E-VACCINE. A WEB BASED VACCINATION MANAGEMENT SYSTEM CASE STUDY: MUKONO GENERAL HOSPITAL

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A PROJECT REPORT SUBMITTED TO THE FACULTY OF ENGINEERING, DESIGN AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A DEGREE OF BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY OF UGANDA CHRISTIAN UNIVERSITY

May, 2026

UGANDA CHRISTIAN UNIVERSITY

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DECLARATION

We, the undersigned, do hereby declare that the project report entitled “E-VACCINE “ is the result of our original and independent work, undertaken as part of our academic program in fulfilment of the requirements for the award of the Bachelor of Science in Information Technology at Uganda Christian University.

This report has not been submitted to any other institution for the purpose of academic credit. All sources of information, ideas and data drawn from the works of others have been clearly acknowledged and referenced in accordance with academic standards.

The development of this project was guided by a commitment to ethical conduct, academic integrity, and a passion for using technology to solve real-world health challenges. We take full responsibility for the content herein and affirm that it reflects our genuine effort and contributions.

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ACKNOWLEDGEMENT

We would like to extend our deepest gratitude to all those who contributed to the successful completion of this project, titled *"E-VACCINE"*.

First, we are profoundly thankful to Uganda Christian University for fostering a learning environment that encourages innovation, research, and the practical application of knowledge to solve real-world problems. This institution has played a pivotal role in shaping our academic journey and technical competencies.

We express our sincere appreciation to our project supervisors, Mr. Solomon Opio and Madam Justine, whose guidance, encouragement, and expert insights were vital throughout every phase of the project. Their support helped us refine our ideas and stay focused on our objectives.

Special thanks go to the Faculty of Information Technology, whose comprehensive instruction and mentorship formed the foundation upon which this project was built. We are especially grateful to Mr. Opio Solomon for his guidance and Madam Justine for her hands-on mentorship and infrastructure, both of which greatly enhanced our understanding of practical deployment scenarios.

We also wish to acknowledge the healthcare professionals and community members from rural Uganda who contributed their perspectives during our research. Their lived experiences, feedback, and cooperation were instrumental in shaping a solution that is both relevant and impactful.

To our families and close friends, thank you for your unwavering moral support, patience, and encouragement. Your faith in our abilities kept us motivated and focused during the more challenging phases of the project.

Lastly, to fellow team members Lwanga Shawn Geoffrey, Luyima Rodine, Kurre Bosco and Odipio Gerald. we recognize and appreciate the commitment, collaboration, and hard work that brought this vision to life. The E-vaccine platform is a reflection of our shared dedication to using technology for social good.

We are truly grateful to everyone who played a role, directly or indirectly, in the realization of this project.

Table of Contents

Abstract

Vaccination stands as the most successful public health measure which stops infectious diseases while decreasing child death rates. Uganda conducts its immunization efforts through the Uganda National Expanded Programme on Immunization (UNEPI) which implements its vaccination programs. Healthcare facilities need to switch to digital systems because their existing paper-based systems still need to address proper vaccination data management. The manual systems generate record loss together with incomplete data which creates obstacles for tracking vaccination timelines that result in children missing vital vaccination periods.

This project shows how to create and operate an E-Vaccination Management System which allows for better control over vaccination documentation and appointment management and parent-healthcare provider communication. The system enables parents to track their children's vaccination schedules, book vaccination appointments, and receive reminders for upcoming vaccinations. Health workers can register parents and children, update vaccination records, and monitor immunization progress, while administrators manage hospitals and healthcare workers within the system.

The system used a web-based technology stack which includes HTML, CSS, JavaScript, PHP, MySQL through phpMyAdmin, and PHPMailer for sending automatic email alerts. The project used a structured methodology which included requirement analysis and system design and implementation and testing and evaluation processes.

The system demonstrates its ability to enhance record management while decreasing vaccination appointment failures and improving communication between health professionals and parents. System evaluation confirmed that the application meets all three benchmarks through which it assesses its operational performance and user experience and information retrieval process.

CHAPTER ONE

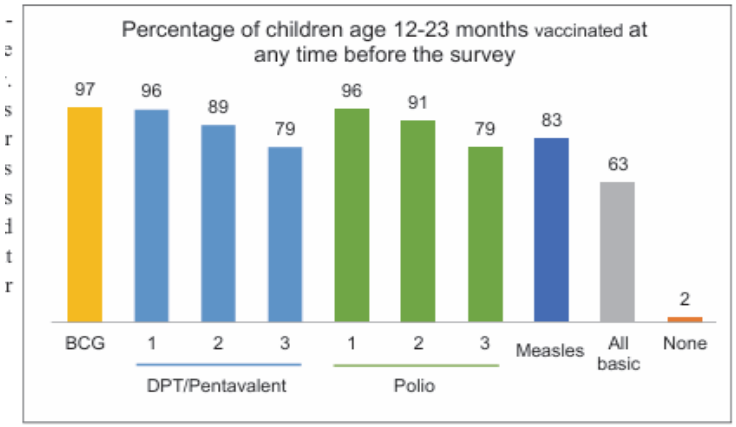
1.1 Introduction

Vaccination is one of the most effective and cost-effective ways of protecting children and communities from infectious diseases. Vaccination helps to prevent serious diseases such as measles, tuberculosis, polio, hepatitis B, and tetanus, which were responsible for high mortality rates among children in the past. Vaccination programs have been instrumental in reducing the mortality rates of children worldwide and the morbidity rates associated with vaccine-preventable diseases.

In Uganda, the vaccination program is carried out through the Uganda National Expanded Program on Immunization (UNEPI) under the Ministry of Health. The program helps children access routine vaccination at recommended ages through health facilities within the country. According to health reports, the country has managed to achieve high coverage rates for various childhood vaccinations, with BCG vaccination reaching a coverage of 97%, Polio vaccination reaching 96%, and Pentavalent vaccination reaching 95.6% among children.

Though there is considerable media coverage of individual vaccines, fewer children are completing the full schedule of recommended vaccines. According to the Uganda Demographic and Health Survey (UDHS, 2022), only 63% of children aged 12 to 23 months are fully immunized, and about 2% have never been immunized with any vaccine.

Figure 10. 1 Childhood vaccinations



In some districts, such as Mukono, immunization services are provided through hospitals, health centers, and outreach services, with the main goal of increasing immunization coverage. However, some children do not complete the full schedule of vaccines due to a number of issues such as poor follow-up, lack of reminders, and poor record management.

Many healthcare facilities use paper-based systems to record immunization data, which is difficult to track, access, and monitor children who miss immunization schedules. As a result, digital health solutions are increasingly being used to improve healthcare services.

The E-Vaccination Management System is a digital system that helps automate the whole vaccination process, from registration of children to the actual vaccination and sending of reminders to parents. In this way, the whole process is centralized, helping health teams keep track of everything and reducing the chances of children missing their vaccinations.

1.2 Background of the study

The administration of vaccination programs is an essential tool in the fight against childhood illness and mortality. In Uganda, the national health system is responsible for the administration of routine immunization programs, with support from international bodies such as the World Health Organization and UNICEF. The government has expanded the program to cover

vaccines that protect against tuberculosis, measles, diphtheria, hepatitis B, and polio among other diseases.

In the last two decades, Uganda has registered significant milestones in improving immunization. The proportion of children aged 12–23 months who are fully immunized increased from 37% in 2000 to 63% in 2022.

Figure 10. 2 Trends in childhood vaccination

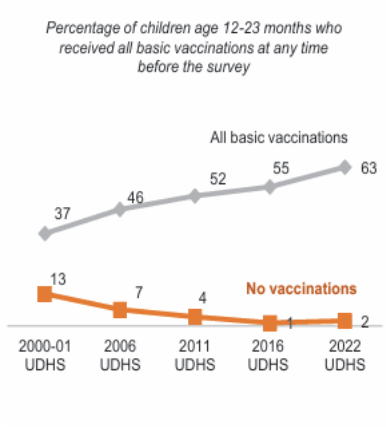
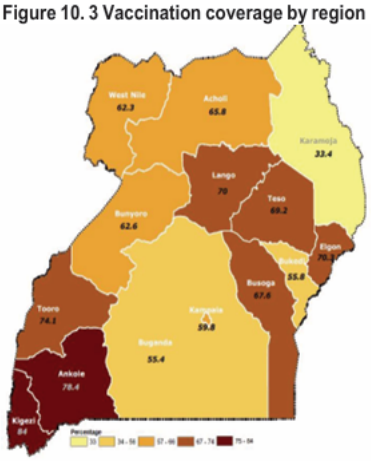


Figure 10. 3 Vaccination coverage by region



However, despite these improvements, there is still much to be accomplished. According to health reports, thousands of Ugandan children miss vaccines every year, and more than 100,000 children have never received any vaccine, commonly referred to as “zero-dose” children.

In areas such as Mukono District, health clinics provide routine vaccinations and outreach services to reach children in both urban and rural areas. However, studies have highlighted issues such as poor record-keeping, missed appointments, and limited communication between parents and health workers, which continue to pose challenges to vaccination programs.

