

Development of a Web-Based Child Immunization Management System for Monitoring Vaccination Records and Improving Immunization Coverage in Primary Health Centers

Ogbuli Arthur Ibeziakor¹, Ezenwegbu Nnamdi Chimaobi²

Department of Computer Science, Chukwuemeka Odumegwu Ojukwu University, Uli, AN, NG P.M.B.
02 Uli Campus in the ihiala L.G.A., Anambra State.

DOI: <https://doi.org/10.47772/IJRISS.2026.100700585>

Received: 26 July 2026; Accepted: 31 July 2026; Published: 08 August 2026

ABSTRACT

Childhood immunization remains one of the most effective public health interventions for preventing vaccine-preventable diseases. However, many Primary Health Centers (PHCs), particularly in developing countries, continue to rely on paper-based immunization records, which often result in misplaced files, inaccurate documentation, delayed reporting, missed vaccination appointments, and poor monitoring of immunization coverage. These challenges negatively affect healthcare delivery and increase the risk of incomplete immunization among children.

This study presents the development of a Web-Based System for child immunization management designed to improve the management of vaccination records and enhance immunization coverage in Primary Health Centers. The study adopted the Object-Oriented Analysis and Design Methodology (OOADM) to analyze user requirements, model system processes, and develop an efficient software solution. The proposed system enables healthcare workers to register children, maintain digital vaccination histories, generate immunization schedules, send reminders for upcoming vaccinations, monitor vaccine availability, and produce real-time statistical reports for decision-making.

The system architecture integrates secure authentication, centralized database management, and role-based access control to ensure data integrity, confidentiality, and accessibility. The implementation employs modern web technologies for both front-end and back-end development, providing an intuitive interface for healthcare personnel.

The findings demonstrate that the proposed system significantly improves record management, minimizes human errors associated with manual documentation, facilitates timely vaccination tracking, and supports healthcare administrators in monitoring immunization performance. The study concludes that adopting a web-based child immunization management system can substantially strengthen immunization services and improve immunization coverage, thereby contributing to better child healthcare outcomes in Primary Health Centers.

Keywords: Child Immunization, Web-Based System, Vaccination Records, Immunization Coverage, Primary Health Centers

INTRODUCTION

Background to the Study

Childhood immunization is a fundamental component of primary healthcare and one of the most effective public health interventions for preventing vaccine-preventable diseases among children. It has significantly contributed to reducing child morbidity and mortality by protecting children against diseases such as measles, poliomyelitis, tuberculosis, hepatitis B, diphtheria, pertussis, tetanus, and yellow fever. Routine immunization has remained a

major strategy for reducing childhood mortality and improving public health outcomes. However, many developing countries continue to experience low immunization coverage due to inadequate healthcare infrastructure, poor record management practices, and limited access to reliable health information systems (Ogbuli & Ezenwegbu, 2026; Okeke & Ezenwegbu, 2024).

Primary Health Centers (PHCs) serve as the first level of healthcare delivery and are responsible for implementing routine childhood immunization programmes. These facilities register children, administer vaccines, maintain vaccination records, monitor immunization schedules, and report immunization data to relevant health authorities. However, many PHCs still rely on manual paper-based systems for recording and managing vaccination information. Such systems are prone to misplaced records, inaccurate documentation, duplication of data, delayed retrieval of patient information, and challenges in generating timely reports. These shortcomings often result in missed vaccination appointments, incomplete immunization schedules, and poor monitoring of immunization coverage (Okeke & Ezenwegbu, 2024; Ogbuli & Ezenwegbu, 2026).

The rapid advancement of Information and Communication Technology (ICT) has transformed healthcare delivery through the adoption of Healthcare Information Systems that improve data management, accessibility, and decision-making. Web-based systems provide centralized platforms for storing and retrieving patient information, automating appointment scheduling, generating real-time reports, and supporting efficient healthcare administration. In immunization programmes, these technologies enable healthcare workers to monitor vaccination records accurately, identify children who miss scheduled vaccinations, and improve communication with parents or caregivers through automated reminder mechanisms (Ogbuli & Ezenwegbu, 2026; Okeke & Ezenwegbu, 2024).

Developing a Web-Based Child Immunization Management System provides an effective solution to the challenges associated with manual immunization record management. Such a system enhances data accuracy, improves accessibility to vaccination records, reduces administrative workload, supports timely monitoring of children's immunization status, and strengthens immunization coverage within Primary Health Centers. Furthermore, the availability of reliable digital records supports healthcare planning, resource allocation, disease surveillance, and evidence-based decision-making by health administrators (Ogbuli & Ezenwegbu, 2026; Ezenwegbu, 2025).

Therefore, this study focuses on the development of a Web-Based Child Immunization Management System for Monitoring Vaccination Records and Improving Immunization Coverage in Primary Health Centers. The study aims to provide a secure, reliable, and user-friendly platform that enhances vaccination record management, supports healthcare professionals in delivering quality immunization services, and contributes to improved child health outcomes (Ogbuli & Ezenwegbu, 2026; Okeke & Ezenwegbu, 2024).

Statement of the Problem

Despite the importance of childhood immunization in preventing vaccine-preventable diseases, many Primary Health Centers (PHCs) continue to face significant challenges in managing immunization records and monitoring vaccination schedules. These challenges have created the need for a more efficient, secure, and reliable web-based system for managing child immunization records. Therefore, this study seeks to address the following problems:

1. **Inaccurate and Incomplete Vaccination Records:** Manual documentation often results in errors such as incorrect data entry, duplication of records, and incomplete vaccination histories. These inaccuracies make it difficult for healthcare workers to determine a child's immunization status and administer vaccines appropriately.
2. **Poor Monitoring of Immunization Schedules:** The absence of an automated tracking system makes it difficult to monitor children's vaccination schedules effectively. Consequently, many children miss scheduled vaccinations, leading to incomplete immunization and reduced immunization coverage.

3. **Lack of a Centralized and Secure Information System:** Most PHCs do not have a centralized digital platform for storing and retrieving vaccination records. As a result, accessing patient information, sharing records among authorized healthcare personnel, and generating timely reports become challenging, thereby limiting effective healthcare planning and decision-making.

Research Aim and Objectives

Aim of the Study

The aim of this study is to develop a Web-Based Child Immunization Management System for Monitoring Vaccination Records and Improving Immunization Coverage in Primary Health Centers.

Objectives of the Study

The specific objectives of this study are:

1. To develop a web-based system that minimizes inaccuracies, duplication, and incomplete documentation of vaccination records.
2. To design a system that effectively monitors children's immunization schedules and reduces missed vaccination appointments to improve immunization coverage.
3. To implement a centralized and secure database for efficient storage, retrieval, and management of child immunization records.

Significance of the Study

This study is significant because it provides a practical solution to the challenges associated with the manual management of child immunization records in Primary Health Centers. By examining the limitations of the existing paper-based system, the study contributes to a better understanding of the factors affecting effective vaccination record management and immunization coverage.

The development of a web-based Child Immunization Management System will improve the accuracy, reliability, and accessibility of vaccination records by minimizing errors, duplication, and incomplete documentation. The system will also facilitate the effective monitoring of children's immunization schedules, helping healthcare workers identify children who miss scheduled vaccinations and improving immunization coverage through timely follow-up.

Furthermore, the implementation of a centralized and secure database will enhance the storage, retrieval, and management of child immunization records while supporting the generation of timely and accurate reports for healthcare planning and decision-making. The automation of key processes such as child registration, vaccination scheduling, reminder notifications, and report generation is expected to reduce administrative workload, improve operational efficiency, and enhance the quality of healthcare service delivery in Primary Health Centers.

Scope of the Study

This study is limited to the development of a Web-Based Child Immunization Management System for monitoring vaccination records and improving immunization coverage in Primary Health Centers. The study focuses on the design and implementation of a system that enables the registration of children, management of vaccination records, monitoring of immunization schedules, generation of reminder notifications for upcoming vaccinations, and production of immunization reports.

The system also provides a centralized and secure database for storing and retrieving child immunization records, thereby improving data accuracy, accessibility, and management. The study is restricted to the use of the Object-

Oriented Analysis and Design Methodology (OOADM) in the analysis, design, and development of the proposed system.

However, the study does not cover hospital-wide electronic medical record systems, vaccine manufacturing and distribution, financial management, or the treatment of childhood diseases. Its primary focus is on improving vaccination record management and immunization coverage within Primary Health Centers through a web-based solution.

