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Digital Health Record Management System for Migrant Workers In Kerala Aligned with Sustainable Development Goals

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Abstract: Kerala has somewhere between 2.5 and 3.5 million inter-state migrant workers at any given time, most of them from Odisha, West Bengal, Bihar, and Assam. When they get sick, they are essentially starting from scratch at every new hospital — no prior records, no prescription history, nothing. Doctors repeat tests. Chronic conditions go untracked. During COVID-19, contact tracing for this population was nearly impossible for exactly this reason.

This paper describes the Digital Health Record Management System (DHRMS), built in response to Smart India Hackathon 2025 (Problem Statement ID 25083) issued by Kerala's Health Service Department. The system lets hospitals register migrant workers using Aadhaar-based identification, build longitudinal medical records across visits, upload prescriptions and clinical documents, and flag infectious disease cases for public health monitoring. Patients get read-only access to their own records.

The platform runs on React.js, Firebase, Cloudinary, and Vercel. Access is role-based: Super Admins manage hospitals, hospital staff handle clinical records, and patients view their own data. The system directly addresses SDG 3, SDG 10, and SDG 17. There are real limitations — no ABDM integration yet, no offline mode, English only for now. But the core problem it solves is real, the gap it fills is documented, and the system is functional and deployed.

Keywords: Migrant Health Records, Digital Health, Electronic Health Records (EHR), Healthcare Information System, React.js, Role-Based Access Control, Public Health Surveillance, Kerala, Sustainable Development Goals

I. INTRODUCTION

India has one of the largest internal migrant populations in the world. According to the 2011 Census, approximately 450 million people were classified as internal migrants [1]. Kerala, despite its relatively small geographical size, draws a particularly large number of workers from Odisha, West Bengal, Bihar, Jharkhand, Uttar Pradesh, and Assam, collectively referred to as Guest Workers [2]. At any given time, the state hosts between 2.5 and 3.5 million inter-state migrant workers [3].

These workers move frequently. They take up construction jobs, work in hospitality, agriculture, and manufacturing, and shift between worksites as contracts end [21]. The healthcare system was not built with this kind of mobility in mind. Most hospitals store patient data locally, tied to a single facility. When a migrant worker moves to a new city and visits a different hospital, their previous records don't follow them. The doctor starts from scratch.

This creates real problems. Chronic conditions go unmonitored. Prescriptions get repeated or contraindicated without the prescribing doctor knowing. Infectious diseases go untracked across facilities. During the COVID-19 pandemic, this gap became impossible to ignore. Contact tracing for migrant populations proved extremely difficult because there was no structured health record system connecting facilities [6].

Existing national infrastructure like the Ayushman Bharat Digital Mission (ABDM) represents progress toward universal digital health coverage, but its adoption among transient, informally employed migrant workers remains limited. Structural barriers including lack of local residential documentation, language challenges, and unstable employment make enrollment difficult for this population [5].

The Digital Health Record Management System (DHRMS) was developed in direct response to Problem Statement ID 25083 issued by the Government of Kerala's Health Service Department under Smart India Hackathon 2025. The system provides a centralized, cloud-based platform where hospitals can register migrant workers, maintain longitudinal medical records, upload clinical documents, flag infectious disease cases, and allow patients to access their own health data

securely. The use of Aadhaar-based identification ensures each worker has a single unique record regardless of which hospital registers them first.

This paper covers the system's architecture, workflow, module design, security mechanisms, SDG alignment, implementation details, and results, along with an honest assessment of current limitations and future directions.

II. LITERATURE REVIEW

A. *Migrant Health Challenges in India and Kerala*

Migrant workers face a distinct set of health vulnerabilities that differ from resident populations. Their mobility results in fragmented or entirely absent medical records, making continuity of care nearly impossible. Studies have identified migrant populations as significant carriers of communicable diseases including tuberculosis, malaria, and sexually transmitted infections [4]. Language barriers, unfamiliarity with local health systems, financial constraints, and fear of documentation are consistently cited as barriers to healthcare-seeking behavior [15].

The Gulati Institute of Finance and Taxation estimates that inter-state migrants contribute significantly to Kerala's GDP while often living and working in substandard conditions with limited healthcare access [20][22]. A large proportion of these workers are informally employed, making them ineligible for Employees' State Insurance and other formal health benefit schemes [16]. The COVID-19 pandemic exposed these vulnerabilities sharply, as health monitoring and contact tracing for migrant populations proved almost impossible due to absent structured records [6].

