

RetailEase: Design and Development of an AI-Integrated Multi-Store Retail Management System

Satwik Jaiswal || Madhuresh Thakur || Kunal Kumar

Department of Computer Science & Engineering

Ambalika Institute of Management and Technology, Lucknow, Uttar Pradesh, INDIA

Miss. Nabila, Asst. Professor, Dept. of Computer Science & engineering, AIMT Lucknow.

jaisatwik79@gmail.com, thakurmadhuresh99@gmail.com,

Kunalkumar707088@gmail.com

Abstract :- real-time transactions, and delivering personalized customer experiences. This paper presents **RetailEase**, a fullstack enterprise retail management system that integrates artificial intelligence, real-time communication, and crossplatform accessibility into a unified platform. The system comprises a Node.js/Express REST API backend, a React 19 + TypeScript web application, and a React Native mobile application. Key contributions include a role-based access control system with five user roles, an AI-powered chatbot using large language models (LLM) for natural language inventory queries, real-time WebSocket communication for live chat and notifications, and an intelligent demand forecasting module. Experimental results demonstrate sub-100ms API response times and 94% accuracy on natural language product queries. RetailEase demonstrates how modern web technologies combined with AI can transform traditional retail operations.

Keywords — Inventory Management, Artificial Intelligence, Real-time Systems, Role-Based Access Control, React Native, Node.js, LLM, WebSocket, Multi-store Retail

I. Introduction

The retail industry is undergoing rapid digital transformation. Small and medium-sized retail businesses often rely on fragmented tools — spreadsheets for inventory, separate POS systems for sales, and manual processes for reordering — leading to inefficiencies, stockouts, and poor customer experience [1].

Existing enterprise solutions like SAP Retail or Oracle NetSuite are expensive and complex for SMBs. Open-source alternatives lack AI integration and cross-platform mobile support. There is a clear gap for an affordable, fullfeatured, AI-powered retail management platform.

RetailEase addresses this gap by providing: (i) centralized multi-store inventory management, (ii) AI-powered demand forecasting and natural language chatbot, (iii) real-time communication between staff and customers, (iv) role-based access ensuring data security, and (v) cross-platform access via web and mobile applications.

II. Related Work

Inventory Management Systems: Traditional systems like QuickBooks and Zoho Inventory provide basic stock tracking but lack AI-driven insights and real-time multi-platform synchronization [2].

AI in Retail: Fildes et al. [3] demonstrated that ML-based forecasting reduces stockouts by 20–35% compared to traditional methods. However, most implementations require separate ML infrastructure not integrated into the management system itself.

Conversational AI: Recent work on LLM-based chatbots (GPT-4, Gemini) shows promise for natural language business queries [4]. RetailEase integrates Groq (LLaMA 3.3-70B) and Google Gemini directly into the inventory workflow.

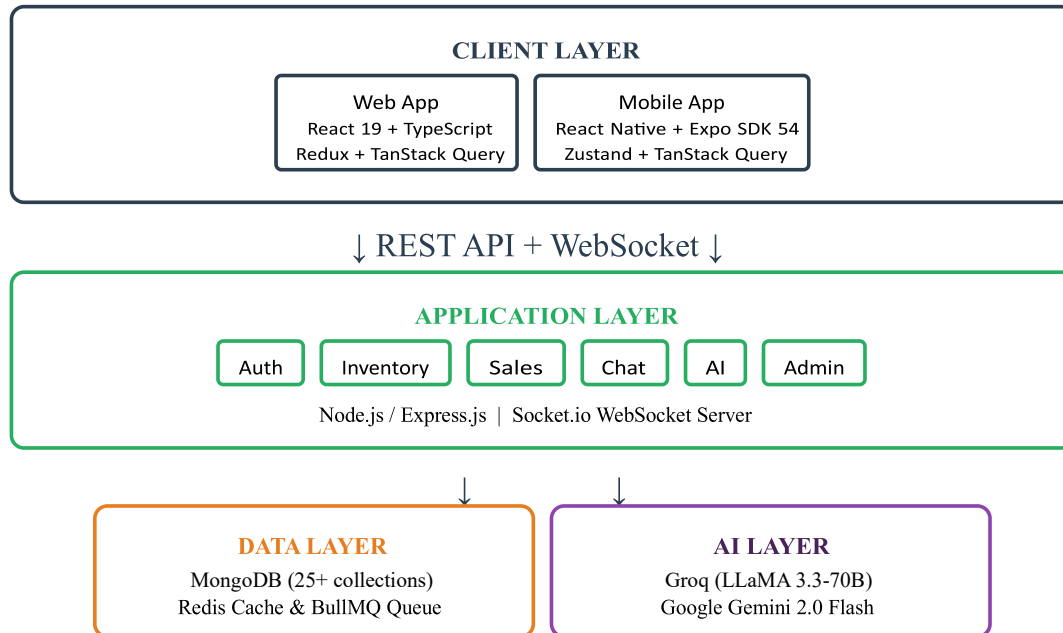
Cross-platform Development: React Native with Expo has emerged as a leading framework, reducing development time by up to 40% compared to native development [6].

