Smart Medical Inventory Management System and Personalized Health Recommendation System

Urmila Gatkul,Om Shambhuling Swami, Prathmesh Ramdas Shingare, Shubham Sanjay Shingade, Rohit Mahadev Kadakbhavi

Department Of Computer Science And Engineering N. B. Navale Sinhgad College Of Engineering Solapur, India.

Abstract:
In the transforming digital healthcare paradigm, bringing pharmacy inventory automation together with smart health suggestions is essential to enhance patient outcomes and automate clinical workflows. This article introduces a Smart Medical Inventory Management System and Personalized Health Recommendation System based on the MERN stack (MongoDB, Express.js, React.js, Node.js) and Python-based machine learning models trained on Google Colab.

It has two portals - an admin dashboard for pharmacists, which is OTP-authenticated, having support for real-time QR code-based tracking of medicines, automated bill generation in PDF format, low-stock and expiry alerts, as well as alternate medicine suggestions; and a user dashboard, facilitating login, uploading prescriptions, viewing purchase history, and AI-based personalized health advice based on their respective medical profiles and prescription history.

This smart platform improves pharmacy operation efficiency for pharmacists while empowering patients with evidence-based health insights. The system has been proven to be scalable, cross-platform, and modular, and exhibits a high potential for practical implementation in smart pharmacies and e-health models.

1. Introduction

In the data-driven healthcare environment of the present, the intersection of automation, artificial intelligence (AI), and digital health platforms is restructuring how patients are provided care and how health facilities function. Some of the most important areas in such transformation are medicine inventory management and personalized health recommendation systems. Typical pharmacy inventory monitoring practices are usually manual, prone to errors, and inefficient—resulting in overstocking, failure to alert on approaching expiry dates, and undue delays in dispensing crucial drugs. At the same time, increasing pressure for personalized health solutions has brought to the forefront the requirement for platforms that can provide smart health advice based on user-specific information.

This project suggests a common platform: Smart Medical Inventory Management System and Personalized Health Recommendation System, designed using the MERN stack (MongoDB, Express.js, React.js, Node.js) and combined with Python-based machine learning models trained on Google Colab. The system meets two fundamental requirements of contemporary healthcare:

1. For Pharmacists/Admins: A user-friendly, OTP-protected dashboard for medicines management. Functions include adding and editing medicines, creating unique QR codes for each medicine, scanning QR codes for quick access to information, automatic billing with PDF generation, tracking low-stock and expiry reminders, and recommending alternate medicine choices while billing or out-of-stock.

2. For Users/Patients: A safe portal that allows users to upload prescriptions, view their purchase history, and receive health recommendations tailored to their needs. These recommendations are created based on machine learning models trained on large medical datasets, providing users information on diseases, preventive practices, medications, workout routines, and dietary recommendations based on their uploaded information.

The use of QR code technology eliminates not only the manual overhead but also enhances the accuracy of billing and dispensing. The health recommendation engine drives proactive management of health, and users are more aware of what they have and what is on offer. Finally, the system is user-experience focused with responsive design patterns that

ensure users can access from any device.

The project innovation is its twin-functionality—combining pharmacy automation with patient-focused AI services in one scalable application. Equipped with real-time data handling, secure engagements, and adaptation based on feedback from users as well as expanding medical knowledge, the platform becomes a new reference point for smart healthcare solutions on both community and institutional scales.

2 Literature Review

The infusion of smart technologies in the field of healthcare has expanded dramatically in the last decade, particularly in sectors like medical stock management, pharmacy automation, and individualized health guidance. Past research reports numerous standalone solutions but limited efforts in creating an integrated system that unifies stock control with individualized health assistance. This section discusses past work within these primary areas to determine gaps and defend the scope of the current system.

