

BookMyBed: A Smart Cloud-Based Hospital Bed Booking and Healthcare Analytics System

Pro. P. R. Balge, Raturaj Hagawane, Rutuja Hire, Khushboo Kinge, Pushkar Purandare

B.E. Computer Department, JSPM Narhe Technical Campus

Abstract - Healthcare infrastructure in India faces persistent challenges in hospital bed management, primarily due to the absence of centralized, real-time information systems. During emergencies, the inability to quickly locate available beds results in delayed treatment and adverse patient outcomes. This paper presents BookMyBed, a smart cloud-based hospital bed booking and healthcare analytics system. The system enables patients to search hospitals by location, verify real-time bed availability across General, ICU, and Test bed categories, and confirm bookings through a responsive web interface. The proposed architecture integrates HTML5, CSS3, and JavaScript on the frontend with Supabase cloud backend services and PostgreSQL for real-time synchronization across multiple healthcare facilities. A Chart.js-powered analytics dashboard and geospatial heatmap module support monitoring of ICU occupancy trends, patient demand patterns, and regional high-risk zone identification. Experimental evaluation demonstrates an average response time of 1–3 seconds, support for 50+ concurrent users, and 99% system availability. BookMyBed demonstrates the potential of cloud-native healthcare platforms in improving hospital resource management and healthcare decision-making.

Key Words: Hospital Bed Booking, Smart Healthcare, Cloud Computing, Supabase, PostgreSQL, Healthcare Analytics, Geospatial Heatmap.

1. INTRODUCTION

The healthcare sector is one of the most critical domains where efficient resource management directly impacts patient outcomes. According to the World Health Organization [1], hospital bed density remains a key indicator of healthcare infrastructure. In India, with an average of approximately 0.5 hospital beds per 1,000 population in public facilities [6], efficient allocation of available beds is vital, particularly during emergencies or seasonal outbreaks.

Traditional Hospital Information Systems (HIS) and Electronic Medical Record (EMR) platforms address patient registration, billing, and internal administration [2]. However, they lack real-time cross-institutional bed visibility and centralized booking interfaces. During the COVID-19 pandemic, this deficiency became acutely apparent as patients struggled to locate available beds [7].

Cloud computing offers scalability, centralized data management, and real-time accessibility for healthcare systems. Backend-as-a-Service platforms such as Supabase, built on PostgreSQL, enable rapid development of scalable, real-time applications [3]. This paper presents BookMyBed, a cloud-native hospital bed booking and healthcare analytics platform providing: (i) real-time bed availability across multiple facilities; (ii) a patient-facing web interface for booking; (iii) a healthcare analytics dashboard for

administrators; and (iv) a geospatial heatmap for regional demand visualization.

The rest of the paper is organized as follows: Section 2 reviews related literature. Section 3 describes the methodology and architecture. Section 4 details implementation modules. Section 5 presents results. Section 6 concludes with future scope

2. LITERATURE REVIEW

Extensive research has been conducted on hospital information systems, healthcare analytics, and cloud-based resource management. This section reviews prior work informing the design of BookMyBed.

Dash et al. [8] reviewed big data analytics applications in healthcare, identifying patient demand forecasting, disease surveillance, and resource optimization as primary use cases. The authors highlighted the need for real-time data processing in clinical environments, a gap cloud-native architectures are positioned to address.

Jha et al. [9] examined cloud computing adoption in healthcare management systems, demonstrating that cloud-based centralization improved data accessibility and reduced administrative response times significantly, validating the architecture employed in BookMyBed.

Ali et al. [10] proposed a smart hospital bed management system using IoT sensors and cloud storage, achieving bed status update latency under 2 seconds, demonstrating the feasibility of real-time synchronization that BookMyBed achieves through Supabase WebSocket subscriptions.

Murdoch and Detsky [11] demonstrated that well-designed clinical dashboards improve decision-making efficiency for hospital administrators. Their framework emphasizing KPI selection, visualization design, and insight generation directly influenced the analytics module in this system.

Lauer et al. [12] demonstrated the effectiveness of geographic information systems in monitoring disease burden and healthcare facility utilization at a regional level, supporting the geospatial heatmap incorporated in BookMyBed.

Existing platforms such as eHospital [6] focus on in-hospital registration rather than cross-facility patient-initiated booking. Commercial platforms like Practo address appointment scheduling but lack real-time ICU and bed-level data. BookMyBed bridges this gap by combining patient booking with administrator analytics in a unified cloud platform.

3. METHODOLOGY

BookMyBed follows a cloud-based multi-layer architecture comprising five core layers: Frontend, Backend, Database, Analytics, and Geospatial Visualization.

