

Maternal and Child Vaccination System

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Abstract: The Maternal and Child Vaccination System (MCVS) is an integrated digital healthcare solution developed to streamline the maternal and child health journey — from the first antenatal check-up to the completion of childhood immunizations up to five years of age. In rural areas of Tamil Nadu, healthcare outreach is primarily conducted through Thadupusi Mugam (village-level immunization camps), where manual data entry and fragmented tracking often lead to missed vaccinations and inconsistent maternal care. To address these challenges, the proposed system provides a unified and automated digital platform that ensures real-time monitoring, timely reminders, and accurate record management for both mothers and children. The system begins with the digital registration of pregnant women and records detailed antenatal information including ANC visits, Tetanus Toxoid (TT) doses, blood pressure, hemoglobin levels, and high-risk indicators. Upon delivery, the system automatically transitions to the child module, generating a personalized immunization schedule aligned with the Universal Immunization Programme (UIP). Automated SMS notifications are sent in both Tamil and English to alert parents and healthcare workers about upcoming vaccinations, thereby improving adherence and reducing the chances of missed doses. Designed with inclusivity in mind, MCVS incorporates offline functionality for field workers in remote areas and a mobile-friendly interface for easy data entry. Advanced features include QR code-based health IDs, digital vaccination certificates, PHC-level dashboards, camp scheduling, village-wise coverage reports, and real-time tracking of high-risk pregnancies or under-immunized children. The system not only supports healthcare workers and Primary Health Centres (PHCs) but also strengthens the government's data-driven health initiatives by providing accurate analytics for better decision-making. Ultimately, MCVS bridges the digital divide in rural healthcare, promotes complete immunization coverage, and contributes to reducing maternal and infant mortality across underserved regions.

Keywords: Digital Healthcare, Immunization, Analytics, Automation, QR based Health ID.

I. INTRODUCTION

Maternal and child health plays a vital role in strengthening public healthcare systems, especially in rural regions where access to hospitals and proper digital records remains limited. In India, a significant portion of maternal and child deaths occur due to delayed vaccination, missed antenatal care, and the absence of reliable data tracking. Existing manual methods using paper registers or Excel sheets often lead to data duplication, errors, and communication gaps between Primary Health Centres (PHCs) and field workers. The proposed Maternal and Child Vaccination System addresses these issues by offering a unified web-based solution that records antenatal details, vaccination schedules, and follow-ups efficiently. It automates the registration of pregnant women, monitors risk factors, and shifts automatically to child records upon delivery. Each child receives a unique QR-based health ID, and reminders are sent to parents via SMS in both Tamil and English to ensure timely immunizations. The system empowers healthcare workers with mobile-friendly and offline access for remote areas, enhancing the continuity of care. By centralizing data and automating notifications, the system helps PHC staff and government agencies generate real-time reports, monitor vaccination coverage, and identify high-risk cases. This initiative ultimately contributes to reducing maternal and infant mortality, achieving full immunization coverage, and supporting India's Universal Immunization Programme (UIP) through technology-driven healthcare management.

II. LITERATURE SURVEY

A comprehensive review of related works was carried out to understand existing systems in the field of vaccination and maternal health management. The studies examined focus on improving digital

healthcare delivery, vaccination tracking, and data accessibility for healthcare professionals. However, most existing models address child vaccination alone and lack integration with maternal health services or analytical reporting features.

[1] Renuka Kajale, Nazneen Shaikh, and Gayatri Nagendre (2025) in their paper “*Vaccidoc: Child Vaccination Management System*” published in IJCSPUB, introduced a web-based system for managing child immunizations. The system supports centralized record-keeping, automated reminders for parents, and role-based access for healthcare staff. The approach effectively reduces missed vaccinations and improves adherence to immunization schedules. However, it primarily focuses on children and does not extend to maternal health tracking or include analytics for healthcare administrators.

[2] Kamal Acharya (2023) in “*Vaccine Management System Project Report*” (DOI:10.13140/RG.2.2.26233.68961) emphasized a modular design and data-driven approach for managing vaccination schedules. The system integrates real-time notifications, digital reporting tools, and structured data management for healthcare providers and parents. While the project demonstrates a strong practical framework for vaccination compliance and operational efficiency, it lacks discussion on scalability, rural usability, and integration with maternal care modules.