2.1 Medical Inventory Management Systems

The medical inventory systems have conventionally depended on manual processes or simple computer tools to handle stock, billing, and expiry tracking. Kumar and Gupta [1] explained the implementation of barcode-based inventory tools in the local pharmacies, which enhanced recording but did not feature automation and alerting mechanisms. Alvi et al. [5] suggested a QR

code-enabled inventory system that supported real-time scanning of medicines but was restricted to tracking and didn't support patient-facing features or automated billing. These research papers establish the necessity for a sophisticated, dynamic inventory management system with automated reminders, alternative suggestions, and secure billing functionality.

2.2 Pharmacy Automation and Billing

Healthcare billing systems have progressed to support digital invoicing, e-prescription, and intelligent medicine databases. Mishra and Sinha [4] worked on a cloud-based pharmacy management system that created PDF bills and tracked inventory in real-time. Although their solution enhanced administrative effectiveness, it lacked decision support functionalities like alternate medicine recommendations or QR code-based scan-and-bill processes. This reflects a clear opportunity to merge smart scanning technology with intelligent billing and record generation in one pharmacist dashboard.

2.3 Personalized Health Recommendation Systems

New developments in machine learning (ML) and artificial intelligence (AI) have made it possible to create systems that give health advice using user-specific information. Singh and Kaur [2] have compared AI-based health advisors using symptom-based inputs to make disease predictions and give preventive advice. Most of the current systems are based on static rule engines or external APIs with low flexibility. Also, these systems are usually isolated from pharmacy operations and fail to utilize prescription data imported by the user.

2.4 AI and NLP in Health Informatics

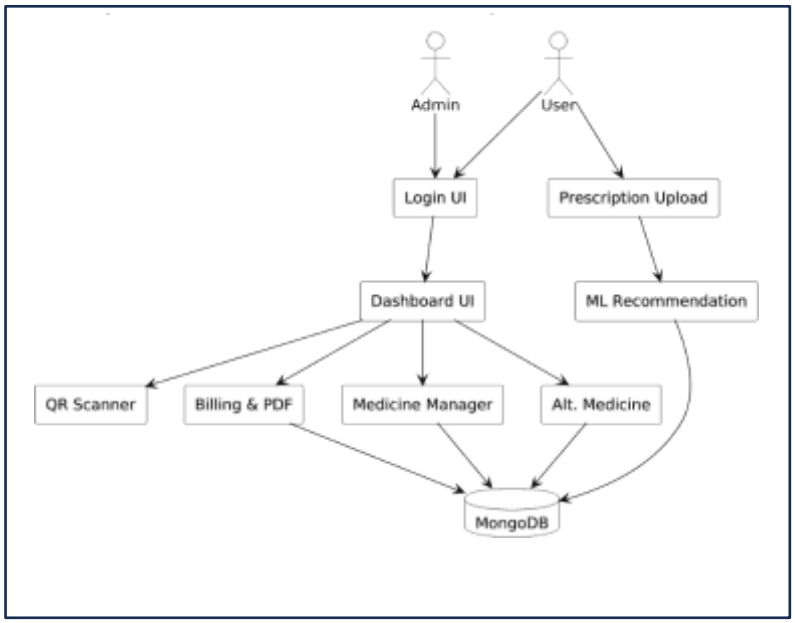
Natural language processing (NLP) and ML-based classification algorithms have extensively been used in health informatics for applications such as prescription analysis and disease forecasting. Verma et al. [8] illustrated the employment of support vector machines (SVM) in medical diagnosis based on symptom information. In addition, various studies have also investigated the use of OCR and NLP in parsing prescription images to facilitate data extraction and tailored recommendations. How these methods are integrated into a real-time system is still a research topic of interest.

2.5 Gaps and Motivation

Though there are several systems for inventory management or tailored health recommendations, there are no

integrated platforms addressing both pharmacist processes and patient-specific recommendations. There are no systems that connect inventory updates with real-time notifications or AI-driven medical recommendations. The system presented addresses this by integrating QR-based inventory automation with ML-based health recommendations on a horizontally scalable MERN stack with Python-based AI services.