B. *Electronic Health Records*

Electronic Health Records have been widely adopted across developed healthcare systems. Systematic reviews have demonstrated that well-implemented EHR systems improve care coordination, reduce medical errors, and support better clinical decision-making [7]. In the United States, the HITECH Act accelerated EHR adoption significantly. In India, the Ministry of Health and Family Welfare released EHR Standards in 2013, revised in 2016, establishing a framework for interoperable health records [17].

However, most EHR systems are designed for fixed, resident populations. Transient migrant workers face structural barriers to enrolling in national frameworks like ABDM due to lack of local documentation and language challenges [5]. There is a clear gap in the literature for EHR systems specifically designed around mobility and cross-facility continuity for migrant populations.

C. *Cloud-Based Health Information Systems*

Cloud computing has emerged as a practical solution for healthcare information systems that need to scale without dedicated server infrastructure. Firebase, a Backend-as-a-Service platform by Google, has been widely adopted for healthcare applications due to its real-time database capabilities, built-in authentication, and serverless architecture [8]. Cloud-native implementations have been found significantly more cost-effective than traditional server-based systems while maintaining comparable security profiles when properly configured [12].

React.js has become a dominant framework for healthcare web applications, valued for its component-based architecture and performance optimizations [13]. Cloudinary provides cloud-based media management suitable for storing sensitive clinical documents including prescriptions and diagnostic reports [14].

D. *Role-Based Access Control in Healthcare*

Role-Based Access Control is a foundational security mechanism in health information systems. The principle of least privilege ensures users access only data required for their specific role [9]. In healthcare, RBAC prevents unauthorized access to protected health information while enabling efficient clinical workflows. National and international standards including ISO 27799 and the HIPAA Security Rule mandate access control as a core requirement for systems handling sensitive patient data [11].

E. *Identity-Based Deduplication*

Aadhaar, India's biometric-based national identity system, has been explored as a mechanism for patient deduplication in healthcare settings. Its high penetration among India's population, including migrant workers, makes it a practical unique identifier for preventing duplicate registrations across facilities [5]. Using Aadhaar as a primary key ensures that a single longitudinal record exists per patient regardless of which hospital first registers them.

III. PROBLEM STATEMENT

A. *Challenges Faced by Migrant Workers*

Migrant workers face multiple barriers in accessing consistent healthcare, including lack of centralized medical records, frequent loss of prescriptions and reports, duplicate patient registrations across facilities, inconsistent treatment due to missing history, and limited access to previous diagnoses.

B. *Gaps in Hospital-Side Record Management*

Doctors don't always have the luxury of a clean patient history. When a migrant comes in from another city, the treating physician works with whatever the patient remembers, which isn't always accurate or complete. Tests get repeated. Medications get prescribed without knowing what was already tried. It's not negligence, it's just a missing system.

On the admin side, duplicate registrations are a real headache. The same patient might exist under slightly different names across three hospitals. There's no way to catch that without a centralized check. Records pile up, documents get misplaced, and by the time the patient returns, the previous visit might as well not have happened.

IV. SYSTEM ARCHITECTURE

The DHRMS follows a cloud-native architecture built entirely on managed services, eliminating the need for dedicated server infrastructure.

The frontend is built with React.js using React Router for navigation, React Hook Form for form management, and Context API for global state. This gives each user role a distinct dashboard experience while keeping the codebase maintainable. The component-based structure means individual parts of the interface can be updated without affecting the whole application.

Firebase serves as the backend. Firebase Authentication handles all login and session management using email and password credentials with token-based session handling. Cloud Firestore, a NoSQL document database, stores all structured data including hospital records, migrant profiles, staff accounts, and medical records. Firestore's real-time synchronization means records created by hospital staff appear immediately on the patient's end without requiring a page refresh.

Cloudinary handles all file storage. When hospital staff upload a prescription or lab report, the file goes to Cloudinary and a reference link is stored in the corresponding Firestore medical record. Files are accessed through signed URLs, which expire after a set period and cannot be shared or accessed without a valid token.

The application is hosted on Vercel with continuous deployment and a global CDN, ensuring low-latency access across different geographic regions within India.

Aadhaar number is used as the unique patient identifier. When a new migrant is registered, the system checks the Aadhaar against existing records in Firestore in real time. If a match is found, the registration is blocked. This single check is what prevents the fragmented multi-record problem that exists in conventional hospital systems.