Research conducted in districts such as Mukono and Kalungu has identified inefficiencies in vaccine management. For example, vaccine wastage was reported to be 70% for BCG and 58% for measles-rubella, mainly due to poor tracking and coordination of vaccination services.

Most vaccination records in health facilities are recorded manually using paper-based systems. Although this system is easy to use, it is inefficient because duplication, missing information, and difficulties in accessing previous patient records remain major challenges. However, with the advancement of information and communication technology, digital health systems are becoming an important solution for improving healthcare management. An E-Vaccination Management System serves as an important platform for addressing these challenges in vaccination management.

In Uganda, including Mukono District, most clinics still rely on paper records to track immunization services. However, paper records often get lost, damaged, or remain incomplete, making it difficult for medical staff to retrieve vaccination histories when needed.

One major challenge is the management of records. Paper records can easily be misplaced or destroyed, and if parents lose the child's health card, it becomes difficult to verify the vaccination history of the child.

1.3 Problem statement

Vaccination is essential for preventing infectious diseases and improving child health. However, for vaccination programs to be effective, vaccination data must be properly recorded, stored, and shared.

Currently, many health facilities in Uganda, including those in Mukono District, still use paper-based systems to record vaccination information. These systems often lead to loss of records, incomplete information, and difficulties in retrieving children's vaccination histories.

The main challenge is the management of records, since paper records can be damaged, misplaced, or lost, making it difficult for health workers to access accurate vaccination information. If parents lose their child's health cards, health workers may find it difficult to determine which vaccines the child has already received.

Another challenge is tracking vaccination schedules and identifying children who miss their vaccinations. Vaccination schedules require children to receive vaccines at specific times, but

health workers often lack efficient tools for identifying children who fail to comply with these schedules.

Communication between parents and health workers is also limited. Appointment dates are normally written on child health cards, but parents sometimes forget the dates or lose the cards. This situation contributes to incomplete vaccination because children fail to receive essential vaccines on time.

These challenges contribute to low full-immunization coverage. Although Uganda has high coverage for individual vaccines, only about 63% of children are fully immunized, meaning many children do not complete the full vaccination schedule.

Therefore, there is a need for a digital solution that improves the management of vaccination records, scheduling, and communication between parents and healthcare providers. An E-Vaccination Management System can help address these challenges by automating vaccination management and improving access to vaccination information.

1.4 Aim of the study

The aim of the study is to design and deploy an E-Vaccination Management System that improves the management of vaccination records, appointment scheduling, and communication between parents, health workers, and administrators.

1.5 Specific Objectives

The objectives of the study are to:

I. Develop a system that allows parents to register their children and update vaccination information.
II. Develop a system for booking vaccination appointments.
III. Enable health workers to update vaccination records.
IV. Enable the system to track vaccinations that have been received or missed.

V. Enable the system to send reminders for upcoming vaccination appointments.
VI. Enable administrators to monitor system users and health facilities.
VII. Enable the system to generate reports for monitoring vaccination programs.

1.6 Project Scope

The project focuses on designing a web-based E-Vaccination Management System that facilitates the management of child vaccination records in health facilities.

The users who interact with the system include:

I. Parents
II. Health workers
III. Administrators

The system includes the following features:

i. Registration of children
ii. Management of children's profiles
iii. Appointment scheduling
iv. Management of vaccination records
v. Tracking overdue vaccinations
vi. Notification services
vii. Report generation

The system is accessible through computers or mobile devices with internet connectivity.

However, the system does not include vaccine procurement, vaccine storage management, or financial transactions related to vaccines.

1.7 Significance of the system

The E-Vaccination Management System will benefit several groups. For parents, the system will help them track vaccination schedules, book appointments, and receive timely reminders so that their children remain up to date with vaccinations. For health workers, the system will improve efficiency by simplifying access to vaccination records and reducing paperwork. For health administrators, the system will provide better monitoring and data analysis to support decision-making.

At the national level, the system will contribute to improving vaccination coverage by reducing missed immunizations. For researchers and students, the system will serve as a valuable reference for future studies related to digital health systems.

1.8 Organizational Structure of the current system

In Uganda, vaccination management is organized through different levels of the healthcare system.

At the national level, vaccination programs are coordinated by the Ministry of Health through the Uganda National Expanded Program on Immunization. This department develops policies, vaccination schedules, and guidelines for immunization services across the country.

At the district level, District Health Offices are responsible for supervising immunization services and collecting vaccination data from health facilities.
At the health facility level, healthcare workers administer vaccines and record immunization information in logbooks or child health cards.

Parents or guardians are responsible for taking their children to healthcare facilities for vaccination according to the scheduled dates.

Although this system has supported immunization programs in Uganda for many years, the reliance on manual logbooks makes data management difficult and sometimes inaccurate. This situation creates the need for a digital system that improves the management and monitoring of vaccination records.

CHAPTER 2: LITERATURE REVIEW

3.1 Introduction

This chapter reviews existing literature related to child immunization systems and vaccination management practices in Uganda. The purpose of this chapter is to examine previous studies, policies, and technological solutions used to support vaccination programs and healthcare data management. The chapter also discusses the challenges affecting vaccination programs and the role of digital health systems in improving immunization coverage. By analyzing existing literature, this chapter identifies gaps that justify the development of a Vaccination Management System aimed at improving vaccination record management and service delivery in Uganda.

Child immunization is widely recognized as one of the most effective public health interventions for preventing childhood diseases and reducing mortality among children under the age of five. Vaccines protect children from life-threatening diseases such as measles, tuberculosis, polio, diphtheria, tetanus, and hepatitis. The global vaccination effort is coordinated by organizations such as the World Health Organization and the United Nations Children's Fund, which support countries in implementing national immunization programs.

Uganda has adopted immunization programs as part of its national healthcare strategy to reduce child mortality and improve overall public health outcomes. However, despite improvements in vaccination coverage, several challenges remain, including incomplete immunization schedules, limited healthcare infrastructure, and inefficient record-keeping systems. These challenges highlight the importance of technological solutions such as vaccination management systems.

3.2 Overview of Immunization Programs in Uganda

Uganda's national immunization program is implemented through the Uganda National Expanded Programme on Immunization (UNEPI) under the Uganda Ministry of Health. The program was introduced to increase vaccination coverage and reduce the prevalence of vaccine-preventable diseases among children.

The immunization program provides vaccines for diseases including tuberculosis, polio, measles, diphtheria, pertussis, tetanus, hepatitis B, and pneumococcal infections. These vaccines are administered according to a national immunization schedule that specifies the recommended age for each vaccine dose.

The vaccination program operates through a hierarchical healthcare structure that includes national referral hospitals, regional referral hospitals, district hospitals, health centre IVs, health centre IIIs, and health centre IIs. Vaccination services are provided at health facilities and through outreach programs that reach communities located far from healthcare centres.

The government of Uganda has made significant progress in expanding vaccination coverage over the years. For example, the introduction of new vaccines such as rotavirus and pneumococcal vaccines has helped reduce childhood illnesses and hospital admissions. These efforts are supported by international organizations such as Gavi, the Vaccine Alliance, which provides financial and technical support for vaccine procurement and distribution.

Despite these improvements, some children still miss scheduled vaccinations due to various challenges related to access, awareness, and healthcare infrastructure.

3.3 Importance of Child Immunization in Uganda

Child immunization plays a critical role in preventing disease outbreaks and improving child survival rates. Vaccines stimulate the body's immune system to develop protection against specific diseases, thereby reducing the likelihood of infection.

In Uganda, immunization programs have contributed significantly to the reduction of childhood diseases. For example, vaccination campaigns have helped control diseases such as measles and polio, which previously caused widespread illness among children.

Immunization also contributes to herd immunity, which occurs when a large percentage of the population becomes immune to a disease. This reduces the spread of infectious diseases and protects vulnerable individuals who cannot be vaccinated due to medical reasons.

Furthermore, vaccination programs reduce healthcare costs by preventing diseases that would otherwise require expensive medical treatment. Preventive healthcare strategies such as immunization are therefore considered more cost-effective compared to treating diseases after infection occurs.

3.4 Immunization Policies and Legal Framework in Uganda

To strengthen vaccination programs, the government of Uganda has established legal and policy frameworks that support immunization services. One important policy initiative is the Immunization Act of 2016, which was enacted to ensure that all children receive essential vaccines.

The Immunization Act promotes universal immunization coverage and encourages government agencies to allocate adequate resources for vaccination programs. The Act also emphasizes the responsibility of parents and caregivers to ensure that children receive recommended vaccines.

In addition to national laws, Uganda has developed national health strategies that prioritize immunization services. These strategies focus on expanding vaccination access, improving healthcare infrastructure, and strengthening disease surveillance systems.

The government also collaborates with international health organizations to implement vaccination campaigns and improve healthcare service delivery. These partnerships help provide funding, training, and technical support for immunization programs.

3.5 Factors Affecting Vaccination Coverage in Uganda

Several factors influence the level of vaccination coverage in Uganda. These factors include social, economic, geographical, and health system-related challenges.