3 System Architecture



The system proposed, named Smart Medical Inventory Management System and Personalized Health Recommendation System, is a modular, client-server-based system that combines real- time inventory management with AI-driven health analytics. The system consists of four main components: frontend interface, backend server, database, and a machine learning (ML) recommendation module.

4.1. Frontend (React.js)

The frontend is built using React.js and consists of two role-based interfaces: User Dashboard and Admin Dashboard.

The User Dashboard allows users to register/login, upload medical prescriptions, see past purchases, and get personalized health tips.

The Admin Dashboard (for pharmacists) provides OTP-secured login and features the addition and updating of medicine entries, generation and scanning of QR codes, creation of PDF bills, receiving low stock and expiry reminders, and generation of alternative medicine suggestions on stockouts.

React components are intended to make API requests to backend APIs for safe and real-time interaction with services like QR scan, authentication, and recommendations.

4.2. Backend (Node.js + Express.js)

The backend is used as the control center for all business logic and API routing. It is developed using Node.js with Express.js and exposes RESTful endpoints for the following services:

Authentication and role-based login (user and admin) OTP-based admin login verification
Medicine CRUD operations (create, read, update, delete) QR code generation and decoding
PDF billing with downloadable outputs Prescription file upload and storage
Recommendation request routing to the ML API

The backend is tasked with ensuring secure communication with both the frontend and database, validating incoming data, and efficient routing of requests.

4.3. Database (MongoDB)

MongoDB is utilized as the main data store because of its document-based flexibility and scalability for user and medical data. Important collections are:

users: User credentials and roles (admin/user) are stored

medicines: Detailed medicine information such as stock, expiry, salt composition, QR metadata is stored

prescriptions: User-uploaded prescriptions purchases: Purchase history of medicines

alternatives: Predefined or dynamically mapped alternate medicines

The database schema is optimized for fast retrieval, update triggers on stock levels, and medicine similarity queries.

4.4. Machine Learning Module (Python, Google Colab)

The personalized health recommendation engine is written in Python and trained using large medical data with Google Colab. The trained model is served as a lightweight REST API that takes user prescription and health history as input, processes it, and provides:

Disease prediction (on symptoms/keywords) Medication advice
Preventive recommendations Diet and exercise plans
The recommendation engine utilizes Natural Language Processing (NLP) for information extraction from prescriptions and utilizes classification models such as Support Vector Machines (SVM) for prediction.

4.5. QR Code and PDF Integration

For every medicine added by the admin, a separate QR code is given. At the time of billing, when this code is scanned, all the details related (name, price, expiry date, dosage, stock) are fetched. When the selection is made, in real time, a bill is created utilizing PDF libraries and either stored or downloaded for records.

4.6. Alerts and Alternate Suggestions

The backend consists of a rules-based service that constantly checks stock quantities and dates of expiry. In case of a scanned medication being out of stock or expired, the system retrieves equivalent drugs by composition or therapeutic class, enabling pharmacists to rapidly recommend possible substitutes to patients.

4.7. Summary of System Flow

The overall structure enables effortless interaction between every layer: The frontend records user/admin activity.
Requests are channeled through Express.js APIs. Data is read, written, or modified in MongoDB.
ML engine refines recommendations with Python-based models.

Auxiliary functions such as QR, PDF, and OTP facilitate operational efficiency.

5] How The System Operates:

Smart Medical Inventory Management System and Personalized Health Recommendation System is implemented as a dual-purpose web application running on a client-server architecture. It supports separate operations for two categories of users: Administrators (Pharmacists) and End Users (Patients). Following is a step-by-step description of how each module works in the system.

5.1 User Module Operation

1. Account Registration and Login

Users trigger the access by registering an account or logging into the system. Request for authentication goes through the backend (Node.js/Express.js) and then checked against database records in MongoDB.