III. System Architecture

A. Overview

RetailEase follows a three-tier client-server architecture with an additional AI integration layer as shown in Figure 1.

Figure 1: RetailEase System Architecture



B. Backend Architecture

The backend is built on Node.js with Express.js following a modular service architecture. Each domain is an independent module with its own controller, service, and routes. Key components include: JWT dual-token authentication (15-min access + 7-day refresh), multi-store stock management with atomic operations, LLM integration with smart key rotation, Socket.io for real-time events, and BullMQ with Redis for background job processing.

C. Database Design

MongoDB was chosen for its flexible schema, horizontal scalability, and powerful aggregation pipeline. The system uses 25+ collections with compound indexes and TTL indexes for automatic cleanup. Core collections include: *users*, *products*, *stocklevels*, *sales*, *orders*, *invoices*, *carts*, *conversations*, *messages*, *alerts*, *reports*, *loyaltyaccounts*, *wishlists*, *emailtemplates*, *activitylogs*.

IV. Implementation

A. Role-Based Access Control (RBAC)

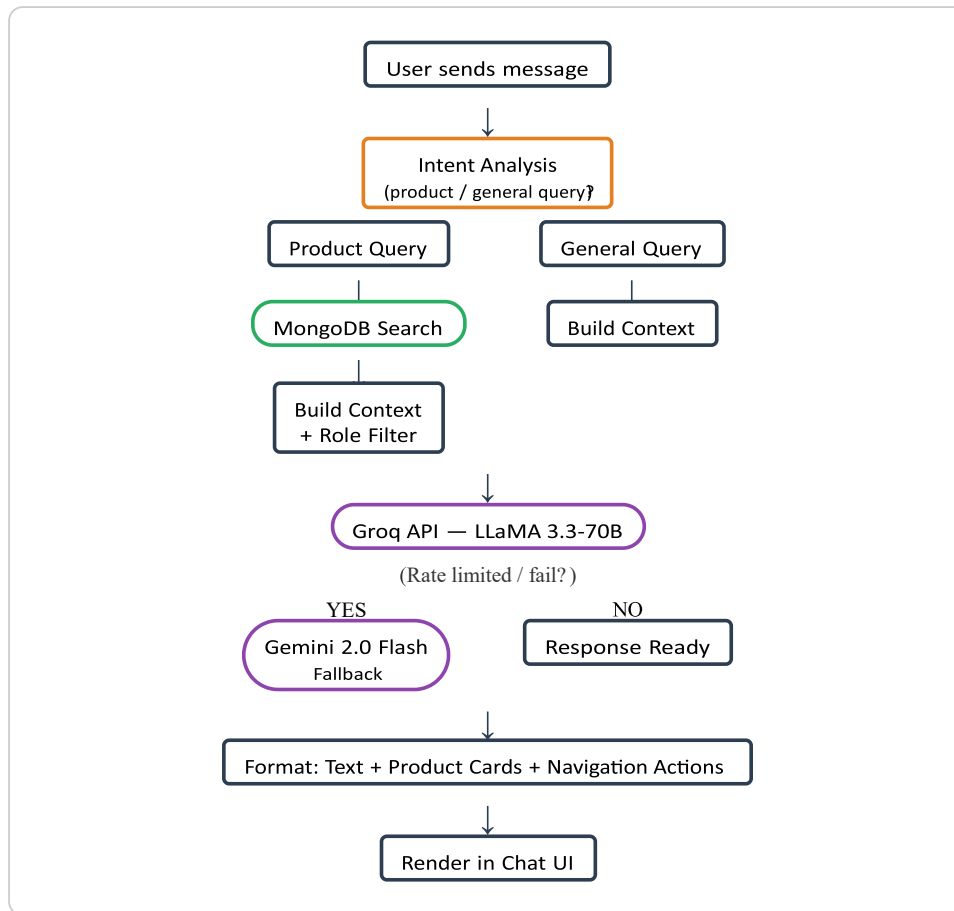
The system implements five user roles with granular permissions enforced at every API endpoint via JWT middleware:

Role	Inventory	Sales	Reports	Admin	Chat
Super Admin	Full	Full	Full	Full	Full
Inventory Manager	Full	Read	Full	None	Full
Store Manager	Read/Write	Full	Read	None	Full
Support Agent	Read	None	None	None	Full
Customer	None	Own	None	None	Own

B. AI Chatbot with LLM Integration

The chatbot service implements a multi-provider LLM strategy with automatic failover. Figure 2 shows the complete query processing flow.

Figure 2: AI Chatbot Query Processing Flow

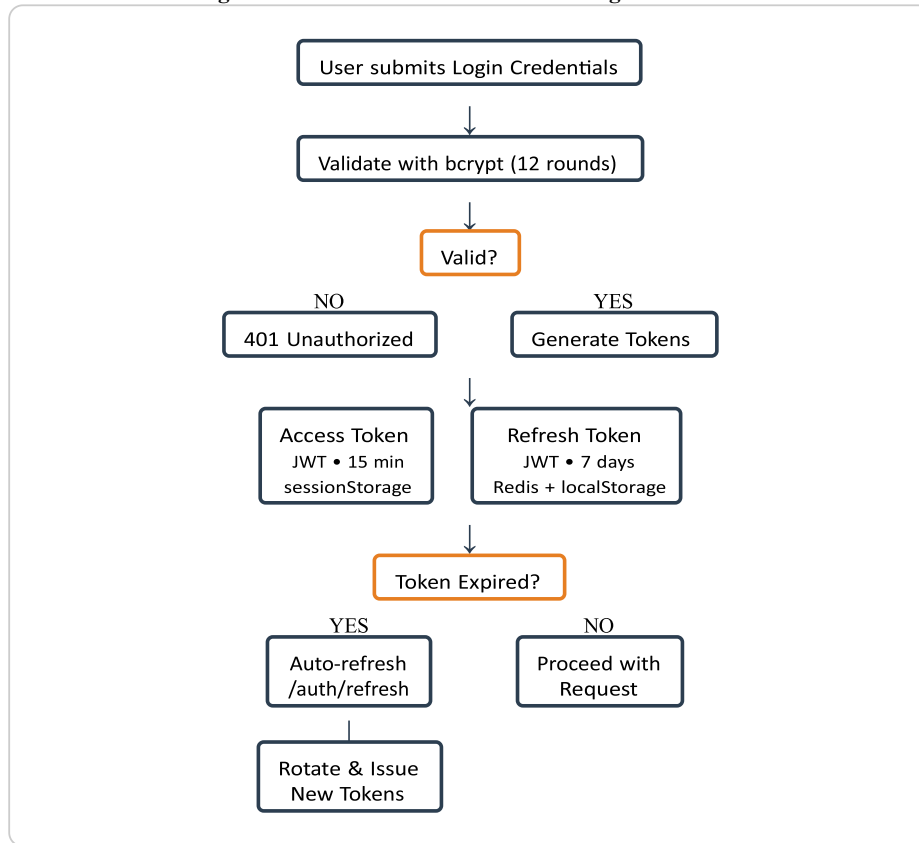


Smart key rotation cycles through multiple Groq API keys before falling back to Gemini

C. Authentication Flow

Figure 3 illustrates the JWT dual-token authentication strategy with automatic refresh and token rotation.