One important factor is parental awareness and education. Some caregivers lack sufficient knowledge about vaccination schedules and the importance of completing the full immunization program. As a result, some children receive initial vaccine doses but fail to complete subsequent doses.

Geographical barriers also affect vaccination coverage, especially in rural communities where health facilities are located far from households. Poor road networks and limited transportation options make it difficult for parents to take children to health centres for vaccination services.

Healthcare system challenges also contribute to incomplete immunization coverage. These challenges include shortages of trained healthcare workers, vaccine stockouts, and inadequate cold chain infrastructure required for vaccine storage.

Cultural beliefs and misinformation about vaccines can also influence vaccination decisions among some communities. In certain cases, myths and misconceptions about vaccine safety discourage caregivers from taking their children for immunization.

3.6 Challenges of Traditional Vaccination Record Systems

Many healthcare facilities in Uganda rely on paper-based record systems to document vaccination information. When a child receives a vaccine, the details are recorded on a child health card and in facility registers.

Although this method has been used for many years, it presents several limitations. One major challenge is the risk of losing vaccination cards. Caregivers may lose or damage the cards, making it difficult for healthcare workers to verify vaccination history during future visits.

Manual record systems also make it difficult to track children who miss vaccination appointments. Without automated tracking mechanisms, healthcare workers may not easily identify children who fail to return for follow-up vaccinations.

Another challenge is the difficulty of generating vaccination reports. Healthcare workers must manually review large registers to compile statistics for district and national reporting. This process is time-consuming and increases the likelihood of data entry errors.

Paper-based records also require significant physical storage space and may deteriorate over time due to poor storage conditions.

3.7 Digital Health Systems in Uganda

Digital health technologies are increasingly being adopted in Uganda to improve healthcare service delivery. Electronic health information systems enable healthcare workers to collect, store, and analyze patient data more efficiently.

Digital vaccination systems can significantly improve immunization programs by allowing healthcare workers to maintain electronic vaccination records. These systems enable quick retrieval of patient information and reduce the risk of lost records.

Electronic systems also improve data accuracy by minimizing manual errors associated with paper-based documentation. Additionally, digital systems support real-time reporting and data analysis, which helps health administrators monitor immunization coverage and identify areas requiring intervention.

3.8 Role of Notification Systems in Vaccination Programs

One of the key advantages of digital vaccination systems is the ability to send automated reminders to caregivers. Reminder systems use communication technologies such as SMS messages and email notifications to inform parents about upcoming vaccination appointments.

Reminder systems help improve vaccination adherence by reducing the likelihood of missed appointments. Studies have shown that reminder messages significantly increase vaccination attendance rates among caregivers.

Automated notifications also help healthcare workers maintain regular communication with parents, which improves trust and engagement with healthcare services.

3.9 Community Participation in Immunization Programs

Community involvement is essential for the success of immunization programs in Uganda. Community health workers, commonly known as Village Health Teams (VHTs), play an important role in mobilizing communities and educating parents about vaccination services.

Village Health Teams conduct household visits to identify children who have not been vaccinated and encourage caregivers to attend immunization sessions. They also provide education about the benefits of vaccines and address concerns related to vaccine safety.

Community outreach programs are also used to deliver vaccination services to remote areas. Healthcare workers organize outreach sessions in schools, community centres, and churches to ensure that children living far from health facilities can access vaccination services.

3.10 Benefits of a Vaccination Management System

A Vaccination Management System provides several advantages for healthcare facilities and caregivers. First, it improves the accuracy and reliability of vaccination records by storing data electronically.

Second, the system allows healthcare workers to easily track vaccination schedules and identify children who have missed certain vaccines. This improves follow-up and ensures that children complete the full immunization program.

Third, digital systems support automated appointment scheduling and notification services, which help reduce missed vaccination sessions.

Fourth, vaccination management systems provide analytical reports that support healthcare planning and decision-making. Health administrators can use these reports to monitor vaccination coverage and allocate resources more effectively.

3.11 Research Gap

Although Uganda has made progress in strengthening immunization programs, many healthcare facilities still rely on manual record systems that are inefficient and prone to data loss. Existing digital health solutions may not fully address the specific needs of vaccination tracking and appointment management at the local healthcare facility level.

Furthermore, many systems lack integrated reminder mechanisms that notify caregivers about upcoming vaccination schedules. Without such systems, many children fail to complete their vaccination programs.

Therefore, there is a need to develop a reliable and user-friendly Vaccination Management System that can register children, track vaccination records, schedule appointments, and send automated reminders to parents. The proposed system aims to address these challenges by improving data management and supporting healthcare workers in delivering efficient immunization services.
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Chapter Three

3.1 Methodology

The project was developed using a **systematic approach**:

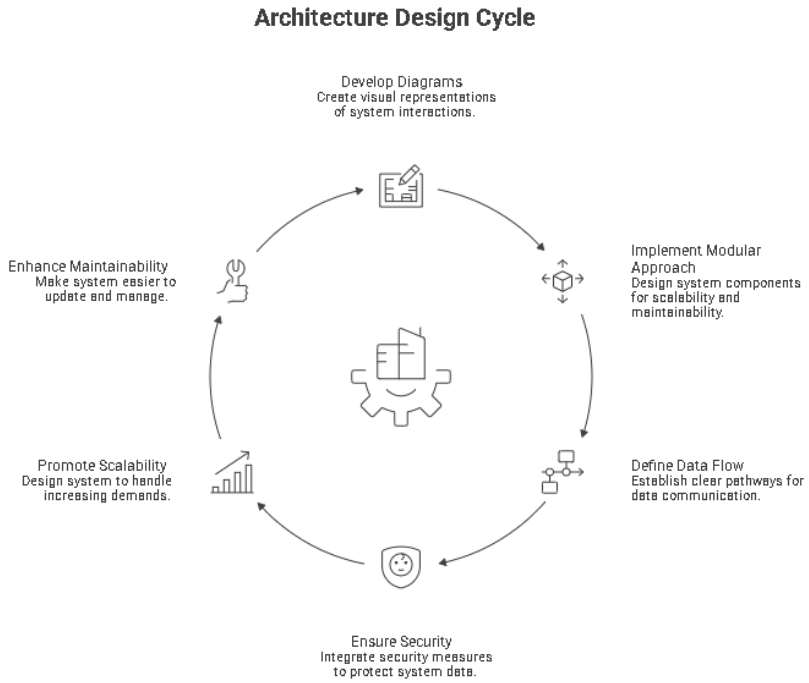
1. **Requirement Analysis** – Interviews with healthcare workers, review of vaccination schedules.
2. **System Design** – Creation of architecture diagrams, database schema, and UI prototypes.
3. **Implementation** – Coding frontend, backend, and database; integrating SMS/email reminders.
4. **Testing and Validation** – Unit, integration, and user acceptance testing; trial runs with sample data.

3.2 System Design

Following requirement analysis, the system design phase focused on translating functional requirements into a structured technical framework.

3.2.1 System Architecture Design

Architecture diagrams were developed to illustrate the interaction between the frontend interface, backend logic, and database system. The design followed a modular approach to promote scalability, maintainability, and security. Clear data flow pathways were defined to ensure efficient communication between system components.