2. Prescription Upload

After authentication, users can upload photographed or scanned medical prescriptions via the frontend interface developed with React.js. These documents are safely sent to the backend and stored in the database within the prescriptions collection. An optional OCR module extracts useful information like symptoms or medicine names if enabled.

3. Personalized Health Recommendations

Uploaded prescriptions or user entries are sent to a Python-driven machine learning model hosted as either a local API or cloud service. The model processes the input and provides the following outputs:

Predicted disease or condition Medical description and causes
Preventive measures and lifestyle advice

Recommended medications, diets, and exercise regimes

These outputs are presented to the user in a personalized health dashboard.

4. Purchase History Access

Users are able to see their past purchases, past uploaded prescriptions, and past health suggestions. All such data is fetched from the purchase_logs and prescriptions databases.

5.2 Admin (Pharmacist) Module Function

1. Secure Login with OTP

The admin (pharmacist) logs in through an OTP-verified interface. The OTP is created on the server and is sent via email or SMS. After successful verification, the admin dashboard becomes accessible.

2. Medicine Management

Addition of new medicines is done by filling out information like name, composition, manufacturer, cost, expiry date, and quantity available. Every new entry causes the generation of a unique QR code for that medicine. The admin can update or delete existing records of medicines as well.

3. Billing and QR Code Scanning

At the time of billing customers, the pharmacist is able to scan the QR code for every medicine or look it up manually. All the information is retrieved from the database and auto-filled in the form for billing. After filling, the final bill is created in the form of a PDF and saved in the purchase_logs collection.

4. Alternate Medicine Suggestions

If a drug is identified as being out of stock or expired, the system automatically offers a list of substitute drugs. These are proposed on the basis of therapeutic class or salt content and ensure continuity of care even during shortages.

5. Inventory Alerts

The system constantly tracks stock levels and expiration dates. Upon reaching thresholds or exceeding them (e.g., stock level low, or expiry imminent), warnings are triggered and displayed in the admin dashboard. This enables timely replenishment or disposal of medicines.

5.3 Backend Integration and Data Flow

All operations pass through a Node.js and Express.js-built backend. It acts as the middle control layer for processing HTTP requests, authenticating users, accessing the database, calling external services (like OTP and machine learning APIs), and business logic management.

MongoDB is used as the persistent data store for all modules like medicines, users, purchases, prescriptions, and alternative drug mappings.

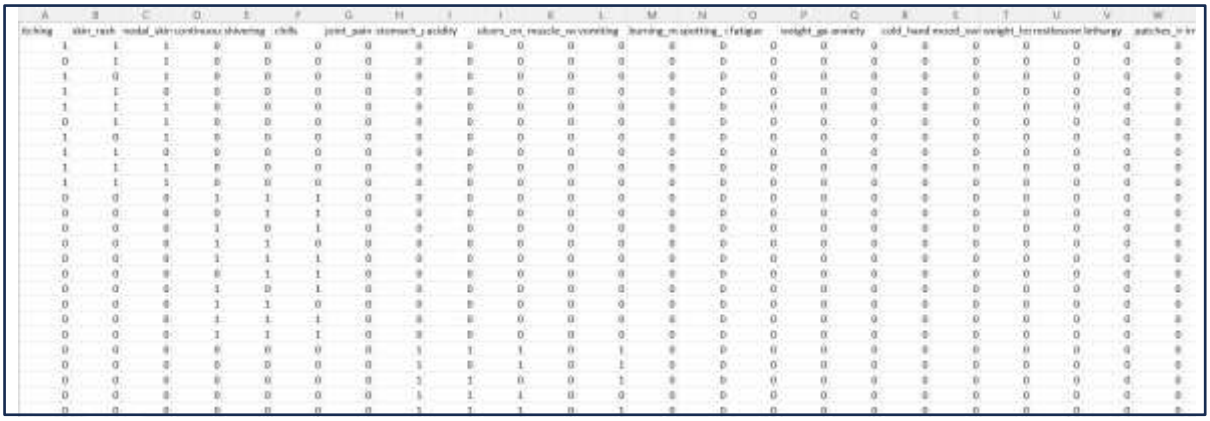
Health recommendation engine is developed in Python and fine-tuned with appropriate healthcare datasets on Google Colab. It is deployed as a RESTful API or used as a callable service.