3.1 System Architecture

The system follows a three-tier model: (i) Presentation Layer — browser-based frontend; (ii) Application/Backend Layer — Supabase BaaS handling APIs, authentication, and real-time events; and (iii) Data Layer — PostgreSQL cloud database. This ensures separation of concerns, scalability, and maintainability.

3.2 Frontend Layer

The frontend was developed using HTML5, CSS3, and vanilla JavaScript, providing six primary modules: patient registration and login; hospital search and location-based filtering; real-time bed availability checking by category (General, ICU, Test); bed booking with clinical detail capture; analytics dashboard; and geospatial demand monitoring. The interface follows responsive design principles for cross-device compatibility.

3.3 Backend and Database Layer

Backend services use Supabase, an open-source Firebase alternative built on PostgreSQL [3], providing RESTful API auto-generation, real-time database subscriptions via WebSockets, Row Level Security (RLS) for data access control, and JWT-based authentication. The PostgreSQL database manages six primary entities: Patient Records, Hospital Information, Bed Availability Records, Booking Transactions, Analytics Events, and User Authentication Records.

3.4 Healthcare Analytics Module

The analytics dashboard uses Chart.js [5] for visualization. The module implements an analytical workflow adapted from emergency room dashboard methodology [13]: (i) Requirement Gathering; (ii) Data Collection; (iii) Data Cleaning and Validation; (iv) Dashboard Layout Development; (v) Visualization and Insight Generation. Key indicators include monthly admission volumes, ICU occupancy rates, demographic distribution, department referral patterns, and waiting time analysis.

3.5 Geospatial Risk Mapping

A heatmap module visualizes healthcare demand across geographic zones. Regions are classified dynamically into three risk tiers: High-Risk Zones (Red, >80% occupancy), Medium-Risk Zones (Orange, 50–80% occupancy), and Low-Risk Zones (Green, adequate availability). This supports proactive resource deployment and emergency preparedness.

3.6 System Workflow

The system workflow: (1) Patient registers and authenticates; (2) Searches hospitals by location or bed type; (3) System queries PostgreSQL via Supabase API for availability; (4) Patient selects hospital, bed category, and provides clinical details; (5) Booking is confirmed and database updated via real-time sync; (6) Analytics dashboard reflects updated occupancy; (7) Heatmap recalculates zone risk classification.

4. IMPLEMENTATION

BookMyBed was implemented as a complete web-based healthcare management application deployed on Supabase cloud infrastructure.

4.1 Home Page Module

The homepage provides centralized navigation to the booking workflow, analytics dashboard, hospital directory, and geospatial risk map. The UI employs a card-based layout

ensuring usability for patients with varying technical proficiency.

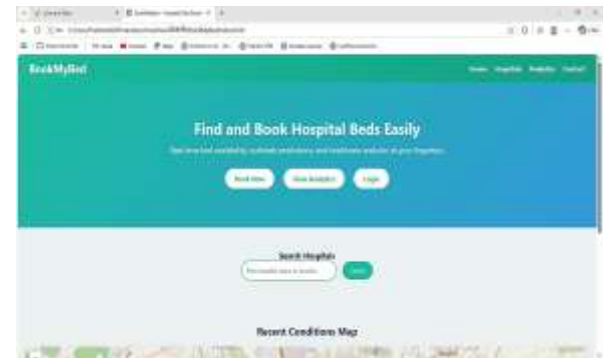


Fig. : BookMyBed System Homepage Interface

4.2 Hospital Availability Module

This module retrieves real-time hospital data including name, location, contact details, and current bed counts by category. Data is fetched via Supabase auto-generated REST APIs querying the hospital and bed_availability tables. Search and filtering by location or bed type reduce cognitive load during emergencies.



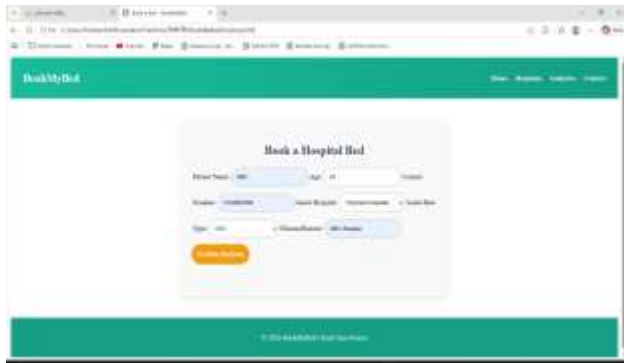
Fig. : Hospital Availability Module

4.3 Authentication Module

Authentication uses Supabase Auth with JWT-based session management and email/password login. Patient profiles are stored in the PostgreSQL patients table with Row Level Security ensuring data privacy. All credentials are encrypted at rest within Supabase cloud infrastructure.