[3] Alnssayan, Azza Abdullah, and Hassan (2022) proposed “*VacChain: A Blockchain-Based EMR System to Manage Child Vaccination Records*,” published in EBSCO, Volume 40, Issue 3, p. 927. This system leverages blockchain technology to ensure transparency, data security, and immutability in electronic medical records (EMRs). VacChain decentralizes data storage across multiple healthcare facilities, thereby improving reliability and trust. Despite its strength in maintaining data integrity, it does not explore automated reminders, maternal health linkages, or reporting analytics that support public health interventions.

[4] Salawu and Okide (2021) presented “*Implementation of Web- Based Architecture for Child Immunization Information Management System Integrated with SMS Reminder*,” in IJIRAS, Volume 8, Issue 1, ISSN: 2394-4404. Their study developed an immunization information system capable of sending SMS alerts to parents to minimize missed vaccination

appointments. The system improves parent engagement and ensures timely vaccination updates. However, its scope is limited to child immunization and does not provide maternal health monitoring, analytics dashboards, or hierarchical access controls for healthcare providers.

From the above studies, it is evident that while multiple systems exist for managing child immunizations, there is a clear gap in integrating maternal and child health within a single unified digital platform. Most prior research focuses on child-centric systems or technological innovations such as blockchain or SMS alerts. The proposed Maternal and Child Vaccination System (MCVS) distinguishes itself by addressing both maternal and child health, offering comprehensive data analytics, bilingual communication (Tamil and English), and offline functionality for rural healthcare workers.

III. PROPOSED SYSTEM

The proposed KiddoWell system is a comprehensive digital healthcare management platform designed to address the limitations of the existing manual maternal and child healthcare systems. It introduces automation, centralized data management, and role-based access control to ensure efficiency, transparency, and reliability in healthcare delivery. The system aims to strengthen maternal and child health services, especially in rural and semi-urban areas, by integrating antenatal care tracking, child immunization monitoring, and real-time data reporting into a single, unified web-based solution. The proposed system digitizes the entire maternal and child healthcare workflow — from antenatal registration and ANC visit tracking to child vaccination scheduling and follow-up notifications. Each stakeholder, including doctors, pregnant women, parents, and PHC staff, has a dedicated role-based dashboard that enables secure and personalized access to relevant functionalities. Security is enforced through JWT-based authentication to protect sensitive medical records and prevent unauthorized access.

One of the key strengths of the proposed system is its automation capabilities. Features such as automated SMS reminders, QR code-based digital health cards, and real-time growth tracking charts keep beneficiaries informed about upcoming medical appointments, vaccination due dates, and health

progress. Healthcare providers can efficiently manage immunization camps, record attendance, and generate analytical reports in PDF or Excel formats for district-level review and decision-making.

From a technical perspective, the backend of the KiddoWell system is developed using Node.js and Express, ensuring efficient API handling and scalability. The frontend is built using React and TypeScript, offering a responsive, user-friendly, and modern interface optimized for both desktop and mobile devices. Data is securely stored and managed using the PostgreSQL database through Prisma ORM, ensuring consistency, reliability, and high performance. The integration of RESTful APIs facilitates seamless communication between the client and server, enabling smooth and real-time data flow across all modules.

By automating repetitive healthcare processes and enabling real-time monitoring, the KiddoWell system significantly reduces human errors, enhances data accuracy, and improves coordination between doctors, field workers, and beneficiaries. The centralized platform supports effective healthcare planning by providing actionable insights and reports based on real-time data analytics. Furthermore, the system contributes to reducing missed vaccinations, improving maternal health outcomes, and supporting government healthcare initiatives by promoting digital transformation in the healthcare sector.

In conclusion, the proposed KiddoWell system provides a scalable, secure, and user-centric solution that bridges the digital gap in rural healthcare infrastructure. It serves as a sustainable technological framework for future enhancements such as AI-based risk prediction, mobile app integration, and interoperability with national health databases, ensuring a long-term impact on public health management.