Limitations of the Study

The study is limited to the following:

1. **Dependence on Internet Connectivity:** The developed system requires a stable internet connection for users to access, update, and synchronize immunization records. Consequently, its performance may be affected in Primary Health Centers located in areas with poor or unstable network coverage.
2. **Dependence on Accurate Data Entry:** The effectiveness of the system depends on the accuracy and completeness of data entered by authorized healthcare personnel. Incorrect or incomplete data entry may affect the reliability of vaccination records, reports, and immunization schedules.
3. **Limited User Evaluation:** Although the system was implemented and tested, the evaluation was conducted on a limited number of healthcare workers. Therefore, the findings may not fully represent the experiences of users in all Primary Health Centers, and broader evaluation is recommended.

LITERATURE REVIEW

The literature review provides a comprehensive examination of existing knowledge, concepts, theories, and previous studies relevant to the research topic. It helps establish the current state of knowledge, identifies gaps in existing studies, and provides the theoretical and conceptual foundation upon which the present study is built. For this study, the literature review focuses on the key concepts related to child immunization, vaccination records, immunization coverage, Primary Health Centers, web-based information systems, and healthcare information systems.

Child Immunization

Child immunization is the process of administering vaccines to infants and children to protect them against vaccine-preventable diseases such as measles, poliomyelitis, tuberculosis, diphtheria, pertussis, tetanus, hepatitis B, and yellow fever. It is regarded as one of the most effective and cost-efficient public health interventions for reducing childhood morbidity and mortality. Immunization strengthens the immune system by stimulating the body's natural defense mechanisms to recognize and fight disease-causing pathogens without causing the disease itself. Routine childhood immunization programmes are implemented according to national immunization schedules to ensure that children receive vaccines at the appropriate ages. Effective immunization programmes contribute significantly to disease prevention, improved child survival, and overall public health development (Asif & Rahman, 2026; Bangure et al., 2025; Vasanth & Josephine, 2024).

Vaccination Records

Vaccination records are official documents that contain detailed information about the vaccines administered to an individual, including the type of vaccine, date of administration, dosage, batch number, healthcare provider, and the next scheduled vaccination date. These records enable healthcare professionals to monitor a child's immunization status, determine vaccine eligibility, and ensure compliance with recommended immunization schedules. Traditionally, vaccination records have been maintained using paper-based systems, which are susceptible to loss, damage, duplication, and inaccuracies. The adoption of electronic vaccination records has

improved data accuracy, accessibility, security, and continuity of healthcare services while facilitating efficient monitoring and reporting (Smith & Amber, 2023; Okeke & Ezenwegbu, 2024; Al-Nineveh, 2024).

Immunization Coverage

Immunization coverage refers to the proportion of children within a target population who have received the recommended vaccines according to the national immunization schedule. It is a key indicator used to assess the effectiveness and performance of immunization programmes. High immunization coverage reduces the spread of infectious diseases, promotes herd immunity, and decreases childhood morbidity and mortality. Conversely, low immunization coverage increases the risk of disease outbreaks and places children at greater risk of vaccine-preventable illnesses. Monitoring immunization coverage enables healthcare authorities to identify underserved populations, evaluate programme performance, and implement interventions that improve vaccine uptake. Automated monitoring systems and reminder technologies have significantly improved vaccination compliance and immunization coverage in healthcare facilities (Vasanth & Josephine, 2024; Bangure et al., 2025; Sharma & Patel, 2025).

Primary Health Centers (PHCs)

Primary Health Centers (PHCs) are the first level of healthcare delivery and serve as the foundation of the healthcare system in many developing countries. They provide essential healthcare services, including maternal and child healthcare, routine immunization, disease prevention, health education, family planning, and basic medical treatment. PHCs play a critical role in implementing childhood immunization programmes by registering children, administering vaccines, maintaining vaccination records, monitoring immunization schedules, and reporting immunization data to relevant health authorities. The effectiveness of these responsibilities depends largely on the availability of efficient health information management systems capable of supporting timely and accurate service delivery (Nwinyi & Odigie, 2021; Al-Nineveh, 2024; Ogbuli & Ezenwegbu, 2026).

Web-Based Information Systems

A web-based information system is an application that operates through web technologies and is accessible via a web browser over a local network or the Internet. Such systems enable users to access, update, and manage information from different locations without requiring software installation on individual computers. Web-based information systems offer several advantages, including centralized data storage, real-time information sharing, scalability, improved accessibility, enhanced collaboration, and simplified system maintenance. In the healthcare sector, web-based systems support electronic record management, appointment scheduling, clinical decision-making, reporting, and communication among healthcare providers, thereby improving operational efficiency and service delivery (Verma & Kumar, 2026; Ogbuli & Ezenwegbu, 2026; Al-Nineveh, 2024).

Healthcare Information Systems

Healthcare Information Systems (HIS) are integrated computer-based systems designed to collect, process, store, retrieve, and manage healthcare information to support clinical, administrative, and managerial activities. These systems facilitate the efficient management of patient records, healthcare services, laboratory results, pharmacy operations, billing, and public health reporting. In child immunization programmes, Healthcare Information Systems enable healthcare workers to maintain electronic vaccination records, monitor immunization schedules, generate reminder notifications, produce statistical reports, and improve decision-making. The adoption of Healthcare Information Systems has been shown to enhance data quality, reduce documentation errors, improve healthcare efficiency, and strengthen the overall delivery of healthcare services (Okeke & Ezenwegbu, 2024; Ogbuli & Ezenwegbu, 2026; Ezenwegbu, 2025).

Comparison of Existing Immunization Information Systems

Authors	System	Strength	Limitation
Smith & Amber (2023)	Electronic Vaccination Record	Accurate records	No reminder feature
Bangure et al. (2025)	SMS Reminder System	Improves attendance	No centralized database
Verma & Kumar (2026)	Child Vaccination Management System	Online registration	Limited reporting
Proposed System	Web-Based Child Immunization Management System	Registration, reminders, reporting, centralized database, authentication, dashboard	Requires internet connectivity

From the comparison above, it is evident that previous systems focused on individual functionalities such as electronic record keeping or reminder notifications. However, the proposed system integrates child registration, centralized record management, vaccination scheduling, reminder notifications, user authentication, reporting, and role-based access control into a unified platform suitable for Primary Health Centers.

Summary of the Literature Review and Research Gap

The literature reviewed shows that childhood immunization is an essential public health intervention for preventing vaccine-preventable diseases and improving child survival. Previous studies have established the importance of accurate vaccination records, effective monitoring of immunization schedules, and the role of Primary Health Centers (PHCs) in delivering routine immunization services. The review also revealed that web-based information systems and healthcare information systems have significantly improved data management, accessibility, reporting, and decision-making in healthcare institutions.

Despite these advancements, many Primary Health Centers, particularly in developing countries, still rely on manual paper-based methods for managing child immunization records. Existing systems often lack centralized data management, real-time monitoring of vaccination schedules, automated reminder notifications, and efficient report generation. These limitations contribute to incomplete vaccination records, missed immunization appointments, and reduced immunization coverage.

Therefore, the research gap identified in this study is the absence of an integrated web-based Child Immunization Management System specifically designed to monitor vaccination records and improve immunization coverage in Primary Health Centers. This study seeks to bridge this gap by developing a secure, centralized, and user-friendly web-based system using the Object-Oriented Analysis and Design Methodology (OOADM). The proposed system is expected to enhance vaccination record management, improve immunization schedule monitoring, facilitate timely reporting, and support informed decision-making by healthcare professionals.

METHODOLOGY

Research Methodology

This study adopted the Object-Oriented Analysis and Design Methodology (OOADM) for the development of the Web-Based Child Immunization Management System for Monitoring Vaccination Records and Improving Immunization Coverage in Primary Health Centers. OOADM was selected because it provides a structured and systematic approach to software development by emphasizing object identification, system modelling, and

modular design. The methodology facilitates the analysis of user requirements, the design of system components, and the implementation of a reliable, scalable, and maintainable web-based application.

Requirements Gathering

The requirements gathering phase was conducted at selected Primary Health Centers within Anambra State to understand the challenges associated with the existing paper-based child immunization record management system. Data were collected from healthcare personnel directly involved in immunization services, including nurses, community health extension workers (CHEWs), and health records officers.