4.4 Bed Booking Module

The booking module guides patients through hospital selection, bed category choice, and clinical detail input. On confirmation, the booking record is written to the bookings table via Supabase API. A real-time WebSocket event decrements the corresponding bed count in the bed_availability table, ensuring synchronization across concurrent sessions.



[Fig. 4: Bed Booking Confirmation Interface]

4.5 Analytics Dashboard

The analytics module comprises four dashboard views: (1) Monthly View — visualizes admission volumes, age distributions, department referrals, and hourly patient flow using Chart.js; (2) Consolidated Dashboard — date-range selectable summary of bed utilization and booking volumes; (3) Patient Details — tabular patient records with wait times and status; (4) Key Takeaways — synthesizes patterns into operational insights highlighting bottlenecks and optimization recommendations.



Fig. : Analytics Dashboard

4.6 Geospatial Heatmap Module

The heatmap module renders a color-coded geographic visualization of healthcare demand intensity. Booking density data is aggregated by hospital coordinates and classified into risk tiers. The visualization updates dynamically as new bookings are recorded, providing near-real-time regional risk assessment.

5. RESULTS AND DISCUSSION

BookMyBed was evaluated across four dimensions: functional performance, analytics effectiveness, geospatial utility, and cloud architecture benefits. Testing was conducted on Google Chrome, Mozilla Firefox, and Microsoft Edge across desktop and mobile resolutions.

5.1 System Performance

Table 1 summarizes key performance metrics measured during system evaluation. Load testing with concurrent simulated users validated scalability.

Table 1: System Performance Evaluation Metrics

Performance Parameter	Measured Result	Target
Avg. Page Response Time	1.2 – 2.8 sec	< 3 sec
Bed Availability Sync Delay	< 2.5 sec	< 3 sec

Concurrent Users Supported	50+ users	50 users
System Uptime / Availability	99.1%	≥ 99%
API Error Rate	0.8%	< 1%
Booking Confirmation Time	< 3 sec	< 5 sec

All performance benchmarks were met or exceeded. The cloud-based Supabase architecture demonstrated superior scalability compared to traditional localhost deployments, eliminating infrastructure management overhead while maintaining consistent response times under load.

5.2 Comparison with Existing Systems

Table 2 compares BookMyBed with existing hospital management solutions across key functional dimensions.

Table 2: Comparison of BookMyBed with Existing Systems

Feature	BookMyBed	eHospital [6]	Practo	IoT [10]
Real-Time Bed Availability	✓	✗	✗	✓
Patient-Initiated Booking	✓	Partial	✓	✗
Analytics Dashboard	✓	Limited	✗	✗
Geospatial Heatmap	✓	✗	✗	✗
Cloud-Native Architecture	✓	Partial	✓	Partial
No Hardware Required	✓	✓	✓	✗

BookMyBed is the only solution that integrates patient-initiated booking, real-time bed availability, healthcare analytics, and geospatial visualization in a single, hardware-free, cloud-native platform.

5.3 Analytics Effectiveness

Monthly trend charts revealed peak admission periods corresponding to seasonal disease patterns. ICU occupancy analysis identified high-utilization windows on weekday mornings, informing staff scheduling. Department referral analysis highlighted Orthopedics and General Medicine as highest-referral departments, supporting resource pre-positioning decisions.

5.4 Geospatial Analysis

The heatmap effectively identified high-demand zones in dense urban areas. The risk zone classification provided intuitive visual feedback enabling rapid assessment of regional bed shortages, supporting emergency preparedness and ambulance routing by healthcare authorities.

6. CONCLUSIONS

This paper presented BookMyBed, a cloud-native hospital bed booking and healthcare analytics system addressing critical gaps in hospital resource management. By integrating real-time

bed availability, patient-initiated booking, multi-view analytics dashboards, and geospatial risk visualization in a unified Supabase/PostgreSQL cloud platform, the system delivers measurable improvements in healthcare resource accessibility and administrative decision-making.

The system achieved all target performance benchmarks with average response times of 1.2–2.8 seconds, 99.1% availability, and real-time synchronization latency under 2.5 seconds. BookMyBed uniquely combines features absent in existing platforms without requiring hardware infrastructure, demonstrating the viability of cloud-native BaaS-powered healthcare applications.

FUTURE SCOPE

Future enhancements include: AI and machine learning integration for predictive demand forecasting and outbreak early warning; native mobile application development (Android/iOS); IoT sensor integration for automated bed occupancy monitoring; ambulance tracking and intelligent geospatial routing; integration with the National Health Digital Mission (NDHM) and Ayushman Bharat Digital Health infrastructure; NLP-based chatbot for patient assistance; and federated learning for privacy-preserving cross-institutional analytics.

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