IV. PROPOSED SOLUTION

The proposed solution focuses on transforming the existing manual maternal and child healthcare system into a fully digital, automated, and accessible web-based platform that ensures accurate tracking, improved communication, and efficient data management. The solution directly addresses the inefficiencies of traditional healthcare workflows, such as data duplication, lack of timely reminders, and

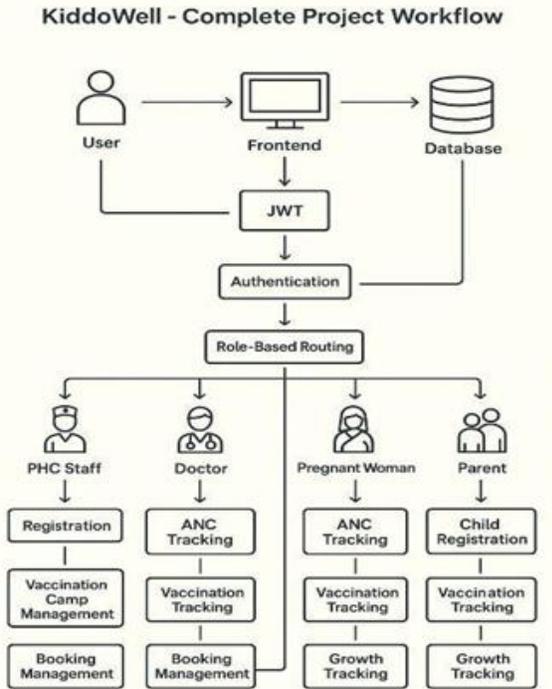
poor record accessibility, which often result in missed vaccinations and delayed interventions.

The KiddoWell system integrates multiple modules — Doctor, Pregnant Woman, Parent, and PHC Staff — into a unified platform connected through a secure, role-based login mechanism. Each user is provided with personalized access to features relevant to their responsibilities, ensuring accountability and data privacy. The system automates vital healthcare functions including antenatal care (ANC) tracking, child immunization scheduling, automated SMS reminders, and digital health record maintenance.

To support modern healthcare needs, the solution leverages advanced web technologies such as React for building a responsive and intuitive frontend, Node.js and Express for backend services, and PostgreSQL as the core database managed via Prisma ORM for efficient data storage and retrieval. The integration of RESTful APIs ensures seamless communication between the client and server, while the use of JWT-based authentication safeguards sensitive medical data against unauthorized access.

KiddoWell introduces groundbreaking innovations to digitize maternal and child healthcare. It features QR-based health cards for instant access to patient information, growth tracking charts for monitoring child development, and bilingual SMS alerts in Tamil and English to ensure inclusive communication. The system automates ANC and vaccination reminders, reducing missed appointments while maintaining digital health records to eliminate duplication and enhance accessibility. With PHC-level analytics, healthcare staff gain actionable insights for planning and evaluation. By enabling real-time tracking, seamless coordination, and consistent service delivery, KiddoWell establishes a transparent, data-driven ecosystem that significantly improves maternal and child health outcomes. In essence, the proposed KiddoWell solution represents a modern, data-driven approach to public healthcare, designed to empower rural and semi-urban communities with timely, accurate, and digitally accessible maternal and child health services.

MODULES



V. IMPLEMENTATION

The Maternal and Child Vaccination System (KiddoWell) is built on a three-tier architecture, ensuring seamless functionality, security, and scalability. The system integrates a React + TypeScript frontend, a Node.js and Express backend, and a PostgreSQL database with Prisma ORM, providing a robust and efficient full-stack solution for healthcare management.

The frontend serves as a responsive and user-friendly interface that allows different users—doctors, pregnant women, parents, and PHC staff—to access their respective dashboards. It features real-time notifications, dynamic charts, and role-based navigation, ensuring accessibility even in rural and mobile environments.

The backend, powered by Node.js and Express, handles business logic, role-based authentication, and secure API communication using JWT (JSON Web Token). It processes user requests, manages automated SMS alerts, QR code generation, and report creation in PDF/Excel formats, ensuring smooth interaction between users and the database.

The PostgreSQL database, managed through Prisma ORM, serves as the data backbone. It stores critical

healthcare information such as antenatal care (ANC) visit records, immunization schedules, patient profiles, and camp details. The database ensures data integrity through normalization, role-based access, and encryption, while supporting analytics for vaccination coverage and maternal health tracking.