A purposive sampling technique was adopted to select fifteen (15) participants because of their direct involvement in immunization activities. Data collection was carried out using structured interviews, direct observation, and questionnaires. The interviews focused on identifying operational challenges, user requirements, existing workflow, reporting procedures, and desired functionalities of the proposed system.

Information gathered revealed problems such as misplaced vaccination records, delayed retrieval of patient information, poor monitoring of immunization schedules, duplicate records, and delayed report generation. These findings formed the basis for the functional and non-functional requirements used in designing the proposed system.

The proposed system was developed as a web-based healthcare information system that enables healthcare workers to register children, maintain vaccination records, monitor immunization schedules, generate reminder notifications, and produce immunization reports. The system employs a centralized database to ensure data consistency, integrity, and security while providing authorized users with real-time access to immunization records.

Object-Oriented Analysis and Design Methodology (OOADM)

The Object-Oriented Analysis and Design Methodology (OOADM) is a software development methodology that models a system as a collection of interacting objects. It provides a structured approach to analysing user requirements, designing system components, implementing software applications, and ensuring that the developed system is efficient, reliable, maintainable, and scalable. In this study, OOADM was adopted because it supports modular system development and the use of Unified Modeling Language (UML) diagrams to represent system processes and relationships.

The methodology adopted in this study consists of the following phases:

Requirements Analysis

This phase involved gathering and analysing information about the existing child immunization record management process in Primary Health Centers. Data were collected to identify user requirements, operational challenges, and functional needs of the proposed system. The analysis revealed problems such as manual record keeping, inaccurate documentation, delayed retrieval of vaccination records, and poor monitoring of immunization schedules.

System Analysis

The system analysis phase focused on examining the existing manual system to identify its strengths, weaknesses, inputs, outputs, processes, and user interactions. The findings from this phase served as the basis for defining the functional and non-functional requirements of the proposed web-based Child Immunization Management System.

Object-Oriented System Design

During this phase, the requirements identified during system analysis were translated into system models using Unified Modeling Language (UML). The design defined the architecture of the proposed system, including user interactions, system modules, database structure, and relationships among system objects. The UML diagrams developed include the Use Case Diagram, Activity Diagram, Sequence Diagram, Class Diagram, and Entity Relationship Diagram (ERD).

System Implementation

The implementation phase involved translating the system design into a functional web-based application. The system was developed using HTML5, CSS3, JavaScript, Bootstrap, PHP, and MySQL. The implementation included modules for user authentication, child registration, vaccination management, appointment scheduling, reminder notifications, and report generation.

System Testing

The developed system was tested to verify that all modules functioned correctly and met the specified requirements. Testing was carried out to identify and correct errors, evaluate system performance, ensure data integrity, and confirm that the system produced accurate outputs under different operating conditions.

System Deployment

The final phase involved deploying the completed web-based Child Immunization Management System for use in Primary Health Centers. Deployment included configuring the application on a web server, connecting it to the database, and making it available for authorized healthcare personnel. This phase also involved user orientation to ensure effective utilization of the system.

System Analysis

System analysis involves examining the existing system to identify its operational procedures, strengths, weaknesses, inputs, outputs, and user requirements. It provides a clear understanding of how the current system operates and serves as the basis for designing an improved system. In this study, the analysis focused on the existing manual child immunization record management system and the proposed web-based Child Immunization Management System.

Existing System

The existing child immunization management system used in many Primary Health Centers is predominantly manual and paper-based. Healthcare workers record children's biodata, vaccination history, and appointment schedules in registers and immunization cards. Although this method has been used for many years, it presents several challenges, including loss or damage of records, inaccurate documentation, difficulty in retrieving patient information, poor monitoring of vaccination schedules, delayed report generation, and inefficient data management. These shortcomings contribute to missed vaccination appointments and reduced immunization coverage among children.

Proposed System

The proposed system is a web-based Child Immunization Management System designed to automate the management of child vaccination records and improve immunization coverage in Primary Health Centers. The system provides a centralized database that enables authorized healthcare personnel to register children, record vaccinations, monitor immunization schedules, generate reminder notifications, manage vaccine information, and produce real-time reports. The proposed system enhances data accuracy, security, accessibility, and operational efficiency while supporting effective healthcare service delivery.

Use Case Diagram

The Use Case Diagram illustrates the interaction between the users (actors) and the proposed system. It identifies the major functions performed by the system and shows how each actor interacts with these functions.

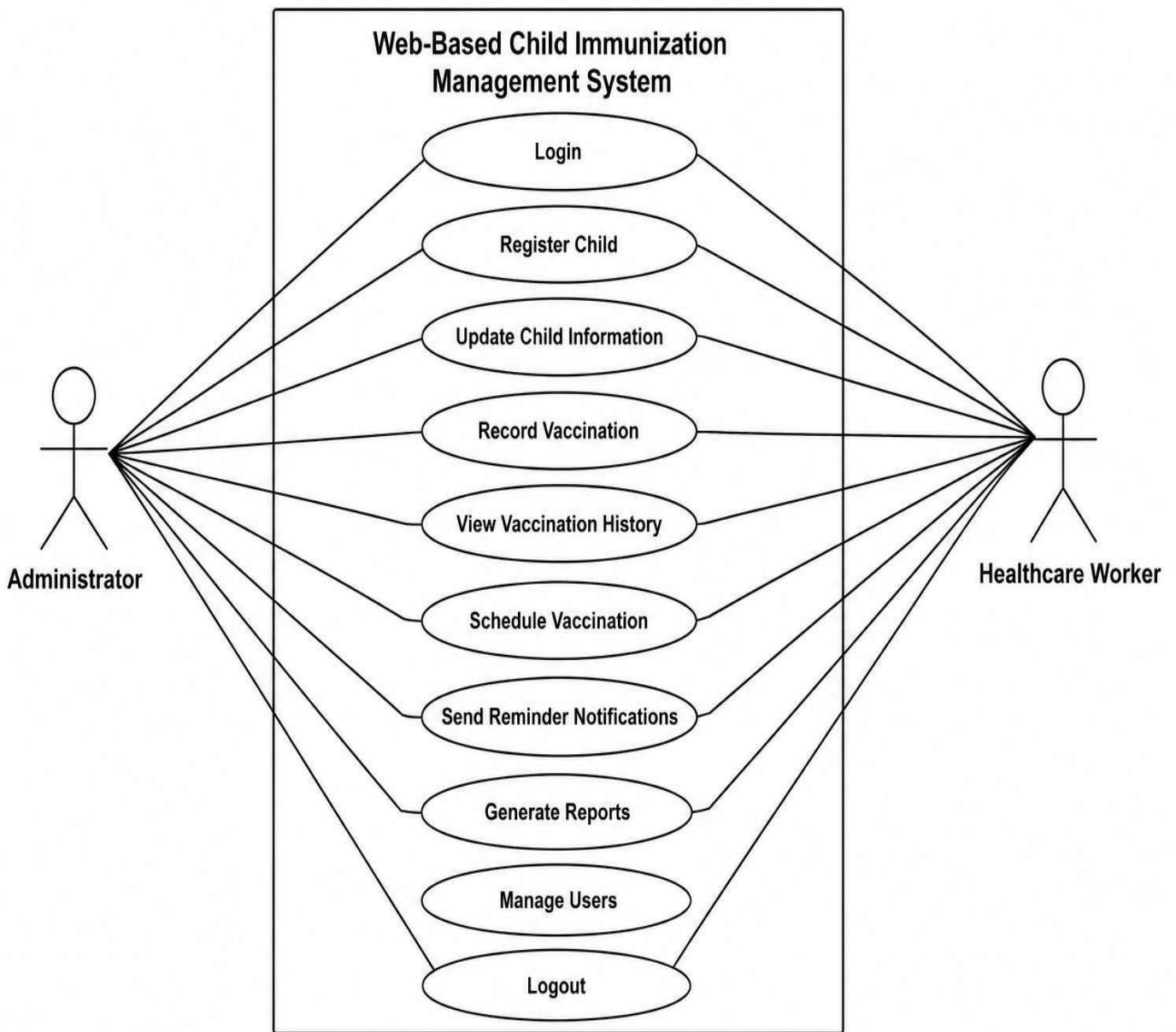


Figure 1: Use Case Diagram of the Proposed Web-Based Child Immunization Management System.