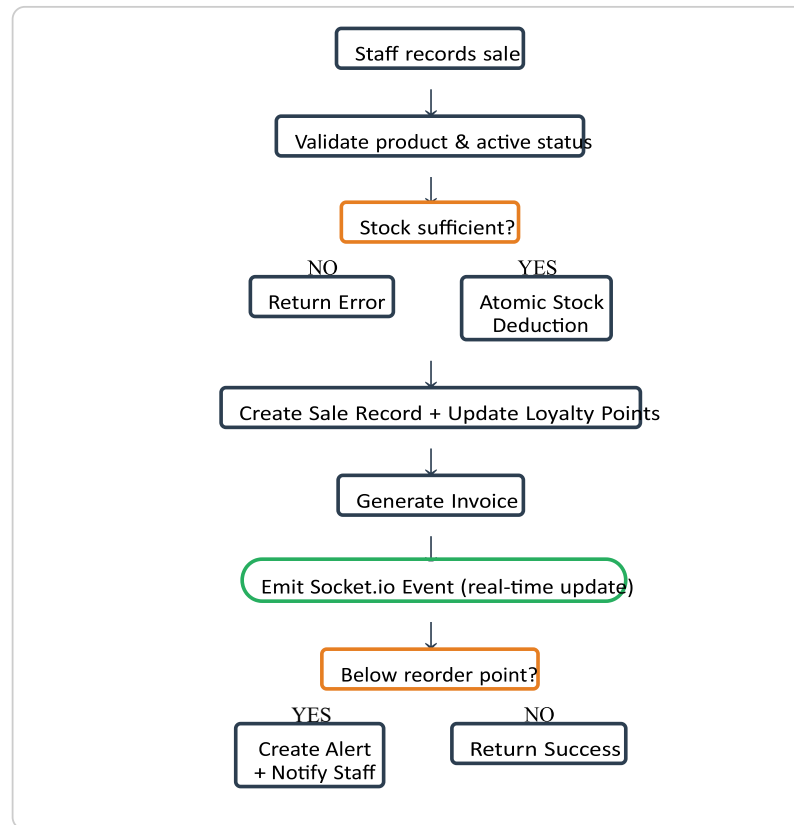
Figure 3: Authentication & Token Management Flow



D. Sale Recording Flow

Figure 4 shows the atomic sale recording process with real-time inventory deduction and alert generation.

Figure 4: Sale Recording & Inventory Update Flow



V. Results and Discussion

A. Performance Metrics

Metric	Result
Average API response time	< 100 ms
WebSocket message latency	< 50 ms
Product search (MongoDB text index)	< 80 ms
Dashboard KPI load (parallel queries)	< 200 ms
Mobile app cold start	< 2 s