A structured role-based access system governs data operations and dashboard visibility. Each user—Doctor, Pregnant Woman, Parent, or PHC Staff—is provided a customized interface that displays functionalities specific to their role. Doctors can update ANC details and monitor pregnancies, pregnant women can track appointments and receive reminders, parents can manage vaccination records, and PHC staff can register beneficiaries and organize health camps.

The system architecture ensures data security, real-time synchronization, and efficient reporting, aligning with modern healthcare standards for community health management. The following modules have been implemented to achieve the project objectives:

1. LOGIN MODULE

The Login Page acts as the secure entry point for all users. Each user must authenticate using registered credentials, and JWT ensures encrypted client-server communication. Upon successful login, users are redirected to their respective dashboards based on role identification. Features such as *Forgot Password* and form validation enhance both security and usability.

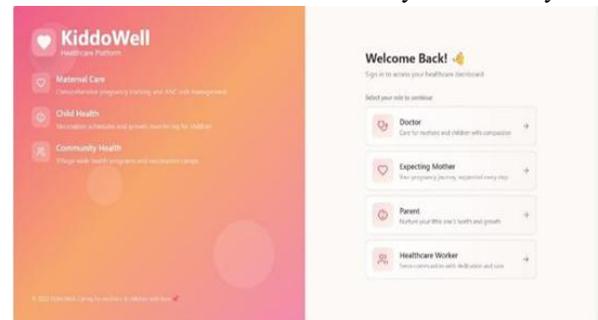


Fig 1.2 Login

2. DOCTOR MODULE

This module provides healthcare professionals with access to digital patient records, ANC updates, immunization tracking, and growth monitoring charts. It includes analytical visualizations that help doctors identify high-risk pregnancies and evaluate maternal health patterns. Automated alerts for upcoming

appointments and real-time data sharing with PHC staff improve healthcare coordination.

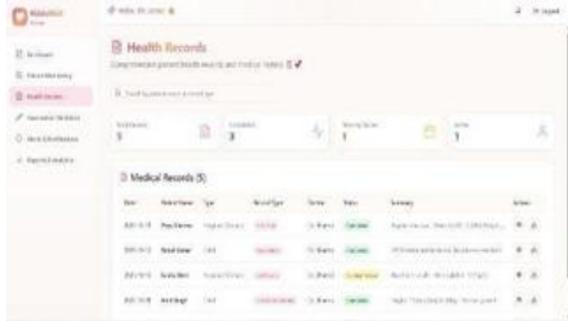


Fig 1.2 Doctor dashboard

3. PREGNANT WOMAN MODULE

The module empowers expectant mothers with access to their ANC visit records, health parameters, and automated SMS reminders for upcoming checkups. It features a digital health card with a QR code for quick patient identification at clinics. Educational guidance on nutrition and wellness ensures improved compliance and awareness throughout pregnancy.

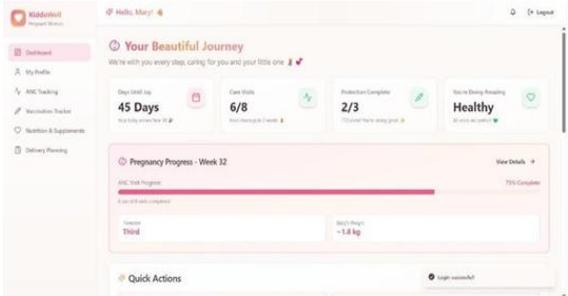


Fig 1.3 Pregnant Woman dashboard

4. PARENT MODULE

The Parent Module enables parents to manage their children's immunization schedules, track growth metrics, and receive timely vaccine alerts. Parents can download health reports, view vaccination history, and manage multiple child profiles from a single account. The interface includes progress charts and color-coded reminders for better usability.

5. PHC STAFF MODULE

This module assists Primary Health Centre staff in managing community healthcare operations, registering beneficiaries, and organizing ANC or vaccination camps. It offers interactive dashboards, report generation tools, and real-time analytics for vaccination coverage and ANC visit compliance. Automated alerts ensure timely actions and data

synchronization across the healthcare network.

6. SOFTWARE ENVIRONMENT

Frontend:

Developed using React with TypeScript, the frontend provides a responsive and interactive experience. It supports form validation, live notifications, and data visualization through dynamic charts.

Backend:

Built using Node.js and Express, the backend manages secure authentication, routing, and API integration. It uses JWT for encrypted login sessions and bcrypt for password hashing.