Activity Diagram

The Activity Diagram illustrates the workflow of the proposed system from the beginning of an operation to its completion. The process begins when an authorized healthcare worker logs into the system. The user registers a child, records vaccination details, schedules the next immunization appointment, and updates the vaccination history. The system stores the information in the database, generates reminder notifications for upcoming vaccinations, and produces reports whenever required. The workflow ends when the user logs out of the system.

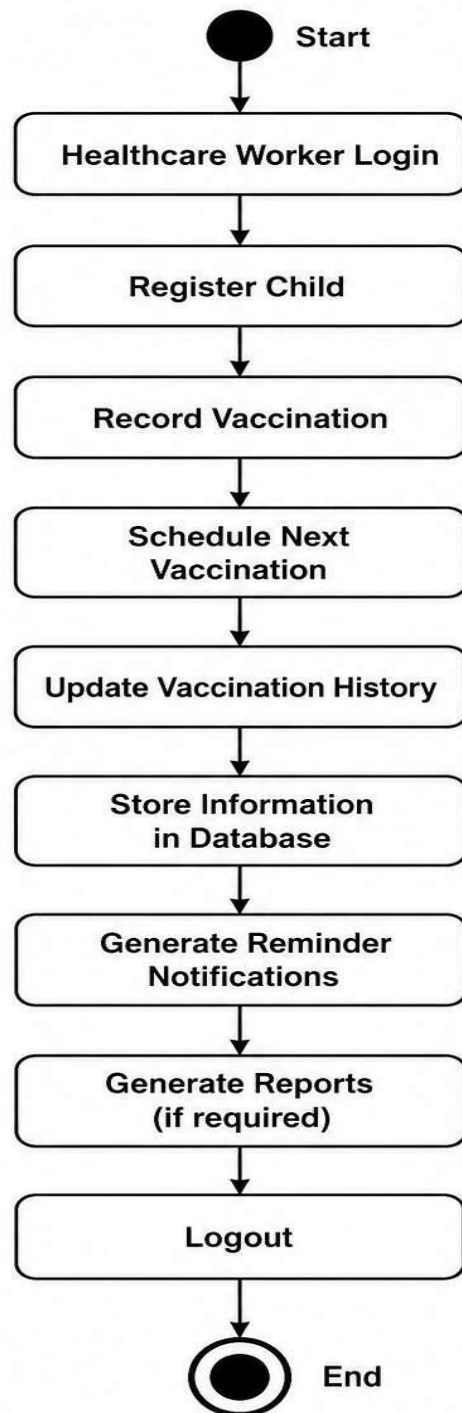


Figure 2: Activity Diagram of the Proposed System.

Sequence Diagram

The Sequence Diagram illustrates the chronological interaction between users and the proposed system. It shows how requests are exchanged between the healthcare worker, the web application, and the database during system operations. For example, when a healthcare worker logs in, the request is sent to the system for authentication. After successful authentication, the user registers a child, records vaccination details, and the information is stored in the database. The database confirms successful storage, after which the system displays the updated vaccination record and generates reminder notifications or reports when required. This sequence ensures efficient communication among the system components.

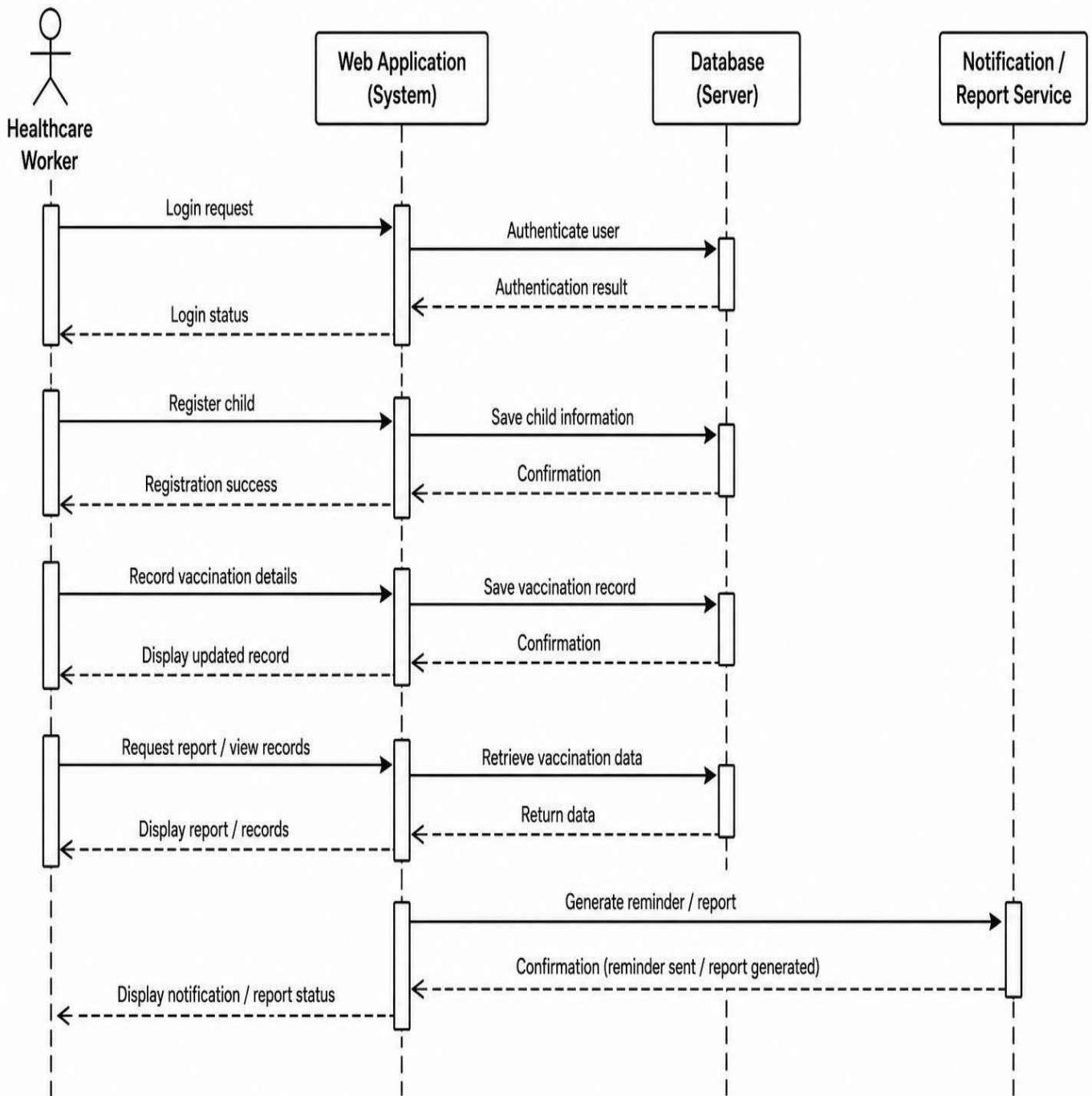


Figure 3: Sequence Diagram of the Proposed Web-Based Child Immunization Management System.

System Design

System design is the process of translating the requirements identified during system analysis into a logical and physical structure that guides the implementation of the proposed system. In this study, the system was designed using Object-Oriented Analysis and Design Methodology (OOADM) and Unified Modeling Language (UML) diagrams. The design specifies the system architecture, software components, database structure, and interactions among the various modules to ensure efficient management of child immunization records.

Class Diagram

The Class Diagram represents the static structure of the proposed system by illustrating the classes, their attributes, methods, and the relationships among them. It identifies the major objects required for implementing the Child Immunization Management System and demonstrates how these objects interact with one another.

The major classes in the proposed system include:

User: Attributes include UserID, Username, Password, Role, FullName, and Email. This class is responsible for user authentication and access control.

Child: Attributes include ChildID, FirstName, LastName, DateOfBirth, Gender, ParentID, and Address. It stores information relating to registered children.

Parent: Attributes include ParentID, ParentName, PhoneNumber, Address, and Email. This class maintains information about parents or guardians.

Vaccine: Attributes include VaccineID, VaccineName, DoseNumber, RecommendedAge, and Description. It stores details of available vaccines.

Vaccination Record: Attributes include RecordID, ChildID, VaccineID, DateAdministered, NextDueDate, and Status. This class records the vaccination history of each child.

Appointment: Attributes include AppointmentID, ChildID, AppointmentDate, ReminderStatus, and AppointmentStatus. It manages vaccination schedules and reminders.