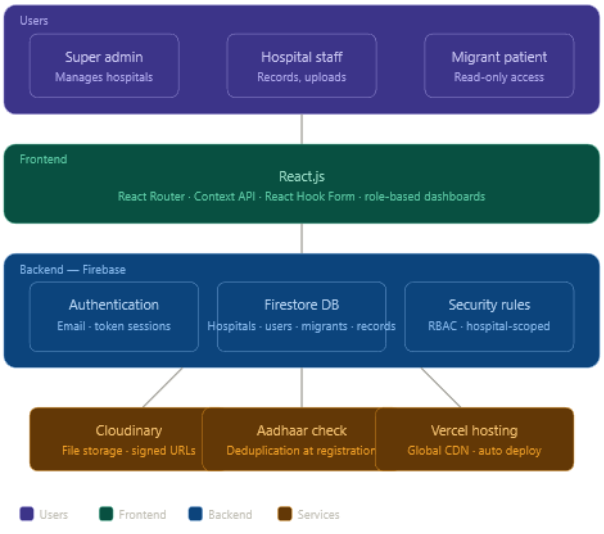

Fig. 3.1 — System Architecture Diagram

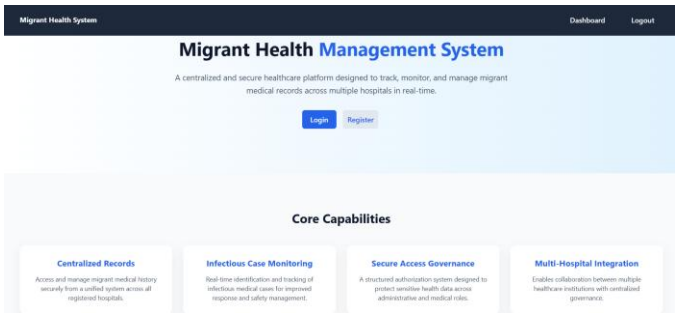

Fig. 3.2 — Home Page

V. SYSTEM WORKFLOW

The workflow of the system operates through six stages across three user roles.

A. Super Admin

The Super Admin logs in and gets a system-wide view, showing total hospitals, active hospitals, total migrants registered, and medical records created. From here, new hospitals can be added and existing ones managed. Each hospital gets a unique code (e.g., HOSP-2026-0002) and is tracked by district and state.

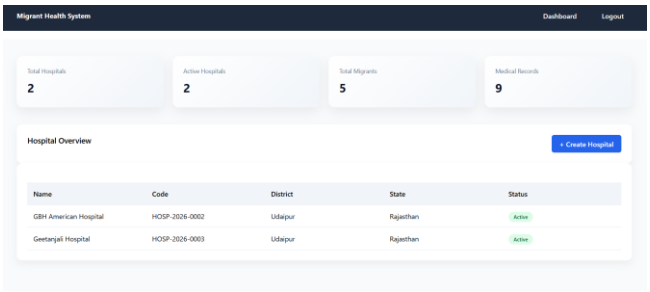

Fig. 4.1 — Super Admin Dashboard showing hospital overview

B. Hospital Staff

Once logged in, hospital staff see their own hospital's dashboard showing number of migrants registered, medical records added, infectious cases flagged, and active staff. From here they can register new migrants or pull up existing ones. The migrant list is searchable by name, mobile number, or Aadhaar, which is how duplicate registrations get caught.