3.2.2 Database Design

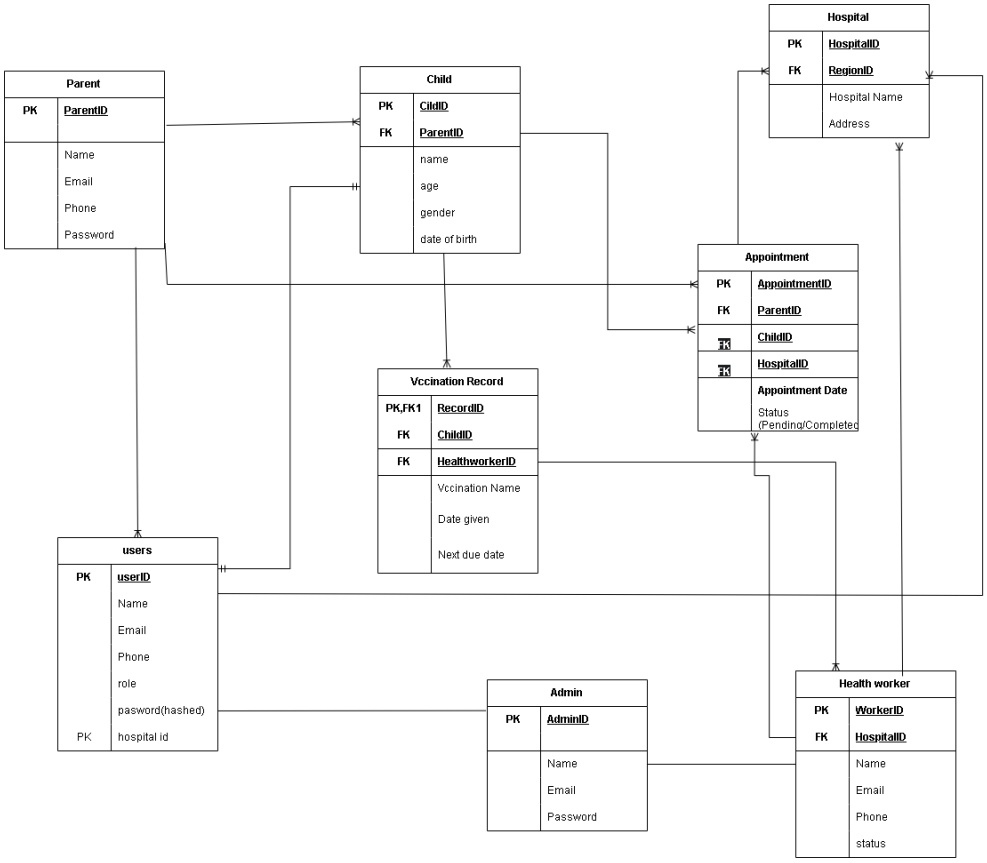
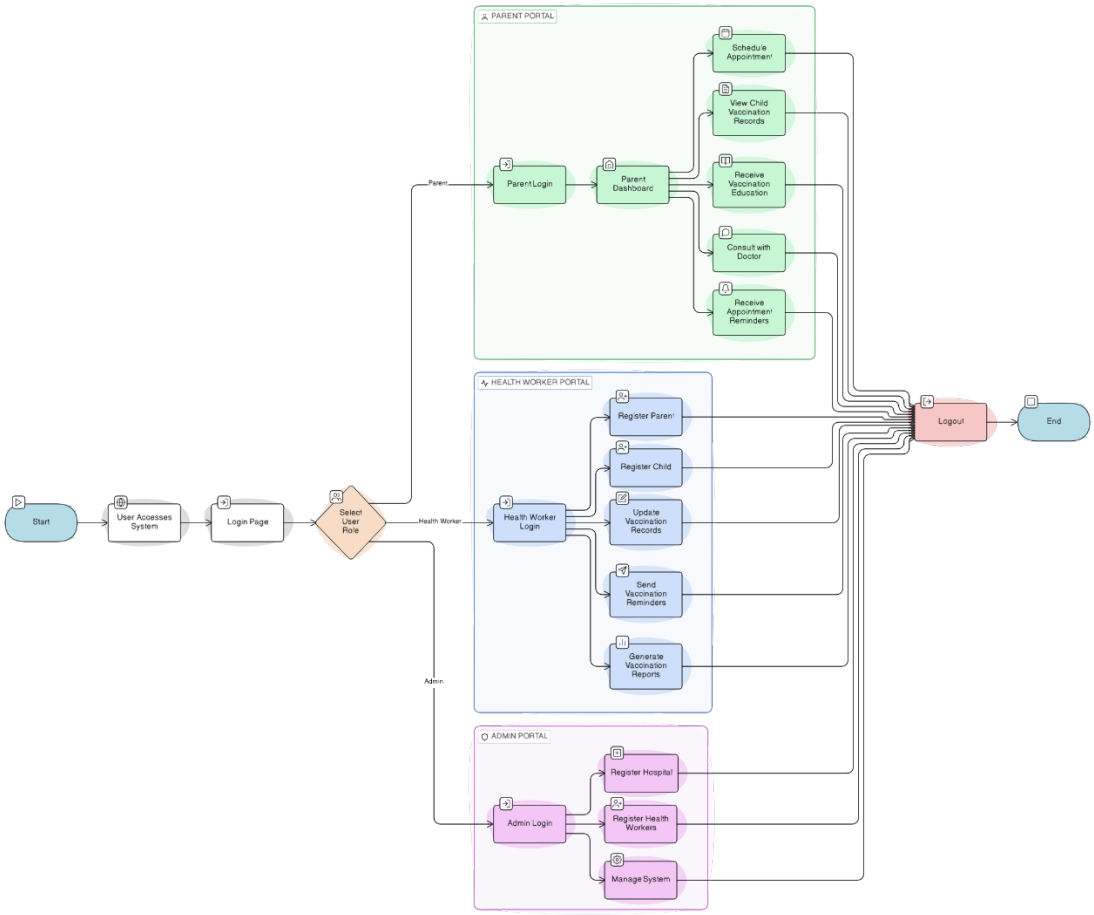


Table	Purpose
Parents	Store personal information of the parents
Vaccines	Store vaccine types, doses, and schedules
Vaccination Records	Track administered vaccines and responsible staff
Appointments	Store scheduled sessions and reminders
Users	Manage system users and access levels

3.2.3 System Flowchart



3.2.4 Offline-First Data Synchronization Design

The system adopts an offline-first architecture to address challenges related to unreliable internet connectivity, especially in rural health facilities.

In this approach, the system is designed to function even when there is no active internet connection. Data entered by users (such as patient registration, vaccination records, and appointments) is first stored locally on the user's device using browser storage technologies such as Local Storage or IndexedDB.

When internet connectivity becomes available, the system automatically synchronizes the locally stored data with the central MySQL database hosted on the server.

The synchronization process follows these steps:

1. Data is captured and stored locally when offline.
2. A background process continuously checks for internet availability.

3. Once a connection is detected, unsynchronized records are uploaded to the server.
4. The system resolves conflicts by prioritizing the most recent updates.

A confirmation message is displayed once synchronization is complete.

This design ensures:

- Continuous system usability without internet
- Reduced data loss risks
- Improved service delivery in remote clinics

Chapter 4

4.1 Implementation

The Vaccination Management System (VMS) was implemented using a web-based technology stack consisting of HTML, CSS, JavaScript, PHP, phpMyAdmin (MySQL), and PHPMailer for notifications. Each tool was selected carefully based on functionality, cost, efficiency, and suitability for healthcare environments.

4.1 Frontend Technologies

4.1.1 HTML (HyperText Markup Language)

HTML was used to structure the web pages of the system.

Reason for Selection:

- It is the standard markup language for web applications.
- It allows structured creation of forms for patient registration, login, and appointment scheduling.
- It is lightweight and compatible with all modern browsers.
- It integrates easily with backend technologies like PHP.

Since the system required multiple structured input forms (patient details, vaccination data, appointment dates), HTML was essential for organizing user input fields properly.

4.1.2 CSS (Cascading Style Sheets)

CSS was used to design and style the user interface.

Reason for Selection:

- Improves visual presentation and readability.
- Makes the system user-friendly and professional.
- Enhances accessibility for healthcare workers.
- Allows responsive design for use on desktops and mobile devices.

A clean and simple interface was important because healthcare workers may not have advanced technical skills. CSS ensured that the system is easy to navigate and reduces user errors.

4.1.3 JavaScript

JavaScript was implemented to enhance interactivity and client-side validation.

Reason for Selection:

- Validates form inputs before submission.
- Reduces server load by handling minor checks on the client side.
- Improves user experience through dynamic content updates.
- Prevents incomplete or incorrect data entry.

For example, ensuring that required fields are filled before submission helps maintain data integrity and reduces database errors.

4.2 Backend Technology

4.2.1 PHP

PHP was used as the server-side scripting language to handle business logic and database communication.

Reason for Selection:

- It integrates seamlessly with HTML and MySQL.
- It is widely supported by web hosting services.
- It is cost-effective and open-source.
- It is suitable for small to medium-scale web applications.
- It allows secure handling of user authentication and session management.

PHP was responsible for:

- Processing login authentication
- Managing patient registration
- Storing and retrieving vaccination records
- Handling appointment scheduling
- Generating reports

Its simplicity and compatibility made it ideal for a healthcare system that may be deployed in resource-limited environments.

4.3 Database Management System

4.3.1 MySQL (Managed via phpMyAdmin)

The system uses MySQL as the relational database, administered through phpMyAdmin.

Reason for Selection:

- MySQL is reliable and widely used for web-based systems.
- It supports structured relational database design.
- It ensures data integrity through primary and foreign keys.
- It handles large volumes of structured data efficiently.
- It supports backup and recovery mechanisms.

phpMyAdmin was selected because:

- It provides a graphical interface for database management.
- It simplifies database creation and maintenance.

- It allows easy execution of SQL queries.
- It helps in monitoring and debugging database operations.

Vaccination records are sensitive health data. Therefore, a relational database system was necessary to maintain relationships between:

- Patients
- Vaccines
- Appointments
- Healthcare workers
- Vaccination records

This structure prevents duplication and ensures accurate reporting.

4.4 Notification System

4.4.1 SMS and Email Integration using PHPMailer

PHPMailer was used to send automated email notifications, and SMS integration was configured for patient reminders.

Reason for Selection:

- PHPMailer is secure and reliable for sending emails via SMTP.
- It supports authentication and encryption.
- It integrates easily with PHP.
- It automates appointment reminders.

Notifications are critical in vaccination systems because:

- They reduce missed appointments.
- They improve patient compliance.
- They increase vaccination completion rates.
- They enhance communication between healthcare providers and patients.

Automated reminders make the system proactive rather than reactive.