Report: Attributes include ReportID, ReportType, GeneratedDate, and GeneratedBy. It supports report generation for healthcare management and decision-making.

The classes are related through association relationships. A parent may have one or more registered children, while each child may have multiple vaccination records and appointments. Each vaccination record is linked to a specific vaccine, and authorized users manage all system operations.

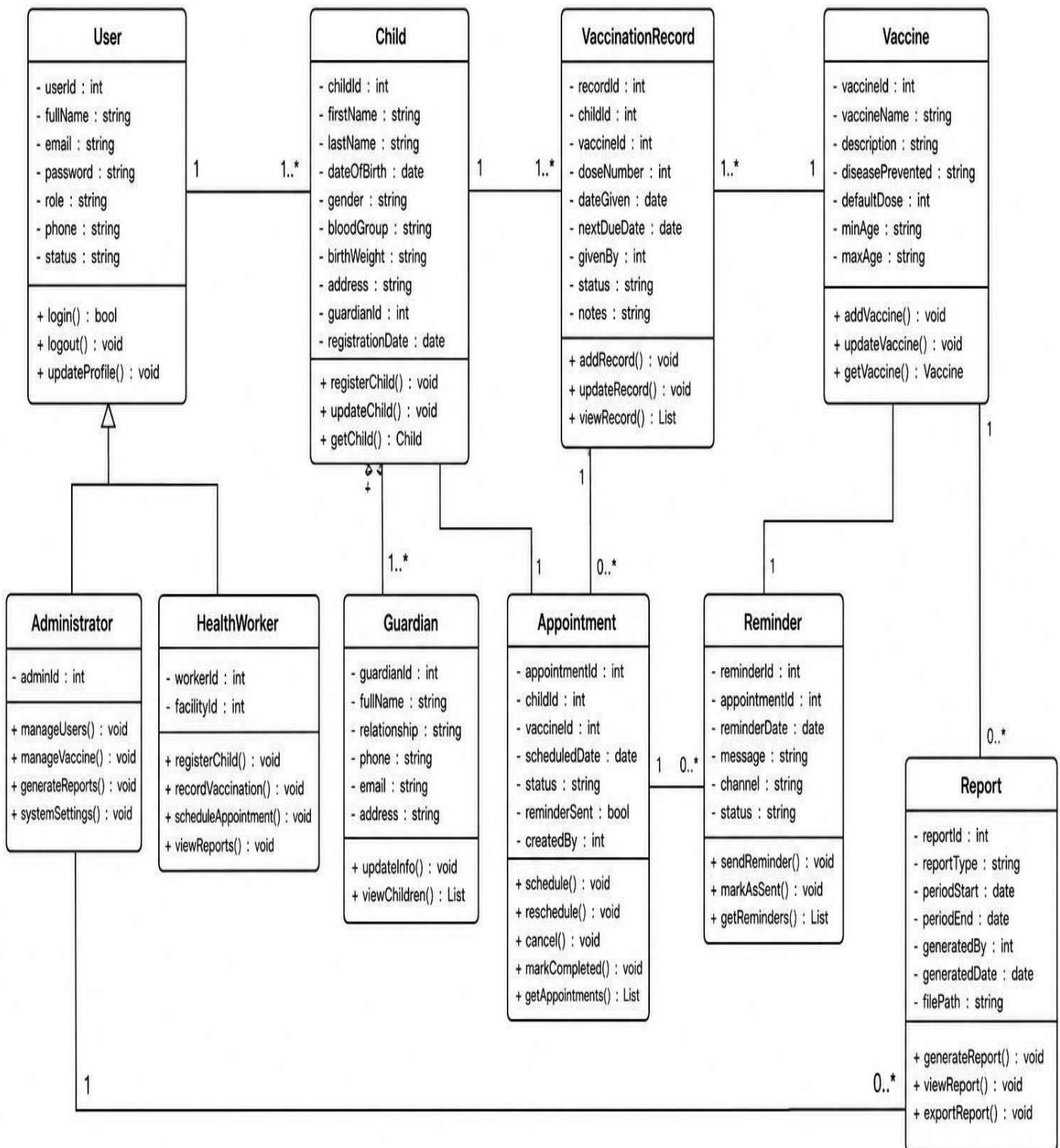


Figure 4: Class Diagram of the Proposed Web-Based Child Immunization Management System.

Entity Relationship Diagram (ERD)

The Entity Relationship Diagram (ERD) illustrates the logical structure of the system database by showing the entities, their attributes, primary keys, foreign keys, and the relationships among the database tables. It serves as the blueprint for implementing the relational database used by the proposed system.

The database consists of the following tables:

Users: Stores information about system users and login credentials.

Parents: Stores the personal information of parents or guardians.

Children: Stores details of registered children and references the Parents table through the ParentID foreign key.

Vaccines: Stores information about vaccines available for immunization.

Vaccination_Records: Stores vaccination details for each child and references both the Children and Vaccines tables.

Appointments: Stores scheduled vaccination appointments and reminder information for each child.

Reports: Stores information relating to generated reports.

The relationships among the tables ensure data consistency and integrity. One parent can register multiple children, one child can have several vaccination records and appointments, and one vaccine can be administered to many children through the Vaccination_Records table. The use of primary and foreign keys maintains referential integrity within the database.

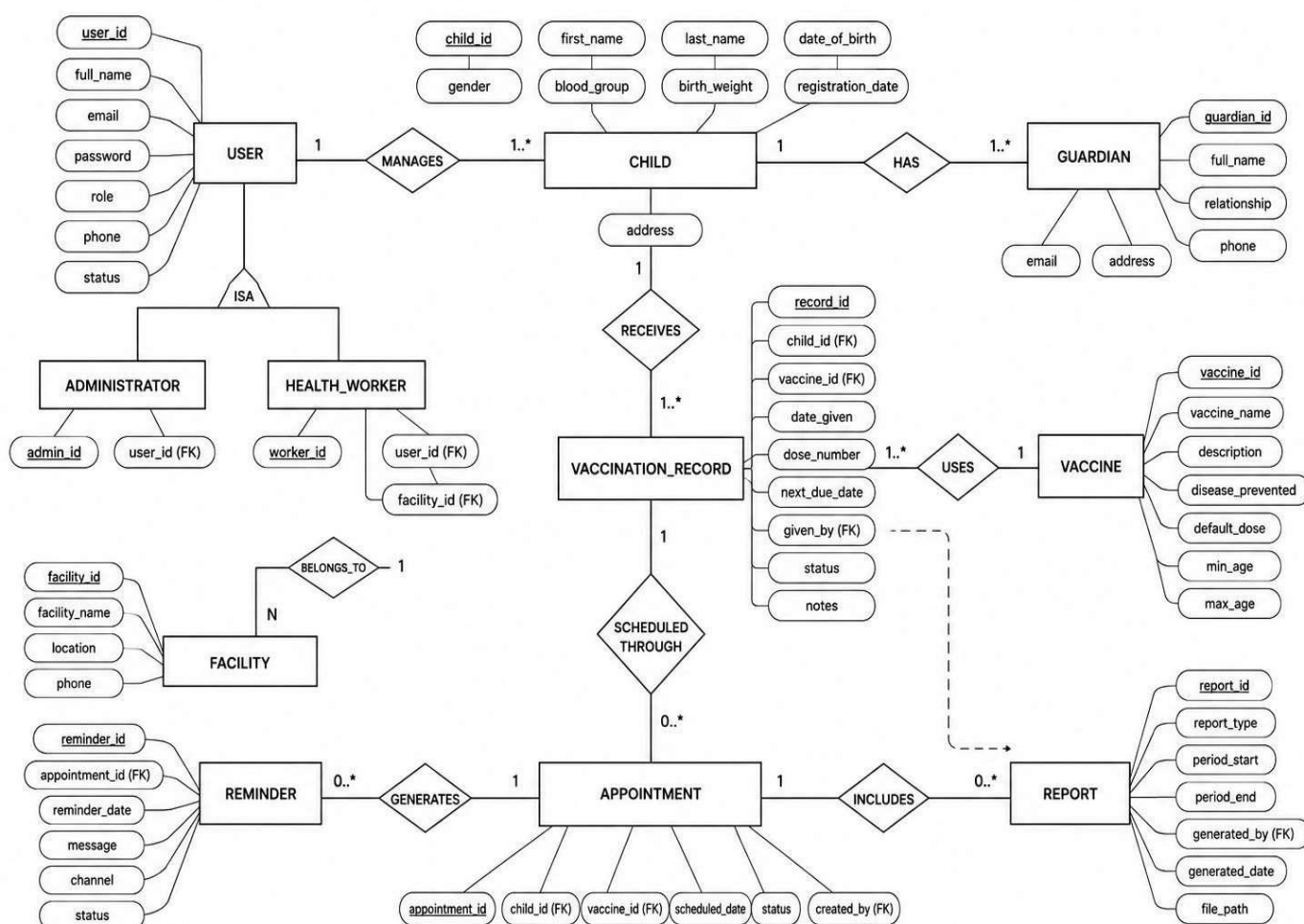


Figure 5: Entity Relationship Diagram (ERD) of the Proposed Web-Based Child Immunization Management System.