5.4 System Flow Overview

React.js frontend is used by users and admins.

RESTful API calls to the Express.js backend process all submissions.

Records of medicines, prescriptions, purchases, and user information are stored in MongoDB. The Python-driven ML model delivers smart health suggestions.
Additional services are QR code generation, PDF bill generation, and OTP authentication.



Personalized Health Recommendations Dataset Image:

Result Of Implementation:

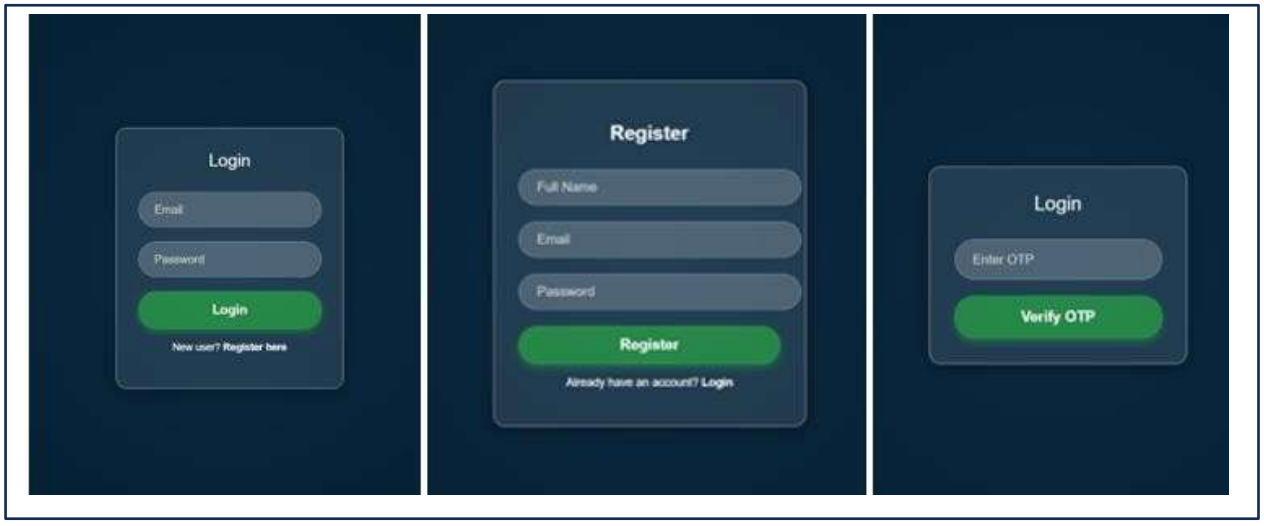


Image 1) Login ,Register ,Otp

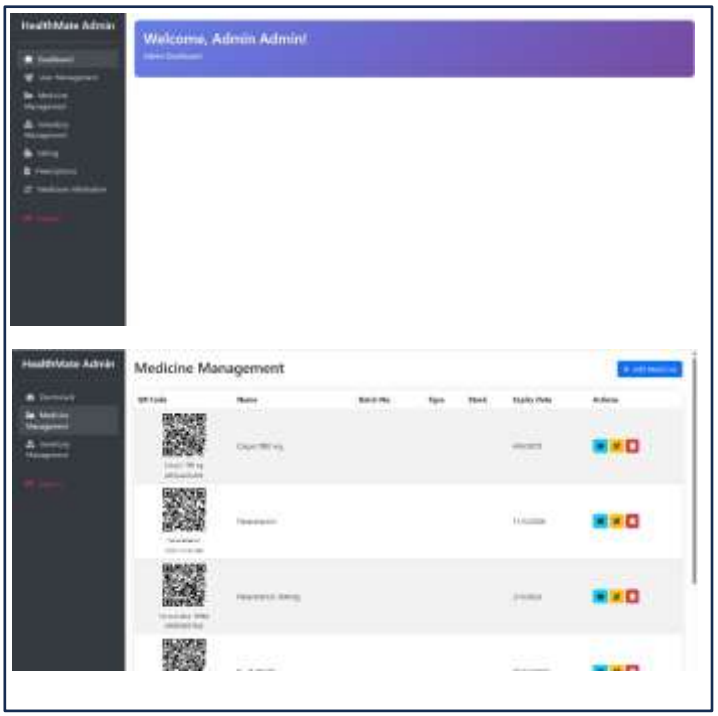


Image 2) User&Admin Side Dashboard View

6] Conclusion

This article introduced the design and development of a Smart Medical Inventory Management System coupled with a Personalized Health Recommendation System using the MERN stack, Python-based machine learning, and cloud-based technologies. The main goal was to eliminate typical issues in conventional pharmacy practices—like manual billing, mismanagement of stocks, and insufficient timely health guidance—by merging intelligent automation with AI- powered user assistance.

The system allows pharmacists to manage medicine inventories efficiently through functionalities such as QR code scanning, real-time stock alerts, and auto-generate PDF billing, and also provides alternate medicine suggestions to ensure continued patient care. At the same time, users get to enjoy a patient-focused dashboard where they can upload prescriptions, view their purchase history, and get personalized health suggestions from a trained machine learning model.

The two-module design—incorporating secure admin/user portals, a modular backend, a NoSQL database, and an in-built ML recommendation engine—is designed to make the platform responsive, scalable, and flexible enough for actual-world healthcare applications. Role-based access, OTP validation, and dynamic QR code generation also add an extra layer of operational reliability and security.