Database:

PostgreSQL, managed by Prisma ORM, ensures reliable data storage, efficient retrieval, and role-based security. Regular backups and encryption maintain data integrity and confidentiality.

IDE:

The project is developed using Visual Studio Code (VS Code), featuring extensions like ESLint, Prettier, and Docker for debugging, code formatting, and version control.

7. CODE IMPLEMENTATION

Step 1: Authentication System

Implements secure login using JWT and bcrypt for all user roles, ensuring encrypted data flow between client and server.

Step 2: Role-Based Dashboards

Custom dashboards provide quick access to relevant features and statistics based on user roles (Doctor, Pregnant Woman, Parent, PHC Staff).

Step 3: Vaccination Tracking System

Displays national immunization schedules, due dates, and completion status for children, ensuring timely vaccination.

Step 4: ANC Tracking System

Allows pregnant women and doctors to view visit history, update medical data, and receive appointment alerts.

Step 5: Vaccination Camp Management

PHC staff can create, manage, and schedule vaccination camps with automated notifications sent to registered users.

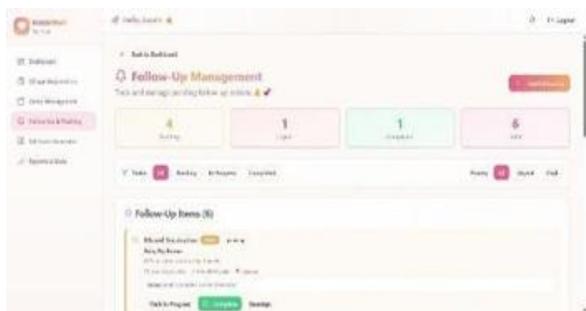


Fig 1.4 Parent module with notification system

8. RESULT AND DISCUSSION

The *KiddoWell* system demonstrates a fully functional, secure, and efficient web-based maternal and child healthcare platform.

Functional Outcomes

- **Doctor Dashboard:** Enables ANC record management, vaccination review, and analytical insights.
- **Pregnant Woman Dashboard:** Provides health card access, appointment tracking, and SMS reminders.
- **Parent Dashboard:** Supports vaccination tracking, child growth charts, and downloadable reports.
- **PHC Staff Dashboard:** Facilitates beneficiary registration, camp scheduling, and report generation.

Performance and Usability

- Fully responsive design accessible across desktop and mobile devices.
- JWT-based authentication ensures high security and controlled access.
- Real-time SMS alerts reduce missed ANC visits and vaccination delays.
- PostgreSQL ensures centralized, reliable, and secure data storage.
- Analytical dashboards assist healthcare workers in data-driven decision-making.

Overall, *KiddoWell* meets the project objectives of digitizing maternal and child healthcare, enhancing accessibility, improving compliance, and supporting public health initiatives for better outcomes.

VI. CONCLUSION

The KiddoWell system has successfully demonstrated the development of a comprehensive digital healthcare management platform designed to enhance maternal and child health services in rural and semi-urban regions. By integrating modern web technologies such as React, TypeScript, Node.js, Express, and PostgreSQL with Prisma ORM, the platform ensures a secure, responsive, and scalable environment for healthcare management.

Through its role-based dashboards, the system efficiently caters to the needs of doctors, pregnant women, parents, and PHC staff, streamlining healthcare operations and minimizing manual errors. Features such as ANC tracking, vaccination reminders, QR-based health cards, growth monitoring, and automated report generation bridge the communication gap between healthcare providers and beneficiaries.

By automating routine healthcare processes and facilitating real-time record management, KiddoWell enhances efficiency, transparency, and accessibility in healthcare delivery. The inclusion of data analytics and visualization tools empowers administrators to make data-driven decisions, improving overall public health management and service coordination.

The project highlights the transformative potential of digital technologies in addressing healthcare challenges in underserved regions. By digitizing maternal and child health tracking, the system reduces missed appointments, ensures timely vaccinations, and supports preventive care.

In conclusion, KiddoWell stands as a scalable and impactful digital healthcare solution, capable of supporting both community-level and national public health initiatives. It not only modernizes healthcare record-keeping but also contributes significantly to improving maternal and child health outcomes through digital innovation and effective healthcare coordination.

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