Development Tools

The proposed system was developed using modern web development technologies that support the implementation of dynamic, secure, and user-friendly web applications.

HTML5: Used to design the structure and layout of the web pages.

CSS3: Used to style the user interface and improve the visual appearance of the application.

JavaScript: Used to implement client-side validation, interactive features, and dynamic user interface components.

Bootstrap: Used as a front-end framework to develop responsive and mobile-friendly web pages.

PHP: Used as the server-side scripting language to implement the application logic and process user requests.

MySQL: Used as the relational database management system for storing and managing child immunization records.

XAMPP: Used as the local development environment, providing Apache web server support, PHP execution, and MySQL database services during system development and testing.

Draw.io/Microsoft Visio: Used for designing the UML diagrams and Entity Relationship Diagram (ERD) required for system modelling.

Server Configuration

The application was deployed on an Apache Web Server using the XAMPP development environment. The minimum hardware specification consisted of an Intel Core i3 processor, 4GB RAM, 500GB hard disk storage, Windows 10 operating system, PHP 8.x, MySQL database server, and Apache Web Server.

Database Design

The database consists of seven major tables namely Users, Parents, Children, Vaccines, Vaccination_Records, Appointments, and Reports. Primary and foreign key constraints were implemented to maintain data integrity and eliminate redundancy.

Security Measures

Security mechanisms implemented in the system include password hashing, user authentication, role-based access control, input validation, session management, SQL injection prevention using prepared statements, and regular database backup procedures.

System Implementation, Results and Discussion

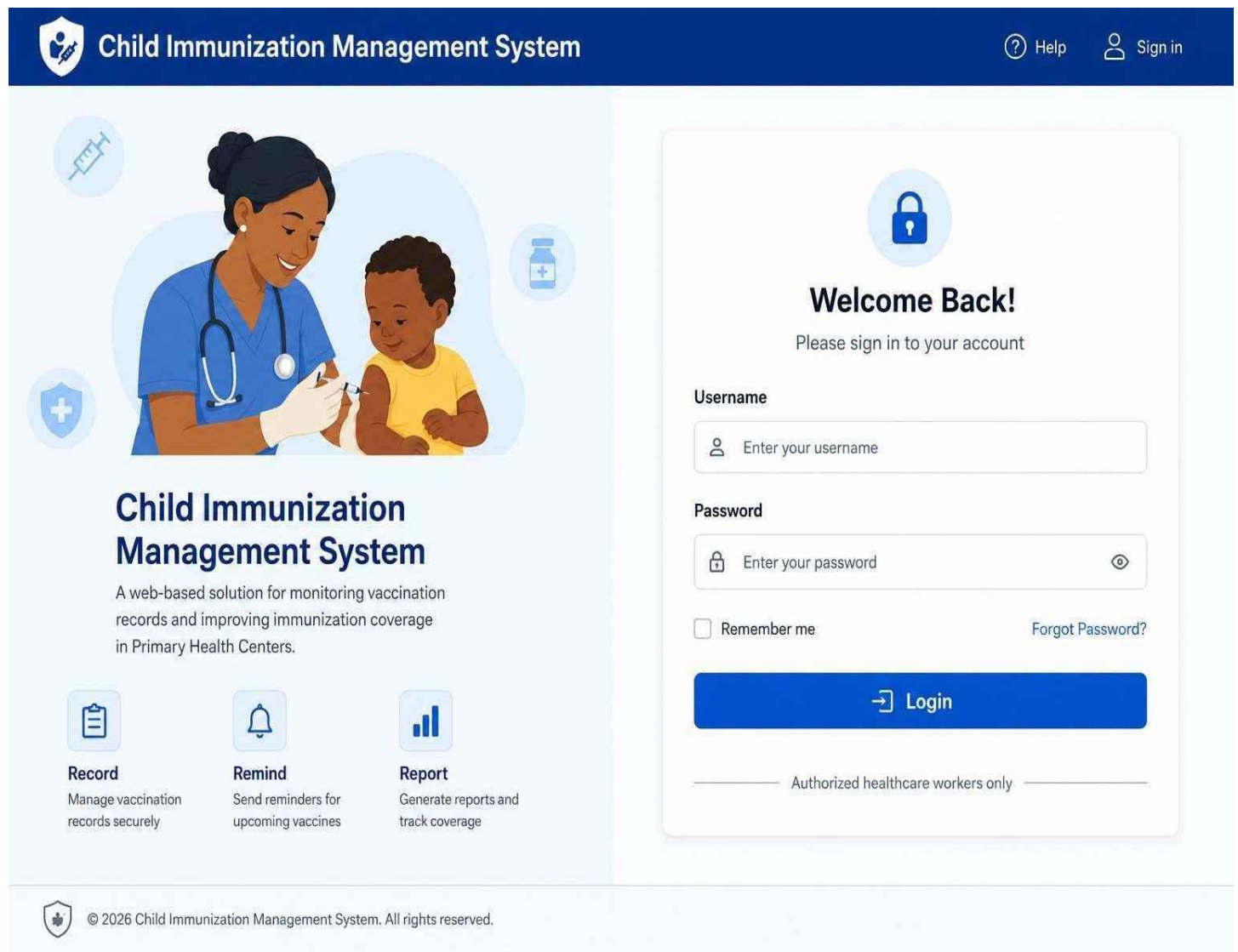
System Implementation

The proposed Web-Based Child Immunization Management System was implemented using modern web technologies to provide an efficient, secure, and user-friendly platform for managing child immunization records in Primary Health Centers. The system was developed using HTML5, CSS3, JavaScript, Bootstrap, PHP, and MySQL, while XAMPP served as the local development environment. The application was designed with a responsive user interface to ensure accessibility across different devices with internet connectivity.

The implementation consists of several integrated modules, including user authentication, child registration, vaccination record management, immunization scheduling, reminder notification, report generation, and user

management. These modules interact with a centralized MySQL database, enabling healthcare personnel to securely store, retrieve, update, and manage child immunization records in real time.

The implemented system provides role-based access control, ensuring that only authorized users can access sensitive health information. Healthcare workers can register new children, record administered vaccines, schedule future vaccinations, monitor immunization status, and generate statistical reports that support effective healthcare planning and decision-making.



The image shows the login interface of the 'Child Immunization Management System'. The interface is divided into two main sections: a left sidebar with navigation options and a right main content area for login.

Left Sidebar:

- Header:** 'Child Immunization Management System' with a shield icon, a 'Help' link, and a 'Sign in' link.
- Main Content:**
 - Illustration:** A healthcare worker administering a vaccine to a child.
 - Title:** 'Child Immunization Management System'.
 - Description:** 'A web-based solution for monitoring vaccination records and improving immunization coverage in Primary Health Centers.'
 - Modules:**
 - Record:** Manage vaccination records securely.
 - Remind:** Send reminders for upcoming vaccines.
 - Report:** Generate reports and track coverage.
- Footer:** '© 2026 Child Immunization Management System. All rights reserved.'

Right Main Content Area:

- Header:** 'Welcome Back!' with a lock icon, followed by 'Please sign in to your account'.
- Username:** A text input field with a placeholder 'Enter your username'.
- Password:** A text input field with a placeholder 'Enter your password' and a toggle icon.
- Remember me:** A checkbox labeled 'Remember me'.
- Forgot Password?:** A link to reset the password.
- Login:** A blue button with a right arrow icon and the text 'Login'.
- Footer:** 'Authorized healthcare workers only'.

Figure 6: Login Interface of the Proposed System.