4.5 Offline Functionality Implementation

To implement offline capabilities, the system integrates client-side storage mechanisms such as IndexedDB and Local Storage using JavaScript.

A service worker is used to cache important system resources, allowing the application to load even without internet access. The service worker also enables background synchronization.

Key features implemented include:

- Local storage of form data before submission
- Automatic retry mechanism for failed requests
- Background synchronization when connectivity is restored
- User notifications indicating sync status

This approach ensures that healthcare workers can continue registering patients and updating vaccination records without interruption.

4.6 Key System Feature Interface Screenshots

4.6.1 Parent interface

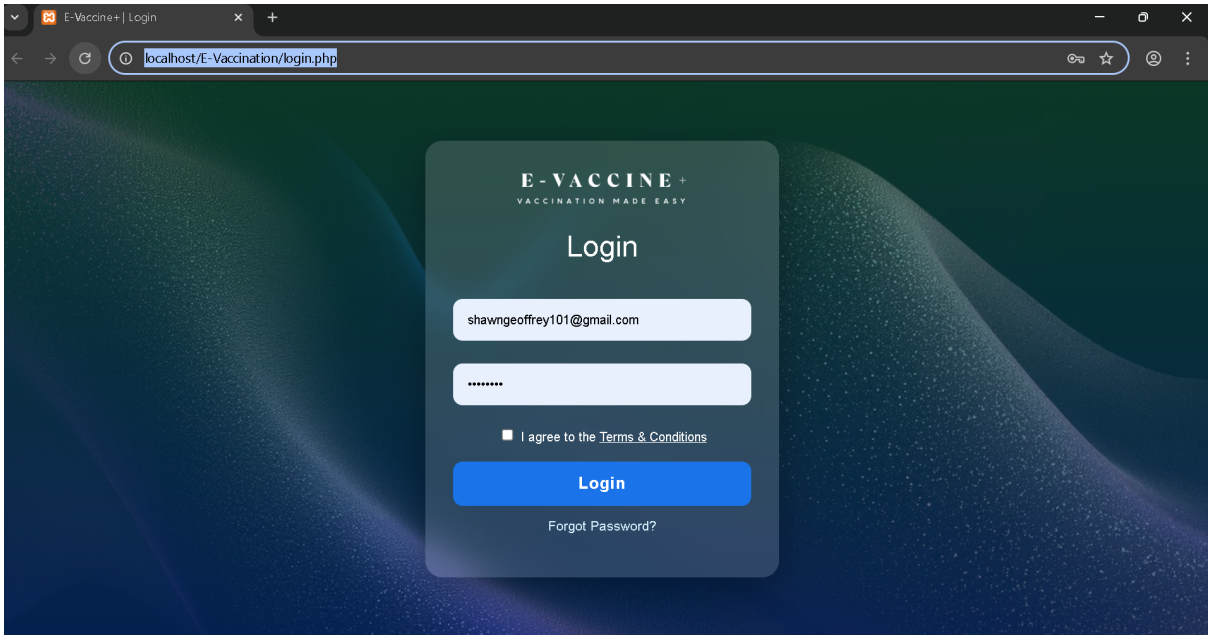


Figure: Login Page Interface

The login interface provides secure access to the E-Vaccination Management System for authorized users, including parents, health workers, and administrators. The interface requires users to enter valid credentials (username/email and password) before accessing system functionalities. Authentication is handled on the server side using PHP, ensuring that only registered users can access sensitive vaccination data. This enhances system security and protects patient information from unauthorized access.

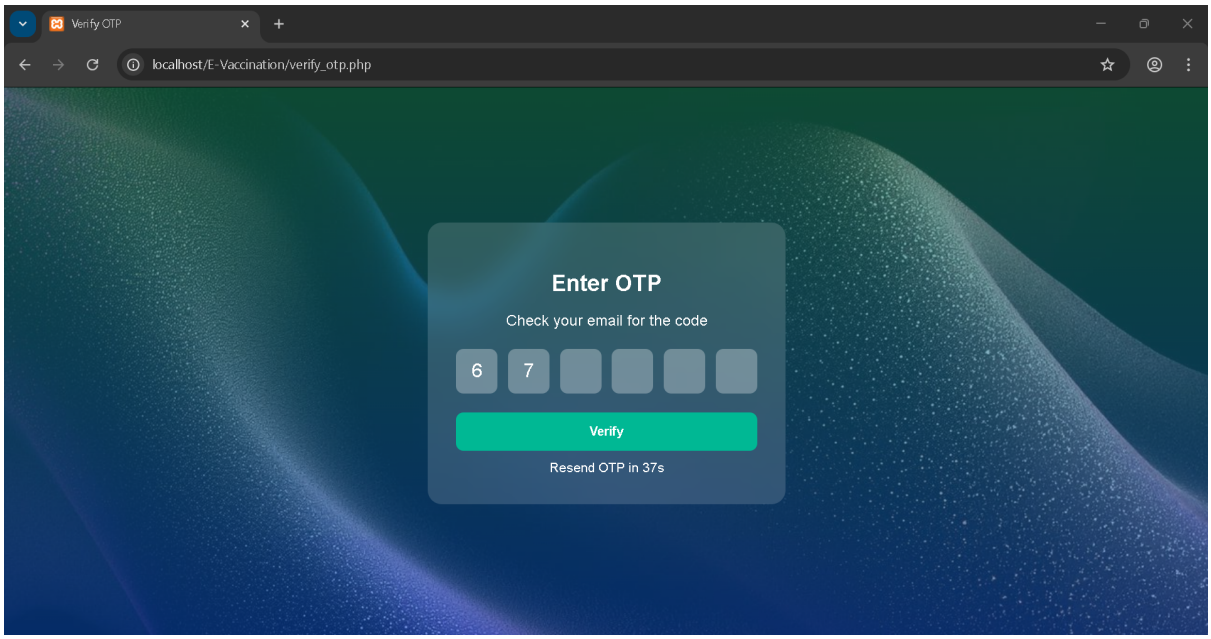


Figure: Multi-Factor Authentication (only healthworkers and admins) use otp code

The Multi-Factor Authentication (MFA) process is used by health workers and administrators, which adds an extra layer of security during login. After entering their credentials, users are required to verify their identity using a One-Time Password (OTP) sent to their registered contact. This ensures that only authorized personnel can access sensitive system functions, improving overall system security and preventing unauthorized access.

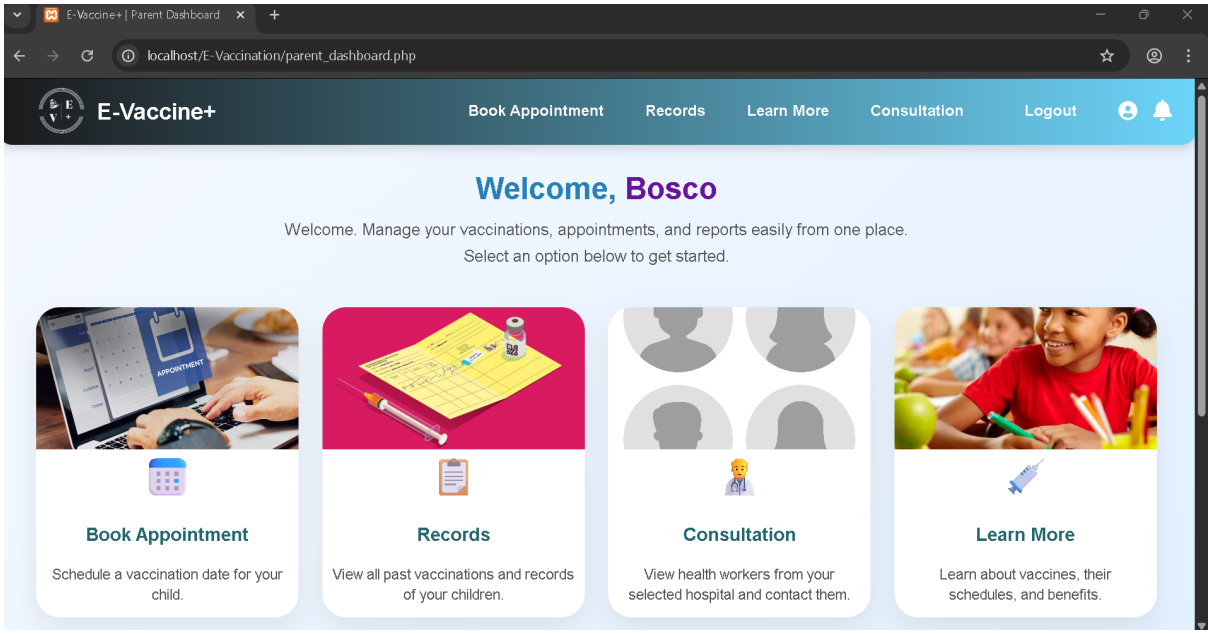


Figure: Parent Dashboard

The parent dashboard provides a centralized interface for parents or guardians to access key child health information. It displays important features such as vaccination records, appointment booking, and notifications in an organized layout. The dashboard is designed for easy navigation, allowing users to quickly monitor their child's immunization progress and upcoming schedules in one place.