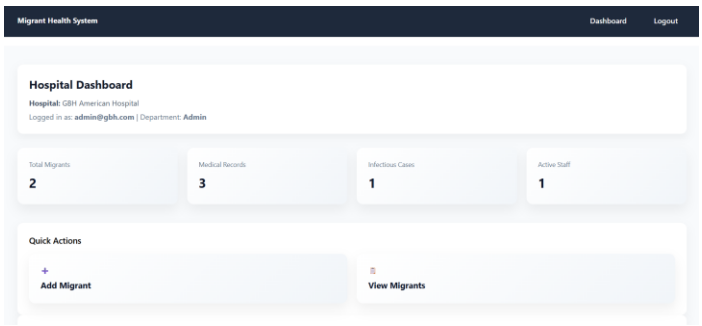

Fig. 4.2 — Hospital Dashboard with stats and quick actions

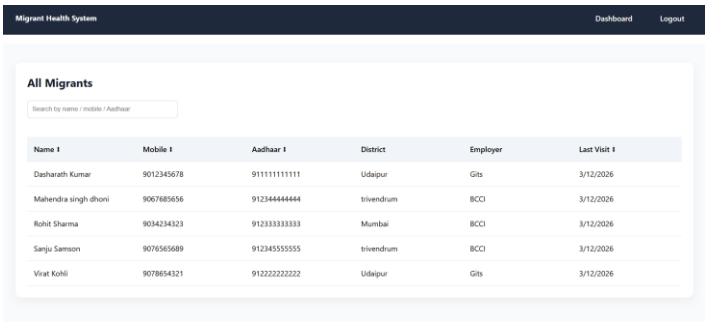

Fig. 4.3 — All Migrants list with search

C. *Migrant Patient*

Patients log in and see their own records only. Personal details, full medical history across visits, diagnosis, medicines prescribed, doctor notes, and whether the case was flagged as infectious. They cannot edit anything.

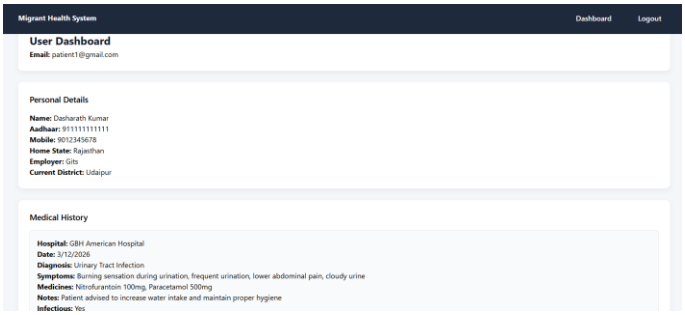

Fig. 4.4 — Patient dashboard showing medical history

VI. System Modules

A. *Super Admin Module*

The Super Admin sits above all hospitals in the system. They create hospital accounts, assign credentials to hospital administrators, and have a system-wide view of activity, showing how many hospitals are registered, how many migrants are in the system, and how many medical records exist across all facilities. Importantly, the Super Admin cannot access individual patient records. That separation is intentional; system management and clinical data stay in different hands.

B. *Hospital Module*

Hospital staff do the actual clinical work inside the system. They register new migrants, create medical records after each visit, upload prescriptions and lab reports, and flag cases as infectious where relevant. Staff can access the complete medical history of any registered migrant across all hospitals — this is intentional, since a worker who moves from one city to another needs their full history to be visible to the new treating doctor. For example, a doctor at Hospital 2 can view records created at Hospital 1, ensuring continuity of care without the patient having to repeat their history. The Aadhaar check runs at registration too, blocking duplicate entries before they happen.

C. *Patient Module*

Once registered, migrants get their own login. They can see everything that was recorded about them, including personal details, visit history, diagnoses, prescribed medicines, doctor notes, and uploaded documents. They cannot change anything. The read-only access is deliberate; it gives patients visibility into their own health data without creating any risk of records being altered.

VII. Alignment with Sustainable Development Goals

The DHRMS directly addresses three of the seventeen United Nations Sustainable Development Goals [10].

A. *SDG 3 — Good Health and Well-being*

SDG 3 calls for ensuring healthy lives and promoting well-being for all ages. Target 3.8 specifically focuses on achieving universal health coverage including access to quality essential healthcare services. Migrant workers are one of the most health-vulnerable populations in Kerala, yet they fall outside most existing healthcare frameworks. By giving every registered migrant a portable, cross-hospital medical record, the system extends structured healthcare access to people who previously had none.

Target 3.3 focuses on ending epidemics of communicable diseases. The infectious disease flag built into every medical record creates a foundation for disease surveillance within migrant communities. Target 3.d addresses strengthening early warning capacity for health risks, which the system's aggregated infectious case data directly supports [10].

B. *SDG 10 — Reduced Inequalities*

Migrant workers represent one of the most structurally disadvantaged populations in Kerala's healthcare landscape. They are informally employed, linguistically isolated, and excluded from most digital health infrastructure by design. Target 10.2 promotes social and economic inclusion of all, and Target 10.3 focuses on reducing inequalities of outcome. Building a health system specifically for this population rather than expecting them to fit into a system built for permanent residents is a direct response to both targets.

C. *SDG 17 — Partnerships for the Goals*

The system was developed through a public-private partnership. The Government of Kerala's Health Service Department defined the problem through Smart India Hackathon 2025. Student developer teams provided implementation. This model directly reflects Target 17.17, which encourages effective public, public-private, and civil society partnerships for sustainable development [10].