Child Immunization Management System





Mary Johnson
Health Worker

MAIN MENU

- Dashboard
- Children
 - Register New Child
 - View Children
- Vaccinations
- Appointments
- Reminders
- Reports
- Users
- Settings
- Logout

Dashboard / Children / Register New Child



Child Registration

Register a new child to the system

Child Information

First Name *

Last Name *

Date of Birth *

Gender *
-- Select Gender --

Blood Group
-- Select Blood Group --

Birth Weight (kg)

Address *

Guardian Name *

Relationship *
-- Select Relationship --

Phone Number *

Alternative Phone Number

Email Address

Nationality

Reset

Save Child Information

© 2026 Child Immunization Management System. All rights reserved.

Figure 7: Child Registration Interface.


Child Immunization Management System





Mary Johnson
Health Worker

[Dashboard](#) / [Vaccinations](#) / [Vaccination Records](#)


Vaccination Record Management
View and manage child vaccination records

[+ Record New Vaccination](#)

#	Child Name	Child ID	Vaccine	Dose/Stage	Date Administered	Next Due Date	Status	Action
1	Chinedu Okafor 8 months	CHD-0001	BCG	Dose 1	15/01/2026	-	Completed	View
2	Chinedu Okafor 8 months	CHD-0001	OPV	Dose 1	15/01/2026	15/02/2026	Next Due	View
3	Amara Nwosu 6 months	CHD-0002	Pentavalent (DPT-HepB-Hib)	Dose 1	20/01/2026	20/02/2026	Next Due	View
4	Amara Nwosu 6 months	CHD-0002	PCV	Dose 1	20/01/2026	20/02/2026	Next Due	View
5	Tunde Adeyemi 9 months	CHD-0003	Measles	Dose 1	18/02/2026	-	Completed	View
6	Zainab Yusuf 7 months	CHD-0004	OPV	Dose 2	22/02/2026	22/03/2026	Next Due	View
7	Emeka Obi 12 months	CHD-0005	Yellow Fever	Dose 1	25/02/2026	-	Completed	View

Showing 1 to 7 of 7 records

[Previous](#)

1

[Next](#)


All vaccination records are securely stored and up to date.
Ensure accurate data entry for effective immunization tracking.

[Export Records](#)

© 2026 Child Immunization Management System. All rights reserved.

Figure 8: Vaccination Record Management Interface.

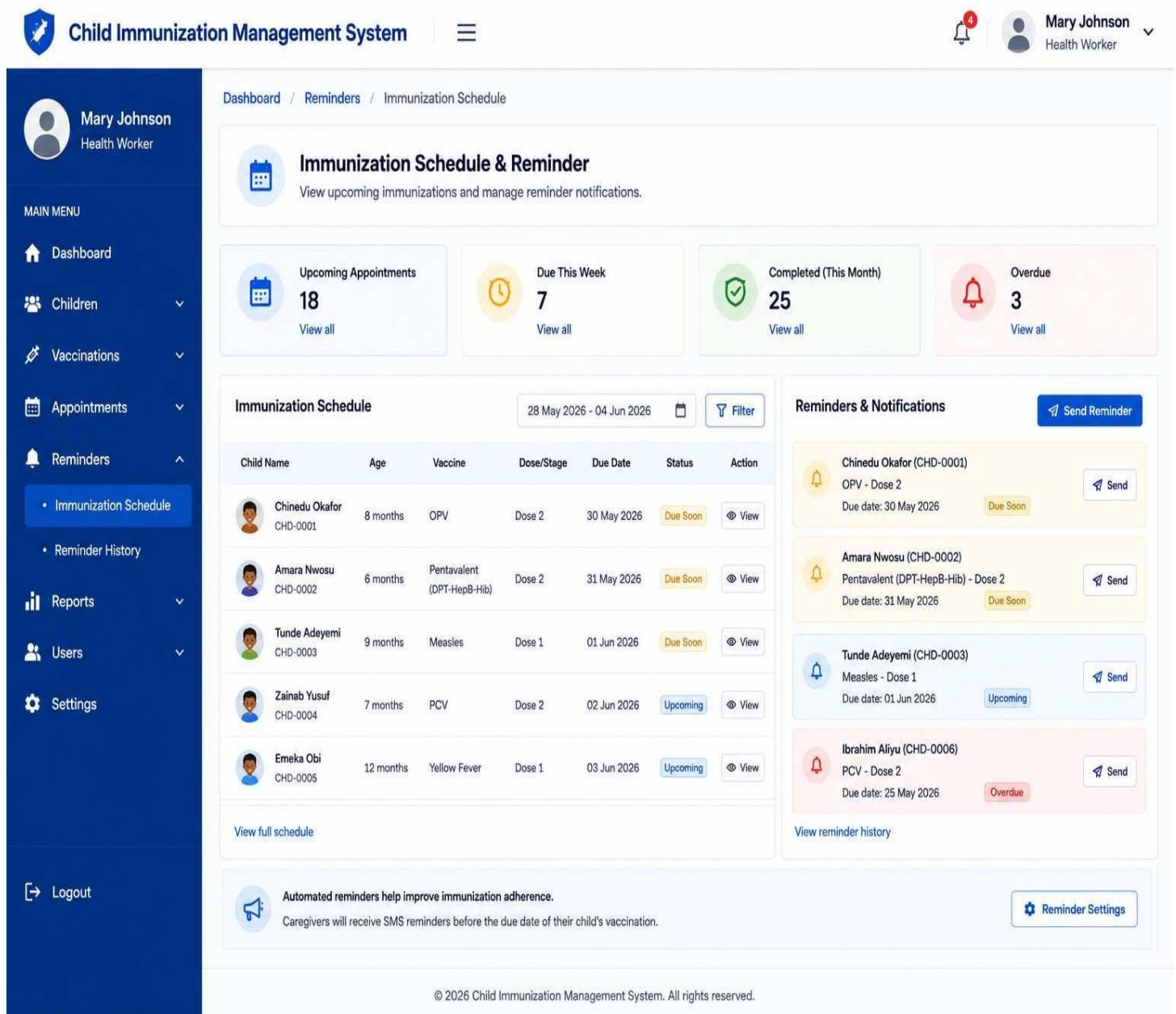


Figure 9: Immunization Schedule and Reminder Interface.

