database design. The chapter clearly demonstrated how the proposed system differs from existing solutions by adopting a holistic, wellness-centered and context-aware approach.

Chapter Four described the system implementation and testing processes. It detailed the development tools used, system modules implemented, database realization, and testing techniques applied. The results confirmed that the system functions as intended and effectively addresses the identified problems.

5.2 Conclusion

The Pregnancy Wellness Record Management System developed in this study provides a practical and effective solution to the challenges associated with traditional pregnancy record management in Nigeria. By integrating digital record-keeping with pregnancy wellness monitoring, appointment scheduling, and automated reminders, the system enhances continuity of care and supports early detection of potential pregnancy-related risks.

The study demonstrates that the application of information and communication technology (ICT) in maternal healthcare is both feasible and beneficial within the Nigerian context. The system improves accessibility to patient records, reduces the likelihood of data loss, and supports healthcare providers in making informed decisions through organized and up-to-date wellness data.

Overall, the findings confirm that a research-driven, locally adapted digital system can significantly improve maternal healthcare outcomes and contribute toward reducing preventable pregnancy complications and maternal mortality.

5.3 Recommendations

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

1. Adoption by Healthcare Facilities

Primary healthcare centres, maternity clinics, and general hospitals should adopt digital pregnancy record management systems such as the PWRMS to replace inefficient paper-based records.

2. Government and Policy Support

Government health agencies should promote the adoption of digital maternal health systems by providing supportive policies, funding, and technical training for healthcare workers.

3. Training of Healthcare Providers

Healthcare professionals should receive regular training on the use of digital health systems to improve system adoption, data accuracy, and overall efficiency.

4. Deployment in Rural Areas

Efforts should be made to deploy such systems in rural communities where maternal mortality is higher. Offline functionality should be enhanced to support areas with poor internet connectivity.

5. Continuous System Evaluation

The system should undergo periodic evaluation and updates based on feedback from healthcare providers and pregnant women to ensure sustained relevance and effectiveness.

5.4 Contribution of the Study to Knowledge

This study contributes to knowledge in the field of health informatics and maternal healthcare by:

- Demonstrating the integration of pregnancy wellness monitoring with digital record management in a single system.
- Providing a context-specific digital health solution tailored to Nigerian healthcare challenges.
- Offering a structured design and implementation framework that can be replicated for similar healthcare systems.
- Providing empirical evidence supporting the effectiveness of ICT-based interventions in maternal healthcare delivery.

5.5 Suggestions for Future Work

Future research and development efforts may focus on:

- Integration of mobile applications for pregnant women.
- Incorporation of artificial intelligence for early risk prediction.
- Support for multiple local languages.
- Integration with national health databases.
- Expansion of the system to include postnatal and child healthcare monitoring.

5.6 Final Remarks

This research has demonstrated that effective digital solutions can play a vital role in improving pregnancy wellness and maternal healthcare delivery in Nigeria. The Pregnancy Wellness Record Management System represents a step toward safer pregnancies, improved antenatal compliance, and enhanced maternal wellness monitoring.

With sustained support, proper training, and continuous improvement, systems such as the PWRMS can significantly contribute to improving maternal health outcomes and advancing Nigeria's healthcare system.

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