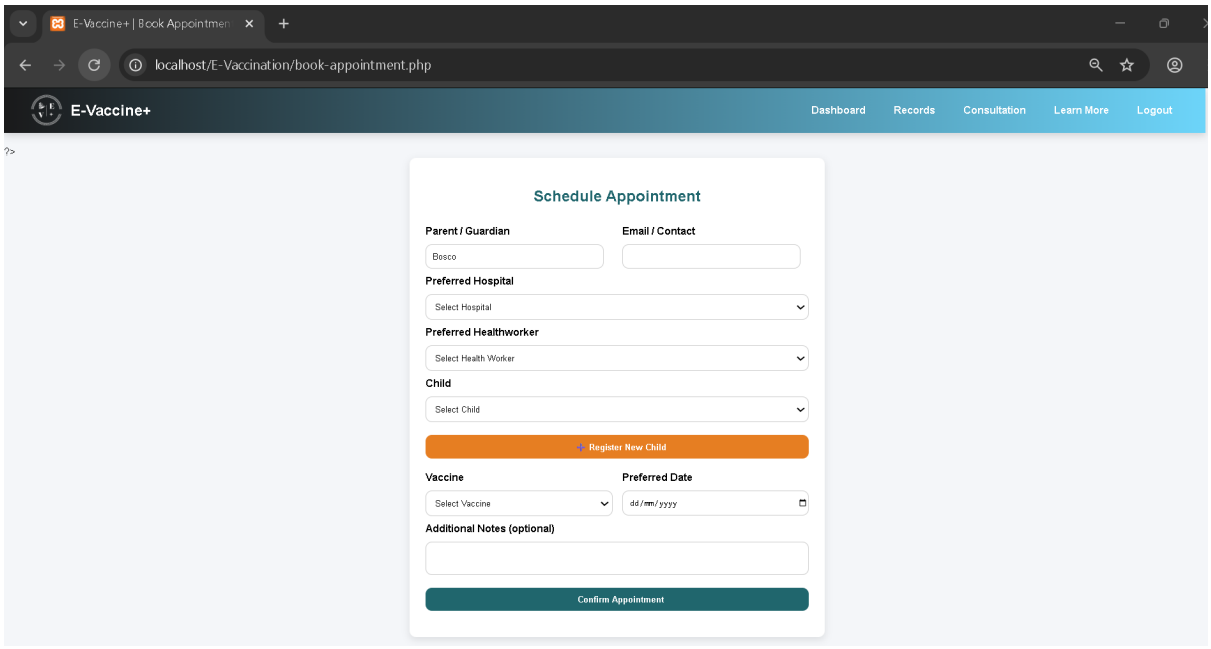


Figure: Appointment Booking Page

The Appointment Booking Page allows parents or guardians to schedule vaccination appointments by selecting a service, date, and time slot. Once submitted, the booking is saved in the system for confirmation by a healthcare provider. It helps improve organization, reduce waiting time, and allows easy tracking of upcoming appointments.

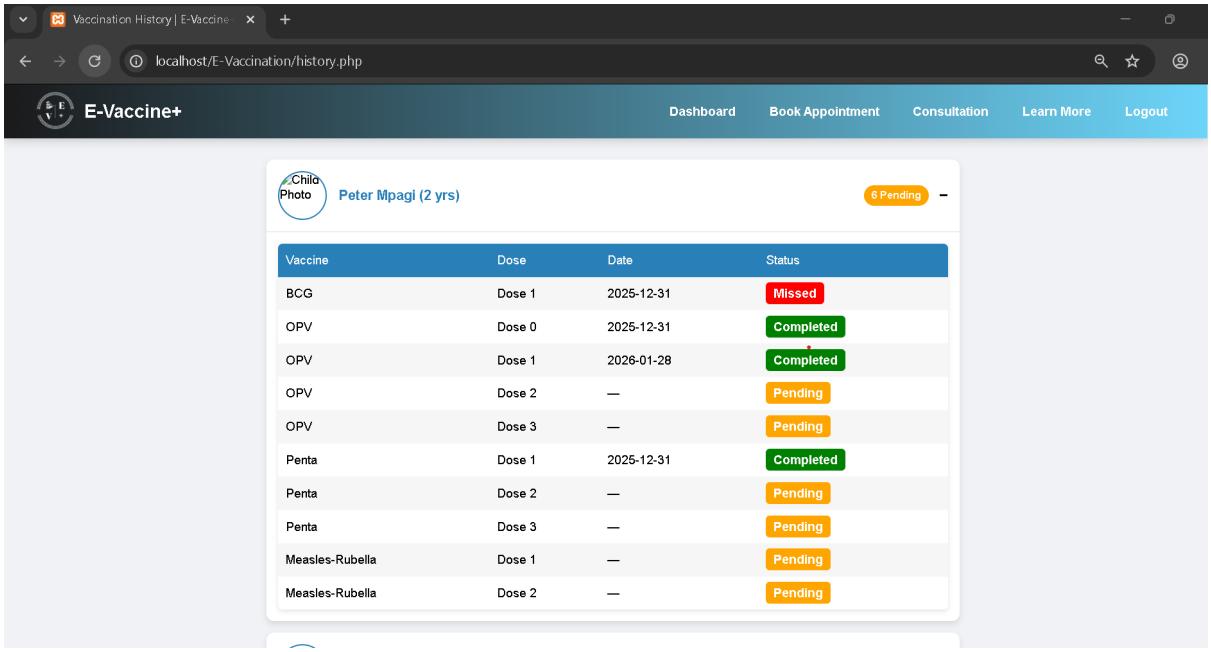


Figure: Records Page

The Records Page on the parent interface provides a secure, read-only view of a child's vaccination history and related medical records. This page is designed to enhance transparency and allow parents or guardians to monitor immunization progress without the ability to modify any data, ensuring data integrity and compliance with healthcare standards.

4.6.2. Healthworker interface

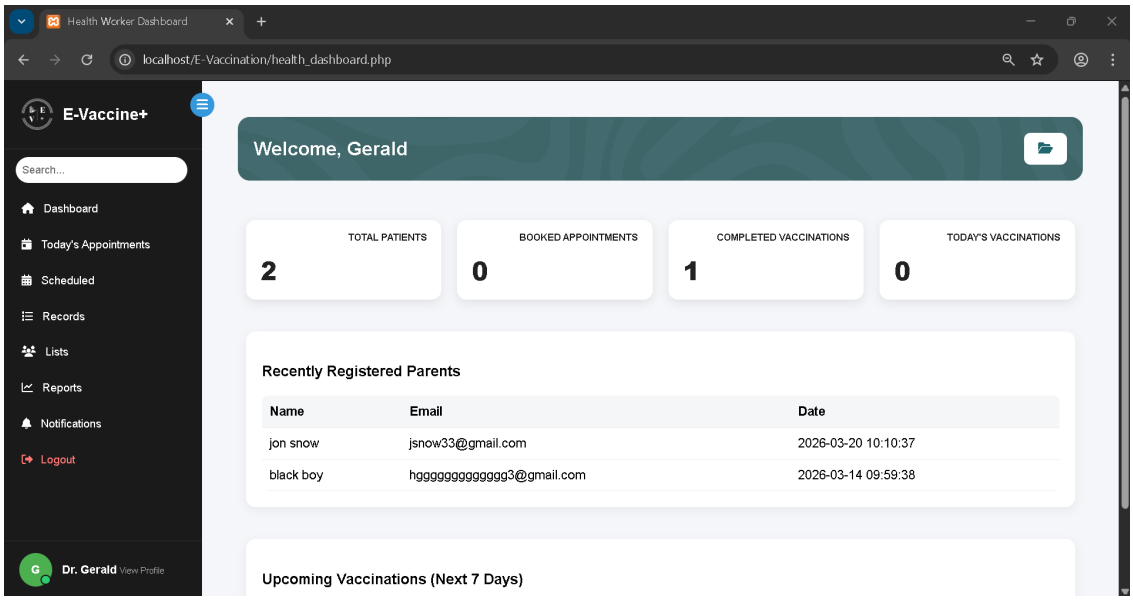


Figure: Healthworker Dashboard

The healthworker dashboard provides a centralized interface for managing vaccination activities and patient records. It allows health workers to view assigned children, update immunization records, manage appointments, and track vaccination schedules efficiently. The dashboard is designed to improve workflow, ensure accurate data entry, and support timely delivery of healthcare services.