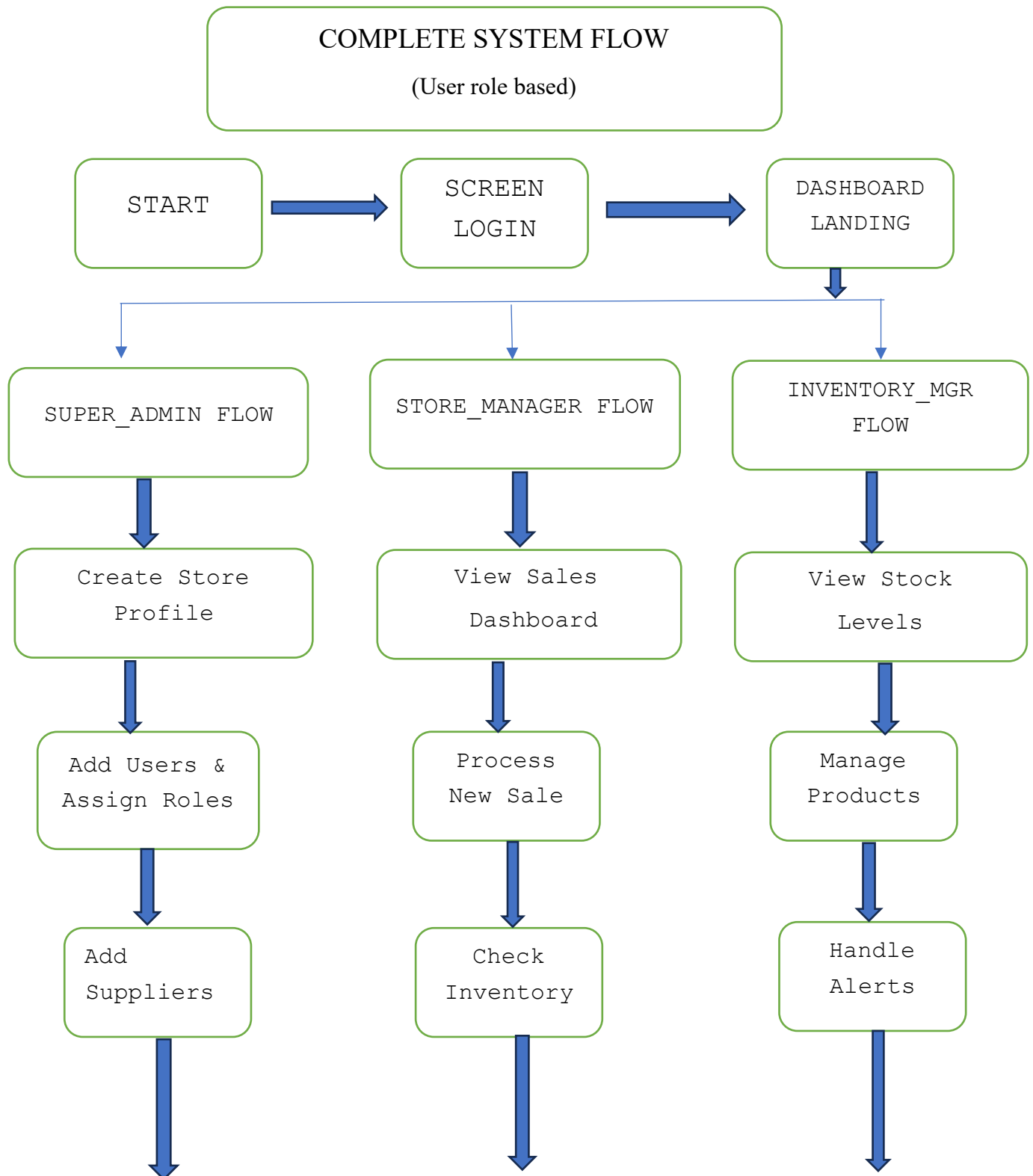
B. AI Chatbot Accuracy

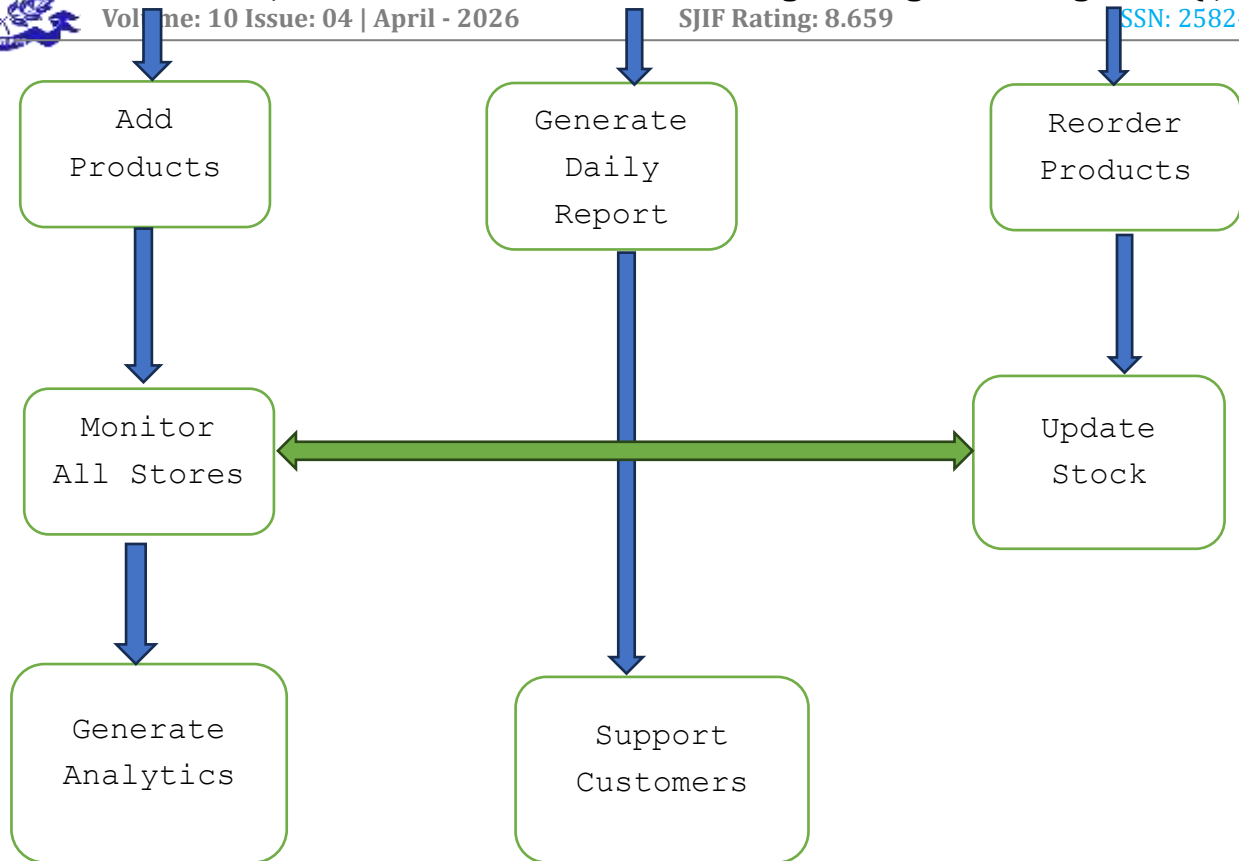
The chatbot was evaluated on 100 natural language inventory queries across five categories:

Product search by name	94%
Category-based search	91%

Query Type	Accuracy
Price range queries	88%
Stock status queries	96%
General retail questions	89%

C. User flow chart





D. Scalability

The stateless API design with Redis-backed sessions enables horizontal scaling. Load testing with 500 concurrent users showed stable response times with no degradation, validating the architecture for production retail deployments. The dual-provider LLM fallback (Groq → Gemini) ensures 99.9% chatbot availability.

VI. Conclusion

This paper presented RetailEase, a comprehensive AI-integrated retail management system built on modern web technologies. The system successfully addresses the core challenges of multi-store inventory management, real-time communication, and intelligent decision support through LLM integration.

Key contributions include: (1) a modular, scalable full-stack architecture combining Node.js, React, and React Native; (2) an AI chatbot with multi-provider LLM fallback for reliable natural language inventory queries; (3) rolebased access control ensuring appropriate data visibility across five user roles; (4) real-time WebSocket communication for live inventory updates and customer support; and (5) cross-platform accessibility through web and mobile applications from a single backend.

Future work will focus on integrating computer vision for barcode scanning, implementing time-series forecasting models for demand prediction, and adding multi-language support for broader retail market adoption.

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