VIII. Implementation And Technology Stack

The system is built entirely on cloud-based services, which means no dedicated server infrastructure to maintain. That was

a practical decision for a government-facing deployment where operational costs and setup complexity matter.

React.js handles the frontend. It renders separate dashboards for each user role and keeps the interface responsive without full page reloads. Firebase sits at the core of the backend, managing both authentication and the Firestore database. Firestore stores all structured data, including hospital records, migrant profiles, and medical history, and syncs in real time so records created by hospital staff are immediately visible to patients.

Cloudinary handles file storage. Prescriptions, lab reports, and clinical documents are uploaded there and linked to the corresponding medical record. Signed URLs mean the files are not publicly accessible. The whole application is deployed on Vercel, which provides fast load times through a global CDN without needing a separate hosting setup.

The system has been tested across all three user roles. Firestore Security Rules enforce access control at the database level, independent of the application layer, so hospital-scoped restrictions cannot be bypassed through the frontend. Average document upload time is under 3 seconds for files up to 5MB on a standard connection.

IX. Security Mechanisms

A. *Role-Based Access Control*

Every user in the system, whether Super Admin, hospital staff, or patient, sees only what their role permits. Hospital staff can read patient records across all hospitals but can only create and update records within their own hospital. So, a doctor at Hospital 2 can view a patient's history from Hospital 1 but cannot modify those records. The Super Admin has system-wide visibility but no access to individual patient records. Patients can only see their own data. These rules are enforced at the database level through Firestore Security Rules, not just the application interface, so restrictions cannot be bypassed through the frontend.

B. *Authentication*

Firebase Authentication manages all logins using email and password with token-based session handling. Sessions expire automatically and cannot be shared across devices without re-authentication.

C. *Data Encryption*

All data transmission between the client and Firebase runs over HTTPS with TLS encryption. Medical documents stored on Cloudinary are accessed through signed URLs, which expire after a set period and cannot be accessed without a valid token.

D. *Duplicate Detection*

Every migrant registration is checked against existing Aadhaar numbers in the database before a new record is created. If a match is found, the system blocks the registration. This prevents the same patient from having multiple fragmented records across different hospitals, which is one of the core problems the system was built to solve.

X. Results

The system was tested across all three user roles to verify that each part of the workflow functions as intended.

On the Super Admin side, hospital creation works correctly. Each hospital is assigned a unique code, tracked by district and state, and appears immediately in the system overview. The dashboard gives an accurate real-time count of total hospitals, registered migrants, and medical records across all facilities.

From the hospital staff side, migrant registration completes without issues. The Aadhaar check correctly blocks duplicate entries at the point of registration. Medical records created by staff are immediately visible to the patient on their end. Document uploads through Cloudinary average under 3 seconds for standard file sizes, and the files are only accessible through signed URLs.

The infectious disease flag works as intended. Cases marked as infectious are filterable in the hospital view, which is the foundation for any future public health reporting built on top of this system.

On the patient side, login gives read-only access to personal details, full visit history, diagnoses, prescribed medicines, and uploaded documents. Records from multiple hospital visits accumulate in a single timeline. Patients cannot modify anything.

Firestore Security Rules were verified to enforce role-based access correctly. Hospital staff can read patient records across all hospitals but can only create and update records within their own hospital. Patients are restricted to their own records only.

XI. Conclusion And Future Scope

Kerala's migrant worker population has been moving between states for decades, and the healthcare system largely hasn't kept up. Records stay local. Patients start over at every new hospital. Infectious cases go untracked across facilities.

The system built here is a direct attempt to fix that. Hospitals can register workers, build a medical history that travels with the patient, flag infectious cases, and give patients read-only access to their own data. It's not a complete solution to every problem in migrant healthcare, but it solves the specific one it was built for: a worker who moves from Rajasthan to Kerala shouldn't have to explain their entire medical history from memory.

The Aadhaar-based deduplication works. The role separation works. The records are accessible across hospitals. That's what the system promised, and the deployed version delivers it.

A few things are missing that would make this significantly more useful. ABDM integration would connect it to the national health ID framework, which is the obvious next step. Multi-language support for Bengali, Odia, and Hindi would help the actual patients use it without relying on someone to translate. Offline capability matters too, since not every hospital has reliable internet. Longer term, the infectious disease flags across hospitals could feed into a real-time disease monitoring network, which is exactly the kind of tool that was missing during COVID-19 contact tracing for migrant populations.

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