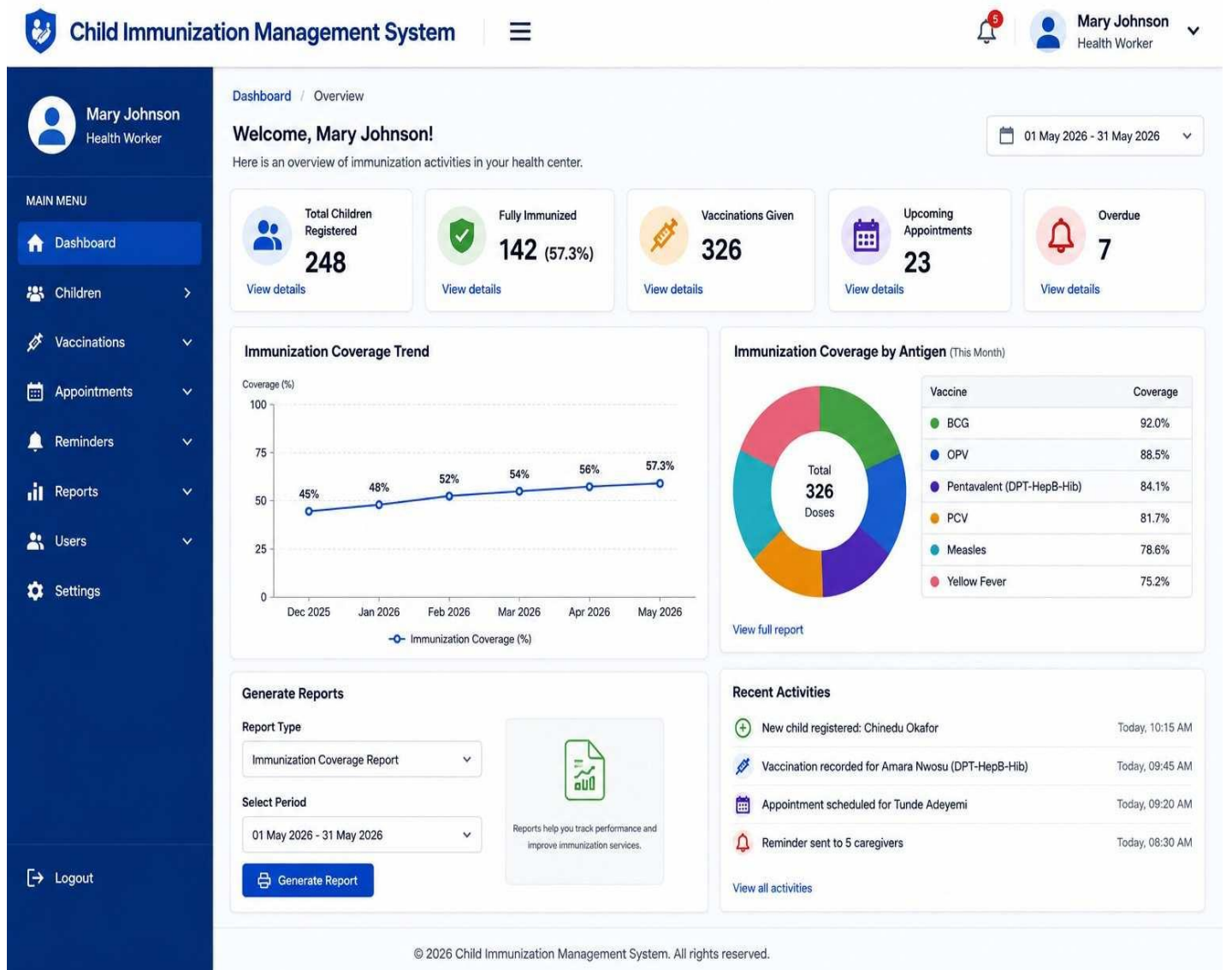


Figure 10: Dashboard and Report Generation Interface.

RESULTS

The implementation of the proposed Web-Based Child Immunization Management System achieved the objectives of the study by providing an efficient platform for managing child vaccination records in Primary Health Centers. The system successfully automated child registration, vaccination record management, immunization scheduling, reminder notifications, and report generation.

The centralized database improved the storage and retrieval of vaccination records while reducing errors associated with manual documentation. Healthcare personnel were able to monitor children's immunization status efficiently, identify missed vaccination appointments, and generate real-time reports for administrative and healthcare planning purposes. The implementation also enhanced data security through secure user authentication and role-based access control.

Overall, the developed system demonstrated improved operational efficiency, enhanced data accuracy, timely monitoring of immunization schedules, and better management of child immunization records.

User Acceptance Testing (UAT)

To evaluate the usability of the developed system, User Acceptance Testing (UAT) was conducted with fifteen (15) healthcare workers comprising nurses, community health extension workers, and records officers from selected Primary Health Centers.

Participants used the developed application to register children, record vaccinations, search vaccination records, generate reports, and schedule immunization appointments. After completing these tasks, they completed a structured usability questionnaire.

The evaluation showed that 93% of participants found the system easy to use, 90% believed it reduced documentation errors, while 95% agreed that retrieving vaccination records was significantly faster than the manual paper-based method. Overall user satisfaction was recorded at 92%.

System Performance Evaluation

Metric	Result
Login Response Time	1.2 seconds
Child Registration	2.0 seconds
Record Retrieval	1.1 seconds
Report Generation	3.0 seconds
User Satisfaction	92%
Error Rate	Less than 2%

The evaluation indicates that the proposed system performs efficiently under normal operating conditions. The average response time remained below three seconds, while the low error rate demonstrates the reliability of the application.

DISCUSSION

The findings of this study demonstrate that the proposed Web-Based Child Immunization Management System effectively addresses the limitations associated with manual paper-based immunization record management in Primary Health Centers. The implementation of the system provides healthcare personnel with a reliable platform for maintaining accurate vaccination records, monitoring immunization schedules, and generating reports for informed decision-making.

The findings agree with Smith and Amber (2023), who reported that electronic vaccination systems improve record accuracy and accessibility. Similarly, Bangure et al. (2025) observed that reminder systems significantly improve vaccination compliance. The centralized database and reporting features implemented in the present study also support the findings of Verma and Kumar (2026), who emphasized that web-based immunization systems improve healthcare efficiency. Unlike previous studies, however, the proposed system integrates child registration, appointment scheduling, reminder notifications, authentication, and report generation into a single platform specifically designed for Primary Health Centers.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study presented the development of a Web-Based Child Immunization Management System for monitoring vaccination records and improving immunization coverage in Primary Health Centers. The study identified the limitations of the existing paper-based immunization record management system, including inaccurate documentation, difficulty in retrieving records, poor monitoring of vaccination schedules, delayed report

generation, and inadequate data security. To address these challenges, a web-based system was developed using the Object-Oriented Analysis and Design Methodology (OOADM).

The developed system provides an efficient platform for child registration, vaccination record management, immunization scheduling, reminder notifications, and report generation through a centralized and secure database. The findings demonstrate that the system improves the accuracy, accessibility, and management of vaccination records while reducing human errors and enhancing the monitoring of immunization schedules. The study concludes that the adoption of a web-based Child Immunization Management System can significantly improve healthcare service delivery and contribute to increased immunization coverage and better child health outcomes in Primary Health Centers.

Recommendations

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

1. Primary Health Centers should adopt web-based Child Immunization Management Systems to replace manual paper-based record management and improve the efficiency of immunization services.
2. Government agencies and healthcare authorities should provide adequate information technology infrastructure, including reliable internet connectivity and computer systems, to support the effective implementation of web-based healthcare information systems.
3. Healthcare workers should receive regular training on the use of digital immunization management systems to enhance their technical competence and ensure effective system utilization.

REFERENCES

1. Asif, M., & Rahman, M. M. (2026). A web-based child vaccination system: Digitalizing the Expanded Program on Immunization. *Journal of Health Informatics*, 14(1), 45–53.
2. Al-Nineveh, H. M. (2024). Implementing a web-based information system to manage children's vaccinations in health units and centers. *Journal of Digital Health Systems*, 19(2), 201–215.
3. Bangure, D., et al. (2025). Effectiveness of short message service (SMS) reminders on childhood immunization outcomes in low- and middle-income countries: A scoping review. *Vaccine*, 43(12), 1540–1549.
4. Donckels, E. A., Cunniff, L., Regenold, N., Esselman, K., Muther, E., Bhatti, A., & Eiden, A. L. (2023). Understanding diversity of policies, functionalities, and operationalization of Immunization Information Systems and their impact: A targeted review of the literature. *Vaccines*, 11(7), 1242.
5. Nelson, S. D., Koop, R., Fontaine, P., et al. (2024). Evolving interoperability across a state public health immunization registry and electronic health records. *Studies in Health Technology and Informatics*, 310, 23–27.
6. Nwinyi, C. O., & Odigie, I. A. (2021). Implementation of web-based architecture for child immunization tracking in primary healthcare centers. *International Journal of Innovative Research and Advanced Studies*, 8(4), 78–85.
7. Odone, A., Bert, F., De Vito, C., Siliquini, R., et al. (2025). Immunization information systems' implementation and characteristics across the world: A systematic review of the literature. *Expert Review of Vaccines*, 24(1), 668–702.
8. Ogbuli, A. I., & Ezenwegbu, N. C. (2026). Unified cloud-based healthcare record management for rural clinics: A case study of hospitals in Ihiala Local Government Area, Anambra State. *International Journal of Research and Innovation in Social Science (IJRISS)*, 10(6), 7563–7572.
9. Okeke, O. C., & Ezenwegbu, N. C. (2024). Enhancing healthcare data entry efficiency and accuracy through voice assistant systems: A case study of Obijackson Hospital Okija. *International Journal of Research and Innovation in Applied Science (IJRIAS)*, 9(10), 114–125.
10. Sharma, A., & Patel, R. (2025). Vaccidoc: Automated scheduling and round-robin load-balancing for high-traffic vaccine registries. *International Journal of Computer Sciences and Practices*, 11(1), 89–97.

11. Smith, L., & Amber, T. (2023). Utilizing an electronic health record system and barcode technology to improve childhood vaccination compliance. *Applied Clinical Informatics*, 14(3), 322–330.
12. Vasanth, K., & Josephine, A. (2024). Automated recommendation and predictive monitoring systems for regional childhood immunization coverage. *BMC Public Health*, 24(1), 411.
13. Verma, R., & Kumar, S. (2026). Child Vaccination Management System (CVMS): A MERN stack application for digitalizing healthcare records. *International Journal of Progressive Research in Engineering Management and Science (IJPREAMS)*, 6(1), 112–120.