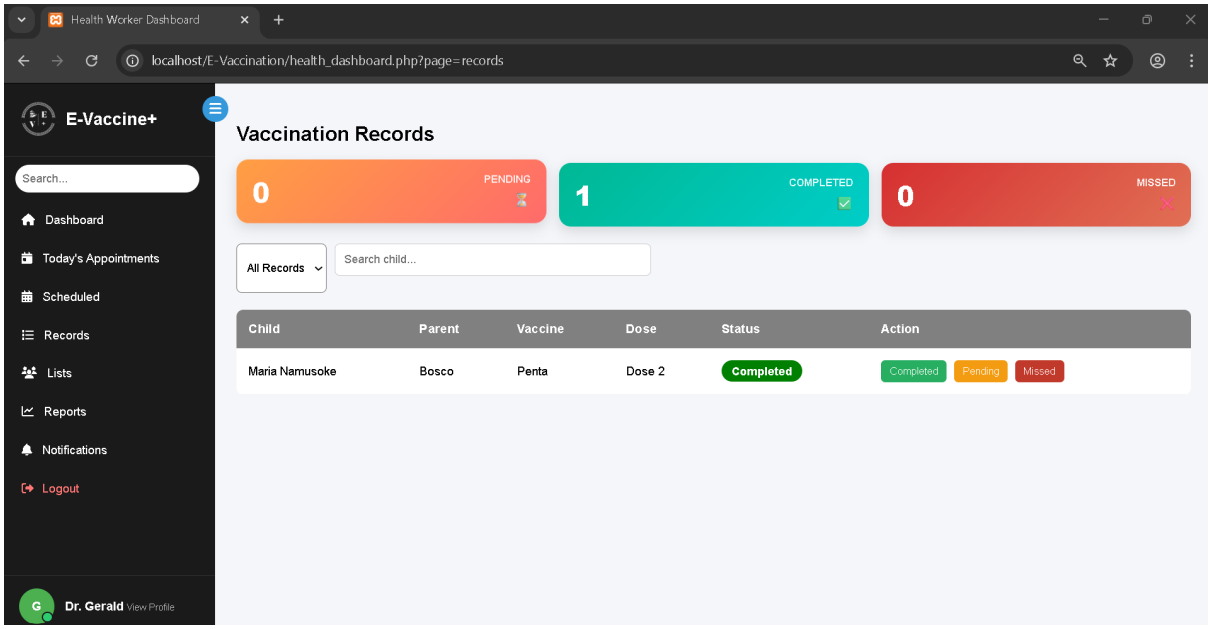


Figure: Vaccination records Page

The vaccination records interface enables health workers to view, update, and manage immunization data for each child. It displays information such as vaccine type, date administered, and responsible health worker. The system ensures accurate tracking of completed and pending vaccinations. This feature improves record accessibility and eliminates the challenges associated with paper-based systems.

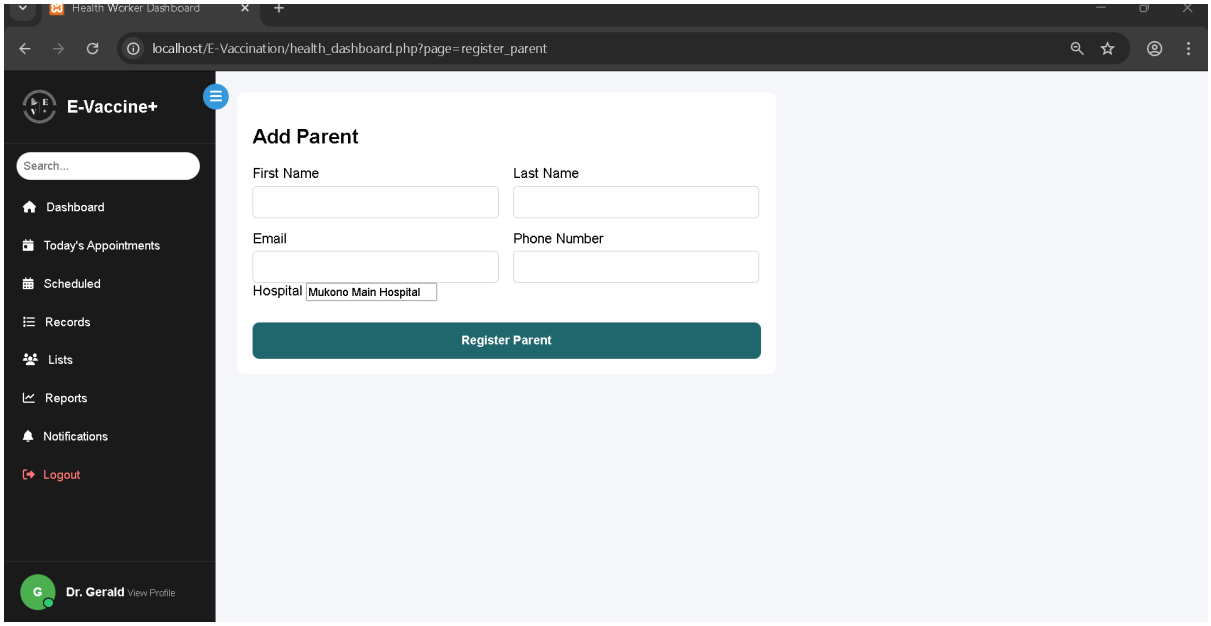


Figure: Parent Registration Page

The Parent Registration Page allows new users to create an account in the system by entering their personal details and setting login credentials. It captures essential information such as name, contact details, and child-related information where applicable. Once submitted, the data is securely stored in the database, enabling parents to access system features like vaccination records and appointment booking.

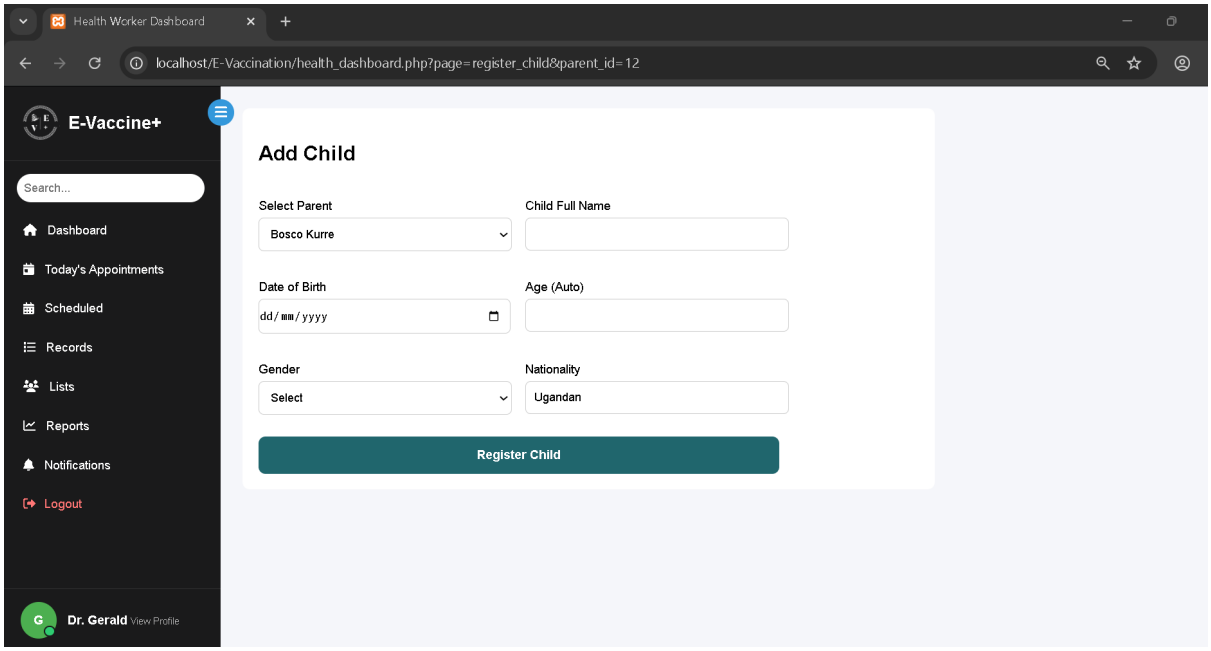


Figure: Child Registration Page

This interface allows health workers or parents to register a child into the system by entering essential details such as name, date of birth, parent information, and contact details. The form includes input validation mechanisms implemented using JavaScript and PHP to ensure data accuracy and completeness. Once submitted, the data is stored in the MySQL database, forming the basis for tracking the child's vaccination schedule.

CHAPTER FIVE

5.1 System Evaluation

Apart from checking how well it worked, testers looked closely at whether people found it easy to use. Performance showed up under pressure situations, revealing strengths along with weak spots now and then. Reliability came through during long runs without crashing once. Matching what the team set out to achieve shaped much of how decisions were made later on.

5.1.1 Functional Evaluation

One goal after another fell into place just like the plan showed back in Chapter One and again later in Chapter Three. Each feature went through checks - results came back clear every time

Finding a way into the system? Parents get safe access without hassle. Entry stays protected at all times.

- Parents who have kids might book shots ahead of time.
- Parents can view and track their children’s vaccination records.
- Parents and kids might get signed up by health staff.
- Vaccination records can be updated accurately.
- Automated reminders can be sent via email using PHPMailer.
- Reports can be generated for monitoring vaccination coverage.

Hospital setups happen under admin supervision. Workers get added by those in charge. System control stays with the administrators. Oversight includes updates and access handling.