By integrating the capabilities of web technology and artificial intelligence, this system illustrates how contemporary software systems can enhance pharmaceutical services, improve patient involvement, and help realize the ultimate aim of intelligent and tailored healthcare delivery.

7] References

[1] P. Kumar and L. Gupta, "Digital Pharmacy Management Systems," International Journal of Computer Applications, vol. 179, no. 39, pp. 10–16, Jan. 2021.

[2] A. Singh and R. Kaur, "AI-based Health Advisory Systems: A Review," Journal of Medical Informatics, vol. 45, no. 2, pp. 123–135, 2022.

[3] World Health Organization, "Ensuring Safe Medicine Storage and Distribution," 2023. [Online]. Available: https://www.who.int/publications/i/item/9789240033831

[4] D. Mishra and S. Sinha, "An Intelligent Approach for Generating Personalized Health Recommendations," in Proc. 2022 IEEE International Conference on Healthcare Informatics (ICHI), pp. 88–95.

[5] S. A. Alvi, H. Abbas, and M. Iqbal, "A QR-Code Based Smart Medical Inventory System," in Proc. 2021 IEEE Global Humanitarian Technology Conference (GHTC), pp. 309–314.

[6] L. Tan and J. Wang, "Using MongoDB for High-Volume Medical Data Storage and Analysis," International Journal of Database Management Systems, vol. 14, no. 3, pp. 35–44, 2021.

[7] R. T. Kalgaonkar and A. Thakur, "Secure Role-Based Access and OTP Verification in Web Applications," in Proc. 2020 International Conference on Cybersecurity and Computing (ICCC), pp. 200–206.

[8] A. Verma and P. Shah, "Design and Deployment of React-Based Frontend Architecture in Scalable Web Applications," in Proc. 2022 ACM Symposium on Web Technologies, pp. 56– 64.