Failing often at first, the system eventually ran without hiccups through every function check. Meeting core needs turned out true once tests finished.

5.1.2 Usability Evaluation

Through testing user interactions, ease of use became clear. The way people worked with the system revealed its usability. Watching tasks unfold showed how smooth or rough the experience felt. User effort during navigation helped measure overall accessibility. Performance during real usage shaped the final judgment.

A fresh look at how things connect shows clarity matters most. Built with care, the layout guides each step without fuss. What stands out comes down to smooth moves between tasks. Ease follows when choices feel natural, not forced. Clear paths appear where actions link well. Strength lives in how quietly it works. Little details add up to something that just runs

- Clear dashboard layout for each user role.
- Organized navigation menus.
- Simple data entry forms.

Fewer mistakes happen when people only see what they need. Access follows responsibility, not titles. What you can do depends on your tasks. Confusion drops when options are limited. Seeing less means understanding more.

Folks in hospitals picked up the system fast, even with just a little practice - proof that how it looks and works fits real tasks they do every day.

5.1.3 Performance Evaluation

What mattered most was how fast responses came through. Speed of the whole setup played a big role too. Operations tied to data storage were checked closely as well.

The system demonstrated:

- Fast authentication processing.
- Efficient data retrieval from the MySQL database.

Reports appear fast when used a little now and then. Speed holds up fine unless pushed too hard.

Facing tight deadlines meant skipping full stress tests when lots of users tried accessing at once. Because of that, how the system handles nationwide rollout still needs more checking.

5.1.4 Security Evaluation

Basic security measures were implemented, including:

- User authentication and session management.
- Role-based access restrictions.
- Server-side input validation.
- Controlled database access.

Even though basic protections are in place, extra layers like login verification through two steps, secure vaults for stored information, plus constant monitoring for break-in attempts haven’t been added yet. Later updates could make things safer by including them.

5.2 Technological Limitations

Even though it works well, there are some tech limits built into how it runs.

5.2.1 PHP Limitations

Even so, PHP has some drawbacks despite being fast and commonly used. Issues came up during testing that are worth noting

When more parts get added, handling raw PHP by itself could turn tricky. Starting small helps, yet scaling up might bring confusion without structure.

Faulty code opens doors to risks when rules slip. Mistakes creep in without tight guidelines. Looser practices invite trouble quietly. Weak spots show up where discipline fades. Rules ignored mean safety lost.

One day, growth could mean switching to a tighter system. Jumping ahead might demand a clearer setup later on. When things expand, a sturdier structure may take over. Pushing forward can lead to needing stricter forms down the line. Bigger operations might swap frameworks when ready. Expanding often brings along different rules eventually.

5.2.2 MySQL and phpMyAdmin Have Limits

Even so, the database setup works well for apps of modest size. Still, it holds up when handling light to moderate loads. Yet performance stays steady in everyday use cases

- Performance may decrease with extremely large datasets.
- Manual backup management is required.

Without strong analytics tools, it falls short next to large-scale databases.

5.2.3 Notification System Limitations

Despite its usefulness, the PHPMailer-based email notification setup comes with specific limitations

Stability of the connection decides how well it works. Without steady access, things might slow down or stop altogether.

- Emails may occasionally be marked as spam.

Fees can add up when linking SMS through outside companies. Costs often come along with using external platforms for messaging setup.

5.2.4 Internet Dependency

Although the system initially depended heavily on internet connectivity, an offline-first enhancement strategy has been proposed to address this limitation.

The system now incorporates local data storage mechanisms that allow users to continue performing key operations such as patient registration and vaccination updates even when offline.

Once internet connectivity is restored, the system automatically synchronizes all locally stored data with the central server database.

This improvement significantly reduces downtime, enhances system reliability in rural areas, and ensures continuous healthcare service delivery.

5.3 Challenges Faced

Midway through building things got tricky. Still, each hiccup taught a new lesson. Out of confusion came better design choices. Progress slowed at times yet kept moving forward.

5.3.1 Code Problems and Fixing Mistakes

At first, a few PHP scripts didn’t work because of:

- Incorrect database connection parameters
- Syntax errors in SQL queries.
- Mismatched variable names.
- Improper session handling.

Fixing these problems meant going back again and again - rewriting chunks of code, checking each piece step by step until things finally ran without breaking.

5.3.2 Database Relationship Challenges

At first, adding kids under their parents tripped up the system because of foreign key rules. That meant reshaping how tables connect plus rewriting some SQL so things stayed accurate.

At first, some small repeats of information showed up until the right limits got added.

5.3.3 Miscommunication During Requirement Analysis

Missteps popped up when first collecting needs. Once comments arrived, showing what users actually wanted, some processes got rebuilt. That meant circling back on earlier choices, shifting how the system was set up.

5.3.4 Email Configuration Difficulties

PHPMailer setup led to initial issues;

- SMTP authentication failures.
- Incorrect port configuration.
- Firewall restrictions blocking outgoing mail.

Fixing the problems came down to setting up secure SMTP correctly while making sure login details matched. One step relied on the next, without skipping checks.

5.3.5 Time Constraints

Due to limited development time:

Security upgrades stayed incomplete. Some protections never turned on. Full safety tools remained offline. Not every guard got put in place.

Testing big systems happened only a little.

Without a built-in mobile app, connecting through smartphones stayed unsupported.

5.4 Future research and recommendations

One way ahead might make the system work much better while growing easily. What comes next could help it handle more without slowing down.

5.4.1 Mobile Application Development

Future versions should include:

Apps built for Android devices, also available on Apple's mobile operating system.

- Push notifications for reminders.

When internet drops, info still gets saved. Later, once connection returns, everything updates automatically.

Families could reach care more easily, while clinics might run smoother. Getting help may feel simpler when systems adapt to real needs.

5.4.2 Advanced Security Enhancements

Looking ahead, studies might dig into:

- Two-factor authentication (2FA).
- End-to-end encryption.
- Biometric login for health workers.
- Secure cloud-based hosting.

5.5 Activities

Activity	Description
Requirement Gathering	Stakeholder interviews, process review
System Design	Architecture diagrams, database, UI prototypes
Development	Coding frontend/backend, database integration
Notification Setup	Configure SMS/email reminders
Testing	Unit, integration, user acceptance testing
Reporting	Develop coverage reports

5.6 Outputs

1. Functional Vaccination Management System.
2. Secure database of patients and vaccines.
3. Automated reports on vaccination coverage.
4. Trained users (healthcare workers and administrators).

5.7 Indicators

Output	Indicator
Functional VMS	Users can log in, schedule appointments, record vaccinations, and receive reminders
Database	All patient and vaccine data stored and retrievable
Reports	Correct generation of vaccination coverage and trends reports
Trained Users	Users navigate system, enter data, generate reports independently
System Reliability	Minimal errors, handles multiple simultaneous users

CONCLUSION

This project aimed to build a digital tool helping track vaccines, plan visits, plus link families with clinics more smoothly. It came about after spotting problems with paper-based systems still common across health centers in Uganda - especially within Mukono District.

It shows up early - paper vaccine records tend to go missing. Pulling up a person’s history? Often tricky. Keeping tabs on when shots are due doesn’t work well either. Because of these hiccups, many miss full protection. Care routines end up slower, less reliable. Each gap adds up.

Parents, health staff, and office teams now connect through one digital space built to handle shared tasks. Child sign-ups happen faster because forms move straight into the system instead of getting lost. Records stay updated each time a shot is given, cutting confusion later on. Scheduling fits around family needs since available slots show up clearly without delays. Reminders go out automatically so visits are less likely to be missed. Reports form step by step as data enters, giving clearer views over time. Efficiency grows not by pushing speed but by reducing repeated work. Trust builds slowly when information appears right where it should.

Built with basic web tools like HTML, CSS, and JavaScript - alongside PHP and MySQL through phpMyAdmin - the setup keeps costs low while staying practical for clinics lacking advanced tech. Testing showed solid performance: tasks work smoothly, navigation feels straightforward, information gets stored reliably. Notifications handled by PHPMailer add a layer of communication without complexity. Overall function, ease of use, and handling records meet real-world needs well.

Missed vaccine visits drop when alerts run on autopilot, records live online. Kids get shots on time, every time, thanks to steady digital tracking. Behind the scenes, clinic staff find files faster, spend less energy chasing forms. Workers breathe easier as routine tasks shrink into the background. Leaders gain clearer views of progress through smoother reports and sharper oversight.

Even so, the setup still offers a reliable base for handling vaccine records online in medical centers, despite needing steady internet and questions about growth. Still, it works where connectivity is stable and demand predictable.

From start to finish, Uganda’s E-Vaccination Management System shows how digital tools can reshape health services. Not just tracking shots better - this system builds stronger vaccine efforts across regions. Instead of paper trails, it uses real-time data to meet public health targets more reliably. Step by step, technology becomes a backbone for trust and coverage where it's needed most.

Few updates down the line might boost how well things work - like tying in phone apps, stronger safeguards, or running through online servers. These steps would stretch how far it reaches across the country when getting more people vaccinated.

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